Programme Name/s : **Chemical Engineering**
Programme Code : **CH**
Semester : **Sixth**
Course Title : **PROCESS SIMULATION IN CHEMICAL ENGINEERING**
Course Code : **316003**

I. RATIONALE

The objective of this curriculum is to provide chemical engineering students a solid foundation in process simulation software. Chemical engineering student will be able to accurately enter data, analyze and optimize processes using process simulation software.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcomes through various teaching learning experiences : Chemical engineering students efficiently use process simulation software for process optimization in industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use the given process simulation software.
- CO2 - Utilize the interface of process simulation software.
- CO3 - Analyze the process simulation within the given software.
- CO4 - Simulate process equipment by adjusting parameters in process simulation software.
- CO5 - Use process simulation software for process optimization through sensitivity analysis.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316003	PROCESS SIMULATION IN CHEMICAL ENGINEERING	PSCE	SEC	2	-	2	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Distinguish between dynamic and steady-state process simulations. TLO 1.2 Enlist types of process simulation software used in chemical engineering	**Unit - I Introduction to Process Simulation Software** 1.1 Process simulation: Basic concept, steady-state and dynamic process simulation. 1.2 Process simulation software: Use of DWSIM(Open source) and other commercial software	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Explore the basic simulation software interface. TLO 2.2 Describe stepwise procedure to solve process simulation. TLO 2.3 Describe the process of building flowsheet and selection of thermodynamic model.	**Unit - II Process Simulation Software Interface** 2.1 Overview of process simulation software interface. 2.2 Steps involve in process simulation software. 2.3 Create basic flowsheets for given process. 2.4 Thermodynamic models: Types (NRTL, UNIQUAC, SRK, Peng-Robinson) and selection of model.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration
3	TLO 3.1 Identify the types of data required for process stream and operations. TLO 3.2 Develop skills to troubleshoot process convergence failures. TLO 3.3 Interpret the result in graphical and tabular way.	**Unit - III Data Input and Result Analysis** 3.1 Data input for feed stream. 3.2 Data input for unit operations (compressor, distillation, heat exchangers, pumps, CSTR, PFR). 3.3 Process convergence. 3.4 Analysis of results: Graphical and tabular.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Identify the fundamentals of binary system distillation column simulation. TLO 4.2 Analyze the behavior of CSTR in process simulation. TLO 4.3 Evaluate the factors affecting pump and compressor efficiency, head, and power requirements. TLO 4.4 Apply material balance principles to solve mixing problems. TLO 4.5 Calculate overall heat load for heat exchangers.	**Unit - IV Simulation of Process Equipment** 4.1 Overview of process simulation of distillation column (binary systems) 4.2 Overview of continuous stirred tank reactor (CSTR) process simulation. 4.3 Pump and compressor process simulation. 4.4 Process simulation of mixer for mixing operation. 4.5 Heat exchanger process simulation (shell and tube: co-current and counter current)	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration
5	TLO 5.1 Analyze the process parameter of distillation and absorption. TLO 5.2 Examine process efficiency through material and energy balance applications. TLO 5.3 Identify key factors influencing process optimization in chemical process. TLO 5.4 Explain application of process simulation in chemical engineering.	**Unit - V Case Studies and Applications** 5.1 Simulation of basic chemical operations to design process data (distillation, absorption) 5.2 Case studies on material and energy balance. 5.3 Process optimization: Introduction, basic concept, sensitivity analysis. 5.4 Applications of process simulation in chemical engineering.	Lecture Using Chalk-Board Presentations Video Demonstrations Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Navigate menus, toolbars, and workspace settings to understand software functionality.	1	*Installation of given simulation software and interact with its interface.	2	CO1
LLO 2.1 Draw a basic process flow diagram using appropriate simulation software.	2	*Creation of any one simple flowsheet in given simulation software.	2	CO1 CO2
LLO 3.1 Draw a distillation column flowsheet using simulation software.	3	*Draw distillation column flowsheet, add feed stream and operation input data using simulation software.	2	CO2 CO3
LLO 4.1 Draw a process flowsheet for a compressor system and accurately enter stream and compressor data for analysis	4	*Creation of compressor flowsheet and enter the stream and compressor data.	2	CO2 CO3
LLO 5.1 Use simulation software to draw a compressor system and predict its outlet temperature.	5	*Simulation of compressor to find outlet temperature and tabulate the result	2	CO2 CO3
LLO 6.1 Draw a process flowsheet for a rigorous distillation column and accurately enter stream and compressor data for analysis.	6	*Generation of rigorous distillation column flowsheet and enter the stream, operation data and find out purity of product.	2	CO2 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Analyze the impact of reflux ratio on stage requirements.	7	Simulation of shortcut distillation column to calculate minimum reflux ratio.	2	CO2 CO3 CO4
LLO 8.1 Analyze the impact of feed composition on number of stage requirements.	8	Calculation of number of stages for gas absorption column using process simulation software.	2	CO2 CO3 CO4
LLO 9.1 Tabulate and interpret condenser duty result.	9	*Calculation of condenser duty using process simulation software.	2	CO2 CO3 CO4
LLO 10.1 Evaluate the effect of different fluids on pump performance and work done.	10	*Simulation of pump for different fluids to calculate its work done.	2	CO2 CO3 CO4
LLO 11.1 Apply energy balance principles to calculate utility outlet stream temperature heat exchanger.	11	*Calculation of utility outlet stream temperature from shell and tube heat exchanger using simulation software.	2	CO2 CO3 CO4
LLO 12.1 Plot Txy diagram at a given pressure for binary system.	12	Generation of boiling point diagram (Txy plot) at given pressure for any binary system using simulation software	2	CO2 CO3 CO4 CO5
LLO 13.1 Tabulate and interpret conversion results from simulation data	13	Calculation of conversion percentage from conversion function in CSTR using simulation software.	2	CO2 CO3 CO4 CO5
LLO 14.1 Determine percentage conversion in Plug Flow Reactor (PFR).	14	Calculation of conversion percentage from conversion function in Plug Flow Reactor (PFR) using simulation software	2	CO2 CO3 CO4 CO5
LLO 15.1 Interpret simulation results to understand the effects of pressure and composition on bubble and dew points.	15	*Calculation of dew point and bubble point of component mixture at different concentration and pressure using simulation software.	2	CO2 CO3 CO4 CO5
LLO 16.1 Analyze the impact of feed stage variation on product purity.	16	Optimization of feed stage location in distillation column by sensitivity analysis (use experiment number 6)	2	CO2 CO3 CO4 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- -NA-

Micro project

- -NA-

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	DWSIM open-source software	All
2	Any other commercial process simulation software	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Process Simulation Software	CO1	4	0	0	0	0
2	II	Process Simulation Software Interface	CO1,CO2	4	0	0	0	0
3	III	Data Input and Result Analysis	CO2,CO3	4	0	0	0	0
4	IV	Simulation of Process Equipment	CO2,CO3,CO4	8	0	0	0	0
5	V	Case Studies and Applications	CO2,CO3,CO4,CO5	10	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work - 25 marks

Summative Assessment (Assessment of Learning)

- End of term Examination (Internal) - 25 Marks

XI. SUGGESTED COS - POS MATRIX FORM

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	PSO-3
CO1	2	-	-	3	-	-	2			
CO2	2	2	2	3	-	-	2			
CO3	3	2	2	3	2	1	3			
CO4	3	2	2	3	2	1	3			
CO5	3	2	2	3	2	1	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dominic Foo	Chemical Engineering Process Simulation	Elsevier ISBN 9780323984553, 032398455X
2	Thomas A. Adams, II	Learn Aspen Plus in 24 Hours, 2nd Edition	McGraw Hill ISBN 9781264266654
3	Juma Haydary	Chemical Process Design and Simulation: Aspen Plus and Aspen Hysys Applications	Wiley, ISBN 9781119311430, 1119311438

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://spoken-tutorial.org/tutorial-search/?search_foss=DWSIM&search_language=English	Spoken tutorials
2	https://dwsim.org/index.php/download/	DWSIM Open source Software
3	https://dwsim.org/wiki/index.php?title=Tutorials	Tutorials
4	https://www.iitg.ac.in/tamalb/documents/introtoaspen.pdf	Notes
5	https://chemstations.com/knowledge_center	Notes

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students