

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2021-2022

Sub: **CHE 407 (Process Design II)**

Full Marks: 140

Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this section. **Question 1** is compulsory and carries 30 marks.Answer question no 1 and any **TWO** questions from the rest.1. **This question is compulsory.**

(a) A bachelor's degree in chemical engineering will qualify you to get a job as a process engineer or design engineer. (10)

i. After graduation what is your probability of getting a job as a design engineer from a global perspective?

ii. If you were offered a job as a design engineer, would you prefer it over a process engineering job? Support your choice by comparing the scopes and prospects of work of a design engineer and a process engineer.

iii. What additional information would you like to know before you make the final decision?

(b) Any drug formulation is composed of two components namely, active pharmaceutical ingredients (APIs) and inactive ingredients or excipients that serve as a medium for conveying the active ingredient. A local pharmaceutical company wants to establish an API plant for Ibuprofen. (20)

i. What information would you need to set up the project definition? What are the steps to be followed to develop the complete definition of the project?

ii. The company eventually decided to establish a 132 kg/day ibuprofen plant from three raw materials i.e., hydrofluoric acid, acetic anhydride, and isobutyl benzene. The plant will be located in an existing facility at Savar. Write down the project definition of this plant.

iii. The company also wanted to establish a tableting plant with a capacity of 264,000 tablets in 500 mg size tablets per day next to the API plant. Give the project definition of the tableting plant.

2. (a) Investors frequently complain that to start business in Bangladesh clearances from at least 20 different government ministries/authorities are required. Mention three key ministers and three key regulatory authorities whose approvals are required for a chemical plant project. (6)

CHE 407

- (b) We have discussed two cement factories situated in Chhhatak, Sylhet in our class. The source of raw material (i.e., limestones) for both factories is Meghalaya, India, but the means of transporting the raw material to the factories are different. Can you shed light on the reasons behind this difference? (7)
- (c) List the four elements of design philosophy we discussed in our class. Think of two additional elements you would like to consider as a design philosophy for Bangladesh. Justify your choice. (7)
3. (a) "Geological data provides essential information for design engineers to make informed decisions and ensure the safety and longevity of their projects"- Justify this statement by elaborating on the different elements of geological data and how they influence the design basis of a chemical plant project. (7)
- (b) The term "Beyond Design Basis Events" became popular particularly in the nuclear industry after the 2011 Japanese nuclear accidents caused by the Tohoku earthquake and tsunami. Give your thoughts on the term "Beyond Design Basis Events" in light of your answer to question number 3a. (6)
- (c) Write down the scope of basic engineering design (BED). At what stage of engineering design does the work of BED start? Outline the table of contents of basic engineering design report. (7)
4. (a) Why is it necessary to evaluate both the process and process licensor while purchasing a process license? Refer to the evaluation methods of process and process licensors in your answer. (6)
- (b) Currently, the Bangladesh Energy Regulatory commission is finalizing its LPG codes and standards. Name at least three internationally accepted codes and standards that are relevant to LPG. Explain your selection. (4)
- (c) You are planning to establish a condensate refinery in Chattogram. (10)
- i. Would you need to purchase a process license for this plant? Why or why not?
 - ii. List the key processing units/equipment in this plant for which engineering specifications are required. Also, mention the items/information to be covered under engineering specifications.

SECTION – B

There are **FOUR** questions in this section. **Question 5** is compulsory and any **TWO** questions from the rest.

5. **This question is compulsory.**

Select the correct answer. You **MUST** give reasons for your selection. It carries 32 marks

- (a) Front End Engineering Design (FEED) is done: **(4x8=32)**
- i) After Basic Engineering Design
 - ii) During Detailed Engineering
 - iii) During Project Definition
 - iv) None of the above
- (b) Engineering documentation for fabrication includes:
- i) PBD
 - ii) Foundation drawings
 - iii) P&I diagram
 - iv) All of the above
- (c) Procurement is the sole responsibility of EPC-
TRUE/FALSE
- (d) Scope of work for EPC includes
- i) Basic and Detailed Engineering
 - ii) Transportation and Shipping
 - iii) Approval of Engineering Documents
 - iv) Only (i) and (ii)
 - v) All of the above
- (e) " It is a difficult task for both the client and bidder to conclude a fair deal during negotiation with a sense of satisfaction for both -
TRUE/FALSE
- (f) During procurement of heat exchanger the scope of supply for the Vendor include:
- ii) Checking of Data Sheet
 - iii) Welding procedure
 - iv) Performance Test
 - v) All of the above
- (g) Inspection includes:
- i) Checking of applicable codes and standard
 - ii) Review and approval of fabrication methods
 - iii) Review of HAZOP procedure adopted
 - iv) All of the above
 - v) None of the above
- (h) "There are mainly 4(FOUR) Types of Performance Tests"- TRUE/FALSE

CHE 407

6. (a) Distinguish between procurement activates of a "Process Plant Project" and an "Operating Plant". Which do you think is more difficult? Give reasons for your answer. (7)
- (b) Which type of inspection could have prevented the "Bhopal Disaster"? Do you think same type of inspection should have been done to prevent the "Ghorasal Stripper Accident"? Give reasons for your answer. (6)
- (c) Which types of equipment would you "Overdesigned" in the plant you have designed in your ChE 408 project? Give reasons. (6)
7. (a) When and why does an EPC firm raise questions regarding the "Design Basis" provided by the Client? (5)
- (b) Sometimes FEED is divided into 3 parts. Why? Who benefits most by this division? (5)
- (c) During Negotiation with a Vendor, the latter suggests a new type of equipment which they have in their stock. What will be your reaction as a Client? How will you proceed with the negotiation? (9)
8. (a) A Client wishes to go for "SINGLE ENVELOPE" system for procurement of pipes and valves. What will be your advice? Justify. (7)
- (b) For your ChE 408 process plant design project, which items in your plant would you consider to be "Time and Process" critical? Justify. (7)
- (c) Why three types of steady state are to be established during performance test of individual equipment/package unit? (6)

SECTION - A

There are **FOUR** questions in this section. **Question No 1 is compulsory and carries 60 marks.**

Answer any **TWO** questions from the rest. Symbols have their usual meaning unless otherwise specified. Assume any reasonable values.

1. (a) In the ChE 408 course, a group of students designed a chemical plant starting from design basis and process selection to detail equipment design. The group has listed all the major equipment and corresponding prices based on available web data. After doing all the necessary capital investment, annual production cost, and profit analysis, the following information was obtained.

Total capital investment	\$5000k
Annual revenue	\$2500k
Annual Expenses	\$1000k
Salvage Value	10% of the initial investment
Useful Life	8 years

In addition to their design, the capital structure of the plant is to be developed too. As a huge amount of capital investment is required for the plant, 60% debt capital and 40% equity capital structure has been selected for borrowing all the necessary money. The income tax for this industry is 27.5%. For the common stock, price of the per share is \$120, dividend is set at \$11.5 per share with an expected 5% growth per year. The risk index, β coefficient, is 1.16 for this company in the share market. The risk-free return rate of the govt. bond is 12% and debt capital is raised at an interest rate of 15%.

- (a) Determine the cost of the equity capital on the discounted cash flow method and CAPM also determines the composite cost of capital for the plant capital structure. **(5+5=10)**
- (b) If the company considers its composite cost of capital as the MARR of the plant, evaluate the economic feasibility of the project through the ERR method. **(10)**
- (c) What is the payback period of the plant? What is your comment on the feasibility and liquidity of the plant based on the calculated payback period? **(10+2=12)**
- (d) As most equipment and material prices are taken from web-based information, there are some uncertainties with the evaluation. The sensitivity of the project with the investment, useful life, and net annual cash flow (Revenue-expenses) was done to investigate whether the factors can change the feasibility of the project. Figure Q1 is the developed spider plot for the project varying the three factors over $\pm 40\%$.

CHE 411

Contd ... Q. No. 1(d)

- (i) List the decision reversal points for the three factors from the figure. On which factors, the project is most sensitive based on the relative degree of sensitivity? **(4+4=8)**
- (ii) If the investment changes from -15% to +20% and net annual cash flow changes from -30% to +10%, analyze whether the project is sensitive to the combined effect of the two sectors with appropriate graphical representation. **(20)**
2. A countryside locality has abundant forest on the east side of it. As wood availability is high in this region, lumber and wood-based industry flourished here. This leads the economy of this locality to depend solely on three industries: lumber and wood products, paper and allied products, and machinery and transportation equipment. An external consultancy firm audited the economy of this region in 2019 and found that on that year the lumber industry had an output valued at \$500k. Of total production, 5% was consumed by itself; 70% was passed as final market demand, and 20% by the paper and allied products industry. The equipment industry used 15 percent of its own products, out of a total of \$1000k; 25% went to final demand; 30% to the lumber industry, and 30% to the paper and allied products industry. Finally, the paper and allied products industry produced \$750k, of which it consumed 6%; 80 percent went to final demand and 8% to the equipment industry.
- (a) Construct the input-output table and the direct requirement matrix for this three-sector economy from the above information. **(5+5=10)**
- (b) Starting from the basic input-output table for multi sector-based economy, develop the Leontief relationship between the total direct-indirect demand to the final demand with appropriate assumptions. **(15)**
- (c) Due to COVID-19-related lockdown, the economy saw a recession. The final market demand for wood & lumber products and machinery and transportation equipment-based industry decreased by 25% and 10% in 2021. However, the consumer-level demand for papers increased sharply to 15%. What would be the total production of all industries required to supply this new final demand? Also, find out the new input-output table and compare it with the 2019. **(10+5=15)**
3. (a) A manufacturing company produces ice cream and yogurt in pint-sized containers. As the consumer ultimately dumps the packaging in the landfills, the environment impact of the post-disposal of the packaging raised concern for the company. The production and sustainability department came up with two possible packaging solutions for the manufactured product-in quart containers or half gallon containers. The higher sizes compared to the current pint containers reduce the labor costs, per gallon packaging costs, and less discarded packaging per pound of the product in the landfills. However, there are additional equipment purchase and installment costs. The total cost breakdown of the proposal with the current packaging practice is in the table- **(25)**

CHE 411
Contd ... Q. No. 3(a)

	Containers		
	Pint-sized	Quarts	Half Gallon
Additional Capital Investment	0	1200k	1900k
Packaging cost per gallon	0.256	0.225	0.210
Labor cost per gallon	0.128	0.120	0.119
Landfill contribution from post-consumer disposal	6500 yd ³ /yr.	5200 yd ³ /yr.	4050 yd ³ /yr.
Useful life	5	7	8

As a company closely following environmental sustainability, 50% of landfill processing costs due to the post-consumer disposal of the packaging is covered by the company. The average landfill processing charge due to this kind of container is \$25 per cubic yard of landfill. The annual ice cream and yogurt production is 10.625 million gallon and the company's MARR is 16.5%.

With the provided information, which of the following MEA packaging proposal should be selected for the company with analyzing IRRs? Should the company select quarts or a half gallon or stick to the current pint-sized packaging?

(b) Emily got a Ph.D. admission to the Georgia Institute of Technology five years ago without funding. Because of that, she planned to take the most common Stafford student educational loan scheme which is under the US government. The students can take loans based on that year's interest rate and this floating interest rate gets readjusted each year. She borrowed \$4250 four years ago when the interest rate was 4.5%, \$5600 three years ago at a 3.45% interest rate, and \$7500 two years ago with a 6.05% interest rate. Now in the current year, after graduating from school, she got a job and earned enough to pay all the loans in equal annual payments. She wants to save some money first and then start the loan payment 2 years from now at 5% fixed annual interest rate. If the plan is to pay all the money in 10 equal payments, what should be the amount of each payment? (15)

4. (a) The city council of Oak Ridge is evaluating to undertake suitable refurbishing landscaping plans to improve public greenways. The plans are independent and more than one plan can undertaken but the federal budget is limited and the city council approved a total \$150,000 initial investment budget. The benefits to the city community, the initial investment costs due to planting trees and shrubbery, and annual maintenance costs are tabulated by the landscaping committee. (25)

	Landscaping Plans		
	A	B	C
Initial Planting cost	\$75,000	\$65,000	\$90,000
Annual Maintenance	\$4,500	\$5,000	\$4,750
Annual Community Benefits	\$27,000	\$24,250	\$30,000
Planning horizon	18	16	20
Discount Rate	8%		

Evaluate the best possible refurbishing plans by analyzing the modified B-C Ratio.

CHE 411
Contd ... Q. No. 4

(b) The Universal Postal Service is considering the possibility of fixing wind deflectors on the tops of 500 of their long-haul tractors. Three types of deflectors, with the following characteristics, are being considered.

(15)

	Deflectors		
	Windshear	Blowby	Air-vantage
Capital Investment	\$1500	\$750	\$1800
Drag Reduction	20%	10%	25%
Maintenance per year	\$16	\$10	\$8
MARR	15%		

If 15% in drag reduction means 2% in fuel savings per mile, how many miles do the tractors have to be driven per year before the wind shear deflector is favored over the other deflectors? Over what range of miles driven per year is air-vantage the best choice? Fuel cost is expected to be \$5.00 per gallon, and average fuel consumption is 5 miles per gallon without the deflectors. State any assumptions you make.

SECTION – B

There are **FOUR** questions in this section. **Question No 5 is compulsory and carries 60 marks.**

Answer any 2 questions from the rest of the 3 questions.

The symbols have their usual meanings if explained.

5. Multiple choice questions - there is only one answer. You must provide explanation/ justification to support your answer. (15×4=60)

(a) Rahman is a successful entrepreneur, so he probably emphasizes which of the following dimensions in his work?

- (i) innovativeness
- (ii) minimizing risks
- (iii) reacting to events rather than being proactive
- (iv) none of the above

(b) The ethical dilemma of choosing between two rights refers to

- (i) choosing between the lesser of two evils.
- (ii) deciding which of two employee rights is the most important.
- (iii) deciding to offer a bribe or lose out on an important opportunity.
- (iv) choosing between two types of sexual harassment.

CHE 411

Contd ... Q. No. 5

- (c) Diversity refers to
 - (i) people with different group identities within the same work environment.
 - (ii) developing the right foreign language skill.
 - (iii) acquiring valid information about the firm's target market.
 - (iv) reducing the trade deficit.
- (d) An important part of defining the present situation in strategic planning is
 - (i) developing budgets.
 - (ii) examining internal capabilities and threats.
 - (iii) making forecast about future opportunities.
 - (iv) establishing goals and objectives.
- (e) A key difference between a vision and a mission is that
 - (i) the mission relates more to today's realities.
 - (ii) a mission is set farther into the future.
 - (iii) a vision does not deal with products or services.
 - (iv) a vision deals more with operations.
- (f) In relation to enhancing your creativity, a recommended technique is to
 - (i) solicit feedback on your performance.
 - (ii) avoid feedback on your performance.
 - (iii) minimize a risk-taking attitude.
 - (iv) stick with a problem when facing a creativity block.
- (g) A major impact of artificial intelligence (AI) on decision making is that it provides
 - (i) a stimulus for managers to become tech savvy.
 - (ii) limits to the amount of data to be analyzed.
 - (iii) an alternative to using human judgment.
 - (iv) additional data for making many types of decisions.
- (h) The critical path is the path through the PERT network with the
 - (i) shortest completion time
 - (ii) longest completion time
 - (iii) most probable time
 - (iv) pessimistic time
- (i) One of the reasons that bureaucracies have endured is that they
 - (i) provide ample opportunity for risk taking and thrill seeking.
 - (ii) help satisfy people's need for order and security.
 - (iii) were designed with the age of the Internet in mind.
 - (iv) are almost immune to downsizing.

CHE 411
Contd ... Q. No. 5

- (j) A wide span of control is advised when
 - (i) there is considerable flux in the work setting.
 - (ii) group members perform quite different tasks.
 - (iii) group members are physically dispersed.
 - (iv) group members and the manager are highly capable.
- (k) When a leader empowers employees, the leader accepts them as
 - (i) part of his or her zone of indifference.
 - (ii) workers with higher rank than himself or herself.
 - (iii) partners in decision making.
 - (iv) leaders by example.
- (l) The major informal communication channel in an organizations is referred to as the
 - (i) grapevine.
 - (ii) company log.
 - (iii) intranet.
 - (iv) company website.
- (m) Tania is gathering her thoughts to send a message to a difficult customer. She is going through the process of
 - (i) transmitting.
 - (ii) using nonverbal communication.
 - (iii) decoding
 - (iv) encoding
- (n) Whereas data are raw unformatted symbols or lists of words or numbers, information is _____
 - (i) data that have been organized in a form that is useful
 - (ii) accumulated knowledge
 - (iii) what you enter into your computer
 - (iv) what your computer prints out for you
- (o) Teams in organizations emphasize type of communication?
 - (i) downward
 - (ii) horizontal
 - (iii) upward
 - (iv) diagonal

6. (a) The table below describes the elements of a project.

(40)

Activity	A	B	C	D	E	F	G	H	I	J
Predecessor	-	-	-	A	A	C	B,C,D	C,D,E	E,G	B,D,F
Duration (weeks)	5	9	8	6	10	7	3	12	8	10

Construct and arrow network and compute (i) the project completion time; (ii) the critical path; and (iii) the total float and free float for each activity.

CHE 411

- 7 (A) It is common now-a-days to start trial-period subscription of various web-based software. It is also common that people may not take action to cancel the subscription before the trial-period ends, leading to people paying for and retaining the service. What is your view on the following? (20)
- (i) Should companies automatically cancel subscription at the end of free trial periods?
 - (ii) Should you as user, subscribe to software for your professional work for trial-period only and then cancel it before the trial ends? Should you subscribe to the same software once more for trial-period using a different email address?
- (b) In your opinion, what are the four major barriers to organizational communication? What do you propose to overcome those barriers? (20)
8. (a) Over the years, large business organizations have steadily reduced the number of layers in the organization structure. Do you agree with this approach? What purposes has this profound change in structure served? Provide justification for your answer. (15)
- (b) A fast-food chain insists that the managers get some experience working the front lines. Do you think such experiences are important for a future executive? Why? (15)
- (c) To what extent do you think communication technologies will eliminate face-to-face meeting in the workplace? (10)
-

= 8 =

Figure for Question 1(d)

