



SARVAJANIK  
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**SARVAJANIK UNIVERSITY**  
Sarvajani College of Engineering and Technology



**Bachelor of Technology (B.Tech)**

**B. Tech. Semester VII**

**Subject Name:** Process Equipment Design & Drawing

**Subject Code:** BTCH13702

**Type of course:** Professional Core Course

**Prerequisite:** Basics of civil engineering, Fluid flow operations, Chemical Engineering materials, Chemical Reaction Engineering, Mass transfer Operations I & II, Chemical Engineering Thermodynamics – I & II, Process Heat transfer

**Rationale:** The subject includes the application of fluid flow operations, Heat and mass transfer etc. for process and mechanical design of various equipments in chemical process industries.

**Teaching and Examination Scheme:**

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

**CA1:** Continuous Assessment (assignments/projects/open book tests/closed book tests) **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

**Content:**

Sr. No.	Topics	Teaching Hrs.	Module % Weightage
1.	<b>Process design of Piping and Pumps:</b> Introduction, Process design of piping, NPSHA & NPSHR, Power required by pump, Power required in Fan, Blower and adiabatic compressor, flow meters, Process design of Orifice meter, Rotameter etc.	7	16
2.	<b>Process design of Heat Exchangers:</b> Shell & Tube heat exchangers, Functions of various parts of shell & Tube Heat exchanger, General design method of shell & tube heat exchanger, Criteria of selection among Fixed Tube sheet, U Tube & Floating Head heat exchanger, Process design of without phase change heat exchanger, Process design of condenser, Criteria of selection for Horizontal and vertical condenser, Process design of Kettle type & Thermosyphon Reboilers and vaporizers, Tinker's flow model.	12	26





3.	<b>Process design of Distillation Column:</b> Introduction, Criteria of selection, Selection of equipment for distillation, Distillation column design, Selection of key components for multi- component distillation, Determination of operating pressure for distillation column, Advantages & disadvantages of vacuum distillation, Determination of nos. of theoretical stages for binary distillation by McCabe Thiele method Determination of nos. of theoretical stages for multi-component distillation by Fenskey- Underwood-Gilliland's method, Selection of trays, Calculations for tower diameter & pressure drop of sieve tray tower, Checking of conditions for weeping, down comer flooding, liquid entrainment, etc, tray efficiency, Jet Flooding & down comer Flooding, Different types of weirs & down comers of tray tower, their selection criteria.	11	24
4.	<b>Process design of Absorbers:</b> Introduction, Criteria for selection among different types of absorption equipment, Process Design of packed tower type absorber: Determination of actual amount of solvent, Selection of packing, Determination of tower diameter & pressure drop, Determination of NtoG, HtoG & height of packing, Process design & selection criteria of liquid distributors, redistributors & packing support, Process design of Spray chamber or spray tower type absorber, Venturi Scrubber.	8	18
5.	<b>Mechanical design of Pressure Vessel:</b> Selection of material of construction, Concept of internal & external design pressure, design stress & design temperature, Different types of equipments, Static & rotary equipments, Different types of static equipments, Different types of welding joints, Joint efficiency, Radiography. Mechanical design of shell, head, Jacket, coil, agitator, nozzle, etc.,	7	16

**Suggested Specification table with Marks (Theory/Practical):**

% Distribution of Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	30	20	20	5

**Legends:** R: Remembrance, U: Understanding; A: Application, N: Analyze, E: Evaluate C: Create and above Levels (**Revised Bloom's Taxonomy**)

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Text Books:**

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Introduction to Process Engineering and Design	S B Thakore and B I Bhatt	McGraw Hill	2015	2nd Edition
2.	Coulson & Richardson's Chemical Engineering Design – Volume 6	R. K. Sinnott	Elseveir Butterworth - Heinemann	2005	4 <sup>th</sup> Edition





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3.	Applied process design for chemical and petrochemical plants- Volume 1,2 & 3	Ludwig, E. E.	Gulf professional publishing Butterworth - Heinemann	1997	3 <sup>rd</sup> Edition
4.	Perry's Chemical Engineers' Handbook	Don W. Green, Robert H. Perry	McGraw -Hill, New York	2008	8th Edn
5.	Process Vessel Design	Brownell and Young	Wiley Eastern	2009	Wiley Student Ed
6.	Illustrated process equipment design	S.B. Thakore, D.A. Shah	Atul prakashan	200	4 <sup>th</sup> Edition
7.	Joshi's Process Equipment Design	V V Mahajani, S B Umarji	Trinity	2016	5 <sup>th</sup> Edition
8.	Chemical Process Equipment - Selection and Design	James R. Couper, James R. Fair & W. Roy Penney	Butterworth - Heinemann	2010	2nd Edition
9.	Process Heat Transfer	Kern Donald Q.	McGrawhill	1997	Indian Edition

Course Outcome:

Sr. No.	CO Statement	Marks % weightage
	<b>After learning this subject, students will be able to</b>	
CO-1	Distinguish between process design and mechanical design and Identify the applications of different equipments in process industry and design	15
CO-2	Perform design calculations of various equipments for various applications like Heat exchange, distillation, transport of fluid, absorption etc. along with their safety considerations in chemical process industry.	30
CO-3	Analyse the process parameters and thereby justify the process design and relate the theoretical conditions with the practical one.	25
CO-4	Develop skills to select appropriate material of construction for process equipments and optimum operating parameters.	15
CO-5	Design process equipment and modify the design of existing equipment to new process conditions or new required capacity.	15

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	3	3	2	2	2	3	3	2	3	3	3	3	3
CO-2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Rationale*	15	15	15	15	14	13	14	15	15	14	15	15	15	15	15

Rationale\*: Explaining why it is matching this particular program outcome





**LIST OF PRACTICALS:**

**FOR LAB SESSIONS: Design and Drawing**

- 1] Drawing based on actual design of selected process equipment, such as pressure vessels, storage vessels, heat exchangers, distillation columns, reaction vessels, crystallizers, absorbers, dryers etc.
- 2] Sketches of equipment accessories such as supports, roofs for storage vessel, jackets, cooling coils, tube sheet for heat exchangers, baffles in heat exchangers, trays for distillation column, packing for distillation towers, liquid distributor etc.

**List of Experiments:**

- 1) Calculation of  $(NPSH)_A$  for the given piping system.
- 2) Calculation of optimum pipe size for transportation of fluid.
- 3) Process Design of Heat Exchanger without phase change.
- 4) Process design of condenser.
- 5) Process design of Distillation column using FUG method.
- 6) Calculation of tower diameter and pressure drop.
- 7) Process design of Packed bed Absorbers.
- 8) Steam distribution system design
- 9) Thermic fluid heater design aspects

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**Major Equipment: Nil**

**List of Open Source/learning website:**

- Open source software like DWSIM, COCO, ChemSep
- Video lectures available on the websites including NPTEL lecture series.
- MIT Open course lecture on Equipment design.

**List of Open Source Software:**

- DWSIM, COCO, ChemSep

