Reg. No: 22BCM0087

BI/K/TX

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BCHE304L - Chemical Process Technology and Economics
Slot: C1+TC1+TCC1
Class NBR(s): 3259
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:

a) Data Sheets can be used by student
b) Use Graph sheets (If necessary)
c) Use Scale, Pencil and Pro-circle to draw the flowsheets

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
2. Explain the manufacture of natural gas with a neat flowsheet.
3. A company plans to study the feasibility by integrating (combining) production of wood pulp by sulfate process and production of white liquor from black liquor (black liquor is used as feed from sulfate process). During the integration (combining), the following recommendations were suggested by the company.
   (i) Use of Blender instead of Mix Tank.
   (ii) Use of single-effect evaporator system instead of multiple-effect evaporator system.
   (iii) Separation of boiler unit and combustion chamber, and use as individual units rather than fused chamber.
   (iv) Use of Electrostatic precipitator instead of Cottrell Precipitator.
   (v) Use of Centrifugation unit instead of Clarifier unit which recovers the sludge from green liquor.
   (vi) Continuous digester unit to be segregated into three separate (individual) units based on difference in temperature.
   (vii) Avoid using Lime Slaker unit. Treat the lime directly in the causticizing tank.

   Draw a neat flowsheet and report as a single flowsheet incorporating all the suggestions recommended by the company during integrating (combining) production of wood pulp by sulfate process and production of white liquor from black liquor (black liquor is used as feed from sulfate process).
4. A leading Indian soap manufacturer, ITC Ltd., produces a popular brand of soap, "Nimbooz," known for its refreshing lime scent. Explain the manufacturing process for Nimbooz soap using a flowsheet. Highlight the key stages involved in industrial soap production and how each stage contributes to the final product characteristics.
5. Describe the primary and secondary process of crude oil processing with a neat flowsheet.
6. Compare Catalytic Reforming Process and Catalytic Cracking Process.

7. A recent surge in global food production has led to increased demand for phosphate fertilizers. Florida Mining and Materials is looking to expand its phosphoric acid and chemical fertilizer production using the strong acid process with sulfuric acid. Describe the key steps involved in this process with a neat flowsheet and explain how the phosphoric acid is converted into a common fertilizer product.

8. With the rise of automation in chemical plants,
   a) How can chemical engineers ensure a balance between economic benefits and workforce considerations?
   b) How can chemical engineers use economic tools to navigate fluctuating raw material prices and ensure supply chain resilience?
   c) How can chemical engineers use techno-economic analysis (TEA) to evaluate the commercial viability of carbon capture and utilization (CCU) technologies?

9. a) The purchased price of glass–lined vessels with agitator, baffle, and thermwell is as follows:

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

(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 purchased price as a function of vessel size.

(OR)

9. 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 the vendor's factory, are:

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

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

10. a) A refinery is planning the addition of a small dewaxing unit. It is estimated that the fixed capital investment is $63MM. Prepare a depreciation schedule using the MACRS method with half-year convention. What is the book value at the end of the fourth year?

(OR)

10. b) Prepare a Balance Sheet for the XYZ Co., for the year ending 31st December 2017 for the following details. All values are in $(000s).

Long-term holdings in equity	2,500		capital receivable	5,000
Prior years' negative income	300		Accounts payable for goods	50
Income for the year	1,925		Legal reserve	1,600
Vehicles	4,000		Payable to public authorities	220
Other owners' contributions	200		Intellectual property	4,000
Interest receivable	50		Expenses paid in advance	270
Inventories	1,000		Short-term credit from tangible fixed assets	500
Shares in the entity	1,000		Capital grants	1,500
Interest payable	10		Provisions for environmental actions	500
Accumulated depreciation of intangible assets	950		Accumulated depreciation of tangible fixed assets	1,000
Customers advances	100		Computers	2,000
Furniture	5,200		Short-term deposits and guarantees given	500
Receivable (income tax refund)	50		Salary payable	20
Short-term debt	2,000		Capital stock	21,000
Cash	1,335		Adjustments in value of cost of sale	50
Long-term debt with credit institutions	2,000		Accounts receivable	200
Constructions	5,000		Constructions in progress	300
Impairment of inventories	100			

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