Curriculum of Diploma Programme

in

Chemical Engineering

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

State Board of Technical Education
(SBTE), Bihar

Semester – IV
Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2414401	**PCC**	**Plant Economics & Energy**	02	01	-	02	05	04
2414402	**PCC**	**Chemical Engg. Thermodynamics**	02	01	-	02	05	04
2414403	**PCC**	**Fluid Flow Operation**	03	-	04	02	09	06
2414404	**PCC**	**Technology of Organic Chemicals**	02	01	-	02	05	04
2414405	**PCC**	**Plant Utilities**	02	01	-	02	05	04
2414406	**PCC**	**Chemical Engg. Drawing**	-	-	04	02	06	03
2400108	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	01	-	-	-	01	01
2400408	**NRC**	**Employability Skills Development** (Common for All Programmes)	01	-	-	-	01	01
2013109	**NRC**	**Sustainability & Renewable Energy Sources** (CHE, CRE)	01	-	-	02	03	02
2400110	**NRC**	**Community/ Society Development** (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM, FPP)	01	-	-	-	01	01
Total			**15**	**4**	**8**	**14**	**41**	**30**

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

Legend:

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

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

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

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

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

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

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

Semester - IV
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2414401	**PCC**	**Plant Economics & Energy**	30	70	20	30	-	-	150
2414402	**PCC**	**Chemical Engg. Thermodynamics**	30	70	20	30	-	-	150
2414403	**PCC**	**Fluid Flow Operation**	30	70	20	30	20	30	200
2414404	**PCC**	**Technology of Organic Chemicals**	30	70	20	30	-	-	150
2414405	**PCC**	**Plant Utilities**	30	70	20	30	-	-	150
2414406	**PCC**	**Chemical Engg. Drawing**	-	-	20	30	15	10	75
2400108	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	25	-	-	-	-	-	25
2400408	**NRC**	**Employability Skills Development** (Common for All Programmes)	25	-	-	-	-	-	25
2013109	**NRC**	**Sustainability & Renewable Energy Sources** (CHE, CRE)	25	-	25	-	-	-	50
2400110	**NRC**	**Community/ Society Development** (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM, FPP)	25	-	-	-	-	-	25
Total			**250**	**350**	**145**	**180**	**35**	**40**	**1000**

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Legend:

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

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

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

Note:

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

A) Course Code : 2414401(T2414401/S2414401)

B) Course Title : Plant Economics and Energy

C) Pre- requisite Course(s) :

D) Rationale :

In the development of any country, energy management and economics play a very important role. The depletion of fossil fuel, problem of global warming, environmental issues related to energy and their adverse effect on business and climate are critically faced by chemical industry. Efficient utilization of available resources and development of upgraded technologies for **energy conversion** are the responsibility of diploma chemical engineers. To achieve this, the diploma chemical engineers, need to study the plant economics. Economics means, where technology meet business. This course is designed to provide basic understanding about the energy resources, environmental impact, different renewable energy resources, technology for energy conversion, management, money and market, investment, cost estimation, taxes, depreciation, budgeting, and business plans.

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

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

CO-1 Apply different cost estimation method to increase the economics of a chemical process plant.
CO-2 Estimate the depreciation for chemical process industry.
CO-3 Identify energy need of India as growing economy.
CO-4 Assess the environmental issue responsible for global warming.
CO-5 Choose appropriate **green & renewable energy sources** as per requirement.

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	2	-	-	-	2	1		
CO-2	2	2	3	1	-	-	1		
CO-3	3	-	-	-	-	-	1		
CO-4	3	-	2	-	3	2	2		
CO-5	2	-	1	1	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)
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2414401	Plant Economics and Energy	02	01	-	02	05	04

Legend:

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

J) Theory Session Outcomes (TSOs) and Units: T2414401

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain some basic terms related to economics. *TSO 1b.* Estimate the cost of a plant by using different methods. *TSO 1c.* Calculate effective interest rate paid on borrowing. *TSO 1d.* Calculate taxes paid on the production of a plant.	**Unit-1.0 Process Economics.** 1.1 Introduction to process economics, definition & concept of some basic terms of economics: debits, credits, accumulation, inventory & cost of sales accounts. 1.2 Cost estimation of a plant: fixed and working capital investment, types of capital cost estimates, estimation of total product cost. 1.3 Types of interest: simple interest, compound interest, nominal & effective interest rates. 1.4 Tax and insurance: concept and types, income tax, excise tax, property tax, benefits of insurance.	**CO1**
TSO 2a. Explain the concept deprecation. *TSO 2b.* Calculate depreciation of an equipment by different methods. *TSO 2c.* Calculate the payout period of a plant.	**Unit-2.0 Deprecation of Equipment & Plant.** 2.1 Concept and types of depreciation. 2.2 Definition & concept of some basic terms: service life, salvage value, present value. 2.3 Methods of determining depreciation: straight line method, sum of year digit method, sinking fund method. 2.4 Concepts of profitability, alternative investment & replacements. 2.5 Concepts of rate of return on investment & payout period for a plant.	**CO2**
TSO 3a. Explain current energy scenario in India. *TSO 3b.* List various acts of energy conservation act, 2001. *TSO 3c.* Identify the energy need of India as a growing economy. *TSO 3d.* Describe energy and its various form.	**Unit-3.0 Energy Scenario** 3.1 Classification of Energy. 3.2 Indian Energy Scenario. 3.3 **Energy Conservation** and its importance. 3.4 Energy conservation Act, 2001. 3.5 Energy need of India as growing economy. 3.6 Energy conservation and its importance. 3.7 Basics of energy and its various form.	**CO3**
TSO 4a. Describe the objective of energy requirement and environment. *TSO 4b.* Identify environmental issues responsible global warming. *TSO 4c.* Explain the requirement for sustainable development in current scenario.	**Unit-4.0 Energy Efficiency and Climate Change** 4.1 Definition and objective of energy and environment. 4.2 Global environmental issues: Acid rain, ozone layer depletion, global warming & climate change. 4.3 The Kyoto protocol. 4.4 Sustainable development.	**CO4**
TSO 5a. Explain the importance of green & renewable energy in current environmental scenario. *TSO 5b.* Identify appropriate renewable energy required for their current energy need.	**Unit-5.0 Green and Renewable Energy Sources.** 5.1 Concept of **green & renewable energy.** 5.2 Fundamentals of solar energy: solar thermal energy, solar electrical energy. 5.3 Concept & working of Wind energy. 5.4 Concept & working Biomass energy. 5.5 Concept & working Tidal & geothermal energy.	**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: S2414401 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Differentiate between **Renewable** and Non-Renewable Sources of Energy.
ii. Prepare a short note on future of **clean energy technologies.**
iii. List different energy act in India.
iv. Write brief notes on Taxation system in India.

b. Micro Projects:

1. Visit nearby industry and prepare report on **clean & renewable energy** technologies adopted in the plant.
2. Suggest method to save energy in the institute during practical hours.
3. Compare the depreciation incurred on the initial cost of a particular equipment (such as double pipe heat exchanger/shell & tube/distillation column/ boiler) used in chemical engineering plant at the end of 5 years w.r.t various methods of depreciation.
4. Using rate of return method of investment calculate the payout period of a particular equipment (such as double pipe heat exchanger/shell & tube/distillation column/ boiler) used in a chemical engineering plant.

c. Other Activities:

1. Seminar Topics:
   - Presentation on **E-20 petrol** used by government of India.
   - Hydrogen as an alternate source of **clean energy.**
   - **Future of renewable energy** in India.

2. Visits: Visit nearby industry to study energy consumption and prepare a brief report on it.

3. Self-Learning Topics:
   - Comparison of simple interest and compound interest.
   - Importance of breakeven point, return on investment, payout period, and net present worth in an industry.
   - Correlation between heat transfer and mass transfer.

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%	20%	10%	10%	-	-
CO-2	30%	30%	10%	20%	20%	-	-
CO-3	10%	10%	20%	20%	20%	-	-
CO-4	10%	10%	20%	25%	25%	-	-
CO-5	20%	20%	30%	25%	25%	-	-
	30	**70**	**20**	**20**	**10**	**-**	**-**

Total Marks			**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 Process Economics.	13	CO1	21	4	5	12
Unit-2.0 Deprecation of Equipment & Plant.	10	CO2	21	3	4	14
Unit-3.0 Energy Scenario	8	CO3	7	3	4	-
Unit-4.0 Energy Efficiency and Climate Change	8	CO4	7	4	3	-
Unit-5.0 Green and Renewable Energy Sources.	9	CO5	14	6	6	2
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.	Handbook For Chemical Engineers of Plant Economics	Mrugank D. Trivedi	Notion Press, latest edition, ISBN: 9781685380601
2.	Plant Design and Economics for Chemical Engineers	Max Peters, Klaus Timmerhaus, Ronald West	McGraw-Hill Education – Europe, latest edition, ISBN: 9780071240444
3.	Industrial Economics: An Introductory Textbook	Dr. R R Barthwal	New Age International Private Limited; Fourth edition (1 August 2021), ISBN: **8195175546**
4.	Energy Management	Umesh Rathore	S.K. Kataria & Sons; Reprint 2013 edition, ISBN: **9350141019**
5.	Advanced Energy Engineering	Prof.R. Devaraj, Dr.S. Ramachandran	Airwalk Publications; First Edition, ISBN: **9388084098**
6.	Industrial energy conservation	Reay, D. A.	Pergammon press, London, ISBN: 9780080232744

(b) Online Educational Resources:

1. http://www.bp.com/centres/energy
2. http://www.epa.org/
3. http://www.calculator.org/properties.html
4. http://www.eeca.govt.nz/
5. http://www.energyusernews.com/
6. http://www.bce-india.nic.in/
7. https://en.wikipedia.org/wiki/Energy_management
8. https://beeindia.gov.in/sites/default/files/1Ch3.pdf
9. https://archive.nptel.ac.in/courses/103/105/103105166/
10. https://nptel.ac.in/courses/103103206

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. NPTEL
2. MIT Open course lecture available on Internet etc.

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A) Course Code **: 2414402(T2414402/S2414402)**

B) Course Title **:** Chemical Engineering Thermodynamics

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

D) Rationale **:**

Diploma in Chemical Engineering must deal with the interrelation of heat and work with respect to chemical reactions and use different chemical engineering properties to perform chemical processes. Chemical engineering thermodynamics is based on the laws of thermodynamics which helps diploma chemical engineers to relate thermodynamic properties to the thermodynamic systems. This course is designed to provide an understanding of the concept of chemical engineering, which involves transformation through chemical reaction and the energy evolved/ absorbed from the chemical system. This knowledge is required to understand the chemical kinetics.

E) Course Outcomes (COs): The theory, practical experience and relevant soft skills associated with this force are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency.

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

CO-1 Select an appropriate thermodynamic process for the given system.

CO-2 Apply first law of thermodynamics in chemical process industry.

CO-3 Establish the relationship among the different thermodynamic quantities.

CO-4 Use second law of thermodynamics for entropy calculation.

CO-5 Apply second law of thermodynamics on different equipment used in chemical industries.

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

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

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2414402	Chemical Engineering Thermodynamics	30	70	20	30	-	-	150

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J) Theory Session Outcomes (TSOs) and Units: T2414402

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe thermodynamics properties for the given system. *TSO 1b.* Differentiate between extensive and intensive property for a given system *TSO 1c.* Identify thermodynamic process for a given system. *TSO 1d.* Identify type of equilibrium for a given system.	**Unit-1.0 Thermodynamic Systems and Equilibrium.** 1.1 Scope and limitations of thermodynamics. Basic concept of following terms: system, surrounding, boundary, process, thermodynamic properties, open system, closed system and isolated systems, homogenous and heterogeneous system. 1.2 Extensive properties & intensive properties of a system. 1.3 Thermodynamic process: isothermal process, adiabatic process, isochoric process, isobaric process, cyclic process, reversible and Irreversible process, quasi static process(definitions). 1.4 Types of equilibrium: stable, unstable, metastable, thermal, chemical, mechanical, thermodynamic. Thermodynamic functions: state function, path function. Macroscopic versus microscopic view. 1.5 Concept of internal energy, enthalpy, and ideal gas law.	**CO 1**
TSO 2a. Describe concept of energy for a given system. *TSO 2b.* Calculate work done for a given system. *TSO 2c.* Identify heat exchange for a given system. *TSO 2d.* Differentiate between Cp and Cv for a given system. *TSO 2e.* Explain the given thermodynamics diagram. *TSO 2f.* Calculate pressure or volume for the given system by using van der Waals equation.	**Unit-2.0 First Law of Thermodynamics.** 2.1 First law of thermodynamics: law of conservation of energy, mathematical statement. Concept of different forms of energy, internal energy, internal energy as a state function, numerical. 2.2 Work and heat as a path function. Sign convention used for work and heat, enthalpy, heat capacity, specific heat, heat capacity at constant volume, heat capacity at constant pressure. Temperature dependence of heat capacity, relationship between C_P and C_V. Numerical for calculating enthalpy., 2.3 Equation of state and concept of ideal gas, processes involving ideal gases: constant volume process, constant temperature process, constant pressure process, adiabatic process, polytropic process (determining ΔU, Q, W for the above processes), numerical. Thermodynamic diagram T-V, P-V & P-T diagram. 2.4 Equation of state for real gases: van der Waals equation, Van der Waals constant. Numerical. 2.5 Zeroth law of thermodynamics: statement.	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3a. Give the relation between Maxwell relations. *TSO 3b.* Explain the temperature dependency of equilibrium constant for a reaction based on Van't Hoff equation. *TSO 3c.* Drive the relation between thermodynamic equilibrium constant and conversion for the given reaction.	**Unit-3.0 Thermodynamic Quantities.** 3.1 Concept of phase, V-T behavior of pure fluids: P-V diagram for a pure substance, P - T diagram for a pure substance, T - V diagram for a pure substance. 3.2 Derivation of thermodynamic equation, Maxwell relations. 3.3 Chemical potential, law of mass action, relation between delta G and Vant Hoff's equation (derivation), variation of equilibrium constant with temperature for exothermic and endothermic reaction (based on Vant Hoff's equation), numerical.	**CO3**
TSO 4a. Apply concept of entropy for the given system. *TSO 4b.* Calculate entropy change of the ideal gas for the given system. *TSO 4c.* Apply entropy change for the given system. *TSO 4d.* Calculate entropy of reaction for the given system. *TSO 4e.* Explain Carnot cycle principle.	**Unit-4.0 Second Law of Thermodynamics.** 4.1 Statement of second law of thermodynamics, concept of Entropy. Mathematical expression of Entropy, standard entropy, relation between first and second law of thermodynamics. 4.2 Entropy change of ideal gas, numerical. 4.3 Clausius inequality: statement and mathematical expression. Calculation of entropy changes during phase change, adiabatic mixing process, isothermal mixing of ideal gases, chemical reaction, numerical. 4.4 Carnot cycle, its corollaries, T- S diagram and its efficiency.	**CO4, CO3**
TSO 5a. Explain refrigeration. *TSO 5b.* Calculate power required on refrigeration *TSO 5c.* Explain two component system. *TSO 5d.* Calculate fugacity and fugacity coefficient. *TSO 5e.* Calculate activity and activity coefficient.	**Unit-5.0 Application of Second Law of Thermodynamics** 5.1 Refrigeration, types of refrigeration, latest refrigerants, their qualities, and applications. 5.2 Refrigeration cycle: Vapor compression cycle, Absorption refrigeration cycle, Air refrigeration cycle. 5.3 Types of compressors, Coefficient of performance of compressor, liquefaction process. Calculation based on refrigeration. 5.4 Calculation of fugacity, fugacity coefficient, activity, and activity coefficient for two components systems.	**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: S2414402 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Prepare the list of ten real life examples of open and closed system.

2. List the devices which convert heat to work in a process plant.
3. Find relationship between the temperature of a hot body and time by plotting a cooling curve.

b. Micro Projects:

1. Develop a mini refrigerator without using any refrigerant and make a brief report on it.
2. Construct a prototype steam engine and make a brief report on it.
3. Construct an adiabatic container to carry hot water and make a brief report on it.
4. Develop a prototype heat engine based on Carnot cycle and make a brief report on it.
5. Find Coefficient of performance (COP) of refrigerator and air conditioner of your institute and prepare a report on the same.

c. Other Activities:

1. Seminar Topics:
   - Significance of T-S diagram for Carnot cycle.
   - Importance of Mollier chart.
   - Latent heat of vaporization of water.
   - Triple point of water.
   - Importance of **green refrigerants** as alternate source of refrigerants.
2. Visits: Visit nearby industries and prepare a report on the principle of thermodynamics operation applied on equipment used in the chemical industries.
3. Self-Learning Topics:
   - Relationship between Gibbs and Helmholtz free energy of a mixtures.
   - Concept of macroscopic analysis and microscopic analysis.

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Thermodynamic System and Equilibrium	11	CO1	21	6	8	7
Unit-2.0 First Law of Thermodynamics	11	CO2	21	6	7	8
Unit-3.0 Thermodynamic Quantities	08	CO3	07	2	2	3
Unit-4.0 Second Law of Thermodynamics	10	CO4	14	3	6	5
Unit-5.0 Application of Second Law of Thermodynamics	08	CO5	07	3	2	2
Total	**48**	-	**70**	**20**	**25**	**25**

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

O) Suggested 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.	A Textbook of Chemical Engineering Thermodynamics	Narayan, K.V.	PHI Learning PVT Ltd. New Delhi,2013, ISBN9788120317321
2.	Introduction to Chemical Engineering Thermodynamics	Smith J.M, Van Ness H.C, Abott M.M.	MC Graw hills Publication, New york,1996, ISBN13:9780073104454
3.	Chemical Engineering Thermodynamics	Rao Y.V.C.	Sangam books, Hyderabad,1997, ISBN9780863116889
4.	Engineering Thermodynamics	P.K Nag	Tata Mc- Hill publishing Company Ltd, New Delhi ISBN 0-07-059114-8
5.	Principles of Physical Chemistry	Puri, Sharma, Pathania	Vishal Publishing Company, Jalandhar. ISBN-13:978-9382956013

(b) Online Educational Resources:

1. WWW.nptel.ac.in
2. www.msubbu.in
3. http:// ocw.mit.edu
4. http:// freevideolectures.com

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

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A) Course Code : 2414403(T2414403/P2414403/S2414403)

B) Course Title : Fluid Flow Operation

C) Pre- requisite Course(s) :

D) Rationale :

In almost every chemical plant fluids have to be handled and hence study of fluids at rest or in motion is important. The information about the basic concepts and principles of hydrostatics, hydrodynamics, and their applications in handling various fluids like gases, vapors, liquids, and slurries are provided in this course which is required for smooth and proper operation of fluid transportation machineries. Using these concepts power requirement for pumps, blowers and compressors can be determined and friction losses through pipes and fittings can also be calculated. Therefore, this course is one of the important courses since it attempts to develop these skills in students.

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** Derive equation of pressure in static fluid.
- **CO-2** Apply Hagen-Poiseuille's & Bernoulli's equation in a flowing fluid.
- **CO-3** Calculate friction losses in a flowing fluid.
- **CO-4** Select appropriate pump for transportation of fluid.
- **CO-5** Use appropriate measuring device for flow measurement.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme. Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO- 1**	**PSO- 2**
CO-1	2	2	-	-	-	-	-		
CO-2	2	2	-	1	-	1	-		
CO-3	2	3	3	-	1	-	1		
CO-4	2	-	2	3	-	1	1		
CO-5	1	1	2	2	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				
2414403	Fluid flow operation	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)	
2414403	Fluid Flow Operation	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: T2414403

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define Ideal fluid and real fluid. *TSO 1b.* Differentiate between fluid statics and dynamics. *TSO 1c.* Classify the types of pressure. *TSO 1d.* Compare compressible and incompressible fluids *TSO 1e.* Explain different types of manometers. *TSO 1f.* Derive equation for pressure difference between two points.	**Unit-1.0 Fluid Statics and its Applications** 1.1 Basic concept of Ideal fluid and Real fluid. 1.2 Fundamentals of fluid statics and dynamics. 1.3 Concept of pressure, static head, static pressure, gauge pressure, absolute pressure, dynamic pressure, total pressure, vacuum (negative pressure). 1.4 Comparison of compressible and incompressible fluids. 1.5 Derivation of equation of pressure in static fluid. 1.6 Principle construction and working of manometers with equation of pressure difference - simple u tube manometer, inclined manometer, piezometer, two fluid manometer.	**CO-1**
TSO 2a. Explain velocity change across section. *TSO 2b.* Explain effect of solid boundary. *TSO 2c.* Define steady state and unsteady state conditions. *TSO 2d.* Describe types of viscosities. *TSO 2e.* Classify Newtonian & non-Newtonian fluids. *TSO 2f.* Describe Reynolds experiment. *TSO 2g.* Derive continuity equation. *TSO 2h.* Derive Bernoulli's equation and explain corrections.	**Unit-2.0 Fluid–Flow Phenomena.** 2.1 Velocity field, velocity gradient, shear stress and rate of shear. 2.2 Boundary layer, its separation and wake formation. 2.3 Steady state and unsteady state conditions. 2.4 Viscosity: Absolute, kinematic & dynamic viscosity. 2.5 Classification of fluids: Newtonian & non-Newtonian with examples. 2.6 Reynolds experiment, Reynolds number, turbulent flow, laminar flow & transition flow for ideal fluid. 2.7 Average velocity & mass velocity of fluid. 2.8 Continuity equation for mass balance in steady flow. 2.9 Bernoulli's equation and corrections in Bernoulli's equation like kinetic energy correction, correction for fluid friction, correction for Pump work. 2.10 Hagen-Poiseuille's equation.	**CO-2**
TSO 3a. Describe roughness of pipe. *TSO 3b.* Explain hydraulic radius and equivalent diameter. *TSO 3c.* Compare skin and form friction. *TSO 3d.* Use friction factor chart. *TSO 3e.* Calculate friction losses.	**Unit-3.0 Friction in Flowing Fluid.** 3.1 Roughness of pipe. 3.2 Hydraulic radius and equivalent diameter. 3.3 Skin friction and form friction. 3.4 Friction factor chart. 3.5 Friction from changes in velocity or direction (a) Friction loss from sudden expansion of cross section	**CO-3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	(b) Friction loss from sudden contraction of cross section (c) Friction loss in fittings and valves.	
TSO 4a. Compare pipe and tube. *TSO 4b.* Describe fittings & joints. *TSO 4c.* Classify different types of pumps. *TSO 4d.* Explain characteristics of centrifugal pump. *TSO 4e.* Calculate NPSH, head and power. *TSO 4f.* Explain construction, working and uses of fluid moving machineries.	**Unit-4.0 Transportation of Fluid.** 4.1 Introduction of pipe and tube. 4.2 Types and uses of fittings and joints. 4.3 Construction and working of various types of valves like (a) Gate valve (b) Globe valve (c) Check valve (d) Control valve. 4.4 Classification of pumps. 4.5 Construction and working of centrifugal, reciprocating, and rotary pump. 4.6 Develop head and power requirement in centrifugal pump. 4.7 NPSH, suction lift and cavitation in centrifugal pump. 4.8 Characteristic curves of centrifugal pump. 4.9 Numerical based on NPSH, efficiency, head, and power. 4.10 Construction, working and uses of Compressor, Fan, Blower, Vacuum pump, and Jet ejectors.	**CO-4**
TSO 5a. Describe methods of flow Measurement. *TSO 5b.* Classify flow measuring devices. *TSO 5c.* Derive equation of flow rate. *TSO 5d.* Solve simple numerical.	**Unit-5.0 Flow Measurement** 5.1 Methods of flow measurement. 5.2 Classification of flow measuring devices. 5.3 Construction, working principles and application of flow meters like Rotameter, Orifice meter, Venturi meter, Pitot tube. 5.4 Derivation of equation of flow rate through Orifice meter, Venturi meter, Pitot tube. 5.5 Numerical of Orifice meter, Venturi Meter.	**CO-5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2414403

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify the types of flow pattern in a fluid. *LSO 1.2.* Use specific apparatus for determining the parameters.	1.	Identification of types of flow by using Reynolds's apparatus.	CO-1, CO-2
LSO 2.1. Use specific apparatus for determining the viscosity.	2.	Measurement of absolute and kinematic viscosity using Oswald viscometer.	CO-1
LSO 3.1. Apply Hagen-Poiseuille's equation for laminar flow.	3.	Estimation of viscosity of water using Hagen-Poiseuille's equation.	CO-1, CO-2
LSO 4.1. Analyze the effect of pipe, fitting, and valves on friction losses. *LSO 4.2.* Compare friction losses through pipe, fitting, and valves.	4.	Measurement of friction losses through pipe, fitting and valves.	CO-2, CO-3
LSO 5.1. Apply Bernoulli's equation for measurement of pressure developed in reciprocating pump. *LSO 5.2.* Select appropriate pump to developed pressure.	5.	Measurement of pressure developed by reciprocating pump.	CO-3, CO-4
LSO 6.1. Measure the head developed by centrifugal pump. *LSO 6.2.* Compare performance of centrifugal pump and reciprocating pump.	6.	Measurement of head developed by centrifugal pump.	CO-3, CO-4
LSO 7.1. Measure flow rate of fluid through pipe. *LSO 7.2.* Apply continuity equation.	7.	Measurement of flow through pipe using venturi meter.	CO-3, CO-5
LSO 8.1. Measure flow rate of fluid through pipe using orifice meter. *LSO 8.2.* Compare change in flow rate of fluid using orifice meter and venturi meter	8.	Measurement of flow through pipe using orifice meter.	CO-3, CO-5
LSO 9.1. Measure flow through pipe using rotameter. *LSO 9.2.* Compare performance and uses of different types of flow meter.	9.	Measurement of flow through pipe using rotameter.	CO-3, CO-5

L) Suggested Term Work and Self Learning: S2414403 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

1. Calculate errors encountered in Bernoulli's equation due to assumption of no frictional losses.
2. Prepare friction factor chart for laminar /turbulent flow.
3. Compare the advantages and disadvantages of Venturimeter and Orifice meter for different installation.

b. Micro Projects:

i. Construct a prototype Reynold's apparatus to determine flow pattern of your institute pipe line. Make a brief report on it.

ii. Construct a mini reciprocating pump to lift a water column up to a height of 3m and make a brief report on it.

iii. Visit all around campus and different labs of the college and prepare the list of types of pumps and different types of valves with their complete description in tabular form. Make a brief report on it.

iv. Use U Tube Manometer and measure the pressure variation in a vertical column with reference to height of fluid. Repeat the process with 4 different manometric liquid to compare and discuss the result. Prepare a report on the same.

c. Other Activities:

1. Seminar Topics:
   - Application of Bernoulli's theorem in daily life.
   - Application of dimensionless number in fluid flow operation.
   - Importance of Reynolds number to determine flow pattern.
   - Different types of pumps used in industries.

2. Visits: Visit to nearby industries where fluid flow equipment are in use and write a brief report on the utility of these equipment.

3. Self-Learning Topics:
   - Characteristic curves of Centrifugal Pump.
   - Friction factor chart.
   - Head developed by a water column at NTP.
   - Measurement of specific gravity and density of the fluid.
   - Types & working of viscometer.

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Fluid Statics & its Application	8	CO1	7	2	2	3
Unit-2.0 Fluid Flow Phenomenon	8	CO2	14	7	4	3
Unit-3.0 Friction in Flowing Fluid	8	CO3	14	2	6	6
Unit-4.0 Transportation of Fluid	12	CO4	21	5	6	10
Unit-5.0 Flow Measurement	12	CO5	14	4	4	6
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):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identification of types of flow by using Reynolds's apparatus	CO-1, CO-2	30	60	10
2.	Measurement of absolute and kinematic viscosity using Oswald viscometer	CO-1	40	50	10
3.	Estimation of viscosity of water using Hagen-Poiseuille's equation.	CO-1, CO-2	30	60	10
4.	Measurement of friction losses through pipe, fitting and valves.	CO-2, CO-3	30	60	10
5.	Measurement of pressure developed by reciprocating pump.	CO-3, CO-4	30	60	10
6.	Measurement of head developed by centrifugal pump	CO-3, CO-4	30	60	10
7.	Measurement of flow through pipe using venturi meter	CO-3, CO-5	30	60	10
8.	Measurement of flow through pipe using orifice meter	CO-3, CO-5	40	50	10
9.	Measurement of flow through pipe using rotameter.	CO-3, CO-5	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.	Venturi meter assembly for fluid flow measurement	Minimum flow rate – 05 lit/min, mercury manometer	7
2.	Orifice meter assembly for fluid flow measurement	Minimum flow rate – 05 lit/min, mercury manometer	8
3.	Rota meter assembly for fluid flow measurement.	Minimum flow rate – 05 lit/min, minimum 1 in. transparent tube	9
4.	Reynold's Experiment setup for studying types of flow	Minimum pipe dia. –0.5 in transparent pipe	1
5.	Bernoulli's experiment setup	flowing fluid with transparent channel of at least 1 in ID.	3
6.	Reciprocating Pump Assembly with pump & motor	minimum 0.25 HP	5
7.	Centrifugal Pump Assembly with pump & motor	minimum 0.25 HP	6
8	Friction through Pipes, Fittings and Valves setup	0.5 in ID pipe with elbow, Tee, Square, Reducer, Enlarger, Glob valve, Gate valve.	4
9.	Oswald viscometer and stopwatch	Glass Viscometer with constant @ 40 deg C, @ 50 deg C, @ 100 deg C, as per ASTM D 446, calibrated at 40 & 100 deg C.	2

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Unit Operations of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Education, Indian edition 2017 (Seventh Edition), ISBN10-9339213238
2.	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw-Hill Inc., US 1955 (Seventh Edition), ISBN - 978-0070850279
3.	Unit Operations of Chemical Engineering Vol-I	Chattopadhyay, P.	Khanna Prakashan, New Delhi, 1996, ISBN-10: 8174091750
4.	A Text Book of Fluid Mechanics	Khurmi, R.S.	S. Chand Publication, New Delhi 2002, ISBN-9352833961
5.	Unit Operations – I [Fluid Flow and Mechanical Operations]	Gavhane K. A.	Nirali Prakashan,Thirtieth Edition, 2021, ISBN: 9788196396114, 9788196396114

(b) Online Educational Resources:

1. http://www.nzifst.org.nz/unitoperations/flfltheory.htm
2. http://www.chemicalprocessing.com/whitepapers/fluid-handling/
3. https://books.google.co.in/books?id=K4almhE5BoAC&pg=PP1&lpg=PP4&ots=1XDNGSxMsY&dq=Unit+Operation-1+nirali+Prakashan+published+year&hl=en#v=onepage&q=Unit%20Operation-1%20nirali%20Prakashan%20published%20year&f=false.
4. https://onlinecourses.nptel.ac.in
5. https://swayam.gov.in/explorer
6. https://learncheme.com

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

(c) Others:

1. Literature available in any laboratory manual of Fluid flow Operation.
2. NPTEL
3. MIT Open course lecture available on Internet etc.

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A) Course Code : 2414404(T2414404/S2414404)

B) Course Title : Technology of Organic Chemicals

C) Pre- requisite Course(s) :

D) Rationale :

Diploma holding chemical engineers may work as plant operators and gain experience in working with various aspects of manufacturing technology during their course of work. It is essential for them to maximize output while minimizing costs & pollution. This course will provide information on raw materials, processes & industrial applications for the manufacturing of organic chemicals such as alcohol, oil, pulp & paper, polymers industry etc. The curriculum will equip the learners with the necessary skills required in technology of organic chemicals for their efficient performance in the field of organic chemical manufacturing.

E) Course Outcomes (COs): The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated mention rationale:

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

CO-1 Use fermentation process for manufacturing of alcohol and its associated products.

CO-2 Use the fundamentals of sugar & fermentation processes for production of industrial alcohol.

CO-3 Prepare the soap and detergent by using relevant oils.

CO-4 Prepare Pulp and Paper using sulphate and sulphite process.

CO-5 Apply the polymerization process to create a range of polymers with varying properties.

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2414404	Technology of Organic Chemicals	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)	
2414404	Technology of Organic Chemicals	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: T2414404

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Identify raw materials for manufacturing of the given alcohol. *TSO 1b.* Describe & sketches the process flow diagram for the given manufacturing of alcohol. *TSO 1c.* Identify the components of chemical reaction for the given manufacturing process with justification.	**Unit-1.0 Alcohol Industry** 1.1 Alcohol by Molasses: Raw materials, chemical reactions, manufacturing process, process flow diagram, industrial application. 1.2 Alcohol by Corn: raw materials, chemical reactions, manufacturing process, process flow diagram, industrial applications. 1.3 Methanol & Ethanol: Raw materials, chemical reaction, manufacturing process, process flow diagram, applications. 1.4 Acetone: Raw materials, chemical reaction, manufacturing process, process flow diagram, applications.	**CO1**
TSO 2a. Describe the manufacturing process of sugar with neat sketch diagram. *TSO 2b.* Describe the manufacturing process of fermentation with neat sketch diagram.	**Unit-2.0 Sugar & Fermentation Industry** 2.1 Sugar Industry: Manufacturing of sugar from cane sugar, various major engineering problems encountered in sugar industry, pollution abatement in sugar industry. 2.2 Fermentation Industry: Introduction of fermentation. Types of fermentation process. Manufacturing process of industrial alcohol: beers, wines & liquors. Various major engineering problems encountered in fermentation industry, Pollution abatement in fermentation industry.	**CO2**
TSO 3 a. Identify the raw materials for manufacturing of given oil with justification. TSO 3 b. Identify the raw material for the given soap with justification. TSO 3 c. Identify the components of given chemical reaction for the given detergent with justification.	**Unit-3.0 Oils, Soap, and Detergents** 3.1 Oils; raw materials, manufacturing process, process flow diagram of hydrogenation of oil and extraction of oil, applications, economics, and major engineering problems involved in it. 3.2 Soap: raw materials, manufacturing process, process flow diagram. 3.3 Detergents: raw materials, chemical reaction, manufacturing process by sulfated fatty alcohol. Manufacturing process of house disinfectants.	**CO3**
TSO 4a. Describe the sulfate and sulfite process for pulp manufacturing. *TSO 4b.* Describe the major engineering problems involved in pulp industry. *TSO 4c.* Describe the major engineering problems involved in paper industry.	**Unit-4.0 Pulp and Paper Industry** 4.1 Different pulping process, manufacturing process with flow sheet, chemical reactions, major engineering problems, industrial application. 4.2 Paper: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications.	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	4.3 Rules of additives. Description of fillers and components added to improve whiteness, strength, and other properties with their functioning. Pollution abatement in pulp and paper industry.	
TSO 5 a. Describe with sketches the process of addition polymerization for the given polymer. TSO 5 b. Describe with sketches the chemical reaction for manufacturing of the given polyester. TSO 5 c. Explain the concept of cleavage formation in manufacturing of the given polyester TSO 5 d. Describe with major engineering problems involved in the polyethylene, poly vinyl chloride, styrene, polyester process.	**Unit-5.0 Polymers Industry** 5.1 Types of polymers, polymerization process, types of polymerizations, Polymerization mechanism. 5.2 Polyethylene: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications. 5.3 Polyvinyl chloride and styrene: Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications. 5.4 Polyester (Nylon 6, Nylon 6,6, and Rayon): Raw materials, chemical reaction, process flow diagram, manufacturing process, industrial applications. 5.5 Rubber: Vulcanization of rubber, Rubber reclaiming, processing of rubber latex.	**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: S2414404 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.

- Compare sulfate kraft and sulfite process for manufacturing of pulp.
- Technical difference between sulfitation and carbonation clarification process for the manufacturing of sugar.
- What is the problem in storage of sugarcane?
- Differentiate between soft soap and hard soap.

b. Micro Projects:

- Construct a prototype oil extraction plant and write a brief report on it.
- Prepare washing soap in the lab. Use this for cleaning purpose and write the properties of the same & submit a brief report on it.
- Prepare detergents in the lab. Use this for cleaning purpose and write the properties of the same & submit a brief report on it.
- Prepare natural crude rubber from latex, find its yield & submit a brief report on it.

c. Other Activities:

1. Seminar Topics:
   - Water pollution due to paper industries.
   - Different trees suitable for pulp manufacturing with justification.
   - Vulcanization of rubber.
   - Pollution abatement in fermentation industry.

2. Visits: Visit nearby dyes/paper industries and prepare a report to control water pollution due to dye/paper industries.

3. Self-Learning Topics:
   - Brief introduction of carbon fiber material.
   - Major engineering problems involved in sugar industries.
   - Importance of synthetic rubber.
   - Significance of bamboo for paper manufacturing.
   - Comparison of soap & detergents.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	10%	30%	-	-
CO-2	10%	10%	10%	10%	-	-	-
CO-3	30%	30%	26%	26%	-	-	-
CO-4	20%	20%	30%	30%	36%	-	-
CO-5	30%	30%	24%	24%	34%	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**-**	**-**
			50				

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Alcohol Industry	12	CO-1	07	3	4	-
Unit-2.0 Sugar & Fermentation Industry.	12	CO-2	07	4	3	-
Unit-3.0 Oil, Soap & Detergent	08	CO-3	21	4	9	8
Unit-4.0 Pulp and Paper Industry	12	CO-4	14	4	6	4
Unit-5.0 Polymers Industry	12	CO-5	21	5	12	4
Total	**48**	**-**	**70**	**20**	**34**	**16**

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.	Dryden's outline of Chemical Technology	Gopal Rao, M. and Sitting, Marshal	East West Publisher, London,2010 ISBN: 9788185938790
2.	Shreve's Chemical Process Industries.	Austin, George T.	McGraw- Hill Book Company, U.S.A ISBN:9780070571471
3.	Unit Process of Organic Synthesis	P.H Groggins	Mc Graw Hill International, NEW York, 1958 ISBN: 8185938792
4.	A Textbook of Chemical Technology Volume–II, 2/e	G N Pandey	Vikas publication, 2nd edition, ISBN: 9780706986877
5.	Chemical Process Technology	Jacob A. Moulijn Michiel Makkee Annelies E. van Diepen	Wiley Publication, 2nd edition, ISBN: 978-1444320251

(b) Online Educational Resources:

1. www.cleaninginstitute.org › Clean Living › Soaps & d detergent
2. www.differencebetween.info/difference-between-sunflower-oil-and-groundnut-o(groundnut oil)
3. https://en.wikipedia.org/wiki/Pulp_and_paper_industry(pulp and paper)
4. https://en.wikipedia.org/wiki/Pulp_(paper)
5. https://en.wikipedia.org/wiki/Polymerization(Polymerization)
6. https://www.britannica.com/science/polymerization
7. https://en.wikipedia.org/wiki/Methanol
8. https://en.wikipedia.org/wiki/Ethanol
9. www.indianmirror.com/indian-industries/(sugar)
10. https://economictimes.indiatimes.com/topic/(sugar-industry)
11. https://en.wikipedia.org/wiki/(Starch_production)
12. https://www.slideshare.net/s181185/(pesticide-industry)
13. https://en.wikipedia.org/wiki/Explosive_material

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

******

A) Course Code **: 2414405(T2414405/S2414405)**

B) Course Title **:** Plant Utilities

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

D) Rationale **:**

Any Chemical Plant requires raw materials in order to produce final products. It also requires various other services called utilities for smoothly carrying out the processes. Utility is neither a reactant nor a product, but utilities are required for maintaining adequate conditions of a manufacturing unit. Utility area is an important area of a chemical plant. This may house various Boilers, Large Compressors, Refrigeration systems, Air Conditioning systems, Water Treatment Plants, Cooling Towers etc. Utilities are situated outside plant limits should not give any wrong impression that utilities are any less important than the main process, as its efficient management of generate profits. The utilities help to maintain proper process conditions like pressure, temperature etc., without which it will be impossible to carry out the process. Air, water, steam, refrigeration, fuel, furnace, insulation etc., are the common utilities used in chemical plants.

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

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

CO-1 Use appropriate water treatment method for a given sample of impure water.
CO-2 Select appropriate boiler for steam generation.
CO-3 Apply refrigeration in various engineering process.
CO-4 Solve numerical using the given psychrometric chart.
CO-5 Use appropriate equipment for getting instrument air.

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	3	2	2		
CO-2	2	2	1	1	-	-	-		
CO-3	2	2	-	2	2	1	2		
CO-4	3	-	1	-	-	-	-		
CO-5	2	-	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				
2414405	Plant Utilities	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)	
2414405	Plant Utilities	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: T2414405

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the importance and use of industrial water as a utility in chemical plant. *TSO 1b.* Identify the type of impurities present in water. *TSO 1c.* Select the appropriate water treatment method for given impure water. *TSO 1d.* Explain the effect of impurities on boiler feed water.	**Unit-1.0 Importance of Water as Utilities** 1.1 Definition, properties, and uses of industrial water. 1.2 Impurities of water: hard water and soft water. 1.3 Methods of water treatment: chemical softening, resins used for water softening, reverse osmosis, membrane separation. 1.4 Effect of impurities on boiler feed water and its treatment: scale and sludge formation, corrosion, priming and foaming, caustic embrittlement.	**CO1**
TSO 2a. Explain the properties of steam. *TSO 2b.* Calculate enthalpy for different kind of steam. *TSO 2c.* Use appropriate boiler for steam generation. *TSO 2d.* Describe components of boiler mounting and accessories. *TSO 2e.* List different Indian boiler act. *TSO 2f.* Explain non-heating system.	**Unit-2.0 Steam, Steam Generations and Non-Steam Heating System.** 2.1 Properties of steam. 2.2 Problem based on enthalpy calculation for wet steam, dry saturated steam, superheated steam. 2.3 Types of steam generator/boiler: water tube boiler, fire tube boiler, solid fuel fired boiler, waste gas fired boiler, waste heat recovery boiler. 2.4 Boiler Mounting and Accessories: Water Level Indicator, Pressure Gauge, Steam Trap, Economizer, and Preheater. 2.5 Preparing boiler for inspection and Indian boiler act. 2.6 Definition, temperature range, principle, construction and working of thermic fluid heater (non-steam heating system).	**CO2**
TSO 3a. Explain the components of refrigeration. *TSO 3b.* Describe the working of different refrigeration cycle. *TSO 3c.* Use appropriate refrigerant for a given duty.	**Unit-3.0 Refrigeration** 3.1 Definition of refrigeration, low temperature reservoir, high temperature reservoir, coefficient of performance. 3.2 Refrigeration cycle: vapor compression cycle, vapor absorption cycle. 3.3 Types of refrigerants: monochlorodifluoro methane(R-22), Chlorofluorocarbons, brines as refrigerants.	**CO3**
TSO 4a. List the Properties of air water vapors. *TSO 4b.* Use humidity chart for finding psychrometry parameters. *TSO 4c.* Explain the working principal of cooling tower.	**Unit-4.0 Psychrometry** 4.1 Properties of air water vapors. 4.2 Use of humidity chart. 4.3 Equipment used for humidification, dehumidification, evaporative cooling, cooling towers.	**CO4**
TSO 5a. Identify different kind of industrial air. *TSO 5b.* Select appropriate industrial air for a given duty.	**Unit-5.0 Industrial Air** 5.1 Definition, types, and use of industrial air: compressed air, processed air, and instrument air. 5.2 Process of greeting instrument air. 5.3 Equipment used for getting instrument air: Cyclone Separator and Scrubber & Electrostatic Precipitator: construction, working and uses.	**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: S2414405 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Compare between PV & TS diagram.
ii. Explain briefly about the duty of boiler inspector.
iii. Describe briefly the working principal of cooling tower.

b. Micro Projects:

1. Identify sources of water at your college premises, while measuring the following physical properties, prepare a brief report on it.

a) Measure temperature of water.
b) Measure TDS of water.
c) Measure pH of water.
d) Measure turbidity of water.

2. Visit nearby industrial water softening plant and prepare a report on water softening methods used by different industries.
3. Prepare model displaying the mountings of various types of the boiler used in chemical industries & prepare a report on the same.

c. Other Activities:

1. Seminar Topics:

- Various new age ecofriendly refrigerant used in the industry.
- Advantage and disadvantage of traditional refrigerant and new age ecofriendly refrigerant.
- Cooling tower.

2. Visits: Visit a nearby thermal power plant/refinery to study steam generation by boiler and prepare a brief report on it.

3. Self-Learning Topics:

- Carnot cycle.
- Psychrometric chart showing different parameters.

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

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

Legend:

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

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

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

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

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Importance of water as utilities	8	CO1	07	4	3	-
Unit-2.0 Steam, Steam Generations and Non-Steam Heating System.	12	CO2	21	5	8	8
Unit-3.0 Refrigeration	12	CO3	21	6	8	7
Unit-4.0 Psychrometry	8	CO4	14	3	3	8
Unit-5.0 Industrial Air	8	CO5	07	2	2	3
Total	**48**	**-**	**70**	**20**	**24**	**26**

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

O) Suggested Assessment Table for Laboratory (Practical): (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.	Engineering chemistry	Jain and Jain	Dhanpatrai publication, New Delhi, ISBN: 9788121903455
2.	Boiler operations	Chattopadhyay	Tata McGraw Hill, New Delhi, ISBN: **0074635611**
3.	Refrigeration & Air conditioning	P. N. Anantha Narayan	Tata McGraw Hill, New Delhi, ISBN: **9383286563**
4.	Thermal engineering	Balleney, P.L.	Khanna publication, New Delhi ISBN: 9788174090317
5.	Industrial water treatment	Powel, S.T.	Mc Graw Hill, New York, ISBN: 9781118843727
6.	A textbook of refrigeration and air conditioning	Rajput, R.K.	S K Kataria and Sons, New Delhi, ISBN: 9789350142554

(b) Online Educational Resources:

1. https://en.wikipedia.org/wiki/Air_compressor-Compress air
2. https://onlinecourses.nptel.ac.in/noc23_ch28/preview
3. https://onlinecourses.nptel.ac.in/noc21_ce25/preview
4. https://archive.nptel.ac.in/courses/112/107/112107208/
5. https://onlinecourses.nptel.ac.in/noc22_me135/preview
6. https://nptel.ac.in/courses/112103277

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. NPTEL
2. MIT Open course lecture available on Internet etc.

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A) Course Code **: 2414406(P2414406/S2414406)**

B) Course Title **:** Chemical Engineering Drawings

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

D) Rationale **:**

Chemical engineering drawings are the drawings that can represent any plant on small scale. Through these drawings & with the use of some standardized symbols plant data can be understood and interpreted easily. They are helpful in making calculations or modifications in design parameters from office, as it is not always possible to go to the plant or site for getting the required data. As the drawings is a language of a engineer, diploma chemical engineers will be able to express their thoughts and ideas in setting up the various equipment/plant according to the drawings prepared by CAD software. This subject includes the detailed drawings and specifications of various equipment like heat exchangers, reactors, storage vessels, distillation columns, valves, process flow sheet etc.

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 Draw different valves, support & joints used in chemical process industry.
CO-2 Draw different types of equipment used in chemical process industry.
CO-3 Analyze the use of packing in chemical industry.
CO-4 Prepare the specification sheet for different chemical process equipment.
CO-5 Draw various process flow diagram using CAD software in chemical process industry.

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	2	2	2	1		
CO-2	2	-	1	2	2	-	1		
CO-3	2	1	1	2	-	-	1		
CO-4	2	1	1	2	-	2	1		
CO-5	2	1		1	1	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				
2414406	Chemical Engineering Drawings	-	-	04	02	06	03

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2414406	Chemical Engineering Drawings	-	-	20	30	15	10	75

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: (Not Applicable)

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2414406

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify different kinds of valves. *LSO 1.2.* Compare different kinds of valves. *LSO 1.3.* Select the relevant valve for specific purpose.	1.	Drawing of sectional views of following valves: gate valve, globe valve, ball valve, check valve, diaphragm valve, safety valve.	CO-1
LSO 2.1. Identify the different kinds of pipe joints used in chemical process industry. *LSO 2.2.* Describe the application of relevant types of joints for the given situation. *LSO 2.3.* Draw the neat and proportionate sketch of given joints.	2.	Drawing of following pipe joints: threaded joint, flanged joint, bend joint, elbow joints, nipple joints, socket joints, union joint.	CO-1
LSO 3.1. Identify different kinds of piping supports. *LSO 3.2.* Compare different kinds of pipe supports. *LSO 3.3.* Select the relevant pipe support for specific purpose.	3.	Drawing of schematic view of following pipe supports – hanger support, roller support, yard piping support.	CO-1
LSO 4.1. Draw neat and proportionate sketch of different kinds of vessel support. *LSO 4.2.* Describe the support used for horizontal and vertical support.	4.	Drawing of schematic view of following vessel support: vertical vessel support, leg support, skirt support, bracket support, horizontal vessel saddle type support.	CO-1
LSO 5.1. Identify the different components of shell and tube heat exchanger. *LSO 5.2.* Describe the use of baffles and heat exchanger. *LSO 5.3.* Draw neat and proportionate sketch of shell and tube heat exchanger.	5.	Fabrication drawing of shell and tube heat exchanger.	CO-1, CO-2
LSO 6.1. Identify the different components of vertical evaporator. *LSO 6.2.* Describe the use of vertical evaporator. *LSO 6.3.* Identify the shell side and tube side fluid for proper application.	6.	Fabrication drawing of vertical evaporator.	CO-1, CO-2
LSO 7.1. Describe components and assembly of the given batch reactor. *LSO 7.2.* Identify the components of batch reactor.	7.	Fabrication drawing of batch reactor.	CO-1, CO-2
LSO 8.1. Identify different rings used for packing. *LSO 8.2.* Select appropriate ring for specific purpose.	8.	Fabrication drawing of types of packing: Raschig rings, Pall ring, Berl saddle ring.	CO-3
LSO 9.1. Identify the parameters required for preparation of specification sheet for a given equipment.	9.	Drawing of specification sheet of: centrifugal pump, reciprocating pump, distillation column, shell, and tube heat exchanger.	CO-4
LSO 10.1. Describe the different components/equipment used in a chemical process industry. *LSO 10.2.* Draw the neat and proportionate sketch of any manufacturing chemical process industry.	10.	Drawing of process flow diagram of any one chemical process industry.	CO-1, CO-2, CO-4
LSO 11.1. Use the CAD in chemical process industry. *LSO 11.2.* Verify the chemical process industry using CAD software.	11.	Drawing of the process flow diagram using CAD software.	CO-5

L) Suggested Term Work and Self Learning: S2414406 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Show different mass transfer equipment with their symbols.
ii. Explain different heat transfer equipment with their symbols.
iii. Describe different fluid flow operation equipment with their symbols.

b. Micro Projects:

1. Visit any chemical industry and draw equipment symbol used in that industry on drawing sheet.
2. Visit nearby chemical industry and collect information regarding different supports used for equipment and pipes in the industry and write a report on the same along with the drawing sheet.
3. Draw a process flow diagram for a refinery on a drawing sheet.

c. Other Activities:

1. Seminar Topics:
   - Importance of different pipe fittings and valves used in the chemical industry.
   - Different components of a heat exchanger.
   - Different components of a distillation column.
2. Visits: Visit nearby chemical industry and draw a block diagram & manufacturing process flow sheet for visited plant.
3. Self-Learning Topics:
   - CAD Software for chemical engineering.
   - Scope & application of shell and tube heat exchanger.
   - Reflux in a distillation column.

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%	10%	10%	20%	20%
CO-2	-	-	50%	30%	40%	10%	10%
CO-3	-	-	10%	30%	10%	50%	50%
CO-4	-	-	10%	20%	30%	10%	10%
CO-5	-	-	10%	10%	10%	10%	10%
Total Marks	**-**	**-**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

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

Note:

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

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

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Drawing of sectional views of following valves: Gate valve, Globe valve, Ball valve, Check valve, Diaphragm valve, Safety valve.	CO-1	30	60	10
2.	Drawing of following pipe joints: threaded joint, flanged joint, bend joint, elbow joints, nipple joints, socket joints, union joint.	CO-1	40	50	10
3.	Drawing of schematic view of following pipe supports – hanger support, roller support, yard piping support.	CO-1	30	60	10
4.	Drawing of schematic view of following vessel support: vertical vessel support, leg support, skirt support, bracket support, horizontal vessel saddle type support.	CO-1	30	60	10
5.	Fabrication drawing of shell and tube heat exchanger.	CO-1, CO-2	30	60	10
6.	Fabrication drawing of vertical evaporator.	CO-1, CO-2	30	60	10
7.	Fabrication drawing of batch reactor.	CO-1, CO-2	30	60	10
8.	Fabrication drawing of types of packing: Raschig rings, Pall ring, Berl saddle ring.	CO-3	40	50	10
9.	Drawing of specification sheet of: centrifugal pump, reciprocating pump, distillation column, shell, and tube heat exchanger.	CO-4	40	50	10
10.	Drawing of process flow diagram of any one chemical process industry.	CO-1, CO-2, CO-4	40	50	10
11.	Drawing of the process flow diagram using CAD software.	CO-5	30	60	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

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

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

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

S. No.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	Drawing Table	Drawing table with drawing board of half imperial size.	All
2.	Drafting Machine	T-square or drafter	All
3.	Protractor	Set squares (45^o and 30^o-60^o)	All
4.	Drawing Instrument Box	Set of compass and divider	All
5.	Interactive Board	With LCD overhead projector	All
6.	ASPEN & MATALB Software.	Latest version, Compatible with windows 10,11,12 & above	10,11

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Process Heat Transfer & Chemical Equipment Design.	D.C. Sikdar	Khanna Publication, First Edition (1 January 2018), ISBN: 9386173611
2.	Perry's Chemical Engineers' Handbook	Don W. Green & Marylee Z. Southard	McGraw Hill; 9th edition (23 September 2018), ISBN: 0071834087
3.	Introduction to Chemical Equipment Design: Mechanical Aspects	Bhattacharyya	CBS publication, latest edition, ISBN: 978-8123909455
4.	Process Equipment Design	M.V. Joshi, V.V. Mahajani	Macmillan India Limited, ISBN: 0333924185
5.	Dryden's outlines of Chemical Technology	M. Gopala Rao, Marshal Sittig	Affiliated East-West Press Pvt Ltd., ISBN: 9788185938790
6.	Chemical Engineering Drawing	K.A Gavhane	Nirali Prakashan, latest edition ISBN: 9789351643265

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/112102101
2. https://ndl.iitkgp.ac.in
3. https://www.digimat.in/103.html
4. https://swayam.gov.in/explorer

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. Literature available in any laboratory manual of chemical engineering drawing.
2. NPTEL
3. MIT Open course lecture available on Internet etc.

******

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

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

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

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

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

R) Suggested Learning Resources:

(a) Books:

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

(b) Online Educational Resources:

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

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

(c) Others:

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

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A) Course Code : 2400408(T2400408)

B) Course Title : Employability Skills Development
(Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

Education may only be enough to qualify for a job, but employability skills are the major criteria to be considered for a job role. Employability skills are building blocks of any career and they equip one to carry out roles in the company to the best of their ability. Employers usually check these employability skills before hiring. These sets of job-readiness skills are behaviors that are necessary for every job and are essential attitudes that enable students to grow in their careers. Employers value employability skills because they regard these as indications of how their employees will get along with other team members and customers, and how efficiently they will be able to handle the job performance and career success. Employers like to hire a technical expert who also displays well-rounded employability skills.

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 Build resume and showcase portfolio for placement activity.
CO-2 Face interviews and participate effectively in Group Discussions.
CO-3 Apply engineering tools in work situations and societal processes.

F) Suggested Course Articulation Matrix (CAM):

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

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

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

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400408	Employability Skills 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)	
2400408	Employability Skills 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: T2400408

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Perform SWOT analysis and reflect. *TSO 1b.* Develop skills in carrier planning & goal setting *TSO 1c.* Build a Resume using Internet formats. *TSO 1d.* Develop and Design portfolios. *TSO 1e.* Maintain good grooming attire. *TSO 1f.* Introduce oneself to others. *TSO 1g.* Develop a personal website.	**Unit-1.0 Goal Setting** 1.1 Career planning, SWOT 1.2 Resume using Internet formats. 1.3 Showcase portfolios. 1.4 Personal grooming. 1.5 Self-Introduction. 1.6 Website Development.	**CO1**
TSO 2a. Face interviews and E- Interviews confidently *TSO 2b.* Participate in group discussions. *TSO 2c.* Use Social media for personal enrichment &Netiquette *TSO 2d.* Manage self for higher growth. *TSO 2e.* Use body language for effective communication *TSO 2f.* Manage Emotions for personal growth	**Unit-2.0 Capacity Development** 2.1 Interview Skills 2.2 Group Discussion – Do's & don'ts, leadership, Teamwork, how to interrupt, synthesis, and analysis of topics. 2.3 Social Media for Personal Enrichment 2.4 Body language 2.5 Self-Management. 2.6 Emotional Intelligence	**CO2**
TSO 3a Develop & Maintain Social Contacts. TSO 3b Engage in Social Service projects. TSO-3c Collaborate for mutual advantage. TSO 3d Apply QC-Tools in work situations. TSO 3e Practice Lean Manufacturing Techniques for Production and Operations	**Unit-3.0 Utilizing Potential** 3.1 Social Networking 3.2 Social Engagements, Volunteering 3.3 Collaboration& Team-work. 3.4 QC-Tools – Check sheets, Fishbone Diagram, Histogram, Pareto chart, Control-chart, Scatter Diagram, Stratification, 3.5 Lean Manufacturing, Kanban, Kaizen, Five S, Poka-yoke, Quality Circle	**CO3**

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

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

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

a. Assignments:

1 Build a resume for Placement Activity.

2 Prepare letters for job applications.

b. Micro Projects:

1. Prepare collage for personal grooming.
2. Develop a showcase portfolio.
3. Prepare a collage of different gestures and postures of Body Language.
4. Apply Five-S in a work situation.
5. Arrange Mock Interviews, appear, and video record. Reflect on your performance.
6. Organize Group discussions on current topics and video record. Reflect on your performance

c. Other Activities:

1. Seminar Topics:
   - Emotional Intelligence.
   - 21st Century Skills.
   - Multitasking

2. Visits: Visit nearby Job Fairs, Career Guidance Fairs, etc.

3. Self-Learning Topics:

   - Use of social media.
   - Self-introduction.
   - Self-grooming.
   - QC Tools.
   - Lean Manufacturing,
   - Emotional Intelligence.

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%	-	-	-	-	-	-
CO-2	40%	-	-	-	-	-	-
CO-3	30%	-	-	-	-	-	-
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 percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

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

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

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

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications
1.	Group Discussion Tables and chairs	Round Table with seating arrangement for 15 person
2..	Mock Interviews infrastructure	2 parallel mock interview set up with recording facility.
3.	Ear phones	Compatible with mobile phones
4	Headphones	Compatible with laptop/desk top
5	Blue tooth	Compatible with mobile phones.
7.	CC TV Camera	Compatible to record presentations and addresses.
8.	Podium	For presentations on stage.
9.	Public address system	For public meetings.
10.	Full Glass Mirrors	For monitoring Body Language

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Employability Skills Skills for Employability	Dr. M. Sen Gupta	Innovation Publication Pvt Ltd, 2020 ISBN: 978-81-933819-1-5
2.	Employability Skills	Dr. Nishith Rajaram Dubey, Anupam Singh	Indra Publishing House, 2023 ISBN - 978-93-93577-68-9
3.	Organizational Behavior	A. K. Chitale, Rajendra Prasad Mohanty and Dr Nishith Dubey	PHI Learning Pvt Ltd ISBN 978-81-203-4696-3
4.	Managerial Skills	Dr Nishith Dubey & Prof Gitanjali Shrivastava	Shiva Prakashan, Indore, India,2010, ISBN 81-7677-100-7,
5.	Body Language	Allan Pease	Pease International PTY. Ltd Australia
6.	Production and Operations Management Goods & Services approach	Dr S.V Deshmukh, Dr A. K. Chitale and Dr Nishith Dubey	Archers & Elevators publishing house, Bangalore, ISBN 9789386501197
7.	Emotional Intelligence	Daniel Goleman	Word Press.Com, 9789382563792
8.	How to win friends and influence people	Dale Carnegie	Srishti Publishers & Distributors, Delhi, India

(b) Online Educational Resources:

1. **4-Year Plan for Career Success:** https://eng.umd.edu/sites/clark.umd.edu/files/4%20Year%20Plan%20For%20Career%20Success_Categorized_1.pdf

2. **CAREER DEVELOPMENT GUIDE** https://www.engineersaustralia.org.au/sites/default/files/content-files/2016-12/career_development_guide_may_2014.pdf

3. **Tips for successful career planning** tips://www.aryacollege.in/tips-for-successful-career-planning-in-2021/

4. **Career Planning** – Complete Guidehttps://www.mygreatlearning.com/blog/what-is-career-planning/

5. **Build Resume:** https://www.themuse.com/advice/how-to-make-a-resume-examples

6. **Build Resume** https://resumegenius.com/blog/resume-help/how-to-write-a-resume

7. **Body Language:** https://ubiquity.acm.org/article.cfm?id=3447263

8. **Group Discussions:** https://brightspeaking.com/en/how-to-effectively-participate-in-a-group-discussion/

9. **Carrier planning & goal setting:** https://www.hays.com.au/career-advice/career-development/setting-career-goals

10. **Carrier planning & goal setting:** https://www.thebalancemoney.com/step-by-step-guide-to-setting-career-goals-2059883

11. **Collaboration & teamwork:** https://www.indeed.com/career-advice/career-development/teamwork-and-collaboration

12. **Interview skills:** https://www.youtube.com/watch?v=lKCTS9dY4h4

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

******

A) Course Code : **2013109(T2013109/S2013109)**

B) Course Title : Sustainability and Renewable Energy Sources (CRE, CHE)

C) Pre- requisite Course(s) :

D) Rationale :

Sustainable development is one of the key factors for a country to progress. Therefore, it is essential to have an increased awareness about sustainability and the issues related with it. For the sustained growth of the economy, to cope up the demand of electrical power worldwide, renewable energy sources are playing major role. Therefore, the course on Sustainability and Renewable Energy Sources has been designed to develop a general awareness and understanding about various aspects of Sustainability and different renewable energy technologies being used for power generation. Emphasis has been given on solar and wind power, as these sources are more popular in India for electric power generation.

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 Appreciate the sustainable practices to resolve the environment related issues.

CO-2 Enumerate the advantages of renewable energy sources over conventional sources for electric power generation.

CO-3 Interpret the solar and wind energy conversion system.

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	1	3	-	2		
CO-2	3	1	2	2	3	-	2		
CO-3	3	-	1	2	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 Code	Scheme of Study (Hours/Week)				
		Classroom Instruction (CI)		Notional Hours (TW/ Activities+ SL)	Total Hours (CI+TW/ Activities)	Total Credits (C)
		L	T			
2013109	Sustainability & Renewable Energy Sources	01	-	02	03	02

Legend:

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

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

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

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

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

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

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

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2013109	Sustainability & Renewable Energy Sources	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: T2013109

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the concept of sustainability. *TSO 1b.* Enlist the factors affecting social, environmental and economic sustainability. *TSO 1c.* Enumerate the problems associated with natural resources. *TSO 1d.* Explain the concept of carbon credits. *TSO 1e.* Describe the contribution of green buildings to the sustainable development goals. *TSO 1f.* List the different types of green materials.	**Unit-1.0 Sustainability** 1.1 Need and concept of sustainability 1.2 Social, environmental and economic sustainability 1.3 Natural resources 1.4 Carbon credits 1.5 Sustainable habitat and Green buildings 1.6 Green Materials 1.7 Sustainable Development Goals	**CO1**
TSO 2a. State the present scenario of electricity generation and demand in India. *TSO 2b.* List the conventional sources of Electric Power Generation. *TSO 2c.* Explain the concept of Sustainable and Renewable energy source. *TSO 2d.* List the different types of Renewable Energy Sources. *TSO 2e.* State the present status of renewable energy in India. *TSO 2f.* State the advantages of renewable energy sources over conventional sources.	**Unit-2.0 Renewable Energy Sources** 2.1 Present Scenario of Electricity Generation and Demand in India. 2.2 Conventional Sources of Electric Power Generation 2.3 Sustainable and Renewable Energy Sources. 2.4 Different types of Renewable Energy Sources; Solar, Wind, Biomass, Fuel Cell, Geothermal, Ocean Energy. 2.5 Present status of Renewable Energy in India 2.6 Advantage of Renewable energy sources over conventional sources.	**CO2**
TSO 3a. Explain the characteristics of solar radiation. *TSO 3b.* Explain the V-I Characteristics of solar cell. *TSO 3c.* Explain the general characteristics of photovoltaic material. *TSO 3d.* State the functions of major components of solar PV system. *TSO 3e.* Explain the principles of wind power generation. *TSO 3f.* Explain the principles of wind energy conversion. *TSO 3g.* State the functions of major components of wind power plants.	**Unit-3.0 Solar and Wind Power Basics** 3.1 Solar radiation 3.2 Solar Cell and its Voltage -Current (V-I) Characteristics 3.3 Solar PV modules 3.4 Photovoltaic Materials 3.5 Major Components of Solar PV System; PV Module, Solar Charge Controller, Inverter, Battery 3.6 Wind Energy 3.7 Principles of Wind Power Generation 3.8 Principles of Wind Power Conversion 3.9 Major Components of Wind Power Plants; Tower, Blades, Gear Box, Generator, Transformer	**CO3**

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

K) Suggested Term Work/ Activities and Self Learning: S2013109 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. Few sample questions are given below:

1. Prepare a brief report on the benefits of sustainability.
2. List the advantages of renewable energy sources oven conventional sources
3. List the major components of Solar PV System and state their function(s).
4. Name the types of towers being used in the various types of wind power plants.

b. Micro Projects:

1. Compare the carbon credits data of India with advanced countries.

2. Observe the daily, weekly and monthly energy consumption of your home and prepare a report on it including ways to minimize the energy consumption.
3. Visit nearby solar PV system installation and note the specifications of different components of the system with name of manufacturers.
4. Prepare a state wise brief report on power generation through wind power plant in India mentioning potential and installed capacity as on date.

c. Other Activities:

1. Seminar Topics:

    - Sustainability goals
    - Environmental impact
    - Advantages of renewable energy sources over conventional sources
    - Properties of solar photovoltaic material
    - Installation of Solar PV systems
    - Wind power generation in India

2. Visits: Visit nearby Solar PV System/Small Wind Turbine Installation. Prepare report of visit mentioning different components of the system, capacity of the system and cost of the system.

3. Self-Learning Topics:

    - Biomass Technology
    - Fuel Cell Technology
    - Power generation using Geothermal Energy
    - Ocean Energy

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: (If Any)

S. No.	Name of Equipment, Tools and Software	Broad Specifications
1.	Solar Panels (Polycrystalline and Monocrystalline).	10/20 /75/100-Watt Capacity
2.	Electromagnetic Radiation EMF Tester	For measuring solar irradiation
3.	Small Wind Turbine	10 /20 Watt Horizontal and Vertical axis
4.	Anemometer	Measurement of wind speed

S. No.	Name of Equipment, Tools and Software	Broad Specifications

N) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Renewable Energy Technologies: A Practical Guide for Beginners	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010 Print Book ISBN: 9788120334342 eBook ISBN: 9789354437151
2.	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
3.	Non-Conventional Energy Resources	D. S. Chouhan, S. K. Shrivastava	New Age International Publishers, 4th Edition, 2022 ISBN: 9789388818933
4.	Non-Conventional Energy Sources	G. D. Rai	Khanna Publisher, Latest. ISBN: 9788174090737, 9788174090737.
5.	Solar Photovoltaic: Fundamentals, Technologies and Applications	Chetan Singh Solanki	PHI Learning; 3rd edition, Latest ISBN: 8120351118, 9788120351110
6.	Solar Energy: Principles of Thermal Collection and Storage.	S. P. Sukhatame	Tata McGraw Hills, Latest ISBN: 0070142963, 978007014296
7.	Fundamentals of Wind Energy Utilisation	Dr. A. G. Powar and Er. A. G. Mohod	Jain Brothers, New Delhi, ISBN: 9788183601337.

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/115105127
3. https://onlinecourses.nptel.ac.in/noc22_ch27/preview.

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

(c) Others:

1. Solar PV System Installation Users' Guide
2. Wind Turbine Installation Users' Guide.
3. Technical Data Sheets of Solar Panels.

******

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 Code	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			
2400110	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 Educational Resources:

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

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

(c) Others:

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

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