


VIT

Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BCHE304L - Chemical Process Technology and Economics

Class NBR(s): 1246

Slot: C1+TC1+TCC1

Max. Marks: 100

Time: Three Hours

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instructions:

- (i) Use Scale, Pencil and Pro-circle to draw the flowsheet
- (ii) For comparison-based questions, write 10 points in each topic
- (iii) Use Graphsheet (if applicable)

COs	CO Statements
CO1	Outline organic and inorganic chemical processes in the industry.
CO2	Explain the manufacture of industrial gases used in the chemical industry.
CO3	Identify the manufacturing processes in the fertilizer industry.
CO4	Describe Sugar, Soap manufacturing and Petroleum refining.
CO5	Understand the economic evaluation concepts as applied in the Chemical Process Industries

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. (a) Explain different types of Portland cement with respect to rate of setting, heat evolution and strength characteristics
(b) Draw a neat flowsheet for the manufacture of Sulfur and Sulfur di-oxide from pyrites
CO1 BL2
2. Explain the manufacture of high purity oxygen and nitrogen with neat flowsheet
CO2 BL2
3. Urea is a vital nitrogenous fertilizer with the highest nitrogen content, making its production a cornerstone of India's agricultural sector. Explain the complete industrial process for the manufacture of urea with neat flowsheet. Additionally, discuss a specific industrial example from India (e.g., a plant from IFFCO or National Fertilizers Ltd.) to illustrate how modern facilities have adopted innovative technologies, such as improved recycling loops or advanced granulation techniques, to enhance efficiency and reduce environmental impact.
CO4 BL4
4. Discuss with neat flowsheet on how modern chemical engineers could propose modifications to existing Solvay process to enhance efficiency and reduce the environmental footprint, where sodium carbonate (soda ash) is a critical component.
CO4 BL2
5. Compare Hydrotreating and Hydrocracking Process
CO4 BL2
6. Describe Fluidized Bed Catalytic Cracking (FCC) Process with neat flowsheet
CO4 BL2
7. Phosphoric acid, a key intermediate in the production of phosphate fertilizers, is primarily manufactured via the wet process. Explain the primary unit operations involved in this "strong acid process," with neat flowsheet which uses sulfuric acid to produce merchant-grade phosphoric acid and chemical fertilizer.
CO3 BL2

8. The modern chemical industry faces a dual challenge: increasing global demand for its products while simultaneously navigating pressing issues of sustainability, resource efficiency, and climate change.

C05 BL4

a) **Process Optimization for Sustainability:** Choose a specific commodity chemical (e.g., ammonia, sulfuric acid, or ethylene) and describe how a chemical engineer could optimize its production process to improve energy efficiency and reduce environmental impact. Discuss at least two specific strategies, such as process intensification, waste heat recovery, or catalyst innovation.

b) **Role of the Chemical Engineer:** Beyond technical optimization, explain the broader role of chemical engineers in addressing these industry challenges. Discuss how their skills in systems thinking, techno-economic analysis, and life-cycle assessment (LCA) can contribute to developing a more circular and sustainable chemical economy.

- 9.a) An integrated pulp and paper mill is implementing advanced technologies to transition towards a circular economy model. With the aid of a simplified process flowsheet, explain the primary unit operations involved in the production of high-quality bleached paper from wood pulp. Also, justify how paper industries enhance their sustainability and energy efficiency by reducing chemical consumption.

C05 BL3

OR

- 9.b) A modern vegetable oil production facility utilizes both mechanical and solvent extraction methods to maximize oil yield from oilseeds. Explain the primary unit operations with neat flowsheet involved in the production of finished vegetable oil, from the initial seed preparation to the final purification stages. Additionally, discuss the importance of solvent extraction in achieving high efficiency and provide an example of how a modern facility manages the solvent for economic and environmental sustainability.

C05 BL3

- 10.a) The purchased price of glass-lined vessels with agitator, baffle, and thermowell is as follows:

C05 BL3

Capacity, gal	Purchased price, FOB factory, \$
500	55,300
750	60,400
1000	66,900
1500	76,800
2000	85,300
3000	109,500
4000	123,000

- (i) Construct a graph of the purchased price as a function of capacity on a logarithmic plot.
- (ii) Determine whether the six-tenths rule applies.
- (iii) Derive an equation of purchase price as a function of vessel size.

OR

- 10.b) A small fluids-processing unit is to be constructed adjacent to a large operating unit in a multiproduct chemical plant. The current purchased equipment costs, FOB at the vendor's factory, are:

Number required	Equipment	Total purchased price
1	Tower and internals	\$375,000
2	Accumulators	182,000
3	Receivers	450,000
6	Heat exchangers	726,000
5	Pumps and motors	200,000
—	Miscellaneous	160,000

If the delivery charges are 5% of the purchased price, estimate the fixed capital investment, using the Hand and Wroth methods.

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