Outcome Based Education (OBE) Curriculum
B.Sc. Engineering Program

Department of Chemical Engineering and Polymer Science

Session: 2024-2025

Shahjalal University of Science and Technology Sylhet-3114, Bangladesh

Part A

1. Title of the Academic Program:
Bachelor of Science (Engineering)

2. Name of the University:
Shahjalal University of Science and Technology (SUST)

3. Vision of the University:
To be a leading university of excellence in Science and Technology with a strong national commitment and significant international impact

4. Mission of the University:

SUST M1:	To advance learning and knowledge through teaching and research in science and technology
SUST M2:	To serve as a center for knowledge creation, technological innovation and transfer among academia, industry, and society
SUST M3:	To assist in transferring Bangladesh a country with sustainable economic growth and equitable social development

5. Name of the Program Offering Entity:
Chemical Engineering and Polymer Science

6. Vision of the Program Offering Entity:
To establish the department of Chemical Engineering and Polymer Science as a leading and world class department in the field of engineering education and research.

7. Mission of the Program Offering Entity:
CEP will be in possession of highly developed and regularly updated curricula that comply with the national and international job market demands. It will have highly qualified and devoted academic staff for teaching and research. High quality graduates with personal skills, ethical values and awareness of the needs of technological advancements, and capable of competing in national and international education, research, and industrial sectors, will be produced through excellence in teaching-learning and research in the department. The ultimate goal of the department is to be established as one of the leading Institutions in the world for education and research in the field of chemical engineering and as such it shall-

1. Play a significant role in the development of scientific and technological education in the related fields.
2. Take active part in solving every day and pertinent problems of the industries in the country.
3. Expand its function as a training center for engineers and workers engaged in chemical industries.
4. Establish partnership with leading education and research institution in the world for student and staff exchange.
5. Develop research center (RC) in the department devoted to research in specialized fields.

8. Objectives of the Program Offering Entity:
The Department of CEP as one of the most active disciplines under the School of Applied Sciences and Technology takes active part in the formation of the philosophy of engineering education in SUST and as such shares the common values and objectives of the school, and they are:

1. The main objective is to serve mainly national industrial sectors, especially, process, polymer and pharmaceuticals.
2. To provide education that focuses on the relationship among engineering people, society and nature.
3. To develop in the graduate-engineers logical thinking, analyzing and integrating abilities.
4. To develop in the graduate-engineers broad outlook, adaptability and creativity for self-enlightenment and study.
5. To develop in the graduate-engineers adaptability to continuously advance in technology.
6. To develop in the graduate-engineers high communications ability.
7. To maintain an updated curriculum of engineering education.

9. Name of the Degree:
Bachelor of Science (Engineering) in Chemical Engineering and Polymer Science

10. Description of the Program:
The department of Chemical Engineering and Polymer Science (CEP) was established in 1993 at Shahjalal University of Science and Technology (SUST) under the school of Applied Sciences & Technology. This is one of the few departments in Bangladesh educational institutions that offer undergraduate and graduate program in Chemical Engineering. Along with general chemical engineering preparation, special attention is given to the specialization

of the graduates in polymer engineering and technology. This is a unique department in the country of its type producing graduates on chemical engineering specialized to some extent in polymer engineering. Having in mind the intensive growth of chemical and polymer industries in Bangladesh, the offer of such an engineering program is correct and in time. The placement of the graduates of this department in different industrial sectors justifies the decision of the establishment of the department. The curriculum of the department provides the graduates with strong foundation on chemical and polymer engineering. The department has a long record of academic achievements by commitment to excellence in teaching and pursuance of high-quality research. The undergraduate program in Chemical Engineering and Polymer Science (CEPS) is accredited by Board of Accreditation for Engineering and Technical Education (BAETE) and the graduates of the program are recognized as the members of Institute of Engineers of Bangladesh (IEB).

The teaching staff of the department consists of Seven Professors, seven Associate Professors, seven Assistant Professors and four Lecturers. The faculty members are specialized in diversified research areas such as water and wastewater treatment technology, membrane technology, material science and nanotechnology, environmental engineering, polymer concrete materials, renewable energy, bioprocess engineering, chemical process safety as well as process engineering. At present, the department has 11 staffs (Lab and office), 225 undergraduate and 25 graduate students. It provides 160 credits at undergraduate level per year. The department has 8 laboratories, 1 workshop and 3 classrooms.

The relationship among the students, academic staff, and the non-academic staff is cordial, sincere and very friendly, and that feelings are carried on even after the graduation of the students. In absence of a job-seeking unit in the department, the alumni are very active in providing information about job opportunity and higher study in home and abroad.

11. Graduate Attributes (based on need assessment):

CEP graduates shall have the following attributes-

1. **Engineering Knowledge:** Apply the knowledge of basic sciences and engineering fundamentals, and technical approaches to the solution of engineering problems.
2. **Problem analysis:** Identify, formulate, consult relevant literature and analyze problems from engineering viewpoint.
3. **Complex problem investigation**: Use theoretical and practical knowledge to design experiments, analyze and interpret data, and synthesize the information to draw valid conclusions.
4. **Modern tool usage**: select and apply appropriate techniques, resources, and modern engineering and IT tools with an understanding of the limitations.
5. **Adaptation to society**: assess social, health, safety, legal and cultural issues, and the responsibilities relevant to the professional engineering practice.
6. **Commitment to sustainable solutions**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
7. **Adherence to ethical principles:** apply professional ethics, norms and responsibilities in engineering practices.
8. **Functionality in individual and teamwork:** Function effectively both individually and as a member/leader in diverse teams, and in multidisciplinary settings.
9. **Ability of communication:** Communicate effectively with engineering community, policy makers, stakeholders, and society at large
10. **Project management ability:** Demonstrate knowledge and understanding of the engineering and management principles in multidisciplinary environments.
11. **Life - long learning desire:** possess desire and readiness to assimilate new knowledge and techniques emerging continuously in rapidly developing technological world.

12. Program Educational Objectives (PEOs):

Graduation from the Chemical Engineering and Polymer Science (CEPS) program implies skill of the following PEOs:

PEO1: To make the graduate to build their careers in industry, academia, or Government

PEO2: To obtain, apply and transfer knowledge across disciplines and into emerging areas of Chemical Engineering, Polymer Science, and related fields

PEO3: To communicate effectively, be leaders in their professional fields and work competently in interdisciplinary teams

PEO4: To be professionally responsible and ethical in professional activities to meet the Sustainable Development Goals (SDGs)

PEO5: To be engaged in professional activities to impact the society on a global scale

13. Program Outcomes (POs):

Graduation from the CEPS program signifies attainment of the following POs:

A. Fundamental Skills	
PO1	**Engineering Knowledge:** Ability to apply acquired theoretical knowledge of mathematics, physics, chemistry, natural science, engineering fundamentals and specialization in the field of Chemical Engineering and Polymer Science.
PO2	**Problem Analysis:** Ability to identify, formulate, design and conduct experiments as well as to analyze complex engineering problems on experiments relevant to Chemical Engineering and Polymer Science practice.
PO3	**Design/Development of Solutions:** Ability to design a system component or process to meet the desired needs within realistic constraints such as economic, environmental, health and safety, social, political, ethical, and sustainability.
B. Social Skills	
PO7	**Environment and Sustainability:** Ability to understand the impact of engineering solutions in a global, economic, environmental and societal context.
PO10	**The Engineer and Society:** Deep understanding of ethics, health, safety, legal and cultural issues, and their responsibility to society in professional engineering practice.
PO11	**Communication:** Ability to comprehend and write reports, design documentation, make presentations, and give and receive clear instructions as well as communicate effectively with engineering community, policy makers, stakeholders and society at large.
C. Thinking Skills	
PO4	**Investigation:** Ability to investigate complex chemical engineering problems based on experimental design and interpret data to provide valid conclusion.
PO5	**Ethics:** Understanding and realization of professional ethics, responsibilities and the norms of engineering practice.
D. Personal Skills	
PO6	**Modern Tool Usage:** Ability to use the technical skills, modern and computer aided engineering tools for Good Chemical Engineering and Polymer Science Practices
PO8	**Individual Work and Teamwork:** Ability to function in multidisciplinary teams and play effective managerial role.
PO9	**Life-long Learning:** Ability to recognize the need for engaging lifelong learning and a knowledge of contemporary issues
PO12	**Project Management and Finance:** Ability to demonstrate knowledge of engineering and financial management as well as to understand project management principles and practice in multidisciplinary environments as a team member or a leader.

14. Mapping mission of the university with PEOs

PEOs	SUST M1	SUST M2	SUST M3
PEO 1	√	√	
PEO 2	√	√	
PEO 3		√	√
PEO 4			√
PEO 5			√

15. Mapping POs with the PEOs

	PEO 1	PEO 2	PEO 3	PEO 4	PEO5
PO 1	√	√			
PO 2	√	√	√		
PO 3		√	√	√	√
PO 4	√	√			
PO 5				√	
PO 6		√	√		
PO 7				√	√
PO 8			√		√
PO 9				√	√
PO 10					√
PO 11			√		
PO 12	√		√		

16. Mapping courses with the POs

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CEP 0711 1151*	√	√	√	√								
CEP 0711 1152	√	√	√	√		√	√	√	√	√		
CEP 0711 1153	√	√	√	√				√				
CEP 0711 1155	√	√	√	√			√	√	√			
CHE 0531 1109B	√	√		√					√			
ENG 0231 1101							√	√	√		√	
IPE 0732 1102B	√		√			√		√	√			
MAT 0541 1101B	√	√		√					√			
SSS 0222 1101									√	√	√	√
CEP 0711 1271	√	√						√	√			
CEP 0711 1272	√	√	√	√		√		√				
CEP 0711 1273*	√	√	√					√	√		√	
CEP 0031 1274*	√			√	√		√	√	√		√	√
EEE 0713 1205B	√	√		√		√		√	√			
EEE 0713 1206B	√	√	√			√		√			√	
MAT 0541 1203B	√	√	√	√					√			
PHY 0533 1209B	√					√			√			
STA 0542 1205B	√	√		√				√	√			
CEP 0711 2151*	√	√	√	√		√	√	√	√			
CEP 0711 2152	√	√		√		√		√	√			
CEP 0531 2153*	√	√	√						√			
ECO 0311 2105B	√											
IPE 0715 2103B	√	√	√			√	√					
IPE 0715 2108B			√			√		√				

MAT 0541 2101B	√	√	√	√					√			
SOC 0134 2101B			√		√		√	√	√	√	√	
CEP 0711 2271*	√	√	√	√				√	√		√	√
CEP 0531 2272	√	√		√		√		√			√	
CEP 0711 2273*	√	√	√	√				√				
CEP 0711 2274	√	√	√	√	√		√	√	√			
CEP 0031 2278*	√			√	√		√	√	√		√	√
CSE 0613 2204B		√			√		√					√
IPE 0715 2205B	√	√	√	√					√			
MAT 0541 2203B	√	√							√			
CEP 0711 3150	√		√	√				√	√		√	√
CEP 0711 3151*	√	√	√	√		√	√	√	√	√		√
CEP 0711 3152	√	√		√		√	√	√	√			
CEP 0711 3153	√	√	√	√	√	√	√		√			
CEP 0711 3155	√	√		√		√		√	√			
CEP 0711 3156	√	√	√	√		√		√	√		√	
CEP 0711 3157	√	√	√	√			√		√	√		√
CEP 0711 3158		√	√			√	√			√		√
CEP 0531 3159*	√	√		√					√			
CEP 0711 3270	√	√	√	√	√	√	√	√	√	√	√	
CEP 0711 3271*	√	√	√	√		√		√	√			
CEP 0611 3272	√	√	√	√		√	√	√	√			
CEP 0711 3273	√	√	√	√		√	√	√				
CEP 0531 3274	√	√	√	√		√			√	√		
CEP 0711 3275	√	√	√	√					√			

CEP 0711 3276	√	√	√	√		√		√			√	
CEP 0711 3277*	√	√	√	√		√	√	√	√			
CEP 0031 3278*	√			√	√		√	√	√		√	√
CEP 0711 3279	√	√	√	√		√	√	√	√	√		√
CEP 0711 4150*	√	√	√	√		√	√		√	√		
CEP 0531 4151*	√	√	√			√	√	√		√		
CEP 0711 4152	√	√	√	√		√						
CEP 0711 4154#	√	√	√	√		√	√	√	√		√	√
CEP 0711 4155	√	√	√	√	√		√	√	√	√	√	√
CEP 0711 4157*	√	√	√	√		√	√	√			√	
CEP 0711 4159	√	√	√	√		√	√	√				
CEP 0711 4263*	√	√	√	√		√	√		√	√		√
CEP 0711 4254#	√	√	√	√		√	√	√	√		√	√
CEP 0711 4271*	√	√	√	√		√	√	√	√	√	√	√
CEP 1022 4273*	√	√	√	√	√	√	√	√	√	√	√	√
CEP 0712 4275*	√	√	√	√		√	√	√				
CEP 0031 4278*	√	√	√		√		√	√	√		√	
CEP 0711 4270**#	√	√	√	√	√		√	√			√	√
CEP 0711 4280**#	√	√	√	√	√	√	√				√	√
CEP 0711 4281	√	√	√	√		√						
CEP 0723 4283	√						√		√			
CEP 0711 4285	√	√	√	√	√	√	√	√	√	√	√	
CEP 0711 4287	√	√	√	√	√	√		√		√		√
CEP 0711 4289	√	√	√	√		√			√			

CEP 0531 4291	√	√	√	√		√	√		√	√	√	√
CEP 0531 4293	√	√						√	√			
CEP 0711 4295	√	√	√				√		√			

Part B

17. Structure of the Curriculum

a) Duration of the program:
Years: Four (04)
Semesters: Eight (08)

b) **Admission Requirements:**
as per the rules and regulations set by academic council, SUST. In order to be eligible for the admission test for the Department of Chemical Engineering and Polymer Science, a student must have completed the national curriculum with a cumulative grade point average (CGPA) of at least 3.00 (both in S.S.C. and H.S.C./equivalent, science background), and the total CGPA for S.S.C. and H.S.C./equivalent, science background should be 7.00. A candidate passing through G.C.E system must have at least B grade in 3 subjects and pass in 5 subjects at O level, and B grade in 2 subjects and pass in 3 subjects at A level to qualify. In addition, a student must satisfy an additional requirement; at least 3.5 in H.S.C/Equivalent or B grade in G.C.E A level in chemistry and mathematics.

c) **Graduating credits:** 160

d) **Total class weeks in a semester:** 14

e) **Minimum CGPA requirements for graduation:** 2.00

f) **Maximum academic years of completion:** Six (06)

g) Category of Courses:

Course category		Courses		Credits
Core	**Theory**	1. Elements of Chemical Engineering – I 2. Introduction to Physico-Chemical Changes of Matters 3. Structure and Properties of Substances 4. Analytical Methods for Chemical Process Industries 5. Elements of Chemical Engineering – II 6. Fluid Mechanics 7. Principles of Polymerization 8. Chemical Engineering Thermodynamics 9. Heat Transfer 10. Chemical Process Technology–I 11. Mass Transfer–I 12. Chemical Process Technology–II 13. Instrumental Methods of Analysis 14. Fuel and Energy 15. Bioprocess Engineering	16. Introduction to Engineering Materials 17. Chemical Reaction Engineering 18. Polymer Characterization and Properties 19. Fundamentals of Electrochemical Engineering 20. Mass Transfer– II 21. Process Design 22. Polymer Processing and Applications 23. Environmental Engineering 24. Industrial Economics and Management 25. Process Control 26. Corrosion Engineering 27. Process Safety Engineering 28. Elective	75
	Sessional	1. Laboratory Safety and elementary operation sessional 2. Equilibrium in Solution: Engg. Aspects Sessional 3. Oral Examination - I 4. Fluid Mechanics Sessional 5. Polymer Science and Engg. Sessional 6. Industrial Tour 7. Heat Transfer Sessional 8. Industrial Process Calculation Sessional 9. Oral Examination - II 10. Chemical Process Principles Sessional 11. Fuel and Energy Sessional 12. Field Work/In-plant Training–I	13. Introduction to Software for Chemical Engineers 14. Polymer Characterization Sessional 15. Mass Transfer Sessional 16. Oral Examination - III 17. Process Unit Operations and Process control (Training) 18. Chemical Reaction Engineering Sessional 19. Plant Design 20. Oral Examination - IV 21. Project/Thesis	41

General Education	**Theory**	1. History of the Emergence of Independent Bangladesh 2. Effective Communication in English 3. Calculus with analytic Geometry 4. Organic Chemistry 5. Matrix and Vector Calculus 6. General Statistics 7. Principles of Economics 8. Basic Electrical and Electronic Circuits 9. Magnetism and Modern Physics 10. Industrial Sociology 11. Differential Equations & Mathematical Methods 12. Engineering Mechanics 13. Mechanics of Solids 14. Numerical Analysis	40
	Sessional	1. Engineering Graphics 2. Basic Electrical and Electronic Circuits Lab 3. Workshop Practice Sessional 4. Introduction to Programming with Python Lab	7
		Total Credits:	163

18. Year/Level/Semester/Term wise distribution of courses

First Year First Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 1151*	Elements of Chemical Engineering – I	Core	3	0	3.0	
CEP 0711 1152	Laboratory Safety and elementary operation sessional	Core	0	4	2.0	
CEP 0711 1153	Analytical Methods for Chemical Process Industries	Core	2	0	2.0	
CEP 0711 1155	Introduction to Physico- Chemical Changes of Matters	Core	3	0	3.0	
CHE 0531 1109B	Organic Chemistry	General Education	2	0	2.0	
ENG 0231 1101	Effective Communication in English	General Education	2	0	2.0	
IPE 0732 1102B	Engineering Graphics	General Education	0	3	1.5	
MAT 0541 1101B	Calculus with analytic Geometry	General Education	3	0	3.0	
SSS 0222 1101	History of the Emergence of Independent Bangladesh	General Education	3	0	3.0	
Total			18	7	21.5	

First Year Second Semester

Course Code	**Course Title**	**Course Category**	**Hours/Week**		**Credits**	**Prerequisite**
			Theory	**Lab**		
CEP 0711 1271	Structure and Properties of Substances	Core	2	0	2.0	
CEP 0711 1272	Equilibrium in Solution: Engg. Aspects Sessional	Core	0	4	2.0	CEP 0711 1153
CEP 0711 1273*	Elements of Chemical Engineering – II	Core	3	0	3.0	CEP 0711 1151*
CEP 0031 1274*	Oral Examination - I	Core	0	0	1.0	
EEE 0713 1205B	Basic Electrical and Electronic Circuits	General Education	3	0	3.0	
EEE 0713 1206B	Basic Electrical and Electronic Circuits Lab	General Education	0	3	1.5	
MAT 0541 1203B	Matrix and Vector Calculus	General Education	3	0	3.0	
PHY 0533 1209B	Magnetism and Modern Physics	General Education	3	0	3.0	
STA 0542 1205B	General Statistics	General Education	3	0	3.0	
Total			**17**	**7**	**21.5**	

Second Year First Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 2151*	Fluid Mechanics	Core	**3**	**0**	**3.0**	
CEP 0711 2152	Fluid Mechanics Sessional	Core	**0**	**4**	**2.0**	CEP 0711 2151*
CEP 0531 2153*	Principles of Polymerization	Core	**3**	**0**	**3.0**	CHE 0531 1109B
ECO 0311 2105B	Principles of Accounting and Management	General Education	**3**	**0**	**3.0**	
IPE 0715 2103B	Engineering Mechanics	General Education	**3**	**0**	**3.0**	
IPE 0715 2108B	Workshop Practice Sessional	General Education	**0**	**2**	**1.0**	
MAT 0541 2101B	Differential Equations & Mathematical Methods	General Education	**3**	**0**	**3.0**	
SOC 0134 2101B	Industrial Sociology	General Education	**3**	**0**	**3.0**	
Total			**18**	**6**	**21.0**	

Second Year Second Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 2271*	Chemical Engineering Thermodynamics	Core	3	0	3.0	CEP 0711 1155
CEP 0531 2272	Polymer Science and Engg. Sessional	Core	0	4	2.0	CEP 0531 2153*
CEP 0711 2273*	Heat Transfer	Core	3	0	3.0	CEP 0711 1273*
CEP 0711 2274	Heat Transfer Sessional	Core	0	4	2.0	CEP 0711 2273*
CEP 0031 2278*	Oral Examination- II	Core	0	0	1.0	
CSE 0613 2204B	Introduction to Programming with Python Lab	General Education	0	6	3.0	
IPE 0715	Mechanics of	General	3	0	3.0	IPE 0715
MAT 05412203B	Numerical Analysis	General Education	3	0	3.0	
Total			**12**	**14**	**20.0**	

Third Year First Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 3150	Industrial Tour	Core	0	0	1.0	
CEP 0711 3151*	Mass Transfer–I	Core	3	0	3.0	
CEP 0711 3152	Chemical Process Principles Sessional	Core	0	4	2.0	CEP 0711 1155
CEP 0711 3153	Chemical Process Technology–I	Core	2	0	2.0	
CEP 0711 3155	Instrumental Methods of Analysis	Core	3	0	3.0	
CEP 0711 3156	Industrial Process Calculation Sessional	Core	0	4	2.0	CEP 0711 1151* CEP 0711 1273*
CEP 0711 3157	Fuel and Energy	Core	3	0	3.0	
CEP 0711 3158	Fuel and Energy Sessional	Core	0	2.0	2.0	
CEP 0531 3159*	Polymer Characterization and Properties	Core	2	0	2.0	CEP 0531 2153*
Total			**13**	**10**	**20.0**	

Third Year Second Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 3270	Field Work/In-plant Training–I	Core	0	4	2.0	
CEP 0711 3271*	Chemical Reaction Engineering	Core	3	0	3.0	CEP 0711 1155 CEP 0711 2271
CEP 0611 3272	Introduction to Software for Chemical Engineers	Core	0	4	2.0	
CEP 0711 3273	Chemical Process Technology–II	Core	2	0	2.0	
CEP 0531 3274	Polymer Characterization Sessional	Core	0	4	2.0	CEP 0531 3159*
CEP 0711 3275	Fundamentals of Electrochemical Engineering	Core	2	0	2.0	
CEP 0711 3276	Mass Transfer Sessional	Core	0	4	2.0	CEP 0711 3151* CEP 0711 3277*
CEP 0711 3277*	Mass Transfer–II	Core	3	0	3.0	CEP 0711 3151*
CEP 0031 3278*	Oral Examination - III	Core	0	0	1.0	
CEP 0711 3279	Introduction to Engineering Materials	Core	3	0	3.0	
Total			**13**	**16**	**22.0**	

Fourth Year First Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 4150*	Process Unit Operations and Process control (Training)	Core	0	0	2.0	
CEP 0531 4151*	Polymer Processing and Applications	Core	3	0	3.0	CEP 0531 2153*
CEP 0711 4152	Chemical Reaction Engineering Sessional	Core	0	4	2.0	CEP 0711 3271*
CEP 0711 4254#	Plant Design	Core	0	4		
CEP 0711 4155	Industrial Economics and Management	Core	3	0	3.0	
CEP 0711 4157*	Process Control	Core	3	0	3.0	MAT 0541 2206B
CEP 0711 4159	Bioprocess Engineering	Core	2	0	2.0	
CEP 0711 4163*	Corrosion Engineering	Core	2	0	2.0	
CEP 0711 4270**#	Project	Core	0	4		
CEP 0711 4280**#	Thesis	Core	0	4		
Total			**13**	**12**	**17.0**	

CEP 0711 4254 is considered as the Capstone Project. This course runs two semesters long and the grade will be counted at the end of 4th Year 2nd semester. Students will begin these courses in the 4th year and 1st semester and will registrar these courses in 4th Year 2nd semester

Fourth Year Second Semester

Course Code	Course Title	Course Category	Hours/Week		Credits	Prerequisite
			Theory	Lab		
CEP 0711 4254#	Plant Design	Core	0	4	4.0	
CEP 0711 4271*	Process Design	Core	3	0	3.0	CEP 0711 2151* CEP 0711 2271* CEP 0711 2273*
CEP 1022 4273*	Process Safety Engineering	Core	3	0	3.0	
CEP 0712 4275*	Environmental Engineering	Core	3	0	3.0	
CEP 0031 4278*	Oral Examination - IV	Core	0	0	1.0	
CEP 0711 4270**#	Project	Core	0	8	4.0	
CEP 0711 4280**#	Thesis	Core	0	8	4.0	
ELECTIVE ⁑		Core	2	0	2.0	
Total			**13**	**12**	**20.0**	

⁑Students can choose one course from Elective courses

ELECTIVE COURSES:

Course No	Course Title	Credits	Course No	Course Title	Credits
CEP 0711 4281	Transport Phenomena	2.0	CEP 0711 4289	Mathematical Modeling in Chemical Engineering Processes	2.0
CEP 0723 4283	Fundamentals of Textile Engineering	2.0	CEP 0531 4291	Polymer Composites	2.0
CEP 0711 4285	Contemporary Industrial Processes in Bangladesh	2.0	CEP 0531 4293	Polymer Kinetic Theory	2.0
CEP 0711 4287	Natural Gas and Petroleum Reservoir Engineering	2.0	CEP 0711 4295	Principles of Catalysis	2.0

Total credits included in all semesters

First Year First Semester	21.5
First Year Second Semester	21.5
Second Year First Semester	21.0
Second Year Second Semester	20.0
Third Year First Semester	20.0
Third Year Second Semester	22.0
Fourth Year First Semester	17.0
Fourth Year Second Semester	20.0
Total Credits	163.0

Note:Degree will not be awarded without the completion of all the sessional courses and the courses marked by * & ** symbols. Prerequisite theory courses are mandatory for attending corresponded laboratory/sessional

Non-Major Courses Offered by CEP to Other Departments

Course Code	Course Title	Offered to	Hours/Week		Credits
			Theory	Lab	
CEP 0711 1201G	Chemical Process Technology	IPE	2	0	2.0
CEP 0711 2101F	Fluid Mechanics and Machineries	FET	3	0	3.0
CEP 0711 2102F	Fluid Mechanics and Machineries Sessional	FET	0	2	1.0
CEP 0711 3101F	Process Control in Food Industry	FET	3	0	3.0

Part C

1. Description of Detail Course Profile

Course Code: CEP 0711 1151*	**Credit: 3**	**Year:** First	**Semester:** First
Course Title: Elements of Chemical Engineering-I		**Course Status: Theory (Core)**	

Rationale of the Course:

The course familiarizes the students with the calculations involved in chemical process systems. This is a foundation course for developing problem solving skills in material balances and the acquired knowledge can be employed in subsequent courses as well as in professional life.

The objectives of this course are to:

- facilitate necessary knowledge about the career opportunities in chemical engineering.
- acquaint students with the basics of calculations and material balances in chemical process system.
- develop different techniques of materials balances in analysing and solving chemical engineering problems.
- grow awareness of the application of material balance concepts to environmental and biological problems**.**

Course content:

Principles of chemical engineering calculation: Units, dimensions, conversion and system of units, force and weight, process data representation and analysis, the chemical equation and stoichiometry.

Process variables: Classification, flow rate, mass, volume, composition, pressure, temperature.

Material balance: Material Balances for Steady State Processes-Non-Reacting single- phase systems - Single and multiple units without recycle, Systems with recycle, bypass and purge, Reacting systems. Single phase system: liquid and solid densities, ideal gases, equation of state for non-ideal gases, compressibility factors equation of state, non- reacting multi-phase systems. Processes involving vaporization and condensation.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: apply knowledge of basic science and engineering fundamentals to solve material and energy balances.

CO2: measure or calculate process variables of a process stream.

CO3: formulate and solve material balance for processes involving single & multiple components with & without reactions.

CO4 define and scope engineering problems and formulate suitable strategies for problem solution

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3	3	2			3			3		
CO 2	3	3	3					1				
CO 3	3	3	3		2		2					2
CO 4	3	3	3		2		2					2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial, and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

1. R.M. Felder & Ronald W. Rousseau — *Elementary Principle of Chemical Processes*
2. D.M. Himmelblau & J.B. Riggs — *Basic Principles and Calculations in Chemical Engineering*

Course Code: CEP 0711 1152	**Credit:** 2	**Year:** First	**Semester:** First
Course Title: Laboratory Safety and elementary operation sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

A chemical engineer should have basic knowledge about the method and techniques being used and the results obtained in a chemistry lab, as this will give him/her the first impression about what is happening in a chemical process industry, and this course is specially designed as an intensive introduction to the techniques of experimental chemistry.

The objectives of this course are to:

- acquaint students with the Chemical Laboratory Safety Rules and waste disposal methods
- help students identify and use the glassware, connecting and other supporting elements in building an experimental set up
- facilitate necessary knowledge on building and operation of some basic chemical process operations

Course Content:

Safety guidelines, rules and regulations of laboratory: laboratory apparel, safety equipment, general behavior, fire, chemicals and chemical spills, laboratory equipment, waste management.

Introduction of basic laboratory apparatus: laboratory equipment, burette, pipette, balance, graduated cylinders, volumetric flask, gravity filtration, vacuum filtration, decanting, centrifuging, ice bath, litmus paper, glowing splint, cleaning laboratory equipment.

Qualitative determination of organic and inorganic compound: functional group test, melting point test, saturation un-saturation test, salt analysis.

Organic laboratory equipment and procedure: product formation and identification

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: handle and use the chemicals, laboratory equipment and chemical waste disposal.
CO2: use experimental setup for a specific operation process
CO3: identify the unknown organic and inorganic compounds
CO4: synthesize an organic compound and its characterization.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3		2	2	2						2	
CO 2	3		3							3	3	
CO 3	3	3									2	
CO 4			2				1				1	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, Group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation.
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Bhal and Bhal — *Organic Chemistry*
2. R.T Morrison & R.N. Boyd — *Organic Chemistry*
3. F.A Carey — *Advanced Organic Chemistry*
4. T.W.G. Solomon — *Organic Chemistry*
5. I. L. Finer, vol. I & II — *Organic Chemistry*
6. Solomon and Solomon — *Organic Chemistry*

Course Code: CEP 0711 1153	**Credit:** 2	**Year:** First	**Semester:** First
Course Title: Analytical Methods for Chemical Process Industries		**Course Status: Theory (Core)**	

Rationale of the Course:

A professional Chemical Engineer should possess some basic knowledge of data interpretation obtained from quality control section to ensure product standard. This course deals with the data treatment and equilibrium calculation about the analytical methods of product and raw material processing.

The objectives of this course are to:

- provide the knowledge of data obtaining and treating for experimental results.
- help students calculate error and accuracy of experiments.
- make the students understand the mechanism of chemical equilibrium and equilibrium calculation.
- acquaint the students with the completion of reaction by different methods

Course Content:

Introduction: Analytical objectives and methods **the assessment of analytical data, definitions and basic concepts:** The nature and origin of errors; the evaluation of results and methods; stability of measurements; the analysis of data; the application of statistical tests; limit of detection.
Aqueous-Solution Chemistry: The chemical composition of aqueous solutions, Chemical Equilibrium The effects of electrolytes on Chemical Equilibrium, activity coefficients, **Systematic Method for Performing Equilibrium Calculations:** A systematic method for solving multiple-equilibrium, the calculation of solubility by systematic method, separation of ions control of the concentration of a precipitating reagent
Theory of Neutralization Titrations: solutions and indicators for neutralization titrations, titration curves for strong acids and strong bases, buffer solutions, titration curves for weak acid, titration curve for weak bases, the composition of buffer solutions as function of pH Theory of Oxidation/Reduction Titrations: Equilibrium Constants for oxidation/reduction reaction, redox titration curves, oxidation/reduction indicators, potentiometric end points. **Complexometric Titrations, Precipitation Reactions and Titrations, Electrochemical Cells and Electrode potential**

Course Outcomes (COs): At the end of the course, students will able to-

CO1: describe basic concept of qualitative and quantitative analysis
CO2 explain the aqueous solution chemistry and equilibrium calculation.
CO3: interpret experimental data.
CO4: apply volumetric methods to express the extent of reaction and calculation.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2										
CO 2	3	3	2				3			2		
CO 3		3					2			3		
CO 4	2						3			3		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:

1. Skoog and West — *Fundamentals of Analytical Chemistry*
2. G. Christian — *Analytical Chemistry*
3. Fifield and Kealy — *Principle of Analytical Chemistry*

Course Code: CEP 0711 1155	**Credit:** 3	**Year:** First	**Semester:** First
Introduction to Physico-Chemical Changes of Matters		**Course Status: Theory (Core)**	

Rationale of the Course:

Chemical engineers must understand physico-chemical properties of matters in reactor and separation units in order to run and manipulate these units effectively. This course deals with quantitative and theoretical study of the properties and structure of matter and their relation to the

interaction of matter and energy. Specifically, it concerns with the study of the properties of gases and liquids, thermodynamics, phase equilibria and colligative properties of solutions.

The objectives of this course are to:

- provide basic knowledge of physical chemistry and thermodynamics and apply this knowledge to chemical processes
- acquaint with different thermodynamic quantities such as heat and work and how they are measured, related or transformed from one to the other
- provide lesson on phase separation and thermal effects of process
- introduce chemical equilibrium and the factors affecting chemical equilibrium
- make the students understand how the catalytic system works
- accumulate basic knowledge about colloidal system and photochemistry

Course Content:

Kinetic molecular Theory and phases of gas: The kinetic theory of gases, Combined gas law, Vander Walls equation, The Hydrogen Bond, The intermolecular potential energy function, Vaporization, fusion and sublimation, Equilibrium vapor pressure, Nature of the equilibrium state, Normal boiling point, Critical temperature and pressure**.**

Energy, Enthalpy and Thermochemistry: State functions, Heat and Work, Work of expansion, Mechanical equivalent of heat, Energy and Enthalpy - at constant volume and pressure, relationship between ΔH and ΔE, Bond Enthalpies, Heat capacity.

Chemical Equilibrium: The ideal Law, Equilibrium constant, Magnitude of equilibrium constant and the direction of reaction, factors affecting equilibrium constant, Le Chatelier's Principle.

Catalysis: Characteristics of catalyzed reaction, types of catalysis, theory of catalysis, catalyst inhibitor, retardation and poisoning and enzyme catalyzed reaction.

Colloid: Ionic purification and properties of colloids, origin of electrical charge and charge particles, ionic micelles.

Photochemistry: Photon, law of photo chemistry, absorption law and mechanism of photochemical reaction, fluorescence, phosphorescence and chemiluminescence.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: describe basic knowledge of physical chemistry and thermodynamics

CO2: Explain how thermodynamic quantities such as heat and work are measured, connected to one another, and changed from one state to another.

CO3: describe the chemical equilibrium and the factors governing equilibrium reaction

CO4 Evaluate the effect of catalyst on the kinetic of chemical reaction and the selectivity of reaction.

CO5: explain the colloidal system and photochemical system

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3			2		2					
CO 2	3	2	2				2					
CO 3		2	2				3			2	2	
CO 4	3	3		2			2				2	
CO 5	3		2									

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Segal B G, *Chemistry* *Experiment and Theory*
2. Barrow G M *Physical Chemistry*
3. Atkins *Physical Chemistry*
4. Alberty *Physical Chemistry*

Course Code: CHE 0531 1109B	**Credit:** 2	**Year:** First	**Semester:** First
Course Title: Organic Chemistry		**Course Status: Theory (General Education)**	

Rationale of the Course:

As a chemical engineering student, one must have knowledge about the structure, properties, composition, reactions, and preparation of carbon-containing compounds that will have a long-lasting impact throughout the whole learning and professional career.

The objectives of this course are to:

- familiarize the students with chemical substances, their symbols, structures, and physical and chemical properties
- acquaint students with the different transformation processes and condition of transformations of chemical substances along with their uses.

Course Content:

Bonding in Organic Molecules: Bonding, Structural formulas of organic compounds,
electronegativity and dipoles, atomic orbital, electron configurations, molecular orbital and bonding – LCAO, sigma and pi- bonds, hybrid orbital, bond angles and bond energies.
Classification and nomenclature of organic compounds-Aliphatic hydrocarbons: Preparation, uses, physical and chemical properties of saturated and unsaturated hydrocarbon. Dienes and polymerization: isolated double bond, Allen cumulated double
bonds, conjugated double bonds, polymerization, and Diels-Alder reaction.
Aromatic Hydrocarbon: structure and bonding in benzene; aromaticity,
electrophilic aromatic substitution; Fridel Craft alkylation and acylation, direction and ease of aromatic
substitution resonance and inductive effect, the steric effect, principles of higher substitution.
Properties, Synthesis and Application of: Halides, Phenols, Ether and Epoxide,
Carbonyl Compound, Carboxylic acid and derivative.
Chemistry of Carbohydrates: Classification and characteristics, reaction, structure and conformation of glucose, structure and configuration of monosaccharides, epimerization and mutatrotation.
Dyes: color and constituents, definition, classification, basic idea of dye formation, some
typical dye preparation and uses.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: analyze the bonding and chemical structure of organic compounds
CO2: classify organic compounds and learn the common preparation method, physical and chemical property of different types of organic compounds; discuss different types of dienes and their preparation and uses.
CO3: describe the complex structure, synthesis, characterization and reaction mechanism of selected organic, aliphatic, and aromatic compounds.
CO4: classify and describe the structure, characteristics of different types of carbohydrate polymers and their monomeric units.
CO5: define different types of dyes with their constituents and know their preparation methods and uses.

Mapping Course Outcomes (COs) with the POs

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3	3									2	
CO 2	3	3					2				2	
CO 3	3	2					2				2	
CO 4	3						2					
CO 5	3										2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	**Teaching-Learning Strategy**	**Assessment Strategy**
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books

1. Arun Bhal and B.S. Bhal	*A textbook of Organic Chemistry*
2. Robert T. Morrison & Robert N. Boyd	*Organic Chemistry*
3. Francis A. Carey & Richard D. Sundberg	*Advance Organic chemistry*
4. T.W.G. Solomon, C.B. Fryhle & S.A. Snyder	*Organic Chemistry*
5. I. L. Finer, vol. I & II	*Organic Chemistry*

Course Code: ENG 0231 1101	**Credit:** 2	**Year:** First	**Semester:** First
Course Title: Effective Communication in English		**Course status: Theory (**General Education)	

Rationale of the Course:

This course is expected to develop two basic skills i.e. reading and writing. A variety of reading strategies and texts will be used to effectively develop first year students' academic reading skills thereby facilitating their future study. Also, the course focuses on developing the writing skills of students by familiarizing them with grammar rules, providing them with practice and enabling them to demonstrate the accurate use of grammar in their writing.

The objectives of this course are to:

- enable students to write with accuracy
- facilitate effective and comprehensible writing
- raise awareness of common errors that occur in writing
- develop students' ability to understand write-ups on issues of general concern
- improve the vocabulary of learners for effective communication

Course Contents

a) Reading

- Different Reading Strategies
- Guessing Meaning from the Context
- Critical Reading (Analyze)
- Critical Reading (Synthesize)
- Critical Reading (Evaluate)
- Annotation
- Summary Writing

b) Materials

- A selection of 08-10 editorials and reports from newspapers/magazines/ journals,etc.
- Reading texts in New Headway Upper Intermediate Student's Book (Current edition)
- Selected passages from recommended books
- A selection of other materials may be supplied as handouts by the instructor as necessary
- Writing
- Forms and functions of different word categories (noun, verb, adjective, etc.)
- Aspects and uses of tense
- Subject-verb agreement
- Use of infinitive, gerund, present participle, past participle, modals, causatives, conditionals, subjunctives, modals.
- Use of sentence connectors/ cohesion markers/ punctuation
- Effective combination of sentences (simple, complex, compound)
- Developing a paragraph

Course Outcomes: At the end of the course, students will be able to

CO 1	apply grammar rules
CO 2	express oneself correctly by using appropriate words, phrases, sentences or ideas
CO 3	critically reflect on a text (grasp abstract ideas and interpret them effectively, arrive at well-reasoned conclusions and solutions)
CO 4	Create using earned knowledge both independently and in collaboration with peer groups
CO 5	Demonstrate a comprehension of subject knowledge and its subsequent use

Mapping Course Outcomes (COs) with the POs

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1				3		3					3	
CO 2				3		3					3	
CO 3				3		3					3	
CO 4				3		3				3	3	
CO 5				3		3					3	

Mapping Course Outcomes (COs) with the Teaching-Learning& Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/ projector, tutorial and assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/ projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Tibbits, E. E. *Exercises in Reading Comprehension*
2. Liz and John Soars *New Headway Upper Intermediate Student's Book*
3. Payle, Michael. *Cliff's TOEFL Preparation Guide (12th edition)*

Other resources recommended by course instructors

Course Code: IPE 0732 1102B	**Credit:** 1.5	**Year:** First	**Semester:** First
Course Title: Engineering Graphics (for CEP)		**Course status: Sessional (**General Education)	

Rationale of the Course:

Engineering drawing is a two-dimensional representation of three-dimensional objects and is the basic form of communication in technology and industry. It expresses ideas and conveys specific information by means of geometric shapes, lines, and dimensions. It is considered as a universal language that provides necessary information about the shape, size, surface quality, material, manufacturing process, etc., of the object. This course is a practical application of knowledge pertaining to the clearly and accurate capture all geometric features of a product or component so that a manufacturer or engineer can produce the required item. This course also aims to develop the dignity of labor, responsibilities, and collaboration of students.

The objectives of this course are to:

- introduce students to reading, understanding, and creating mechanical engineering drawing
- familiarize the students to acquire and use engineering drawing skills on creating accurate, clear sketches of different mechanical objects following the information and instructions
- make students able to draw different types of angle projections, orthographic views, auxiliary, sectional views, isometric views, etc.
- enable students to acquire requisite knowledge required for advanced study of engineering drawing
- apply the drawing and drafting skills as problem-solving tools to resolve the primary design issues
- understand 2D and 3D mechanical drawing as preliminary information for the AutoCAD software.

Course Content:
Introduction, Instruments and their uses, First angle and third angle projections, Orthographic drawing, Sectional views. Isometric views, Missing lines and views. Introduction to Auto CAD:2D Drawing.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: explain basic concepts of engineering drawing as an important form of conveying technical information

CO2: apply principles of engineering visualization and projection theory to prepare mechanical engineering drawings (2D and 3D), using conventional and modern drawing tools

CO3: practice drawing orthographic projection, sectional views, and isometric views of different mechanical parts;

CO4: apply the engineering drawing principles to draw 2-D sketches using AutoCAD drawing and editing tools

CO5: create a review report on mechanical components drawing using the engineering drawing-specific knowledge and skill for the multidisciplinary design team comprised of engineering professionals

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	**3**								2		2	
CO 2	3								3	2	3	
CO 3	3									1	2	
CO 4	3								3		3	
CO 5	3		3						3		3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs)	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials	Quiz and Semester-end oral examination
CO 2	Lecture using board and Tutorial	Quiz, Drawing assessment, and Semester-end oral examination
CO 3	Lecture using board and Tutorial	Quiz, Drawing assessment, and Semester-end oral examination
CO 4	Lecture using board and Assignment	Quiz and Semester-end oral examination
CO 5	Lecture using projectors/AutoCAD software using a PC	Drawing using AutoCAD

Recommended Books:

1. K.V. Reddy, Textbook of Engineering Drawing, 2e, BS Publications
2. K. Rathnam, A First Course in Engineering Drawing, Springer Nature Singapore Pte Ltd.
3. M.B. Shah and B. C. Rana, Engineering Drawing, Dorling Kindersley (India) Pvt Ltd

Course Code: MAT 0541 1101B	**Credit:** 3	**Year:** First	**Semester:** First
Course Title: Calculus with analytic Geometry		**Course status: Theory (**General Education)	

Rationale of the Course:

The focus and themes of the Calculus with analytic Geometry course address the most important foundations for applications of mathematics in science, engineering and commerce. The aim of this course is to introduce the geometry of lines and conics in the Euclidean plane. The course will provide various technics with applications to solve engineering problems using differentiation and integration.

The objectives of this course are to:

- Review two- and three-dimensional geometry and its properties. Students able to develop geometry with a degree of confidence and will gain fluency in the basics of Euclidean geometry.
- provide the basic concepts and principles of calculus of different type of functions and applications of differentiation in real life.
- teach various type of theorems in finite and infinite forms.
- make the students able to evaluate the first and second partial derivatives of functions of several variables.
- teach them to solve applied optimization problems for a function of several variables.
- tach how to find a maximum or minimum value for a function of several variables subject to a given constraint.
- facilitate the necessary knowledge to evaluate definite and indefinite integrals using varies type of techniques.
- teach how to apply integration techniques in evaluating area of the surface, length of the curves and volume of a solid in Cartesian and polar coordinates system.

Course Content:

Geometry: Two dimensional: Review of locus of a point, equations for straight lines, circles, parabola, ellipse and hyperbola;change of axes, pair of straight lines. Three dimensional: equations for straight lines and planes; outlines of spheres, cylinders and cones.
Differential Calculus: Function of a real variable and their graphs; limit, continuity and derivatives; physical meaning of derivative of a function; successive derivatives; Leibnitz's theorem; Rolle's theorem; mean value theorem and Taylor's theorem (statement only); Taylor's and Maclaurin's series and expansion of function; maximum and minimum values of functions; indeterminate forms; curvature; concavity and convexity of a function; .functions of two and three variables; partial and total derivatives.
Integral Calculus: Physical meaning of integration; evaluation of indefinite integrals; definite integral as the limit of a sum and as an area; fundamental theorem of integral calculus and its application to definite integrals; reduction formula; improper integrals; double integration; evaluation of areas and volumes by integration.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1:	identify the varies type of properties of the conic section and their geometrical applications
CO2:	recognize limit, continuity and differential coefficients of various functions apply Leibnitz's, Rolle's, mean value theorem and various form of Taylor's theorems in finite and infinite forms.
CO3:	determine maxima and minima of a function
CO4:	evaluate definite and indefinite integrals through different methods.
CO5:	evaluate areas and volumes by integration in different type of equations in Cartesian and polar coordinates.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3									3	
CO 2	3	3					3				3	
CO 3	3	3					3				3	
CO 4	3	3					3				3	
CO 5	3	3					3				3	

Mapping Course Outcomes (COs) with the Teaching-Learning and Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO1	Lectures using board	Continuous assessment and mid-term exam
CO2	Lectures using board	Continuous assessment and quiz test
CO3	Lectures using board	Continuous assessment and term -test 1
CO4	Lectures using board	Continuous assessment and Assignment
CO5	Lectures using board	Term-test 2 and Semester-end exam

Recommended Books:

1. Spiegel, M. R. *Vector Analysis*
2. Ayres, F. *Matrices*
3. Smith C. *An elementary treatise on coordinate geometry of three dimension*
4. Rahman and Bhattacharjee *A Text Book on coordinate geometry*
5. Kolman, B. *Elementary Linear Algebra*
6. Loney, S. L. *Coordinate Geometry of Two dimensions*
7. Bell, R. J. T *An Elementary Treatise on Coordinate Geometry of Three Dimension.*
8. Askwith, R. E. H. *Analytical Geometry of Conic Sections*

Course Code: SSS 0222 1101	**Credit:** 3	**Year:** First	**Semester:** First
Course Title: History of the Emergence of Independent Bangladesh		**Course status: Theory (**General Education)	

Rationale of the Course:

This is a special compulsory course for all students of Bachelor program of Shahjalal University of Science and Technology, Sylhet. This course deals with the interrelated themes and topics that are essential to understand the emergence of Bangladesh.

The objectives of this course are to:

- give an idea about the War of Liberation and freedom fighters
- clarify the role of different sections of people in the War of Liberation
- explain the role of Bangabandhu in Liberation War
- give an idea about the sacrifices of martyrs for the motherland.

Course Content:

1. Description of the land and its people

b. Impacts of geographical features
c. Ethnic composition of Bengal
d. Development of Bengali language and its significance
e. Cultural syncretism and religious tolerance
f. Distinctive identity of Bengalis in the context of undivided Bengal

2. Proposal for United Independent Bengal State, Pakistan movement and foreshadowing of Bangladesh, the 1947 partition of the subcontinent

a. Rise of communalism under the British colonial rule
b. The 1940 Lahore Resolution
c. Suhrawardy's move for undivided independent Bengal
d. The establishment of Pakistan, 1947
e. Foundation of the Awami Muslim League (1949) and the struggle for emancipation of the Bengalis

3. Pakistan: Structure of the state and disparity

a. Central and provincial structures
b. Influence of military and civil bureaucracies
c. socio-economic, political and cultural disparities

4. Language movement and quest for Bengali identity

a. Misrule by Muslim League and struggle for democratic politics
b. The Language movement: context, phases and international recognition of 21 February as Mother Language Day
c. United Front elections of 1954: Results and consequences

5. Military rule: the regimes of Ayub Khan (1958-1969) and Yahia Khan (1969-1971)

a. Military rule and its characteristics
b. Ayub Khan's rise to power and characteristics of his rule (political repression, Basic democracy, Islamisation)
c. Fall of Ayub regime and Pakistan under Yahya military junta

6. Rise of Bangali nationalism and the movement for the right to self-determination

a. Resistance against Pakistani cultural aggression and resurgence of Bengali nationalism
b. Bangabandhu Sheikh Mujibur Rahman's 6-points programme (1966): Its significance and reaction of the regime
c. The Agartala Conspiracy Case, 1968

7. The mass- upsurge of 1969 and its consequences

a. Background
b. Movement based on 6-points and 11-points programme
c. Fall of the Ayub regime
d. Emergence of Bangabandhu as an undisputed leader

8. Election of 1970 and its significance

a. Legal Framework Order (LFO) of general Yahya Khan
b. Programmes of different political parties
c. Election results
d. Pakistani military junta's conspiracy to thwart the results

9. Non-cooperation movement and 7th March address of Bangabandhu

a. The non-cooperation movement against Pakistani rule and its salient features
b. 7th March address of Bangabandhu:
Background c Significance of 7th March address
c. International recognition of 7th March address as world heritage by UNESCO (2017)

10. Declaration of Independence of Bangladesh

a. Operation Searchlight (25 March 1971)
b. Declaration of Independence of Bangladesh by Bangabandhu
c. Beginning of the Liberation War of Bangladesh

11. The War of Liberation, 1971

a. Genocide, repression of women, Bengali refugees in India
b. Formation of Bangladesh government and Constitutional proclamation of Independence
c. The spontaneous early resistance and subsequent organized resistance by Mukti Fouz, Mukti Bahini, Guerrillas and the frontal war in December 1971
d. Campaign in favour of the War of Liberation (Shadhin Bangla Betar Kendra, campaigns in abroad and formation of international public opinion)
e. Contribution of students, women, the mass people and different political parties in the War of Liberation
f. The role of great powers and the United Nations in the Liberation War
g. The contribution of India in the Liberation War
h. The anti-liberation activities of the Peace Committee, Al-Badar, Al-Shams, Rajakars, pro-Pakistani political parties and other Pakistani collaborators, killing of the Bangali intellectuals at the end of the war
i. Arrest and Trial of Bangabandhu in Pakistani custody and reaction of the World community
j. Formation of joint command of Mukti Bahini and Indian allied forces and Victory in the war
k. **Evaluation of Bangabandhu's contributions in the Independence of Bangladesh**

12. The Bangabandhu government, 1972-1975

a. Homecoming of Bangabandhu and his address at Race Course on 10 January 1972
b. Making of the Bangladesh Constitution, 1972
c. Reconstruction of the war-ravaged country by Bangabandhu government
d. Foreign policy of Bangabandhu; his first address at the United Nations in 1974
e. Bangabandhu's 'Second Revolution' or System change, 1975
f. The assassination of Bangabandhu and his family members and the ideological turn-around

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1						1					3	
CO 2						1					3	1
CO 3						2					3	1
CO 4					2	2					3	1
CO 5					2	1					3	1

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

CO	Test	Assignment	Final Examination
CO 1	√	√	√
CO 2	√	√	√
CO 3	√	√	√
CO 4	√	√	√
CO 5	√		√

Recommended Books

1. Ahmed, Salahuddin and Bazlul Mobin Chowdhury — *Bangladesh: National Culture and Heritage: An Introductory Reader*

2. Harun-or-Roshid	*The Foreshadowing of Bangladesh: Bengal Muslim League and Muslim Politics, 1906-1947*
3. Harun-or-Rashid	*From 1947 Partition to Bangladesh: BANGABANDHU and State Formation in Perspective.*
4. Jahan Rounaq	*Pakistan: Failure in National Integration*
5. Jahan Rounaq	*Political Parties in Bangladesh*
6. Talukder Maniruzzaman	*Radical Politics and the Emergence of Bangladesh*
7. Talukdar Maniruzzaman	*The Bangladesh Revolution and Its Aftermath*
8. Nurul Islam	*Making of a Nation : Bangladesh- An Economist Tale*
9. nviæb-Ai-iwk`	*evsjv‡`k : ivRbxwZ miKvi I kvmbZvwš¿K Dbœqb 1757-2018*
10. nviæb-Ai-iwk`	*e½xq gymwjg jxM : cvwKwÍvb Av‡›`vjb, ev0ji ivó ªfvebv I e½eÜz*
11. nviæb-Ai-iwk	*7B gv‡P© fl¨ †Kb wek^-HwZn¨ m¤ú`, e½eÜz gw³hy× esj¶ `k*
12. †kL gywReyi ingvb	*Amgvß AvZ¥Rxebx*
13. †kL gywReyi ingvb	*KvivMv‡ii †ivRbvgPv*
14. Aj Avnv`	*RvZxq iRbwZ, 1945-1975*
15. ^mq` Av‡bvqvi †nv‡mb	*evsjv‡`‡ki w^vaxbZvhy‡× civkw³i fgKv*
16. Aveyj gvj Ave`yj gywnZ	*evsjv‡`k: RvwZiv‡ó ªi D™¢e*

Course Code: CEP 0711 1271	**Credit:** 2	**Year:** First	**Semester:** Second
Course Title: Structure and Properties of Substances		**Course Status: Theory (Core)**	

Rationale of the Course:

As a chemical engineering student, one must have knowledge about the substances that will move around in their whole learning and professional career and this course provides the information about their preparation, properties and uses.

The objectives of this course are to:

- familiarize the students with theories to describe atomic structure
- make the students understand the electronic configuration and physical properties of atoms
- acquaint the students with the theories to describe electronic configuration of molecules
- help students understand the formation of different types of chemical bonds

Course Content:

Quantum Theory and Atomic Structure: Introduction, older quantum theory, Bohr's theory of the atomic spectrum of hydrogen, extension of Bohr's theory to systems containing more than one electron, Wave mechanics, Schrödinger equation, Application of wave mechanics to simple problems, hydrogen atom and other one- electron species.

Electronic Configuration and Some Physical Properties of Atoms: Introduction, The periodic table, Hund's rule and state symbols for free atoms and ions, Ionization energies, Electron affinities, Atomic dimensions, Relative effects.

Electronic Configuration of Molecules: Introduction, Molecular orbital theory: homonuclear & heteronuclear diatomic molecules, Valence bond theory: diatomic molecules.

Chemical Bonding, I: Electronic theory of valency, bonding in the light of modern atomic structure: types of bond, ionic bond, polyatomic ions, lattice energy of ionic compounds, covalent bond; comparison of properties of ionic and covalent bonds.

Chemical Bonding II: Molecular geometry and Molecular orbitals, Molecular geometry: Hybridization, Hydro-dissociation; bond order; other types of chemical bonds. Shapes of molecular orbital on the basis of Valence Shell Electronic Repulsion Theory (VSERT).

Course Outcomes (COs): At the end of the course students will able to-

CO1:	illustrate the simultaneous existence of particle and wave form of the electron and its properties arising from the wave form of existence.
CO2:	explain the chemical and physical properties of elements in compounds.
CO3:	describe the rearrangement of electron of atom in a molecule.
CO4:	interpret the types of chemical bonds in a molecule.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3											
CO 2	3											
CO 3	3	2										
CO 4	3	2								1	2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam

Recommended Books

1. Alan G. Sharpe — *Inorganic Chemistry*
2. Brian W Pfenning — *Principles of Inorganic Chemistry*
3. Gary L. Miessler & Donal A. Tarr — *Inorganic Chemistry*
4. S.Z. Haider — *Modern Inorganic Chemistry*
5. Cotton and Wilkinson — *Inorganic Chemistry*

Course Code: CEP 0711 1272	**Credit:** 2	**Year:** First	**Semester:** Second
Course Title: Equilibrium in solution: Engineering aspect sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

A chemical engineer should have knowledge about the amount and composition of a process stream under chemical equilibrium and this would enable him/her to choose optimal condition for conducting process. This sessional course will demonstrate to the students' practical application of the theoretical knowledge they obtain from the course on analytical chemistry and they may apply this knowledge in the field of industrial analyses, life science and environmental remediation etc.

The objectives of this course are to:

- To acquaint students with the Chemical Laboratory Safety Rules and waste disposal methods.
- To teach students the methodological procedure for calculating compositions and form of species in aqueous solution under physic-chemical equilibrium.
- make students acquainted with the process of performing a titration.introduce students with acid-base indicators, e.g., litmus, wide range indicator papers and specific titration indicators.
- introduce titration as a means of determining the amount of an acid or base present.
- make the students perform redox titration to find the unknown concentration of the solution that transferred electrons to form new substances.
- help the students understand basic principles of complexometric titration.

Course Content:

Calibration of measuring devices: balance, pipette, burette, graduate cylinder, volumetric flask, preparation of standard solutions; **Acid-base titrations:** Titration of acid and bases. Indicator theory Common acid-base indicators and their use. How to choose a suitable indicator. Mixed indicators. Acid and base standard solutions used in volumetric analysis. Primary standards used in preparing and standardizing acid and base solutions.

Redox titrations: Introduction and theoretical aspects of redox titration. Redox indicators and specific indicators. Properties, reactions and use of permanganate solutions. Identification of the final point. Standardization of permanganate solutions. Determination of iron in a sample by permanganate solution. Iodometric titration: Principles, applications, properties. Use of starch water as an indicator. Examples of iodometric titrations: standardization of sodium thiosulfate.

Complexometric titrations: Titrations employing EDTA. Indicators for EDTA titrations. Direct titrations, back-titrations. Masking agents, masking and damasking. Analysis of complex cations mixtures. Water hardness.

Course Outcomes (COs): At the end of the Course, student will be able to-

CO1: demonstrate experimental skills on different titration methods

CO2: determine the concentration of unknown solutions by different titration methods with a primary standard.

CO3: interpret experimental results, perform calculations and determine the compositions of process stream.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2										
CO 2		3										
CO 3			2				3		2	2		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. G. Christian — *Analytical Chemistry*
2. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney — *Vogel's text book of quantitative analysis.*

Course Code: CEP 0711 1273*	**Credit:** 3	**Year:** First	**Semester:** Second
Course Title: Element of Chemical Engineering-II		**Course Status: Theory (Core)**	

Rationale of the Course:

Engineers perform mass and energy balances to determine the fate of all materials and energy that go into a process, as well as to examine its final products in order to develop more efficient processes, reduce energy consumption, and better predict the spread of pollution. This course introduces the principles of mass and energy conservation and emphasizes on the development of systematic approaches in calculations used for design and analysis of production and physical processes.

The objectives of this course are to:

- make the students understand the fundamental law of mass and energy conservation as applicable to manufacturing industry
- provide students with the knowledge and skills to find unknown process variables by using material and energy balances on chemical processes
- help the students acquaint the different forms of energy and their inter-conversions in energy analysis
- provide the concept of heat balances and the energy use in a facility

Course Content

Energy and Energy Balance: Form of energy, Kinetic and potential energy, energy balance on closed system and open system at steady state, Energy balance procedure, Mechanical energy balances.

Balance on Nonreactive process: State properties and hypothetical process paths, change in pressure at constant temperature, change in temperature, estimation of heat capacities, phase change operations, energy balances on processes involving phase changes, mixing and solutions, balances on dissolution and mixing processes. Balance on reactive process: Heats of reaction, measurement and calculation of heat of reaction, formation reaction, heats of formation, heats of combustion, and energy balance on reactive processes, thermochemistry of solutions, fuel and combustion, adiabatic flame temperature.

Course Outcomes (COs): At the end of the Course, student will be able to-

CO1: apply knowledge of basic science and engineering fundamentals to solve material and energy balances.
CO2: model material and energy flows around reacting chemical systems.
CO3: define and scope engineering problems and formulate suitable strategies for problem solution
CO4: utilize a systems approach to design and operational performance

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3	2									
CO 2	3	3	3				3					
CO 3	3	3	2			1	2				2	
CO 4	3	2	3				3			3	2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/ projector, Problem solving, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Quiz test, Assignment and Semester-end Exam

Recommended Books:

1. R. Felder, R. Rousseau — *Elementary Principle of Chemical Processes*
2. Himmelblau — *Basic Principles and Calculations in Chemical Engg.*
3. Badger and Banchero — *Introduction to chemical engineering*
4. R.W. Field — *Chemical Engineering: Introductory Aspects*
8. Eisberg, R and Resnick, R — *Quantum Physics*

Course Code: CEP 0031 1274*	**Credit:** 1	**Year:** First	**Semester:** Second
Course Title: Oral Examination - I		**Course Status: Sessional (Core)**	

Rationale of the Course:

The oral exam allows students to show their understanding on theory and sessional courses, and the subject as a whole. It provides students with an opportunity to demonstrate their communication skills in a professional manner. It also allows the faculty to evaluate the students' skill and understanding of the courses offered in Level 1.

The objectives of this course are to:

- develop students' oral communication and presentation skills.
- help them to develop the ability to respond to a question from a scientific perspective.

Course Content:

Based on Level 1 theory and sessional courses

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: speak fluently in both formal and informal context
CO2: demonstrate problem-solving skills adapting and linking audience, speaker and occasion
CO3: provide a solution to a problem from scientific point of view

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1						3		1				
CO 2	2					3		2		2	2	1
CO 3	3			2			3	3			3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	NA	Viva voice
CO 2	NA	Talk
CO 3	NA	Viva voice
CO 4	NA	Viva voice
CO 5	NA	Viva voice

Recommended Books:

All the books recommended in Level 1 theory and sessional courses

Course Code: EEE 0713 1205B	**Credit:** 3	**Year:** First	**Semester:** Second
Course Title: Basic Electrical and Electronic Circuits		**Course status: Theory (**General Education)	

Rationale of the Course:

The main aim of this course is to provide practical knowledge of the principles and practices of different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks, including phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skills in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices. The course covers practical experiments on the topics of digital electronics including Number Theory, Boolean Algebra and Logic Circuits. Upon completion, students should be able to construct, analyze, verify, and troubleshoot electrical and digital circuits using appropriate techniques and test equipment.

The objectives of this course are to:

- facilitate the basic concepts of electrical charge, voltage, current and power
- help students develop basic knowledge of DC circuit behavior.
- acquaint the students with the techniques of solving different types of circuits by network theorem.
- help students conceptualize basic AC circuits.
- accumulate basic knowledge about the basics of diode, transistors, op-amps and their applications
- develop student's skills for analysis and design of analog circuits such as amplifiers.
- develop the skills to solve mathematical problems of simple and complex electrical circuits.
- introduce the basic principle operations, device and circuit characteristics of diodes and BJT, JFET and MOSFET transistors.
- provide the basic idea about semiconductor theory
- provide the knowledge to apply Boolean algebra and logic gates to solve logic functions.

Course Content

Circuit variables and elements: Voltage, current, power, energy, independent and dependent sources, and resistance.

Basic laws: Ohm's law, Kirchhoff's current and voltage laws.

Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.

Techniques of circuit analysis: Nodal and mesh analysis.

Network theorems: Source transformation, Thevenin's, Norton's and Superposition theorems with applications in circuits having independent sources, maximum power transfer condition and Reciprocity theorem.

Energy storage elements: Inductors and capacitors, series-parallel combination of inductors and capacitors.

Sinusoidal functions: Instantaneous current, voltage, power, effective current and voltage, average power, phasors and complex quantities, impedance, real and reactive power, power factor.

P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode, Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor,

Bipolar Junction Transistor (BJT) as a circuit element: BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch. Bipolar junction transistor construction, common emitter, common base configuration, operating point of BJT, Fixed bias circuit.

Digital Logic Design: Binary logic, Boolean algebra, De Morgan's theorem, Basic Logic gates, Universal gates.

Course Outcomes (COs): At the end of the Course, students will be able to

CO1: explain the Basic concepts of DC and AC electrical Circuits including resistor, capacitor, inductor, diode, transistors and their applications.

CO2: solve and analyze the electrical circuits using different analysis methods and theorems

CO3: describe the basic concepts of logic gates and boolean algebra

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3								3			
CO 2		3							3	2	2	
CO 3	3								3			

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching Learning Strategy	Assessment Strategy
CO 1	Lectures	Class Test, Final Exam
CO 2	Lectures, Assignments	Class Test, Final Exam
CO 3	Lectures, Demonstration, Project Design, Home Work	Class Test, Final Exam, Assignment

Recommended Books:

1. Charles K. Alexander and Matthew N.O. Sadiku — *Fundamental of Electric Circuits*
2. Robert L. Boylestad — *Introductory Circuit Analysis*
3. Robert L. Boylestad and Louis Nashlesky — *Electronic Devices and Circuit Theory*
4. Sedra/Smith — *Microelectronic Circuits*
5. M. Morris Mano — *Digital logic and Computer Design*

Course Code: EEE 0713 1206B	**Credit:** 1.5	**Year:** First	**Semester:** Second
Course Title: Basic Electrical and Electronic Circuits Lab		**Course status: Sessional (**General Education)	

Rationale of the Course:

In this course, students will perform experiments to verify practically the theories and concepts learned in EEE 0713-1205B. Theoretical knowledge is incomplete without hands- on experiments using the basic components and measuring devices used in electrical circuit analysis. This course teaches the fundamentals of electrical circuits, the application of circuit laws, theorems and measuring techniques for DC circuits. It contains experiments investigating the performance characteristics of diodes and different types of diode circuits. It contains a broad idea of Transistors and their applications. The course covers practical

experiments on the topics of digital electronics including: Number Theory, Boolean algebra, Logic Circuits, and Logic Minimization Techniques.

The objectives of this course are to:

- facilitate the necessary knowledge which will develop the capability of implementing different real-life dc circuits.
- enable students with network analysis techniques to solve different types of circuits.
- provide basic knowledge about voltage, current and load relationships in a network.
- facilitate necessary knowledge about transient analysis and steady-state analysis of a capacitor and inductor in a network.
- help students to develop the ability in building AC electrical circuits and perform experiments on them.
- provide the knowledge to apply Boolean algebra to solve logic functions.
- help students conceptualize the basics of logic family.

Course content

In this course, students will perform experiments to verify practically the theories and concepts learned in EEE 0713-1205B.
To familiarize students with the operation of different electrical instruments including measuring Equipment: Multi-meter, Frequency meter and Oscilloscope.
To verify the following theorems: KCL and KVL theorem, Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum power transfer theorem.
Making AND/OR gates using diode/ transistors and analysis of the wave shape of Half wave and Full wave rectifier circuit
To construct and study the following logic gates: AND, OR, NOT. NAND, NOR, EXOR
To verify the DE Morgan's Law: Law(I) and Law (II)
To Verify different kinds of applications of Boolean algebra. Relevant application based on EEE 0713-1205B

Course Outcomes (COs): At the end of the Course, students will be able to

CO1: explain the basic operation of different types of electrical instruments and measuring devices.
CO2: use network theorems and laws for different types of circuit analysis and construct different rectifier circuits.
CO3: manipulate logic expressions using binary Boolean algebra
CO4: design combinational and sequential circuits.
CO5 demonstrate team-based communication skills, and magnify their moral

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills			Personal Skills		
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	2						3			
CO 2									3			
CO 3									3			
CO 4			3						3			
CO 5						3			3	3		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching Learning Strategy	Assessment Strategy
CO 1	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CO 2	Demonstration	Laboratory Test
CO 3	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CO 4	Lectures, Demonstration	Viva, Quiz, Laboratory Test
CO 5	Lectures, Demonstration	Laboratory Test

Recommended Books:

1. Charles K. Alexander and Matthew N.O. Sadiku — *Fundamental of Electric Circuits*
2. Robert L. Boylestad — *Introductory Circuit Analysis*
3. Robert L. Boylestad and Louis Nashlesky — *Electronic Devices and Circuit Theory*
4. Sedra/Smith — *Microelectronic Circuits*
5. M. Morris Mano — *Digital logic and Computer Design*

Course Code: MAT 0541 1203B	**Credit:** 3	**Year:** First	**Semester:** Second
Course Title: Matrix and Vector Calculus		**Course status: Theory (**General Education)	

Rationale of the Course:
Matrices and Vector Calculus are basic requirements for science and engineering. The first half designs to cover the fundamental properties of linear algebraic structures such as the algebra of matrices, vector space, and inner product space. The last half develops an understanding of multivariable calculus including varies properties and major theorems of vector calculus.

The objectives of this course are to:

- provide expertise on common matrix operations including cofactor expansions and row reductions, and applying these tools in calculating determinant, rank, inverse, and echelon forms of matrices.
- make students able to investigate the consistency of a system of linear equations and to choose an appropriate method to find the solution of a given system of linear equations and also acquaint students with the fundamental properties of vector spaces and subspaces.
- provide the knowledge on basic principles of vector calculus to apply vector calculus methods in engineering problems.
- make students able to understand central terms such as the derivative for multivariable functions and the main integral theorems of vector calculus
- help them able to identify differential vector calculus, and differential operators and their geometrical and physical significance
- teach how to evaluate line, surface and volume integrals in vector calculus use will provide various technics with applications to solve engineering problems.

Course Content
Matrix: Types of matrices; algebraic operations of matrices; inverse of matrices; elementary operations of matrices; rank of a matrix; solutions of system of linear equations; vector space; linear combination; linear dependence and independence of vectors.
Vector Calculus: algebraic operations on vectors; direction cosine and directions of a straight line, derivative of vectors with respect to scalars; vector operator DEL; gradient, divergence, curl and their applications; Vector integration: line, surface and volume integrals in vector calculus. Divergence theorem, Stokes' theorem and related integral theorems.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: calculate the determinant, rank, inverse, and echelon forms of a given matrix by using the cofactor expansion method or the row reduction method.

CO2: investigate the nature of the solution of a system of linear equations and find the solution of a given system of linear equations by choosing an appropriate method.

CO3: test the independence of vectors and find the dimension and basis of a given vector space and its subspaces.

CO4: Competently apply various vector algebra as a tool in the field of applied sciences

CO5: apply various vector theorems to solve line, surface and volume integrals in two-

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3						2					
CO 2	3	2					2					
CO 3	3						2					
CO 4	3						1					
CO 5	3		3									

Mapping Course Outcomes (COs) with the Teaching-Learning and Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO1	Lectures white board	Continuous assessment and mid-term exam
CO2	Lectures white board	Continuous assessment and quiz test
CO3	Lectures white board	Continuous assessment and mid-term exam 1
CO4	Lectures white board	Continuous assessment and Assignment
CO5	Lectures white board	Mid-term exam 2 and Semester-end exam

Recommended Books:

1. Das and Mukherjee *Differential Calculus*
2. Das and Mukherjee *Integral Calculus*
3. Ayres, F. *Differential equations*
4. J. Edwards *Differential Calculus*
5. J. Edwards *Integral Calculus*
6. Mohammed and Bhattacharjee: *Differential Calculus*
7. S. L. Ross *Differential Equations*

Course Code: PHY 0533 1209B	**Credit:** 3	**Year:** First	**Semester:** Second
Course Title: Magnetism and Modern Physics		**Course status: Theory (**General Education)	

Rationale of the Course:

A student needs to learn the science behind everything that makes a modern technological lifestyle. This physics course provides necessary knowledge to understand phenomena related to magnetism, and modern physics.

The objectives of this course are to:

- Develop conceptual clarity in the areas of magnetostatics, optics, wave mechanics, and modern physics by introducing fundamental laws, principles, and their mathematical formulations.
- Enhance problem-solving skills through the application of physical laws such as Ampere's law, Biot–Savart law, Maxwell's equations, and conservation laws to real-world scenarios.
- Foster an understanding of light and optical phenomena, including interference, photoelectric effect, laser operation, and fiber optics, with an emphasis on both theory and practical applications.
- Explore the dynamics of motion, including wave propagation, circular motion, and rotational dynamics, and relate these to everyday physical systems

Course Content

Magnetostatics: Magnetic field, magnetic force on a current, Ampere's law, Biot-Savart law and their applications; Faraday's law of induction, Lenz's law, self and mutual induction, Maxwell's correction to Ampere's law; Maxwell's equations.
Optics: Light theories- dual nature, reflection, refraction, and interference; Photo electric effect- Einstein's photo electric equation, Work function and threshold frequency, Laws of photo electric effect, Applications of photo electric effect, Photo cell. LASER- definition, Spontaneous emission and stimulated emission, Principle and working of LASER, Characteristics and types of LASER, applications of LASER; Total internal reflection, Critical angle, Conditions for total internal reflection; Principle and working of Optical fiber, Types and applications of optical fiber.
Wave and Motion: equation of a progressive wave; Power and intensity of wave motion; Stationary waves; Group velocity and phase velocity. Force, Momentum, Statement and Derivation of Conservation of linear momentum, its applications such as recoil of gun. Impulse and its Applications, Circular motion (Uniform and Non-uniform), definition of angular displacement, angular velocity, angular acceleration, frequency, time period. Relation between linear and angular velocity, linear acceleration and angular acceleration (related numerical) Central force, Expression and Applications of Centripetal and centrifugal forces with examples. Definition of torque with examples, Angular momentum, Conservation of
angular momentum (quantitative) and its examples, Moment of inertia and its physical significance, radius of gyration for rigid body, Rotational kinetic energy, Rolling of sphere on the slant plane. Comparison of linear motion and rotational motion. Application of rotational motions.
Modern Physics: Michelson-Morley's experiment; Galilean transformation; Special theory of relativity and its consequences; Quantum theory of radiation; Photo- electric effect; Compton effect; Wave-particle duality; Interpretation of Bohr's postulates.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: apply magnetostatic and electromagnetic principles to analyze magnetic and induction phenomena.
CO2: explain and evaluate optical effects and devices based on wave and quantum theories.
CO3: solve problems involving wave motion, linear, and rotational dynamics.
CO4: interpret key concepts of modern physics, including relativity and quantum effects.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills			Personal Skills		
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3								1		2	
CO 2	3								1		2	
CO 3	3								1		2	
CO 4	3								1		2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Halliday, D. and Resnick, R — *Physics (Part II)*
2. Halliday, D, Resnick, R and Walker, J — *Fundamentals of Physics*
3. Young, H D and Freedman, R A — *University Physics*
4. Grant, I S and Phillips, W R — *Elements of Physics*
5. Brophy, J J — *Basic Electronics for Scientists*
6. Beiser, A — *Perspectives of Modern Physics*
7. Krane, K S — *Modern Physics*

Course Code: STA 0542 1205B	**Credit:** 3	**Year:** First	**Semester:** Second
Course Title: General Statistics		**Course status: Theory (**General Education)	

Rationale of the Course:

Acquiring descriptive and inferential statistical knowledge to apply on chemical engineering and polymer science.

The objectives of this course are to:

- provide the knowledge on fundamental concepts of statistical methods,
- acquaint students with the basic tools of descriptive statistics, exPOratory data analysis and graphical presentation
- make students understand the basic concepts of probability and probability distribution,
- helping students to develop ability to perform test of hypothesis,
- facilitate necessary knowledge about bivariate data analysis
- Equip students with the tools and strategies of quantitative research in chemical engineering and polymer science.

Course content

Statistics: definition, nature and scope. Organization of data: definition and classification of data, tabulation, frequency distribution, graphical representations.
Measures of Central Tendency: mean, median, mode geometric mean and weighted average.
Measures of Dispersion: range, standard deviation, variance, coefficient of variation, skewness and kurtosis.
Probability and Probability Distributions: definition, statement and interpretation of laws of probability, Bayes' rule, random variables, mathematical expectations, probability distributions, uses, application and properties of binomial, Poisson and normal distribution.
Sampling Distributions and Test of Hypothesis: Brief discussion on χ^2, t and F distributions. Test of hypothesis concerning mean, variance, proportion, test of independence, contingency tables, test of homogeneity, confidence intervals for mean, variance, proportions, sample size determination.
Correlation and Regression: definition, measure, interpretation and significance, curve fitting by least squares method and related tests, multiple linear regression.

Course Outcomes (COs): At the end of the course, students will be able to

CO1:	explain the importance of statistics and statistical analysis for applicability to chemical engineering and polymer science
CO2:	calculate probabilities for some key probability models and construct frequency distribution and present data graphically
CO3:	compute and interpret different measures of central tendency, location, dispersion, and shape characteristics and analyse bivariate data and interpret the results
CO4:	calculate and discuss probability and sampling distribution and demonstrate a solid understanding of the test of the hypothesis
CO5:	apply the statistical methods and tools to make a scientific decision on engineering research

Mapping Course Outcomes (COs) with the POs

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3	2					2			1	1	
CO 2	2	2					2			1	1	
CO 3	2	2					2			1	1	
CO 4	2	2					2			1	1	
CO 5	2	2					2			1	1	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Montgomery, D. C. and Runger, G. C. Applied Statistics and Probability for Engineers
2. Shill R. N. & Debnath S. C. An introduction to the theory of Statistics
3. DeCoursey, W J. Statistics and Probability for Engineering Applications
4. Gupta S. C. and Kapoor V. K. Fundamentals of Mathematical Statistics
5. Islam M. N. Introduction to Statistics and Probability
6. Mostafa M. G. Methods of Statistics
7. Wonnacott T. H. and Wonnacott R. J. Introductory statistics

Course Code: CEP 0711 2151*	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Fluid Mechanics		**Course Status: Theory (Core)**	

Rationale of the Course:
The majority of chemical-processing operations are conducted either partly or totally in the fluid phase. Transport of fluid to and from a chemical reactor and or separation unit is an inseparable part of a chemical process plant. Therefore, it is essential for the chemical engineer to have knowledge on fluid properties, transport devices, and the law governing with the fluid transport. This course is designed to satisfy these necessities.

The objectives of this course are to:
- introduce students to the fundamental of fluid mechanics and its applications in process engineering
- acquaint with the modern pressure and flow measuring devices
- make the students capable how to develop fluid equations to define the fluid flow system
- provide knowledge about operation, design calculation, selection and application of fluid transport devices

Course Content

Fluid Properties: Definition of fluid, properties of fluid; Fluid Statics: hydrostatic law, relationship among absolute, gauge, vacuum, and atmospheric pressure; pressure measurement: manometers, mechanical gauges (bourdon, diaphragm, bellows), and electronic gauges (strain, piezoelectric); **Fluid Flow Measurement:** Pitot tube, orifice meter, venturimeter, rotameter, magnetic flow meter, turbine flow meter, vortex flow meter, and coriolis flow meter.
Kinetics of Fluid Flow: Types of flow, equation of continuity, momentum balance equation, energy balance equation; Bernoulli's Equation: Equation of motion for incompressible fluid; **Dimensionless Number and their Applications**: Reynolds number, Froude number, Mach number, Weber number, Euler number; **Dimensional Analysis:** Overview of dimensional analysis, basic equations in non-dimensional form, laminar and turbulent pipe flow, critical Reynolds number, hydraulic radius, friction factor, effect of roughness, Colebrook equation, Moody diagram, entrance conditions, velocity profile, pipe systems, pipe characterization, and minor loss coefficients
Hydraulic Pumps: Introduction, classification, and application of pumps
Centrifugal pump: classification, working principle, cavitation, and performance curves, selection of centrifugal pump; **Reciprocating pump**: classification, working principle, and performance curves, rotary pump: working principle; head loss and power calculation of pump in the realistic system.
Compressor: Introduction, classification, and functions of compressors, characterization and efficiency of positive displacement and rotary compressors.
Hydraulic Turbines: classifications, applications, and working principles.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: acquire knowledge on fluid properties, and flow measuring devices
CO2 describe basic principles of fluid statics and discuss their application in fluid flow problems
CO3: derive the model equations of fluid flow using the fundamental laws of physics.
CO4 analyze problems using methodical and clearly demonstrated worked solutions;
CO5: design fluid flow systems relevant to chemical processes.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2					3					
CO 2	3	3					3					
CO 3		3	2									
CO 4		3	2	1					2			
CO 5			3							1	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester- end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester- end Exam

Recommended Books:

1. Franzini, Daugherty, Finnemore *Fluid Mechanics with engineering applications*
2. R. S. Khurmi *A Textbook of Hydraulics, Hydraulics Machines, and Hydraulic Machnies*
3. Dr. R. K. Bansal *A Textbook of Fluid Mechanics and Hydraulic Machines*
4. Frank M. White *Fluid Mechanics*
5. Streeter, Wylie, edford *Fluid Mechanics*

Course Code: CEP 0711 2152	**Credit:** 2	**Year:** Second	**Semester:** First
Course Title: Fluid Mechanics Sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

Chemical engineers are expected to have the knowledge and the understanding of the basic principles and concepts of fluid mechanics both in static and dynamic conditions. This sessional is to enable them to deal effectively with practical engineering situations, including analysis and design of engineering systems and devices involving fluids and flow.

The objectives of this course are to:

- help the students learn principal operation and design calculation of flow measuring devices
- make them understand the principles of continuity, momentum, and energy as applied to fluid motions
- equip the students with necessary equations to analyze problems by making good assumptions and learn systematic engineering method to solve practical fluid mechanics problems
- helping the students develop the ability in applying fundamental principles of fluid mechanics for the solution of practical chemical engineering problems of water conveyance in reactor, pipes, pipe networks, and open channels.

Course Content:

Verification of the Bernoulli's equation

Calibration of flow measuring devices: i) Rotameter ii) Venturi meter and iii) Orifice meter

Determination of the Reynolds number

Pump assembly

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: evaluate total pressure drop for different flow patterns and arrangements.

CO2: compare the experimental data with expected theoretical values.

CO3: operate and calibrate different flow measuring devices.

CO4: analyze the pump performance for different flow arrangement.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills			Personal Skills		
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3					3		2	1	3	
CO 2	3	3					3		2	3	3	
CO 3	3	2					3		1	1	3	
CO 4	3	3					3		2	2	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Franzini Daugherty *Fluid Mechanics with engineering applications*
2. R. S. Khurmi *Hydraulics and Hydraulics Machines*
3. Supplied lab Manual

Course Code: CEP 0531 2153*	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Principles of Polymerization		**Course Status: Theory (Core)**	

Rationale of the Course:
Every engineering student should have adequate knowledge in material selection for product design. Polymer has attracted global attention for its versatile applications. This course will provide basic knowledge in polymers and polymerization.

The objectives of this course are to:

- help students distinguish polymers from low molecular weight substances.
- introduce students with the factors affecting polymer properties.
- make the students acquainted with the basic principles of polymer synthesis

Course Content
Fundamentals:
Historical development of polymer; Raw materials for polymer industries and their sources; Basic definitions -monomers, oligomers, polymers; Classification and types of polymers, Polymerization reactions; Concepts of plastics, rubbers and fibers; Glass transition temperature, softening temperature, Melting temperature; Concept of average molecular weight, molecular weight distribution and study of the molecular weight measurements of polymers.
Polymerization: Synthesis of polymers-condensation (step growth), free radical, ionic and coordination polymerization and their general kinetics and mechanism, Techniques of polymerization- Bulk, solution, suspension & emulsion polymerization, their comparative studies & relative importance. Copolymerization- random, block & graft copolymerization, monomer reactivity ratio.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: understand the basic concept of polymer, and its structure, properties and applications.
CO2: identify and explain different types of polymerization reaction mechanisms, kinetics, techniques, and their comparative studies.
CO3: interpret different types of copolymerization reaction.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3										3	
CO 2	2	1	3								3	
CO 3	1	3	3								3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:

1. Robert J. Young and Peter A. Lovell — *Introduction to polymers; 3rd Edition*
2. George Odian — *Principles of Polymerization, 4th Edition*
3. F.W. Billmeyer — *Textbook of polymer science; 3rd Edition*
4. V.R. Gowariker — *Polymer Science; 2nd Edition*

Course Code: ECO 0311 2105B	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Principles of Accounting and Management		**Course status: Theory (**General Education)	

Rationale of the Course:

This course provides an introduction to the main ideas and concepts involved in modern economics and attempts to provide students with an understanding of how the economy works, what type of problems economists attempt to solve, and how they set about trying to solve them. The course is primarily concerned with the analysis of individual decision- making agents, the behavior of firms and industries in the economy (microeconomics), on the economy as a whole (macroeconomics) and the inherent problems facing underdeveloped and developing countries (economic development).

The objectives of this course are to:

- provide a brief and simple introduction to the subject matter, scope of microeconomics, and microeconomic analysis.
- acquaint students with the theory of markets with relevant applications to business, social and individual issues.
- help students understand the principles and consequences of "rational" choice by individual economic agents in markets.
- provide knowledge about the analysis of the role of governments in seeking to ensure the efficient operation of markets.
- provide a brief and simple introduction about the subject matter and scope of macroeconomics.
- accumulate basic ideas about macroeconomic analysis outlining how the national income is measured and determined.
- helping the students to understand the process by which the levels of economic activity, employment are determined.
- enhance the understanding of economic theories and analysis in the field of development economics.
- make the students able to deal with the selection of issues and problems facing the developing economies

Course Content:

1. Introduction to Microeconomics: Definition and scope; basic concepts and tools—PPF and circular flow model; fundamental economic problems and solution systems; Concepts of demand, supply and equilibrium; Concepts of elasticity, different types of elasticities, their applications; Concepts of total and marginal utility; Concepts of production, cost and profit, characteristics of different types of markets.

2. Introduction to Macroeconomics: Key macroeconomic indicators and their performance measurement - GNP, GDP, CPI (Consumer Price Index), inflation, unemployment; money, functions of money, function of commercial and central bank, monetary policy; fiscal policy and structure of govt. budget.

3. Development and related issues: Growth and development; concept of poverty and poverty measures; HDI; key human-socio-economic development indicators of Bangladesh, Sustainable Development Goals (SDG).

Course Outcomes (COs): At the end of the Course, student will be able to-

CO1: understand the analysis of individual decision-making agents, the behavior of firms and industries in the economy

CO2: understand the concept of elasticity quantitatively and qualitatively in economic analysis and know differences between different types of markets

CO3: explain macroeconomic concepts and use simple economic models to interpret the behaviour of key macroeconomic variables

CO4: understand monetary and fiscal policy and Government budget

CO5: understand the main issues confronting underdeveloped and developing countries.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1				1	3						2	
CO 2					2					1	1	
CO 3					2							
CO 4					1	2				2		1
CO 5				2	2					1	2	1

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Arnold, R. A., *Economics*
2. Mankiw, N. G. *Principles of Economics*
3. Samuelson, P. A. and Nordhaus,W. D. *Economics*
4. Todaro, M. P. and Smith,S. C. *Economics of Development in the Third World*

Course Code: IPE 0715 2103B	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Engineering Mechanics (for CEP)		**Course status: Theory (**General Education)	

Rationale of the Course:

This course introduces the basic principles of mechanics (statics and dynamics) essential for engineering students. It focuses on the modeling and analyzing of static equilibrium as well as dynamic concepts based on real life engineering applications and necessary problem- solving knowledge.

The objectives of this course are to:

- provide necessary knowledge about basic principles of mechanics
- help students to analyze and solve matrix and vector notation and operations and recognize equivalence between systems of equations and matrix notation
- make the students understand the structural analysis
- provide the students with knowledge about centroid, first moment of inertia, second moment of inertia of an area and effect of friction
- develop ability to solve the problems related to kinematics and kinetics.

Course Content:

Statics: Statics of particles and rigid bodies. Centroids of lines areas and volumes; Forces in truss, frames, and cables; Friction; Moment of inertia of areas and masses; Relative motion. **Dynamics:** Kinetics of particles: Newton's second law of motion, Principles of work, energy, impulse, and momentum

System of particles: Kinematics of rigid bodies; Kinetics of plane motion of rigid bodies, forces, and acceleration; Principles of work and energy.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: apply the basic principles of mechanics to analyze and solve real life engineering problems

CO2: evaluate different structures under various loading conditions (static and dynamic)

CO3: analyze the effects of friction on a body

CO4: evaluate the different laws of a static/moving body (work, energy, momentum, etc.) in real life context

CO5: apply the knowledge to analyze and solve problems related to kinematics and kinetics

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3		2	2			1		1			
CO 2			3				3		3			
CO 3	2		2				2					
CO 4	2		3				3					
CO 5	3	3	2				2					

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Assignment	Assignment, Midterm Exam 1, and Semester-end Exam
CO 2	Lecture using board/ projectors and Assignment	Assignment, Midterm Exam 1, and Semester-end Exam
CO 3	Lecture using board and Assignment	Assignment, Midterm Exam 2, and Semester-end Exam
CO 4	Lecture using board/ projectors	Assignment and Semester-end Exam
CO 5	Lecture using board/ projectors and Assignment	Assignment, Midterm Exam 2, and Semester-end Exam

Books Recommended:

1. Vector Mechanics for Engineers, Ferdinand P. Beer, E. Russell Johnston, Jr., David F. Mazurek and Phillip J. Cornwell, Tenth edition, McGraw Hill.
2. A Textbook of Engineering Mechanics, R.S. Khurmi, S. Chand publications.

Course Code: IPE 0715 2108B	**Credit:** 1	**Year:** Second	**Semester:** First
Course Title: Workshop Practice Sessional (For CEP)		**Course status: Sessional (**General Education)	

Rationale of the Course:

To have a balanced overall development of CEP graduates, it is necessary to integrate theory with practice. Workshop practice includes basic knowledge about manufacturing that is essential for further study of the engineers. It provides practical knowledge about different hand tools and machine tools. Overall, students can use the gathered knowledge to develop a product.

The objectives of this course are to:

- inform students about different types of hand tools and their uses
- accumulate basic knowledge about different types of machine tools including their components and functions
- provide the opportunity to use gathered knowledge practically
- encourage students to perform teamwork.

CO1: identify different types of hand tools and their purposes

CO2: specify and differentiate different types of machine tools used in manufacturing industries

CO3: identify different components of engine lathe, milling machine, bench drilling machine and surface grinding machine and know about their respective functions

CO4: perform different operations on the selected machine

CO5: develop a product in team based on the design specifications

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1									2	3		
CO 2									1	3		
CO 3									3	3		
CO 4									3	3		
CO 5			2						3	3		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Practical demonstration, Hands on practice	Quiz, Report evaluation, Oral examination
CO 2	Lecture using board and Instruction materials, Practical demonstration, Hands on practice	Quiz, Report evaluation, Oral examination
CO 3	Lecture using board and Instruction materials, Practical demonstration, Hands on practice	Quiz, Report evaluation, Oral examination
CO 4	Instruction materials, Practical demonstration, Hands on practice	Quiz, Report evaluation
CO 5	Instruction materials, Practical demonstration, Hands on practice	Quiz, Report evaluation

Books Recommended:

1. James Anderson — *Shop Theory*
2. Rajender Singh — *Introduction to Basic Manufacturing and Workshop Technology*
3. U.K. Singh and Manish Dwivedi — *Manufacturing Processes*
4. H.N. Gupta, R.C. Gupta, and Arun Mittal — *Manufacturing Processes*

Course Code: MAT 0541 2101B	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Differential Equations and Mathematical Methods		**Course status: Theory (**General Education)	

Rationale of the Course:

Differential equations have become a basic part of fundamental mathematical background in engineering and allied discipline. This course also provides the students a sound knowledge of Fourier transforms along with Fourier integrals and Laplace Transformation.

The objectives of this course are to:

- introduction to ordinary differential equations with applications to provide with the necessary mathematical tools in order to model a wide variety of different physical problems.
- also addresses a number of important mathematical methods often used in physical problems.
- identify appropriate boundary conditions for simple linear PDEs;
- provide knowledge to solve special types of differential equations (e.g. Legendre, Hermite, Laguerre, Bessel and Hypergeometric) and analyze the different properties of their solutions.
- introduce Fourier and Laplace transform methods to solve differential and integral equations.
- solve an initial boundary value problem for a particular partial differential equation, the Laplace equation.

Course content:

Differential equations: Definition; solution of differential equations; basic theory of linear differential equations; homogeneous differential equations of the 2nd and higher order with constant coefficients; power series solution about ordinary and regular singular points; non-homogeneous differential equations; solutions by the methods of undetermined coefficients and variation of parameters.
Special Functions: Hermite and Bessel equations; Legendre and associated Legendre equations;
Partial differential equations: linear and non-linear PDE of 1st order; higher order homogeneous and nonhomogeneous linear PDE with constant coefficients.
Laplace Transform: definition of Laplace transform; elementary transformations and properties; convolution theorem and application; evaluation of integrals by Laplace transforms; solution of differential equations by Laplace transforms.
Fourier Series and Transform: Fourier series of a function; half range Fourier series; Fourier transform; solution of differential equations by Fourier transforms.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: solve ordinary differential equations using different methods
CO2: solve a system of linear equation with the help of matrix.
CO3: discuss about analytic function and how to check analyticity based on Cauchy – Riemann equation
CO4: compute Fourier and Laplace transforms
CO5: solve differential and integral equation using Fourier and Laplace transforms methods

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3						1					
CO 2	3						3					
CO 3	3						2					
CO 4	3						3					
CO 5	3						2					

Mapping Course Outcomes (COs) with the Teaching-Learning and Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO1	Lectures white board	Continuous assessment and mid-term exam
CO2	Lectures white board	Continuous assessment and quiz test
CO3	Lectures white board	Continuous assessment and mid-term exam 1
CO4	Lectures white board	Continuous assessment and Assignment
CO5	Lectures white board	Mid-term exam 2 and Semester-end exam

Recommended Books:

1. Stephenson — *Mathematical Methods*
2. Ross, S. L.**,** — *Differential Equations*
3. Spiegel, M. R. — *Laplace Transform*
4. Khanna, M. L. — *Partial Differential Equations*
5. Khanna, M. L. — *Laplace Transforms*
6. KK Kodaira — *Introduction to Complex analysis*
7. Churchill — *Introduction to Complex Variable and Applications*

Course Code: SOC 0134 2101B	**Credit:** 3	**Year:** Second	**Semester:** First
Course Title: Industrial Sociology		**Course status: Theory (**General Education)	

Rationale of the Course:

The course this designed to teach students from the non-major department the basics of industrial sociology. It helps students learn different aspects related to work including the base of work as a human organization in the industry and how work is being organized in an industrial organization. In addition, it teaches students about labour in the context of the industry. Moreover, it provides students with an understanding of the sociology of industry, labour, human relations, and conflict management.

The objectives of this course are to:

- provide students with basic knowledge of the subject matter and the distinctiveness of industrial sociology.
- help students develop an understanding of key sociological concepts such as society, association, institution, work ideology, work attitude, work satisfaction, work commitment, formal relation in the factory system, and industrial bureaucracy.
- familiarize students with the nature and causes of industrial conflict and conflict management.
- help students develop knowledge of the process of industrial development in development..

Course Content:

Basic Concepts related to Industrial Sociology: Nature and scope of industrial sociology for engineers. Terms and concepts of Industrial sociology. Culture- types, elements, cultural changes. Socialization- process, agents. Sociological perspectives- functionalist, conflict, interactionist, feminist.
History of Industrial Society and Industrial Revolution: Origin and development of social organization of human life, Forerunners of Industrial systems; Industrial revolution in Europe. Structure of industrial society: Marxist and Weberian view.
The Concepts Related to Work: Nature of industrial work, Skills in work, Role of work in human life, work and mental health, and work satisfaction.
The Worker and the Factory: The factory system and the formal relations of production in the factory system. Industrial Bureaucracy: The executive in the industrial bureaucracy and social relations at work.
Industrial Organization & Industrial Management: Meaning of industrial organization, models of industrial organizations; Patterns of industrial management; management as the social elite.
Industrial Conflict: Nature and causes of industrial conflict; role and function of trade union. The resolution of industrial conflict; collective bargaining.
Industrialization and Development: Patterns of industrial development in developing countries, the role of foreign capital and borrowed technology. Industrial development in

Bangladesh: history, scopes, constraints.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: Demonstrate understanding of concepts such as society, culture, perspectives, stratification, institution, work ideology, work attitude, work satisfaction, work commitment, formal relation in the factory system, and industrial bureaucracy;

CO2: analyze the nature and causes of industrial conflict and the role of a trade union

CO3: explain the patterns of industrial development in developed countries and the other part of the world.

CO4: apply sociological concepts in analyzing real social and industrial phenomena.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1			3	1	3			2				
CO 2			3	1								
CO 3			2	2		3					3	
CO 4					3					1	3	

Mapping COs with the Teaching-Learning and Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO1	Lecture and Visual Presentation	Class Participation
CO2	Lecture and Class Discussion	Class Participation & Midterm 1
CO3	Lecture, Visual Presentation, and Class Discussion	Class Participation & Midterm 2
CO4	Lecture, class participation	Assignment & Final exam

Recommended Books:

1. Ivar Berg — *Industrial Sociology*
2. Watson — *Sociology, work and industry*

Course Code: CEP 0711 2271*	**Credit:** 3	**Year:** Second	**Semester:** Second
Course Title: Chemical Engineering Thermodynamics		**Course Status: Theory (Core)**	

Rationale of the Course:

Thermodynamics is essential for the practice of chemical engineering. The principles of thermodynamics have a fundamental role in how chemical processes are understood, analyzed, and designed. This course studies the interrelation of heat and work with chemical reactions or with physical changes of state within the confines of the laws of thermodynamics applied to the design and analysis of chemical engineering processes and unit operations.

The objectives of this course are to:

- impart fundamental concepts of solution thermodynamics involving ideal and non-ideal systems
- provide the basic knowledge of classical concepts and laws of thermodynamics and their application to different systems and constitutive properties of pure material and mixtures.
- build up a basic foundation to adopt the principles of thermodynamics to depict various flow processes, mathematical description of phases and chemical equilibria and to illustrate their application.
- provides practice at developing critical and creative thinking skills.

Course Content:

Fundamental Principles: Laws of thermodynamics: First law and Second law, Entropy, Heat engine, Heat pump, Clausius theorem, Reversibility, Calculation of entropy change, Third and Zeroth laws of thermodynamics.

Multi-component Thermodynamic Properties: Pure component properties: PVT behavior of pure fluids, equation of state (ideal and real gas), classification of properties, thermodynamic relations, the standard heat of formation, Hess's Law of constant heat summation.

Phase and Chemical Equilibria: concepts, application (VLE), phase diagram for binary solution, criteria for chemical reaction equilibria and example of simple phase diagram.

Application of thermodynamics to industrial operation: Pipe flow, Nozzle, Throttling process, Turbine, Compressor, Pump, Ejectors.

Power Cycles: Steam-power plant (Rankine cycle, reheat cycle, regenerative cycle); Internal combustion engine (Otto engine, diesel engine, Dual cycle); Gas turbine power plant.

Refrigeration: Methods of achieving low temperature, refrigeration cycle, types of refrigeration cycles- Carnot-air refrigeration cycle, vapour compression cycle; capacity of refrigeration or tons of refrigeration, Coefficient of Performance (COP), characteristics of

ideal refrigerants, latest refrigerants and their qualities and application.
Liquefaction: definition, methods of liquefaction of gases

Course Outcomes (COs): At the end of the course, students will be able to-
CO1: explain/clarify the concepts and reasons behind different thermodynamic states and relationship among the states.
CO2: apply laws of thermodynamics to different systems and constitutive properties of pure material and mixtures.
CO3: derive fundamental equations that govern the estimation of solution thermodynamic properties in different thermodynamic systems.
CO4: compute phase equilibrium data and construct P-x-y, T-x-y diagram for ideal binary miscible vapour-liquid systems
CO5: analyze and formulate thermodynamic problems in industrial processes and find appropriate solution

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	1										
CO 2	3	3										
CO 3		3	2				3					
CO 4	2	3										
CO 5		3	3			2	2			3	3	2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. J. M. Smith, Van Ness & Abbott — *Introduction to Chemical Engineering Thermodynamics*
2. Yunus A. Cengel and Boles — *Thermodynamics an Engineering Approach*
3. K.V. Narayanan — *A text book of Chemical Engineering Thermodynamics*
4. B.G. Kyle — *Chemical Engineering Thermodynamics*

Course Code: CEP 0531 2272	**Credit:** 2	**Year:** Second	**Semester:** Second
Course Title: Polymer science and engineering sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

The polymer scientist should have knowledge on polymer synthesis and polymer analogous reaction and some physic-chemistry of polymer solution. This course is intended to demonstrate a synthesis of some polymer using conventional polymerization techniques, chemical reaction of the functional group of some polymers and behavior of polymer in solvent/non-solvent system.

The objectives of this course are to:

- demonstrate the synthesis of linear and cross-linked polymer.
- demonstrate the solubility and phase separation behavior of polymer
- make the students able to understand the molecular weight determination**.**

Course Content:
Step growth polymerization: synthesis of Urea-Formaldehyde and Phenol-Formaldehyde
Solubility and swelling behaviour of polymer: investigated the swelling ratio of linear and cross-link polymer in different solvent
Free radical polymerization: synthesis of polystyrene
Determination of the molecular weight of the supplied polymer material by viscometry method

Course Outcomes (COs): at the end of the Course, student will be able to-

CO1: synthesize linear and cross-linked polymer using step-growth, free radical and ionic polymerization.
CO2: explain the solubility and swelling behavior of different class of polymers.

CO3: determine the molecular weight of the supplied polymer.

Mapping Course Outcomes (COs) with the Pos

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	2				1	3		1	1	3	
CO 2	2	3				1	2		1	2	3	
CO 3	1	2				1	3		2	1	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. F.W. Billmeyer — *A text book of polymer Science*
2. V.R. Gowariker — *Polymer Science*
3. William — *A text Book of Polymer Science and Technology.*
4. R.J Young and P.A Love — *Introduction to polymer*
5. George Odian — *Principles of Polymer*

Course Code: CEP 0711 2273*	**Credit:** 3	**Year:** Second	**Semester:** Second
Course Title: Heat Transfer		**Course Status: Theory (Core)**	

Rationale of the Course:

The operation of most of the chemical process plant is unthinkable without heat exchange and a chemical engineer must have adequate knowledge about the heat exchange and heat transfer unit and this is the course that deals with design and calculation of heat transfer processes.

The objectives of this course are to:

- understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries
- make the students able to apply various analyzing techniques and methods to solve the problems related to heat transfer.

Course Content:

Heat transfer background

Introduction, definition, applications in the field of engineering

Modes of Heat transfer

Conduction: Introduction: conduction, steady and unsteady state (transient) conduction, 1-D and 2-D heat conduction- plane wall, composite wall, cylinder and sphere and fin (extended surface)

Convection

Fundamental concepts of convection heat transfer, Force convection, dimensionless numbers for heat transfer and analysis of result, Reynolds'-Colburn analogy and empirical formulae and Natural or free convection

Radiation

Fundamental on radiation, Stefan laws, Kirchhoff law, ideal radiator, radiation shields, Radiative transfer between planner and arbitrary surface, thermal radiation, solar radiation **Heat transfer (HT) with phase change**

Boiling and Condensation HT

Heat transfer equipment

fundamental of heat exchangers (HXs), types, arrangement and application, Simplified and general counter flow HXs(uniform temperature),overall HT coefficient(U) of HXs, Analysis of HXs, LMTD and NTU methods and effectiveness of NTU, Heat Exchanger design: calculation of co and counter current HXs using LMTD and NTU methods.

Course Outcomes (COs): At the end of the course, students will be able to- design

and analyze reactor heating and cooling systems

CO1: Describe the governing law and different mode of heat transfer.
CO2: understand and solve heat transfer problems
CO3: design and analyze the performance of heat exchangers
CO4: design and analyze heating and cooling systems

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3											
CO 2	3	3					3			2		
CO 3		2	3				3					
CO 4			3				3					
CO 5												

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. J.H. Lienhard V and J.H. Lienhard IV — *A Heat Transfer Textbook (4th edition)*
2. M. Necati *Ozisik* — *Heat Transfer*: A Basic Approach
3. J.P. Holman — *Heat transfer (8th edition)*
1. Yunus A. Cengel — *Introduction to Thermodynamics and Heat Transfer, 2nd Edition.*

Course Code: CEP 0711 2274	**Credit:** 2	**Year:** Second	**Semester:** Second
Course Title: Heat Transfer Sessional		**Course Status: Core (** Sessional)	

Rationale of the Course:
A chemical engineer should have possessed in-depth knowledge about heat transfer and design the heat transfer equipment. This sessional course will demonstrate different mode of heat transfer and heat exchangers.

The objectives of this course are to:

- make the students able to handle heat transfer equipment smoothly.
- determine the characteristics of heat transfer equipment.
- develop the ability to design the heat transfer unit.

Course Content
Mode of heat transfer: Conduction, convection and radiation
Determination of latent heat of fusion of ice by using a calorimeter
Measurement of thermal conductivity of materials such as mild steel and polymer
Heat exchanger: Design and calculation

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: analyze different heat transfer mode and explain its mechanisms.
CO2: determine the thermal properties of specific metal and rubber.
CO3: calculate LMTD of double-pipe, and shell and tube heat exchanger for different flow arrangements
CO4: design heat exchanger specifically, double-pipe, and shell and tube.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2										3	
CO 2	3	2								2	3	
CO 3	3	3	2				2				3	
CO 4	3	2	3	3			2	3			3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination,Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:
Handout supplied by laboratory

Course Code: CEP 0031 2278*	**Credit:** 1	**Year:** Second	**Semester:** Second
Course Title: Oral Examination-II		**Course Status: Sessional (Core)**	

Rationale of the Course:

The oral exam allows students to show their understanding on theory and sessional courses, and the subject as a whole. It provides students with an opportunity to demonstrate their communication skills in a professional manner. It also allows the faculty to evaluate the students' skill and understanding of the courses offered in Level 2.

The objectives of this course are to:

- develop students' oral communication and presentation skills.
- help them to develop the ability to respond to a question from a scientific perspective.

Course Content:

Based on Level 2 theory and sessional courses

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: speak fluently in both formal and informal context
CO2: demonstrate problem-solving skills adapting and linking audience, speaker and occasion
CO3: provide a solution to a problem from scientific point of view

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1						3		1				
CO 2	2					3		2		2	2	2
CO 3	3			2			3	3			3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	NA	Viva voice
CO 2	NA	Talk
CO 3	NA	Viva voice
CO 4	NA	Viva voice
CO 5	NA	Viva voice

Recommended Books:
All the books recommended in Level 2

Course Code: CSE 0613 2204B	**Credit:** 3	**Year:** Second	**Semester:** Second
Course Title: Introduction to Programming with Python Lab		**Course status: Sessional (**General Education)	

Rationale of the Course:

In this current world, most of the research works require computational data analysis of corresponding fields. This requirement has emphasized the necessity of a knowledge of computer programming for all the researchers. For research-related purposes, computer programming using Python is one of the best choices. This course is designed with the purpose to make students acquainted with programming using python and make them comfortable to deal with computational data analysis.

The objectives of this course are to:

- help students conceptualize basic theories of computer programming
- make the students understand fundamental components of python programming
- develop skills for writing computer programs using all necessary branches of Python
- accumulate basic ideas about data structures and data manipulations

Course Content:

Laboratory works based on theory classes and basic problem solving from rosalind.info using Pycharm, Jupyter, and Anaconda IDEs.
Computer Basics: Concept on Computer Hardware, Software and its classification, Compiler vs Interpreter.
Using the Python Interpreter: Invoking the Interpreter, Argument Passing, Interactive Mode, The Interpreter and Its Environment, Source Code Encoding;
An Informal Introduction to Python: Using Python as a Calculator- Numbers, Strings, Lists. First Steps Towards Programming; **More Control Flow Tools:** if Statements, for Statements, The range () Function, break and continue Statements, and else Clauses on Loops, pass Statements, Defining Functions;
More on Defining Functions: Default Argument Values, Keyword Arguments, Arbitrary Argument Lists, Unpacking Argument Lists, Lambda Expressions, Documentation Strings, Function Annotations,
Intermezzo: Coding Style; **Data Structures:** More on Lists- Using Lists as Stacks, Using Lists as Queues, List Comprehensions, Nested List Comprehensions, The del statement, Tuples and Sequences, Sets, Dictionaries, Looping Techniques, More on Conditions, Comparing Sequences and Other Types;
Modules: More on Modules- Executing modules as scripts, The Module Search Path, Compiled" Python files, Standard Modules, The dir() Function, Packages- Importing * From a Package, Intra-package References, Packages in Multiple Directories, matplotlib, numpy, other common necessary packages;
Input and Output: Fancier Output Formatting, Old string formatting,
Reading and Writing Files: Methods of File Objects, Saving structured data with json; **Errors and Exceptions:** Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Predefined Clean-up Actions.
Classes: A Word About Names and Objects, Python Scopes and Namespaces, Scopes and Namespaces Example, A First Look at Classes, Class Definition Syntax, Class Objects, Instance Objects, Method Objects, Class and Instance Variables, Random Remarks, Inheritance, Multiple Inheritance, Private Variables, Odds and Ends, Iterators, Generators, Generator Expressions.

Course Outcomes (COs): At the end of the course, students will be able to-
CLO 1: implement knowledge of Python for writing computer programs
CLO 2: design solutions to real-life problems using necessary components of Python
CLO 3: identify errors from a program and use exception handlers to handle errors and exception
CLO 4: design basic data structures to solve efficient data storage issues;
CLO 5: implement object-oriented programming and modular concepts, etc., in data analysis and manipulation

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1								2				
CO 2		2		1				2				1
CO 3		2										
CO 4		1						2				
CO 5				2				2				

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using oard/projectors/Lab work using Python	Viva, Programming language tests and Semester-end Exam
CO 2	Lecture using board/projectors/Lab work using Python	Viva, Programming language tests and Semester-end Exam
CO 3	Lecture using board/projectors/Lab work using Python	Viva, Programming language tests and Semester-end Exam
CO 4	Lecture using board/projectors/Lab work using Python	Viva, Programming language tests and Semester-end Exam
CO 5	Lecture using board/projectors/Lab work using Python	Viva, Programming language tests and Semester-end Exam

Books Recommended:

1. Learning Python, By Mark Lutz
2. Think Python, By Allen B. Downey
3. The Python Tutorial, Official documentation of Python

Course Code: IPE 0715 2205B	**Credit:** 3	**Year:** Second	**Semester:** Second
Course Title: Mechanics of Solids		**Course status: Theory (**General Education)	

Rationale of the Course:

The application of the principles of mechanics to bulk matter is conventionally divided into the mechanics of solids and the mechanics of fluids. Solid mechanics is a basic subject for structural analysis. It is concerned with the stresses, deformation and failure of solid materials and structures. In this course, a student will get the basic idea of the behavior of a body due to the external loading.

The objectives of this course are to:

- help the students conceptualize the fundamental concepts of stress, strain and deformation of solids.
- make the students understand the mechanism of load transfer in beams and columns, the induced stresses and resulting deformations.
- facilitate the necessary knowledge about the effect of torsion on shafts and springs.
- foster analytical and critical thinking required for solving the real-life engineering problems related to product design

Course Content:

Stress and strain concepts, axial load, statically indeterminate axially loaded members, thermal stress, deflection of shaft due to torsional load, helical springs, statically indeterminate torque-loaded members, shear and bending moment in beam, flexural stresses in beam, deflection of beam, combined loadings, stresses and deflection in column.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: apply the fundamental concepts of engineering mechanics for deformable and rigid bodies;

CO2: explain the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loadings;

CO3: analyze beams and columns under various loads;

CO4: apply the systematic methods for solving engineering problems in mechanics for solids

CO5: solve real-life engineering problems and design engineering systems.

Mapping Course Outcomes (COs) with the PO

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3		2									
CO 2			2				3					
CO 3	3		3								3	
CO 4	3		2									
CO 5		3	2								3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board/projectors	Continuous assessment, Midterm Examination 1, Semester-end examination
CO 2	Lecture using board/ projectors /Assignment/tutorial	Continuous assessment, Midterm Examination 1, Quiz, Semester-end examination
CO 3	Lecture using board/projectors /Assignment/tutorial	Midterm Examination 2, Assignment, Semester-end examination
CO 4	Lecture using board/projectors/ Assignment/ tutorial	Assignment, Semester-end examination
CO 5	Lecture using board/projectors /Self-learning	Assignment, Semester-end examination

Books Recommended:

1. Andrew Pytel and Ferdinand L. Singer, Strength of Materials.
2. Andrew Pytel and Jaan Kiusalaas, Mechanics of Materials.
3. William A. Nash and Merle C. Potter, Strength of Materials
4. Ferdinand Beer, Jr. Johnston, E. Russell, John DeWolf and David Mazurek, Mechanics of Materials.

Course Code: MAT 0541 2203B	**Credit:** 3	**Year:** Second	**Semester:** Second
Course Title: Numerical Analysis		**Course status: Theory (**General Education)	

Rationale of the Course:

Develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems for engineers. It provides the student a broad perspective on the subject, illustrates the incredibly rich variety of phenomena encompassed by it, and imparts a working knowledge of the most important techniques of analysis of the solutions of the equations numerically.

The objectives of this course are to:

- introduce students with different type of errors in numerical calculations.
- help them understand common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- teach derivation of numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration,
- make them able deduce the solution of linear equations both direct and iterative methods
- provide necessary knowledge to generate the numerical solution of Ordinary differential equations and Partial differential Equations.
- make them able to analyze and evaluate the accuracy of common numerical methods.

Course Content:

Solution of non-linear equations: bisection method; iteration method; the method of false position; Newton-Raphson method.
Interpolation and extrapolation: difference operators and their relationships; interpolation using Newton's forward and backward formulae, Newton's divided difference formula, central difference formula, Staring's interpolation polynomial; Lagrange's formula; inverse interpolation formula; idea of extrapolation.
Numerical differentiation
Numerical integration: Trapezoidal method; Simpson's method; Weddle's method; Romberg's method; error analysis.
Solution of simultaneous linear equation: Gaussian elimination with and without pivoting; iteration method; solution of tri-diagonal system of equations.
Solution of ODE: Taylor's method; Euler method; Modified Euler and Runge Kutta method.
Numerical solution of PDE: solution of elliptic, parabolic and hyperbolic PDE by finite difference method.

Course Outcomes (COs): At the end of the course, students will be able to-

CO 1: identify the steps required to carry out the solutions in Numerical Analysis.

CO 2: apply appropriate theories, principles and concepts relevant to the numerical analysis

CO 3: apply numerical methods to obtain approximate solutions to mathematical problems.

CO 4: understand the IVP and BVP and numerical techniques to solve them.

CO 5: determine the difference between numerical solution and exact solution.

Mapping Course Outcomes (COs) with the Pos

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3	2										
CO 2	3										3	
CO 3	3	3										
CO 4	3	3										
CO 5	3	3										

Mapping Course Outcomes (COs) with the Teaching-Learning and Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lectures using board	Continuous assessment and mid-term exam
CO 2	Lectures using board	Continuous assessment and quiz test
CO 3	Lectures using board	Continuous assessment and mid-term exam 1
CO 4	Lectures using board	Continuous assessment and Assignment
CO 5	Lectures using board	Mid-term exam 2 and Semester-end exam

Recommended Books:

1. Francis Scheid — *Numerical Analysis*
2. Hilderman, F. B. — *Introduction to Numerical Analysis*
3. Noble, B. — *Numerical Methods Vol. 1 and II*
4. Burden, R. L., and Faires, J. D. — *Numerical Analysis*
5. Gerald and Wheatley — *Applied Numerical Analysis*
6. Smith, G.D. — *Numerical solution of Partial Differential Equations*
7. Jain, M. K. — *Numerical Solution of Differential Equations*
8. Steven C. Chapra and Raymond P. Canale — *Numerical Methods for Engineers*

Course Code: CEP 0711 3150	**Credit:** 1	**Year:** Third	**Semester:** First
Course Title: Industrial Tour		**Course Status: Sessional (Core)**	

Rationale of the Course:

Observation of industrial scale applications of theoretical knowledge is of utmost importance for inspirations and growth of confidence in a chemical engineer. This can be achieved through short/long visit or placement in different chemical industries where student will be given opportunity to visit production site, interact with workers and engineers, exchange views with professionals and managements.

The objectives of this course are to:

- familiarize the students with different unit operations and production as a whole.
- give the practical knowledge about mode of arrangement of process units and their inter connections, and process flow diagram.
- be acquainted with occupational health safety measurements, and environmental pollution.

Course Content:
Visit to Chemical Industries in Bangladesh.

Course Outcomes (COs): At the end of the Course, students will be able to-

CO1: describe industrial production processes
CO2: relate the application of theoretical knowledge in industrial context
CO3: know the health and safety practices in industries

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3		1			1	1	2	3			
CO 2	3		3			1	2	2	3			1
CO 3	3			2					3			

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Industry or Field Visit, group discussion, Hands on practice	Report evaluation, Oral, examination, Quiz test, Presentation
CO 2	Industry or Field Visit, group discussion, Hands on practice	Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Industry or Field Visit, group discussion, Hands on practice	Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:
Handout supplied by industries.

Course Code: CEP 0711 3151*	**Credit:** 3	**Year:** Third	**Semester:** First
Course Title: Mass Transfer-I		**Course Status: Theory (Core)**	

Rationale of the Course:

Mass transfer and separation process constitutes a major class of operations in the chemical and biochemical industries. The chemical engineer often deals with design, operation, and optimization of mass transfer equipment. Considering the depth and vastness of separation processes, mass transfer/separation topics is accommodated into two courses namely Mass Transfer-I & Mass Transfer-II. Mass Transfer-I aims to provide theoretical or analytical aspect to design selected mass transfer equipment and to deal with complex problems of separations.

The objectives of this course are to:

- provide the students with an understanding of the theory, basic principles of separation processes.
- make the students able to apply various analyzing techniques and methods to solve the problems related to mass transfer.
- help the students to select, design and calculation of process units involving mass transfer operations

Course Content:

Mass transfer background: Introduction, definition, applications in the field of engineering

Diffusion mass transfer: Molecular diffusion, convective and inter phase convective mass transfer

Distillation: fundamentals of distillation, types, distillation with reflux, method for trays calculation: Mc-Cabe Thiele method, tray efficiency and packed distillation column

Absorption: fundamental mechanism, types: plate and packed or tray tower, determination of mass transfer coefficient

Evaporation: Definition, types of extraction equipment's, application (purpose)of evaporation process

Principles of operation: criteria to evaporation, boiling and vapor pressure, liquid distribution, factors affecting evaporation, effect of process variables on evaporation

Methods of operation of evaporators: single effect and multi effect evaporators

Liquid-Liquid Extraction (LLE): definition, types of extraction equipment's, application (purpose) of extraction process, Operating modes of extraction: basic principles of extraction, batch and continuous (co- cross, counter current) operation, Solvent selection: criteria of solvent selection, calculation methods, phase equilibrium and triangular diagram

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: describe the fundamental of mass transfer operations and its application
CO2: analyze and design of different separation units including absorption, distillation, evaporation, and extraction.
CO3: analyze and differentiate the criteria for selecting the appropriate materials, contacting equipment for separation process.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	1	1								1	2	
CO 2	3	2	2	1	1		2		2	2	3	
CO 3	3	2	3	3	2		3		1	2	3	1

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. Mc Cabe Smith — *Unit operation of Chemical Engineering Principles of Mass transfer and Separation processes*
2. Binoy K. Dutta — *Transport processes and Unit operation Chemical Engineering vol. 1*
3. Gean Koplise — *Mass-Transfer Operations*
4. Coulson and Richardson — *Mass Transfer Principles and Operations*
5. Robert E. Treybal — *Unit operation of Chemical Engineering Principles of Mass transfer and Separation processes*
6. Sinha De — *Transport processes and Unit operation Chemical Engineering vol. 1*

Course Code: CEP 0711 3152	**Credit:** 2	**Year:** Third	**Semester:** First
Course Title: Chemical Process Principles sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

This course is intended to provide students some idea about experimental techniques used in chemical kinetics, and spectrophotometric and instrumental analyses. Chemical engineers must understand the principles and important techniques involved in acquiring data necessary for unit design and material quality control. This sessional course will help the students to assimilate the theoretical material in quantitative analysis discussed in lecture classes and will assist the students to apply the acquired knowledge to the fields of life science, clinical chemistry, environmental remediation and industrial analyses.

The objectives of this course are to:

- provide the knowledge of an extraction process.
- provide the details of an adsorption process.
- make the students realize a separation process by chromatographic method.
- make the students able to control extent of an adsorption process by spectrophotometric method
- help the students learn about the control of a filtration process**.**

Course Content:

Distribution coefficients: Determination of distribution coefficient of a solute in various inorganic and organic solvents.

Spectrophotometric method: Determination of iron content in a supplied sample by spectrophotometric method.

Paper chromatography: Separation of amino acids by ascending paper chromatography.

Adsorption isotherm: Study of Adsorption isotherm using charcoal

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: use experimental apparatus, determine distribution coefficient of a solute in various solvents, interpret experimental results, perform calculations on these results, writing reports and draw reasonable conclusions.

CO2: determine trace element/dyes in water samples by spectrophotometric method.

CO3: describe the fundamental of paper chromatography and extend this technique in column chromatography for separation of chemicals

CO4: define the principle of an adsorption process, conduct experiment and, fit acquire experimental data in various adsorption model

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3		1			1		1	2	1	
CO 2	3	3		1			1		3	2	2	
CO 3	3	3		1			1		1	2	2	
CO 4	3	3		1			1		2	2	2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, Hands on practice	Continuous internal evaluation based on laboratory performance, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Gar D. Christian, Analytical chemistry, Sixth edition, John Wiley and sons, Inc. United State of America.
2. Vogel and John Mendham, Vogel's textbook of quantitative analysis.

Course Code: CEP 0711 3153	**Credit:** 2	**Year:** Third	**Semester:** First
Course Title: Chemical Process Technology-I		**Course Status: Theory (Core)**	

Rationale of the Course:

Chemical process technology is an integral component of engineering education. A chemical engineer must possess a general view on different types of chemical productions, processes and equipment being under operation in plants. Considering the vastness, chemical process technology is accommodated into two courses namely Chemical Process Technology-I & Chemical Process Technology-II. Chemical Process Technology-I aims to provide knowledge about processes involved in different types chemical industries (mainly chemical fertilizer, soap and detergent industries.

The objectives of this course are to:

- familiarize the students with different types of process plants.
- help the students understand the manufacturing technology of chemical fertilizers, soap and detergents.
- provide necessary knowledge to perceive the process flow diagram and process parameters.
- develop the skills to identify and solve engineering problems during production.

Course Content:

Nitrogenous fertilizer: Raw materials, ammonia synthesis, urea manufacturing, Process used in ammonia/urea manufacturing in Bangladesh, prospects of nitrogen fertilizer industries in Bangladesh, ammonium nitrate and ammonium sulfate manufacturing, DAP manufacturing.

Phosphate fertilizer: Raw materials, chemistry and technology of phosphates and super phosphates, triple superphosphate, prospects of phosphate fertilizer industries in Bangladesh.

Block flow diagram, process symbols, and Process flow diagram of chemical fertilizer manufacturing.

Soap and Detergent Industries: Raw materials, manufacturing of different types of soap, recovery of the glycerin, classification of the detergents, types of surfactant, composition of detergent, significance of different ingredients of detergent, industrial processing for the alkyl aryl sulphonates (AAS), environmental pollution by detergents. Bio-degradability of detergent.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: describe the production techniques of chemical fertilizers, soap and detergent industries.

CO2: identify the standard operation of the manufacturing process.

CO3 illustrate the process symbols and apply them in deducing process flow diagram

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3							2				
CO 2	3	2	2	2			4		2		3	
CO 3	3	3	2	2			3	1	3		3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. G.N Pandey — *A Text Book of Chemical Technology Vol. I and II*
2. N. Austin — *Chemical Process Industries.*
3. Anderson and Winzet — *Introduction to Chemical Engineering*
4. Riegl's — *Industrial Chemistry*
5. B. K. Sharma — *Industrial Chemistry*

Course Code: CEP 0711 3155	**Credit:** 3	**Year:** Third	**Semester:** First
Course Title: Instrumental Methods of Analysis		**Course Status: Theory (Core)**	

Rationale of the Course:

A professional chemical engineer must be capable of comprehending and interpreting the data obtained from instrumental analysis and thus to take measure to improve the product quality and yield and prevent environment. The aim of the course is to provide a learner principle of operation of instruments and to interpret the instrumental data.

The objectives of this course are to:

- provide knowledge about different types of analytical instrumentation method.
- make students able to understand principle of different instrumentation methods.
- make the students able to demonstrate and interpret the instrumental data.
- help the students for the selection of suitable method for analysis

Course Content:

Spectrophotometers: UV-Visible- basic principles, monochromators, filters, grating, prism, dual wavelength and double monochromator systems, rapid scanning spectrophotometers,

IR spectroscopy- basic theory and vibrational energy of a diatomic molecule, rotational structure in vibrational bands, instrumentation, interpretation and applications of IR spectroscopy.

Nuclear magnetic resonance (NMR) spectroscopy: Basic theory of NMR spectroscopy, information from NMR spectra, and structure elucidation.

Mass spectroscopy: Mass Spectrometer (MS): Basic Principles, information from MS spectra, and structure elucidation.

Chromatography: Classification, Liquid Chromatography, High Performance Liquid Chromatography (HPLC): principle, applications

Principles and uses: **Atomic absorption spectroscopy (AAS),** Inductively coupled plasma emission mass spectroscopy (ICP-MS), **X-ray diffractometer (XRD),** Scanning Electron Microscope (SEM) and Transmission Electron Microscopy (TEM), X-ray photoelectron spectroscopy (XPS).

.Course Outcomes (COs): At the end of the course students will able to-

CO1: explain the working principle of UV-Visible, IR, Mass and NMR spectroscopy.

CO2: identify the unknown structure of a molecule by using combined analysis of UV-visible, IR, NMR, and Mass, and GC-Mass spectroscopy.

CO3: Describe the basic principles and application of XRD, SEM, TEM and XPS.

CO4: identify the presence of metal in any sample using AAS and ICP.

CO5: explicate the principle of chromatography and application of each type of chromatography.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2											
CO 2	3	2					3		3	2	2	
CO 3	3	2					3		3	2	2	
CO 4	3	1					3		3	2	2	
CO 5	3								2	2	1	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 5	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. Donald L. Pavia *Introduction to Spectroscopy.*
2. B. Christan *Analytical chemistry.*
3. Balen and Ewing *Instrumental Methods of Chemical Analysis.*
4. Willard, Merritt *Instrumental Methods of Analysis, Seventh edition.*
5. Skoog *Principles of Instrumental Analysis, 5th edition*
6. Galen W. Ewing *Instrumental Methods of Chemical Analysis, McGraw-Hill, Fifth edition.*
7. Robert D. Braun *Introduction to Instrumental Analysis, Robert D. Braun, McGraw-Hill.*

Course Code: CEP 0711 3156	**Credit:** 2	**Year:** Third	**Semester:** First
Course Title: Industrial Process Calculation Sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:
Material and energy balances are very important in an industry. These balances are fundamental to the control of processing, particularly in the control of yields of the products. This course introduces the fundamental problem-solving tools that will need in the subsequent engineering and science courses as well as almost every time in one's carrier when he performs mathematical calculations.

The objectives of this course are to:

- help students understand the basic chemical engineering calculations, including (but not limited to) unit conversions, mass/mole conversions, process data representation and analysis.
- make them familiar with the methods for drawing and labelling a process flow diagram from a written description of a process.
- make the students able to derive and solve the equations needed to solve for unknown process variables
- provide students with the knowledge and skills to find unknown process variables by using material and energy balances on chemical processes
- equip the students with the knowledge of design calculations of chemical processes

Course Content:

Basic material and energy balance Principles, Calculation of Bypass, recycle and purging of a chemical process Calculation of material balance in reacting and non-reacting system Calculation of energy balance in flow and non-flow system Introduction to Computer Aided Process Calculations
Experiments assigned by the course teacher (optional)

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: apply the basic concepts of conservation of mass and energy, including phase equilibrium, reaction equilibrium and non-ideal gas behavior to mass and energy balances
CO2: calculate unknown process variables in a multiple-unit process involving recycle and purge by using material (molecular and/or atomic) balances.
CO3: calculate unknown process variables (such as flow rate, temperature, heating and cooling requirements) by using material and/or energy balances in reactive and nonreactive process.
CO4: perform computer aided process calculation
CO5: Interpret experimental measurements of mass, energy and chemical composition and report the results in a lab report

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3	3				3			3	2	
CO 2	3	3	3				3			3	3	
CO 3	3	3	3				3			3	3	
CO 4	3	3	3				3			3	3	
CO 5	3	3	3			3	3			3	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, group discussion, Problem solving, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, group discussion, Problem solving, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, group discussion, Problem solving, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, group discussion, Problem solving, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 5	Lecture using board and Instruction materials, group discussion, Problem solving, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. R. Felder, R. Rousseau — *Elementary Principle of Chemical Processes*
2. Himmelblau — *Basic Principles and Calculations in Chemical Engg.*

Course Code: CEP 0711 3157	**Credit:** 3	**Year:** Third	**Semester:** First
Course Title: Fuel and Energy		**Course Status: Theory (Core)**	

Rationale of the Course:

As a chemical engineer, one should have moderate knowledge about energy sources to operate chemical plants with proper utilization of the energy. This course aims to provide fundamentals of energy sources, optimization, and identifying potential alternative energy resources to overcome the current energy crisis.

The objectives of this course are to:

- provide fundamentals on fuel types and characterization
- make students understand the techniques to convert low to higher grade fuel
- offer the knowledge about the different types of renewable energy sources and its application
- make the students able to calculate the power generation efficiency of fuel

Course Content:

Origin of Formation and Composition: Sources and Origin of fossil and renewable energies. Composition of solid and liquid fuels.

Properties and test methods for fuel classification: proximate and ultimate analysis of solid fuel, Boiling point ranges, densities and flash point, Aniline points of liquid fuels. Octane and cetane number of petrol and diesel. Determination of gross and net caloric values for solid, liquid and gaseous fuels.

Solid Fuel: Carbonization of coal.

Fractionation and refining of petroleum: Common impurities, fundamental separation techniques, dehydration and desalting of crude's, heating of crude- pipe still heaters, distillation of petroleum, blending of gasoline, air blowing of bitumen, upgradation of heavy crude's, treatment of kerosene, treatment of lubes, wax, and purification., catalytic cracking, catalytic reforming, naphtha cracking, cooking, hydrogen processes, alkylation processes, and isomerization processes.

Renewable energy: Biofuels: feedstocks, 1st, 2nd and 3rd generation of biofuels, production of biofuels such as pyrolysis, gasification, anaerobic digestion and combustion, biorefinery; Solar Energy; Geothermal Energy; Tidal Energy; Wind Energy, Nuclear Energy.

Power generation efficiency, power generation from conventional sources.

Course Outcomes (COs): At the end of the course, students will able to-

CO1: Describe the origin and classify energy sources, including renewables and non-renewables

CO2: interpret different important properties of petroleum products and testing methods to assess the properties.

CO3: explain the basic working principle, efficiency and application of alternative energy sources.

CO4: describe and sketch flow diagram of petroleum fractionation processes.

CO5: summarize different fraction impurities and treatment methods.

Mapping Course Outcomes (COs) with the POs

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	2	1										
CO 2	3	2	2	2	2		2				2	
CO 3	3	2	2	2	2		2				2	1
CO 4	3											
CO 5	3											

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	**Teaching-Learning Strategy**	**Assessment Strategy**
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 5	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. W.L. Nelson — *Petroleum Refinery Engineering*
2. Wilfred Francis — *Fuels and Fuel Technology*
3. L.D Smoot & P.J Smith. — *Coal Combustion and Gasification*
4. R.F. Goldstein & A.L. Waddams — *The Petroleum Chemicals Industry*
5. D.P Kothari, K.C. Singal & R. Ranjan — *Renewable Energy Sources and Emerging Technologies*

6. S.P. Sukhatme & J.K. Nayak — *Solar energy, Principles of Thermal Collection*
7. John Twidell & Tony Weir — *Renewable Energy Resources*
8. M. Kanoglu, Y.A. Cengel & J.M. Cimbala — *Fundamentals and Application of Renewable Energy*
9. G.N. Tiwari & M.K. Ghosal — *Renewable Energy Resources: Basic Principles and Applications*
10. B.K. Bhaskara Rao — *Modern Petroleum Refining Process*
11. G.N. Sarkar — *Petroleum Refining*

Course Code: CEP 0711 3158	**Credit:** 2	**Year:** Third	**Semester:** First
Course Title: Fuel and Energy Sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:
In a number of chemical productions, fossil fuel appears to be an indispensable element of the powers and a chemical engineer must have adequate knowledge about the potentiality and properties of the fuel. This course deals with the property analysis of solid, liquid and gaseous fuels and provides guideline to proper fuel selection criteria for manufacturing processes.

The objectives of this course are to:
- provide the knowledge about the determination of the properties of a fuel
- make the students able to synthesize and characterize Bio-Fuel from natural sources

Course Content
Corrosion behavior of copper wire in different liquid fuel samples.
Determination of flash point and fire point of palm oil.
Determination of moisture content ash content and volatile matter content of coal.
Determination of aniline point of petrol.
Determination of Calorific value of fuel sample using Bomb Calorimeter.
Synthesis of Bio-Fuel from Natural Sources and Characterization

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: evaluate the corrosion characteristics of fuel.
CO2: explain the *Proximate* and *Ultimate Analysis* of the supplied fuel sample.
CO3: calculate *Gross* and *Net calorific* value of fuels and their potentiality.
CO4: determine the properties of *Bio-Fuel*.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1			2	2	1							
CO 2		2			1							2
CO 3		2			1				2			2
CO 4		2		2	1				2			2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. S.S. DARA — *A Textbook of Engineering Chemistry*
2. Francis — *Fuel and Fuel Technology*
3. B. K Sharma — *Industrial Chemistry*

Course Code: CEP 0531 3159*	**Credit**: 2	**Year:** Third	**Semester:** First
Course Title: Polymer Characterization and properties		**Course Status:** Theory (Core)	

Rationale of the Course:
Relation between the synthesis and molecular properties and their molecular and bulk properties of polymers provide one of the foundations of polymer science. Establishment of this relation, and to test the theories, it is essential to characterize the polymer under investigation. Considering the academic and commercial importance, this course aims to provide knowledge for thoroughly characterize the molecular and bulk properties of polymer.

The objectives of this course are to:
- make the students acquaint with theories and techniques involve in molecular characterization of polymer
- introduce and provide details about the phase structure and morphology, and bulk properties of polymer
- familiarize the basic and evaluation technique for mechanical, thermal, rheological and thermo-mechanical properties of polymer.

Course Content:
Thermodynamics and Dissolution behavior of polymers: Dissolution behavior of polymers, thermodynamics of polymer solution, Flory-Huggins Theory, theta of temperature, size & shape and solubility parameter. Determination of solubility parameter by two-valued bar graph and group activity scheme.
Study of molecular weights of polymers: Importance of molecular weight of polymers, relationship between molecular weight and properties of polymers. principles of determination of molecular weights by viscometry, osmometry, dynamic and static light scattering techniques, gel permission chromatography, End group analysis
Polymer Morphology: Lamellar crystals, spherulites, fringed micelle model, extended chain crystal, the effect of crystallinity on mechanical and optical properties, liquid crystal polymers.
Polymer Rheology: The flow behavior of polymers; Viscoelasticity: creep & relaxation effects.
Analysis and testing of polymer: Tensile Test, Compression Test, Different Types of Hardness Test, Adhesion Test, Abrasion Test, Impact Test, Bend Test, Thermo-
Gravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC):

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: correlate polymer molecular theories for explaining the molecular properties of polymer.

CO2: describe the basic principle and applicability of the techniques involve for the determination of average molar mass of polymer

CO3: explain the phase structure and morphology, and analyze the bulk properties
of polymer in relation to compositional and structural parameters.

CO4: describe the flow behavior and rheological properties of polymer.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3						1					
CO 2	3	2					1					
CO 3	3	3					2					
CO 4	3	3					1					

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:

1. F.W. Billmeyer *A text book of polymer Science*
2. V. R. Gowariker *Polymer Science*
3. William *A text Book of Polymer Science and Technology.*
4. R, J Young and P. A Lovel *Introduction to Polymer*

Course Code: CEP 0711 3270	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Field Work/In-plant Training-I		**Course Status: Sessional (Core)**	

Rationale of the Course:
Observation of industrial scale applications of theoretical knowledge is of utmost importance for inspirations and growth of confidence in a chemical engineer. This can be achieved through in-plant placement for affordable time in different chemical industries where student will be given opportunity to visit production sites, interact and discuss with workers and engineers about productions, problems and troubleshooting, and exchange views with professionals and managements.

The objectives of this course are to:
- familiarize the students with different unit operations and unit processes.
- realize discrepancy between theoretical predictions and practically achievable values, and to understand the reasons behind that.
- make the student able to perform mass energy balances for a single unit or interconnected process units.
- give knowledge about health and safety issues and practices in industrial workplace.

Course Content:
In-plant training in industries: Cement, Oil and gas processing, Fertilizer, Paints and pigments, Polymer processing, Chloro-alkali, Glass and Ceramic etc.

Course Outcomes (COs): At the end of the Course, student will be able to-

CO1: calculate degree of applicability of theoretical predictions in industrial problems.
CO2: design sustainable process unit
CO3: evaluate industrial health and safety practices.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	1				3		2	2	1	
CO 2	3	2	3		2				2	3	3	
CO 3		3		3		2	3	2	2	3	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials,Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:
Handout provided by the industries

Course Code: CEP 0711 3271*	**Credit:** 3	**Year:** Third	**Semester:** Second
Course Title: Chemical Reaction Engineering		**Course Status: Theory (Core)**	

Rationale of the Course:
This course aims to develop a clear understanding of the fundamentals of chemical reaction engineering. It also increases the student's critical thinking skills and creative thinking skills that will provide students with the ability to produce engineering designs of ideal reactors where the rate of reaction is controlled by chemical and biochemical reaction kinetics.

The objectives of this course are to:

- provide knowledge from calculus, differential equations, thermodynamics, general chemistry, and material and energy balances to solve reactor design problems.
- make the students able to examine reaction rate data to determine rate laws, and to use them to design chemical reactors.
- make the students understand to simulate several types of reactors in order to choose the most appropriate reactor for a given need.
- help the students able to design chemical reactors with associated cooling/heating equipment.

Course Content:

Mole Balances: Chemical identity, definition of the rate of reaction, general mole balance equation, mole balance on different reactor type**. Conversion and Reactor sizing:** definition of conversion, Design equations, Application of design equations for continuous-flow reactors, reactor in series, space time, space velocity

Rate Laws and Stoichiometry: Basic definition, the reaction rate constant, activation energy, collision theory, transition state theory, the reaction order and rate laws, elementary and reversible reactions, stoichiometric table for batch and flow system.

Isothermal Reactor Design: design structure, scale up of liquid-phase batch reactor data to the design of a CSTR, tubular reactors, pressure drop in reactors.

Collection and Analysis of Rate Data: batch reactor data, differential and integral methods, method of initial rates, method of half-lives, least square analysis, differential reactors, evaluation of laboratory reactors.

Multiple Reactions: Type of multiple reactions, selectivity and yield, maximizing the desired production in parallel and series reactions, algorithm for complex reaction. **Steady state nonisothermal reactor design**: The energy balance, Nonisothermal continuous flow reactors, Equilibrium conversion, nonadiabatic reactor operation, multiple steady states, Nonisothermal Multiple chemical reactions

Catalytic Reactors: catalysts and steps in catalytic reactions, catalyst deactivation

Course Outcomes (COs): At the end of the course, student will be able to

CO1: apply basic design equations of chemical reactors applicable for various conditions in homogeneous and heterogeneous reactions.

CO2: explain the principles of chemical reaction kinetics and to develop rate laws for homogeneous reactions.

CO3: evaluate reaction rate data to determine rate laws, and to use them to design chemical reactors.

CO4: design reactor with optimum operating conditions to get maximum desired product.

CO5: describe catalytic reaction mechanism, derive rate law, analyze experimental data and design catalytic reactor.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	1	2				2		2	2		
CO 2	3	2	3						2	2		
CO 3	3	2					3		3	3		
CO 4	3	2	3				3				2	
CO 5	3	3	3				3		3	3		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 5	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:

1. H. Scott Fogler — *Elements of Chemical Reaction Engineering (Third edition)*
2. Octave Levenspiel — *Chemical Reaction Engineering (Third Edition)*
3. J.M. Smith — *Chemical Engineering Kinetics.*
4. Coulson & Richardson — *Chemical Engineering (Vol-3)*

Course Code: CEP 0611 3272	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Introductions to Software for Chemical Engineers		**Course Status: Sessional (Core)**	

Rationale of the Course:
A chemical engineer should have basic knowledge about computer programs to solve the chemical engineering problems. This course aims to familiarize the tools required for data interpretation, design and simulation of basic chemical process.

The objectives of this course are to:
- make the students acquaint with Excel, MATLAB, Aspen HYSYS.
- help the students in solving chemical engineering problems using software
- make the students able to simulate a chemical process

Course Content:
Excel: fundamentals, data analysis and presentation.
MATLAB: fundamentals, data processing, visualizations, and programing technique.
Aspen HYSYS: fundamentals, and basic process design

Course Outcomes (COs): At the end of the course, student will be able to-
CO1: apply computer-aided tools to data processing and visualization.
CO2: solve the basic mathematical problems related to chemical engineering.
CO3: design, simulate, and optimize steady-state and dynamic chemical processes

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2							3		2	
CO 2	3	3	3				3		3	2	3	
CO 3	3	3	3	2			3		3	2	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/ projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:
1. Kamal I. M. Al-Malah — *Aspen Plus: Chemical Engineering Applications*
2. Thomas A. Adams, II — *Learn Aspen Plus in 24 Hours*
3. Diego Gomez — *Chemical Engineering Computation with MATLAB*
4. Mariano M. Martín — *Introduction to Software for Chemical Engineers*
5. Victor J. Law — *Numerical Methods for Chemical Engineers Using Excel, VBA, and MATLAB*

Course Code: CEP 0711 3273	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Chemical Process Technology-II		**Course Status: Sessional (Core)**	

Rationale of the Course:
The analysis of chemical process technology phenomena is important in engineering design applications. The aim of the course is to provide knowledge about processes in natural chemical industries.

The objectives of this course are to:
- familiarize the students with different types of unit operations.
- introduce the student with the manufacturing technology of selected organic products.
- identify and solve engineering problems during production.

Course Content:
Coating process: paint Varnish, and lacquer, constituents and their functions, factor influencing satisfactory performance of surface coating, properties of pigments, binders and volatile solvents pigments of different colors, paint application, causes of paint failure, emulsion paints, manufacture of paints, varnish and lacquer, heat resistant and acid proof paints, enamels
Cement industries: Raw materials, Composition, signification of different ingredients of cement, properties and uses of different types of cements, and manufacture of cement by different methods, setting and hardening of cement, testing of cement, cement industries in Bangladesh.
Glass industries: Composition, raw materials, properties and uses of different types of glasses, manufacturer of glass, special glasses.
Ceramic industries: Types of ceramic products, Basic raw materials, White wares, manufacturer of porcelain, types of clay, clay preparation, firing, different stages of firing, Chemical conversion including basic ceramic industry, manufacture of refractories.

Sugar industries: Manufacturing and refining of cane sugar, Sugar industries in Bangladesh. Block flow diagram, process symbols, and Process flow diagram of cane sugar manufacturing.
Pulp and Paper Industries: Natural source of the cellulose, constituents associated with cellulose, mfg. of different types of pulp paper boards, black lacquer recovery, deinking of waste paper, pulp and paper industries in Bangladesh. Block flow diagram, process symbols, and relevant process flow diagram of pulp/paper manufacturing.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: identify and describe the basic unit operations for selected industries.

CO2: describe the production techniques and principles of coating, cement, glass, ceramics, sugar, pulp and paper,industries.

CO3: illustrate the process symbols and apply them in deducing process flow diagram.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3								1			
CO 2	3		2						2		2	
CO 3	3	2	2	3			2		2		2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books

1. G.N Pandey — *A Text Book of Chemical Technology Vol. I and II*
2. N. Austin — *Chemical Process Industries.*
3. Anderson and Winzet — *Introduction to Chemical Engineering*
4. Riegl's — *Industrial Chemistry*
5. B. K. Sharma — *Industrial Chemistry*
6. S.S. Dara — *A text book of Engineering Chemistry*

Course Code: CEP 0531 3274	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Polymer characterization sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:
A polymer Engineer should have fundamental understanding about the basic characterization methods and properties of polymer. This course is intended to provide students a clear overview on experimental techniques for characterizing polymers, with emphasis on the provision of a working knowledge of instrumental analysis. Experiments include compounding technique, sample preparation and evaluation of compressive strength, tensile strength, flexural strength, abrasion resistance, and adhesion strength etc.

The objectives of this course are to:
- provide knowledge about experimental techniques used for polymer characterization.
- make the students able to evaluate mechanical and rheological properties of polymer.
- make the students understand basic principles of polymer processing such as compounding and moulding methods.

Course Content:

Polymer compounding and moulding method: Polymer compounding technique and sample preparation. Demonstration of mixing machine, injection molding machine.

Polymer materials characterization methods:
Determination of Mechanical properties of polymer specimens. Melt flow index determination. Density measurement.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1:	perform compounding of different polymer via melt mixing method.
CO2:	prepare test specimens using injection molding and heat pressing of thermoplastic polymers.
CO3:	Perform mechanical and thermal characterization of polymers.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	3	1		1		2		3		2	
CO 2	2	3	2		1		3		3		2	
CO 3	3	3	2		2		3		3		2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended books:

1. F.W. Billmeyer *A textbook of polymer Science.*
2. V.R. Gowariker *Polymer Science.*
3. William *A textbBook of Polymer Science and Technology.*
4. D.H.Morton-Jones *Polymer processing.*

Course Code: CEP 0531 3274	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Fundamentals of Electrochemical Engineering		**Course Status: Theory (Core)**	

Rationale of the Course:

Chemical industries based on the concepts of electrochemistry have drawn much attention due to their applications on the conversion of energy, metal extraction etc. This course will provide knowledge to graduates with current and emerging electrochemical engineering issues.

Course Content:

Fundamental of electrochemical engineering: the scope and importance of Electrochemistry, Electrolytic and Galvanic Cells, Faraday's Law of Electrolysis, conduction in aqueous solution-Debye-Huckel theory, electrode potential, excess current, open circuit voltage.

Thermodynamics of electrochemical system: the electromotive force, standard potential and Nernst Equation, measurements of Gibbs Free energy, Entropy, Enthalpy, standard potential and sign convention.

Electrochemical Kinetics: the electrical double layer, the Tafel equation, charge transfer over potential.

Mass transfer in electrochemical system: concept of polarization, activation and con

The chloro-alkali industry: General concepts of brine electrolysis, modern technological developments, chlorine cell technologies, production of KOH, equipment.

The extraction, refining and production of metal: Electrowining, cementation, electrorefining, electrodeposition of metal powders.

Metal finishing: electroplating, conversion, coatings, electrophoretic painting, other related surface finishing techniques. Anodization of Aluminium: Pretreatment, oxide film formation, electro coloring, post treatments.

Energy storage and conversion systems: Battery technologies- Fundamentals, Characteristics, Specifications, Battery components and types, Primary and secondary batteries and their role in the energy system, Current advancements in new battery technology; Fuel cellscentration polarization.

Course Outcomes (COs): At the end of the course, students will be able to-

- **CO1:** define and explain the fundamentals of electrochemistry, thermodynamics, and kinetics of the electrochemical cells.
- **CO2:** select materials and optimize electrochemical processes.
- **CO3:** apply knowledge in battery technology and fuel cell.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3										1	
CO 2	3	3	2				2				2	
CO 3	3	2	2								2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	*Teaching-Learning Strategy*	*Assessment Strategy*
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. D. Pletcher and F. C. Walsh *Industrial Electrochemistry; 2nd Edition*
2. V.S. Bagotsky *Fundamental of Electrochemistry.*
3. C. L. Mantell *Electrochemical Engineering.*
4. Detchko Pavlov *Lead-Acid Batteries*

Course Code: CEP 0711 3276	**Credit:** 2	**Year:** Third	**Semester:** Second
Course Title: Mass Transfer Sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:
Mass transfer with or without chemical reaction is an inevitable part of a chemical engineering process. This laboratory course has been designed to make the students acquainted with the fundamental operations of the mass transfer units that are used to separate or purify products or impurities in the different chemical industries.

The objectives of this course are to:

- introduce the students with the mass transfer equipment in the lab scale.
- make the students able to apply mass transfer principles in the different mass transfer units.
- make the students able to conduct experiments and analyze the experimental data.
- engage the students to perform lab works independently as well as a team.

Course Content

Filtration: Determine the cake resistance and filter resistance under the vacuum pressure;
Diffusion: Find out the diffusivity and diffusion rate of a volatile liquid (acetone) through the stagnant non diffusing air; determination of liquid-liquid (brine and water) diffusion rate with concentration difference and temperature;
Adsorption: Adsorption study (breakthrough time, saturation time of the bed, used and unused bed, total bed length, length of mass transfer zone and the adsorption capacity of an adsorbent) of the in-house adsorbent in a packed bed;
Absorption: Gas absorption rate determination in the liquid with respect to time and flow;
Distillation: Separate different chemical compounds at different boiling point using fractional distillation column, plot reflux ratio versus product purity, perform mass and energy balance;
Evaporation: Determination of process parameters to achieve specific concentration of the methanol;
Drying: Measure the drying rate, and relative moisture content using tray dryer; and observe the effect of drying rate on free moisture;
Ion-Exchange: Demineralization of water by ion-exchange resin (determine the breakthrough time, saturation time, cation and anion exchange capacity).

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: apply mass transfer principles in the different mass transfer units.
CO2: conduct experiments on mass transfer and analyze the experimental data
CO3: perform lab works independently as well as a team

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3											
CO 2	3	3				3	3		3			
CO 3			3			2						

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction, materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Mc Cabe Smith — *Unit Operation of Chemical Engineering*
2. Binoy K. Dutta — *Principles of Mass Transfer and Separation Processes*
3. Gean Koplise — *Transport Processes and Unit Operation*

Course Code: CEP 0711 3277*	**Credit:** 3	**Year:** Third	**Semester:** Second
Course Title: Mass Transfer-II		**Course Status: Theory (Core)**	

Rationale of the Course:
The analysis of the phenomena of mass transfer is important in engineering design application. This course explains to solve engineering problems involving different mass transfer operations in process industries.

The objectives of this course are to:

- provide fundamental knowledge about separation processes and its application.
- make the students able to choose the appropriate separation process and units.
- help the students for developing a base foundation of knowledge to design different unit of separation processes and integrate with other unit process

Course Content:

Adsorption: Introduction to adsorption processes, Equilibrium relations for adsorbents Absorption at gas solid interface. Physical adsorption and chemisorption Langmuir and BET theory and surface area determination, Adsorption from solution Gibb's adsorption isotherm. Design of fixed bed adsorption. Processing variables and adsorption cycle.

Ion Exchange: Ion exchange resins and their preparation, Exchange kinetics, Ion exchange equipment's. Regeneration technique of ion exchange resin.

Filtration: Introduction to filtration. Basic theory of filtration Types of filtration equipment. Engineering operation and calculation of different types of filters.

Membrane Separation Processes: classification of membrane processes. Liquid permeation membrane processes. Gas permeation membrane processes: Types of membrane. Types of equipment's. Basic equations. Effects of process variables. Reverse-osmosis: Types of membranes. Flux equations for reverse-osmosis. Ultrafiltration membrane Processes: Types of equipment's. Effect of processing in ultra-filtration

Drying: Theory of drying of solids. Types of drying equipment. Engineering operation and calculation of different types of Dryer.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: describe the fundamentals of physical and chemical separation process and their application.

CO2: analyze the criteria for selecting alternative separation process units (e.g., adsorption, filtration, membrane filtration, drying).

CO3: apply the mass transfer fundamentals to solve numerical, design calculations and real industrial problems related to separation processes

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	1										
CO 2	3	2	1				2		2	2	2	
CO 3	3	3	3				3		2	2	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. Geankoplis C.J. *Transport Process and Unit Operation*
2. McCabe and Smith *Unit Operation of Chemical Engineering*
3. Binoy K. Dutta *Principles of Mass Transfer and Separation Processes*
4. Coulson and Rechardson *Chemical Engineering (Vol-2)*
5. Trybal *Mass Transfer Operations*
6. Sinha De *Mass Transfer Principles and Operations*

Course Code: CEP 0031 3278*	Credit: 1	Year: Third	Semester: Second
Course Title: Oral Examination - III		Course Status: Sessional (Core)	

Rationale of the Course:

The oral exam allows students to show their understanding on theory and sessional courses, and the subject as a whole. It provides students with an opportunity to demonstrate their communication skills in a professional manner. It also allows the faculty to evaluate the students' skill and understanding of the courses offered in Level 3.

The objectives of this course are to:

- develop students' oral communication and presentation skills.
- help them to develop the ability to respond to a question from a scientific perspective.

Course Content:

Based on Level 3 theory and sessional courses

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: speak fluently in both formal and informal context

CO2: demonstrate problem-solving skills adapting and linking audience, speaker and occasion

CO3: provide a solution to a problem from scientific point of view

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1						3		1				
CO 2	2					3		2		2	2	1
CO 3	3			2			3	3			3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:
All the books recommended in Level 3

Course Code: CEP 0711 3279	**Credit:** 3	**Year:** Third	**Semester:** Second
Course Title: Introduction to Engineering Materials		**Course Status: Theory (Core)**	

Rationale of the Course:

To understand the structure-property relation and the material behavior at different operational conditions is very important to make proper choice of a material for applications, and this course provides the knowledge about that.

The objectives of this course are to:

- provide the knowledge about mechanical and physical behavior of materials.
- introduce with different types of engineering materials and their utility properties.
- make the students familiar with the principles of test methods.

Course Content:

Introduction to materials Science and Engineering : Materials and Engineering, Types of materials; Crystal structure and Crystal geometry: The space lattice and unit cells, crystal systems and bravais lattices , principal metallic crystal structures ,atom positions in cubic unit cells, directions in cubic unit cells, miller indices for crystallographic planes, crystallographic planes and directions in hexagonal unit cells, comparison of FCC, HCP, and BCC crystal structures , volume ,planar and linear density unit cell.

Solidification, crystalline imperfections and diffusion in solids: Solidification of metals, solidification of single crystals, metallic solid solutions, crystalline imperfections, rate processes in solids, atomic diffusion in solids, and industrial applications of diffusion processes

Mechanical Properties of metals: Recovery and recrystallization of plastically deformed metals, fracture of metals, fatigue of metals, fatigue crack propagation rate, creep and stress rupture of metals, graphical representation of creep- and stress - rupture time -temperature data using the Larsen-Miller Parameter.

Ceramic Materials: Introduction, simple ceramic crystal structures, silicate structures, , traditional and technical ceramics and electrical properties of ceramics mechanical properties of ceramics, thermal properties of ceramics, glasses.

Metals and Ores: Occurrence and ore preparation

Production of Steel and Wrought Iron: Cement steel and crucible steel, alloying addition and steel ingots, influence of minor elements in carbon steel and high alloy steel. General principle of phase diagram of alloys and solid solution: Study of binary alloys, Iron-Iron constitutional diagram.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: define different engineering materials, and describe crystal structures and defects of materials.
CO2: describe the solid-liquid phase separation of metal and diffusion in solid.
CO3: explain the properties and mechanical behavior of materials.
CO4: point out different methods of steel and alloy production.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	1					2				2	
CO 2	2	2	1				1				2	
CO 3	3	2		1			3		3	2	3	
CO 4	2	1	1	2	2		2					1

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended Books:

1. Askeland. D. *The Science & Engineering of Materials.*
2. L.H.Van Black *Elements of Material Science and Engineering.*
3. William *Introduction to Science & Engineering of Materials.*
4. Melvin Nord *Science of Engineering Materials.*
5. William F. Smith *Foundations of Materials Science and Engineering.*

Course Code: CEP 0711 4150*	**Credit:** 2	**Year:** Fourth	**Semester:** First
Course Title: Process Unit Operation and Process Control (Training)		**Course Status: Sessional (Core)**	

Rationale of the Course:

Understanding of different unit operations and processes along with their controls is very important to develop technical skills required in industries, and this course provides the knowledge about that.

The objectives of this course are to:

- provide the knowledge about unit operations and unit processes used in industries
- Help the student learn water & wastewater treatment techniques
- provide the knowledge about different types of machineries and equipment used in process industries
- develop technical knowledge about process control and instruments and their working principle, uses and operation

Course Content:

Introduction to process technology and study of unit operation, process symbols and process drawings
Heat transfer and heat exchanger, Pump technology and operation, Compressor and compression system operation, Steam turbine and turbine operation, Boiler and steam system, Industrial cooling water
Introduction to industrial instrumentation, measuring devices/ sensors and transmitters, controller, control valve, distributed control system
Pollution from chemical industries and pollution control, Industrial safety
Practical assignment on unit operation and control

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: describe different unit operations and engineering drawings
CO2: explain working principles and operation of process equipment's and machineries
CO3: describe and operate control system used in process industries
CO4: identify industrial pollution and its treatment methods

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	1										1	
CO 2	3								2			
CO 3	3		3						2		2	
CO 4	3	3	3		1		2		2		2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture	Class evaluation, Assignment, Quiz test, oral examination
CO 2	Classroom lecture, tutorial and Assignment, Demonstrate equipments/instruments.	Class evaluation, Assignment, Oral examination, group discussion, Hands on practice

CO 3	Classroom lecture, Demonstrate equipments/instruments.	Class evaluation, Assignment, Quiz test, oral examination, Hands on practice
CO 4	Classroom lecture, group assignment, Demonstrate equipments/instruments.	Class evaluation, Assignment Quiz test, oral examination, Hands on practice

Recommended Books:
Handout provided by Training Institute for Chemical Industries (TICI).

Course Code: CEP 0531 4151*	**Credit:** 3	**Year:** Fourth	**Semester:** First
Course Title: Polymer Processing and Application		**Course Status: Theory (Core)**	

Rationale of the Course:
Polymer processing industries in Bangladesh is flourishing very rapidly. For optimal operation and production, theoretical and practical knowledge about polymer processing is very important. This course aims to familiarize the polymer processing and its applications.

The objectives of this course are to:
- provide knowledge about different polymer processing technique
- Apply the knowledge of different types of application
- make the students understand the necessity and functions of different treatment of polymer
- make the students understand role of different additives in polymer composition**.**

Course Content
Plastics Processing: Extrusion, Injection molding, Blow molding, Compression molding, plastics compounding; compounding ingredients, their types & functions; Transfer molding, Thermoforming.
Rubber processing: Principles & chemistry involved in mastication & compounding ingredients--accelerators, accelerator activators, antioxidants, fillers & other additives; Vulcanization & various types of vulcanization systems; Rubber processing machineries-open mills & internal mixers, rubber extruders, calendars of different types.
Radiation processing techniques of polymers:. Surface coating: Polymer curing of different substances (wood, leather, metal, paper, ceramics etc), Grafting on natural polymers (wood, jute, cotton, cellulose, silk etc) and on synthetic polymer (polyethylene, polypropylene etc); Polymer loading, degree of grafting. Radiation effect on synthetic polymers - degradability and stability.
Thin film preparation: Gel content, swelling ratio, properties characterization.
Processing of textile fiber: Preparation and modification.
Polymer Composites: Introduction, fiber reinforced composite, predicting properties of fiber reinforced composite, characteristics of fiber reinforced composite, mfg. of fiber and composite Glass fiber reinforced plastics. Application and uses of polymeric materials in everyday life. Importance of polymeric materials over metal and ceramic, Importance/ necessity of research in polymer science.

Course Outcomes (COs): At the end of the course, student will be able to-
CO1: apply the knowledge of different polymer processing techniques for fabricating polymeric materials.
CO2: identify the effect of additives in polymer processing and on final properties of polymers.
CO3: explain the necessity of different post treatment of polymer
CO4: define and prepare the polymer composites for specific application

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	1										1	
CO 2	3								2			
CO 3	3		3						2		2	
CO 4	3	3	3		1		2		2		2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, presentation, group discussion	Class evaluation, Assignment, Midterm, and final Exam
CO 2	Classroom lecture, tutorial, assignment, and group discussion.	Class evaluation, Assignment, Midterm, and final Exam
CO 3	Classroom lecture, homework, assignment, and group discussion	Class evaluation, Assignment, Midterm, and final Exam
CO 4	Classroom lecture, assignment, and group discussion.	Class evaluation, Assignment, Midterm, and final Exam

RECOMMENDED BOOKS:

1. Robert J. Young and Peter A. Lovell — *Introduction to polymers; 3rd Edition*
2. F.W. Billmeyer — *Textbook of polymer science; 3rd Edition*
3. D. H. Morton-Jones — *Polymer processing;1st Edition*
4. J.M.G. Cowie and Valeria Arrighi — *Polymers: Chemistry and Physics of Modern Materials; 3rd Edition*

Course Code: CEP 0711 4152	**Credit:** 3	**Year:** Fourth	**Semester:** First
Course Title: Chemical Reaction Engineering Sessional		**Course Status: Sessional (Core)**	

Rationale of the Course:

Chemical Reaction Engineering is the very important subject which distinguishes chemical engineering from any other engineering disciplines; this course is designed to acquire some preliminary knowledge about the behavior of a chemical reactor in industrial process.

The objectives of this course are to:

- enable the students of realizing the principles of scaling up of laboratory reactions to large industrial scale.
- make students acquainted with the process of calculating and analyzing experimental data.

Course Content:

Preparation of a calibration curve of conductivity vs concentration

Observe the effect of a step input change for CSTR connected in series

Observation of the influence of flow rate on a three-tank system following a step change in input concentration

Observation of the effect of impulse change in a combination of CSTR's connected in series

Course Outcomes (COs): At the end of the course, student will be able –

CO1	recognize the theory of the chemical reactors and its design.
CO2	conduct and summarize the experimental work and understand the laboratory manual
CO3	interpret the experimental data to determine activation energy, specific rate constant and order of reaction
CO4	demonstrate presentation of the experiment and report writing

Mapping Course Outcomes (COs) with the POs

COs	**Fundamental Skills**			**Social Skills**			**Thinking Skills**		**Personal Skills**			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3	3	2				3		1			
CO 2	2	2	2				2		3			
CO 3	2	2	2				2		2			
CO 4	2						2		2			

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	**Teaching-Learning Strategy**	**Assessment Strategy**
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice.	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice.	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice.	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice.	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Coulson & Richardson — *Chemical Engineering*
2. Octave Levenspiel — *Chemical Reaction Engineering*
3. H.Scott Fogler — *Elements of Chemical Reaction Engineering*
4. J.M. Smith — *Chemical Engineering Kinetic*

Course Code: CEP 0711 4154#	**Credit:** 0	**Year:** Fourth	**Semester:** First
Course Title: Plant Design		**Course Status: Sessional (Core)**	

Rationale of the Course:

Chemical Process Plant design sessional is important for chemical Engineering students for the integrated design of a Chemical plant considering related design considerations and cost estimations.

The objectives of this course are to:

- facilitate necessary knowledge about the plant, design basis, plant location, feasibility survey of a chemical process plant
- help them conceptualize basic theories about material and energy balance calculations in chemical Engineering and their application in a plant.
- acquaint students with the basic tools of plant designing

- develop skills about design practices and techniques by using codes and standards for chemical plants
- provide the knowledge of economic analysis and get details idea of a chemical process plat.

Course Content:
Detailed design of selective chemical process plants (e.g. Fertilizer, Cement, Paint, Chloro-alkali, refineries, pulp and paper, soap, polymer processing plant etc.)

Course Outcomes (COs): At the end of the course, student will be able to

CO1: develop flow sheets (BFD, PFD) for chemical process
CO2: calculate process parameters to design the equipment
CO3: integrate control systems and perform safety analysis
CO4: perform cost analysis of a chemical process plant.

Mapping Course Outcomes (COs) with the Pos

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	2				2			2	1	
CO 2	3	3	3	2			3		2	3	2	
CO 3	3	3	3	2		3	3		2	3		
CO 4	3		3							3	1	3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Coulson & Richardson — *Chemical Engineering (Vol-3)*
2. Peters and Timerhaus — *Plant Design and Economics for Chemical Engineers*
3. Octave Levenspiel — *Chemical Reaction Engineering*
4. H. Scott Fogler — *Elements of Chemical Reaction Engineering*
5. J.M. Smith — *Chemical Engineering Kinetics*

Course Code: CEP 0711 4155	**Credit:** 3	**Year:** Fourth	**Semester:** First
Course Title: Industrial Economics and Management		**Course Status: Theory (Core)**	

Rationale of the course:
Optimization aspect of a project is the key responsibility of an engineer in decision-making processes and hence a chemical engineer should be able to evaluate projects from technical as well as from financial perspectives. This course is designed to impart students the major concepts and techniques of engineering economic analysis and the management of process industry.

The objectives of this course are to:

- provide knowledge about fundamental concepts and principles of economics and management; the basic functions of management, various organizational structures
- help conceptualize basic theories in the economical law and mechanism, function of a firm/organization.
- provide basic knowledge of investment and finance, marketing, supply chain management, quality management; and project and operations management
- provide the basic knowledge of organizational and managerial competencies; and competent leadership in the industry.

Course Content:
Basic Concepts and tools used in economics: Principles of economics; Need, want and demand aspects; Capital and resource allocation, output and outcome scenario, Basics of the absolute and comparative advantage, Break-even analysis, Demand-supply market, Equilibrium, Elasticity concept, Law of diminishing marginal return; Equivalence and interest: Time value of money, calculation of simple, continuous and compound interest; **Basics of the Utility and benefit of the product**: Concept of utility and benefits, level of product, life cycle of product, Customer service and satisfaction, feedback loop of product and service development

Present worth analysis: Cash-flows, payback period, calculation of net present worth; nominal and effective interest rates.
Analysis of Cost Estimation: Capital investment, working capital, fixed capital, factors affecting investment and production costs, types of capital cost estimates;
Cost-Benefit Analysis: Capital budgeting, Efficiency and effectiveness, Cost of capital, Rate of return analysis, Risk premium, Return on investment, IPR, FIRR, EIRR, and its application in decision making.
Asset Depreciation: Types and methods of depreciation, depletion.
Industrial Management: Levels of industry, functions of management, office management, managers at different level, managerial skills; Basics of the organizational behaviors, Basics of the operations management, Functional codes and standards, Matrix and cross cultural communications
Organizational Models and Staffing: office manager, one-location, one-site, one- location multiple sites, public work model, multi-location, fully international; Staffing; outsourcing; Consulting, contracting, Vertical and horizontal communications, Group, team and committee structure
Basics of the Organizational Competency: Value, core and managerial competency: inclusion, integrity and professionalism; and team work, accountability, communication; and leadership and strategic thinking.
Leadership in Management: Leadership definition, leadership philosophy, leadership skill, Objectives of the leader and the manager, leadership styles, attributes and qualities of a good business leader; Basics of accountability, transparency and professionalism;
Quality Management: statistical process control (SPC), Basic tools and techniques, TQM, TPM.
Materials management: Aspects of material management, Methods and techniques: Just in Time (JIT), Inventory control (Basic EOQ Model), Lead time, Communication: five steps of communication, communication skills for project manager, components of communication transaction. Supply chain Management.
Project Management: Defining project management, importance of project management, role of the project manager, Knowledge areas of project management, project life cycle, project management triangle, Keys to successful projects, managing the contractor and contracts, managing the project, Project monitoring and control- Gantt chart, CPM, PERT, The agile manifesto.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1:	define the basic concepts of economics and management for chemical process industries.
CO2:	calculate capital investment, taxes and insurances, depreciation, and operating cost, and make break-even analysis.
CO3:	describe quality management and assessment.
CO4:	develop leadership quality for industries.

Mapping Course Outcomes (COs) with the Pos

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3		2									3
CO 2	2	3	2	1						2	2	2
CO 3	1	1			2	3				2	1	3
CO 4	3			2	3	3	2	2		3	2	3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, presentation, discussion, brainstorming	Class evaluation, Assignment, Midterm, and final Exam
CO 2	Classroom lecture, tutorial, and Assignment	Class evaluation, Assignment, Midterm, and final Exam
CO 3	Classroom lecture, homework, group discussion	Class evaluation, Assignment, Midterm, and final Exam
CO 4	Classroom lecture, brainstorming	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Peters and Timerhaus — *Plant Design and Economics for Chemical Engineers*
2. Aurora — *Industrial and Production management.*
3. Chan S. Park — *Contemporary engineering economics*
4. W. Koontz — *Management principles*
5. Bernadin Russell — *Human resource management*
6. William J. Kolarik — *Quality concepts, systems strategies and tools*
7. Dale H. Besterfield — *Total quality management*

Course Code: CEP 0711 4157*	**Credit:** 3	**Year:** Fourth	**Semester:** First
Course Title: Process Control		**Course Status: Theory (Core)**	

Rationale of the course:
Chemical process plants in modern age are unthinkable without complete or partial automation of the processes and this is the course which introduces the student with design and fundamentals of basic control system of chemical engineering processes.

The objectives of this course are to:

- provide the knowledge of mathematical modeling of basic chemical processes and operations.
- make them acquainted with different control operations.
- give basic idea about response of the processes under control systems.
- apply the knowledge to evaluate the stability of a control system.

Course Content:

Introduction: Illustrative examples of the development and operation of a suitable control system.

The Laplace transformation: The Laplace transform, Inversion by partial fractions, Further properties of transforms.

Linear open-loop systems: Response of first order systems, Physical examples of first-order systems, Response of first-order systems in series, Higher-order systems: Second-order & transportation lag.

Linear COsed-loop systems: The control system, Controllers and final control elements, Block diagram of a chemical-reactor control systems, COsed-loop transfer functions, Transient response of simple control systems, Stability, Root locus.

Frequency response: Introduction to frequency response, transportation lag, Bode diagrams, Nyquist POts. **Control system design by frequency response**: Bode stability criterion, Gain and phase margins, Ziegler-Nichols Tuning technique, Nyquist stability criterion.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: integrate mathematical tools for solving special type of differential and integral equations.

CO2: model simple processes and predict the response of simple systems under well-defined disturbances

CO3: describe how controller operates in practice as mechanical and electrical devices.

CO4 assimilate how a control system reacts at different types of disturbances and determine how far it lies from stability.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3	2				1					
CO 2	3	3	3				2		2			
CO 3	3	2	1	2		3	2			2		
CO 4	3	3	1				2		3			

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, group discussion, brainstorming	Class evaluation, Assignment, Midterm, and final Exam
CO 2	Classroom lecture, group discussion, brainstorming, tutorial, and Assignment	Class evaluation, Assignment, Midterm, and final Exam
CO 3	Classroom lecture, group discussion, brainstorming, homework	Class evaluation, Assignment, Midterm, and final Exam
CO 4	Classroom lecture, group discussion, brainstorming	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Hougen and Watson — *Chemical Process Principles I & II*
2. Levenspiel — *Chemical reaction engineering*
3. George Stephanopolos — *Chemical process control*
4. Donald R.Coughanowr — *Process System Analysis and Control*
5. M Gopal — *Control Systems: Principles and Design*

Course Code: CEP 0711 4159	**Credit:** 2	**Year:** Fourth	**Semester:** First
Course Title: Bioprocess Engineering		**Course Status: Theory (Core)**	

Rationale of the Course:

In advanced world, a chemical engineer is always equipped with adequate knowledge in biochemical processes. Thus, to compete in the global job market, our engineering graduate also must have similar depth of knowledge, and this is in complete agreement with the national educational policy 2017 on technical education. This course will provide basic knowledge in biochemical engineering and reactor design.

The objectives of this course are to:

- provide basic knowledge in biochemical reactions and kinetics specifically enzymatic reactions and fermentation
- demonstrate application of chemical engineering principles in conducting biochemical processes
- provide the details about the application of bioprocesses in environmental pollution control.

Course Content:

Introduction to Biochemical Engineering: Concepts of catalysts, nature of micro-organisms, their requirements and classification, industrially important, micro-organisms.
Growth Kinetics: Indirect Measurements of Cell Growth, Cell Growth in Batch Culture, Growth Phases, Kinetics of Batch Culture, Growth Kinetics for Continuous Culture,

Material Balance for Continuous Stirred Tank Reactor (CSTR).
Enzyme Technology: Enzyme Elementary Reaction Rate, Enzyme Classifications, Enzymes Specific Function, Enzymes Act as Catalysts, Inhibitors of Enzyme-Catalyzed Reactions, Industrial Application of Enzymes, Coenzymes, Effect of pH on Enzyme Activities, Enzyme Unit Activities, Enzyme Deactivation.
Immobilized Enzymes: Why Immobilize Enzymes?, Immobilization Methods, Mass Transfer Effects, Performance of Immobilized Enzymes
Bioreactor Design: Bioreactors: Background, Stirred Tank Bioreactor, Bubble Column Fermenter, Airlift Bioreactors, Heat Transfer, Design Equations for CSTR, Temperature Effect on Rate Constant, Biological Transport of Oxygen through Cells.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: describe basic concept of biochemical reactions and kinetics focusing on enzymatic reactions and fermentation.

CO2: analyze the microbial growth behavior to develop control system.

CO3: describe enzymatic reaction, reaction mechanism, control and efficient application.

CO4: evaluate and design bio-reactor to produce green and suitable bio-product

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2											
CO 2	2	2	1	2								
CO 3	3	2	2				1					
CO 4	3	3	3	3		2	3		3	2		2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester-end Exam

Recommended books:

1. H.W. Blanch and D.S. Clark — *Biochemical Engineering, Marcel Dekker, Inc., New York, 1996.*
2. J.M.Smith — *Chemical Engineering. Kinetics.*
3. J.E. Bailey & D.F. Ollis — *Biochemical Engineering Fundamentals.*
4. S.N. Mukhopadhyay — *Process Biotechnology Fundamentals.*
5. Ghasem D. Najafpour — *Biochemical engineering and biotechnology.*

Course Code: CEP 0711 4163*	**Credit:** 2	**Year:** Fourth	**Semester:** First
Course Title: Corrosion Engineering		**Course Status: Theory (Core)**	

Rationale of the course:
Chemical engineers often involve in handling equipment, instruments which is susceptible to corrosion. Thus, graduate engineers must have possessed knowledge about corrosion phenomena and take necessary steps to protect the chemical processes against corrosion. This course provides the basic understanding of the nature and mechanism of corrosion, and build up foundation for corrosion prevention and control.

The objectives of this course are to:

- introduce students with the principles of corrosion and help to recognize the types of corrosions and its mechanisms.
- provide necessary knowledge to select material or protection method for a specific environment to reduce corrosion cost.
- provide a practical understanding of corrosion control and corrosion monitoring technique and field applications.

Course Content:
Corrosion Basics: Introduction, corrosion and materials, corrosion media/environment, physical and chemical properties for corrosion resistance electrochemical cells, corrosion rates (kinetics), types of corrosion
Corrosion Principles and Mechanism: Chemical and electrochemical principles**,** corrosion thermodynamics (corrosion tendency): Pourbiax (E-pH) diagram and corrosion kinetics (rate): mixed potential theory**,** polarization (activation and concentration), passivity and types of corrosion phenomena.
Corrosion Testing: Importance, material selection and testing, identification of testing technique
Corrosion Prevention: identify corrosion failure, Criteria for corrosion prevention: cathodic protection (sacrificial cathodic, stray/ impressed current cathodic protection) and anodic protection, protective coating (metallic, inorganic, nonmetallic and organic).

Corrosion in Chemical Industries: Boiler plant, Double pipe heat exchangers, Shell and tub heat exchangers, Distillation Column.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1:	explain the basic chemical/electrochemical principles and mechanism of different types of corrosion
CO2:	explain the thermodynamics and kinetics of corrosion processes.
CO3:	perform necessary laboratory and field tests, monitors the corrosion rate and suggest corrosion remedies.
CO4:	design protection systems against corrosion of infrastructure, plant, equipment and machineries.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2	2										
CO 2	3	2					3					
CO 3	2	2	2	3			2		3			
CO 4	3	3	2		3				3		2	2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, assignment, and group work.	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 2	Classroom lecture, tutorial, group work/assignment and presentation.	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 3	Classroom lecture, tutorial, group work/assignment and presentation, field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 4	Classroom lecture, tutorial, group work/assignment	Quiz test, Class evaluation, Assignment, Midterm, and final Exam

Recommended Books:

1. Mars G. Fontana — *Corrosion Engineering (3rd Edition)*
2. Pierre R. Roberge — *Corrosion engineering: principles and practice*
3. Branko N. Popov — *Corrosion Engineering: Principles and Solved Problems(1st Edition)*

Course Code: CEP 0711 4254#	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Plant Design		**Course Status: Sessional (Core)**	

Rationale of the Course:
Chemical Process Plant design sessional is important for chemical Engineering students for the integrated design of a Chemical plant considering related design considerations and cost estimations.

The objectives of this course are to:
- facilitate necessary knowledge about the plant, design basis, plant location, feasibility survey of a chemical process plant
- help them conceptualize basic theories about material and energy balance calculations in chemical Engineering and their application in a plant.
- acquaint students with the basic tools of plant designing
- develop skills about design practices and techniques by using codes and standards for chemical plants
- provide the knowledge of economic analysis and get details idea of a chemical process plants

Course Content:
Detailed design of selective chemical process plants (e.g., Fertilizer, Cement, Paint, Chloro-alkali, refineries, pulp and paper, soap, polymer processing plant etc.)

Course Outcomes (COs): At the end of the course, student will be able to-

CO1:	develop flow sheets (BFD, PFD) for chemical process
CO2:	calculate process parameters to design the equipment
CO3:	integrate control systems and perform safety analysis
CO4:	perform cost analysis of a chemical process plant.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	2				2			2	1	
CO 2	3	3	3	2			3		2	3	2	
CO 3	3	3	3	2		3	3		2	3		
CO 4	3		3							3	1	3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate strategies for problem solution, group discussion, Hands on practice.	Continuous internal evaluation based on design performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Coulson & Richardson — *Chemical Engineering (Vol-3)*
2. Peters and Timerhaus — *Plant Design and Economics for Chemical Engineers*
3. Octave Levenspiel — *Chemical Reaction Engineering*
4. H. Scott Fogler — *Elements of Chemical Reaction Engineering*
5. J.M. Smith — *Chemical Engineering Kinetics*

Course Code: CEP 0711 4271*	**Credit:** 3	**Year:** Fourth	**Semester:** Second
Course Title: Process Design		**Course Status: Theory (Core)**	

Rationale of the Course:

The center to the chemical engineering education is to make student capable of designing equipment and instrument as well as construction of process plant from Greenfield. Erection of process plant from Greenfield requires build up knowledge, working experience on operation, design and integration of instrument and equipment. This course will provide the fundamental preparation to the student for designing process plant.

The objectives of this course are to:

- introduce the basic of chemical process design and integration of chemical plant structure.
- familiarize with design basis, feasibility survey, standards and codes of equipment.
- provide necessary knowledge about flow sheeting, the Process and Instrumentation diagram of a chemical process plant, and plant layout.
- help the students capable of designing the individual equipment such as different fluid motive, heat and mass transfer units.

Course Content:

Basic Concepts: The Nature of Chemical Process Design, Design basis, Design constraints, Role of the Process Design Engineer, Scope of Design, Feasibility survey, standards and codes.

Flow-sheeting: Flow-sheets-Types, Flow-sheet Symbols, BFD, PFD, P & I diagram, Plant Layout, Site layout

Reactor Design: Choice of reactors, determining reaction conditions, configuration of reactors, use of bypass, recycle and purging, economic potential.

Equipment selection and Specification and Design: Heat exchanger, evaporator, Distillation Column, agitator, Ion-exchange column, pump, compressor, valve selection, piping design.

Heat Exchanger Networks: Energy Targets, and Network Design using Pinch Technology.

Materials of Construction: Material properties, Mechanical properties, Selection for corrosion resistance

Course Outcomes (COs): At the end of the course, students will be able to-

- **CO1:** describe the basic steps involved in designing a process plant
- **CO2:** synthesize preliminary process flow diagram (PFD), determine the processing conditions (e.g. processing condition of streams and equipment's) and economic evaluation of proposed PFD
- **CO3:** classify and design the equipment and instruments, and integrate the process units (e.g. heat exchanges, distillation) for a particular process plant.
- **CO4:** develop detailed engineering design (Piping and instrumentation diagram, P&ID) of the process plant including control systems and safety measures

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3			2			1			1	2	
CO 2	3	3	3			2	3		2	2		3
CO 3	3	3	3				3		2			2
CO 4	3	3	3	3	3		3			3		3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 4	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam

Recommended Books:

1. Peters and Timerhaus — Plant Design and Economics for Chemical Enginee
2. Coulson & Richardson — Chemical Engineering (Vol-6)
3. Douglas — Conceptual Design of Chemical Process
4. Ludwig E. — Applied process design for chemical and petrochem
5. Chopey N.P. — Handbook of Chemical Engg. Calculation
6. Daniel A. Crowl — Chemical Process Safety (Second edition)

A. K. M. Abdul Quader — Design and Building of Process Plants

Course Code: CEP 1022 4273*	**Credit:** 3	**Year:** Fourth	**Semester:** Second
Course Title: Process safety engineering		**Course Status: Theory (Core)**	

Rationale of the Course:

Capability of understanding of Chemical Process Safety as well as hazard identification and risk assessment in Chemical Process Plant is integral for the chemical engineering students. This course is design to acquaint the student with the fundamental of process safety.

The objectives of this course are to:

- introduce the basic concept of Safety, Incidents and Environment
- help students to build consciousness about the Inherent Safety and process safety management
- make them know about the toxicology and Industrial Hygiene
- provide necessary knowledge to identify and conduct the hazard analysis, risk assessment and HAZOP study
- help them to develop expertise in incident investigation and case history analysis and to know how to mitigate the incidents

Course Content:

Introduction to Process safety: Safety, Accident and loss statistics, Acceptable risk, inherent safety, concepts of process safety management.
Toxicology and industrial hygiene: Dose and response curves, threshold limit values, Hygiene Identification, evaluation and control techniques, Use, importance & application of MSDS.
Source models: Flow of liquid/vapors/gases through a hole in a tank, through pipes, flashing liquids
Hazard identification and risk assessment: Hazards in Chemical Industries, source modeling for leakage rates, dispersion analysis, relief valve sizing,
Fire and explosion damage analysis, Process hazard checklists,
Hazard and operability studies, Event tree and fault tree analysis, frequency analysis, consequence analysis, LOPA
Accident investigations & Case history analysis

Course Outcomes (COs): At the end of the course, student will be able to-

- **CO1:** define and understand the basic concept of process safety and effect of toxic substances and industrial hygiene
- **CO2:** identify the mechanical integrity of the equipment and determine the equipment failure
- **CO3:** identify the hazard and risk factor, Hazop, LOPA, ETA, FTA of a process plant
- **CO4** understand the Accidents and their reasons and develop the idea to prevent accident

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	1	2		3		3	2	3				2
CO 2	3	3	2		3						1	
CO 3	3	2	2	2				3		3	2	
CO 4	3	2	2	3	3	3	2	2	3	3	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, assignment, and group work.	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 2	Classroom lecture, tutorial, group work/assignment and presentation.	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 3	Classroom lecture, tutorial, group work/ assignment and presentation, field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam

CO 4	Classroom lecture, tutorial, group work/assignment	Quiz test, Class evaluation, Assignment, Midterm, and final Exam

Recommended Books:

1. M.S. Mannan *Lees' Loss Prevention in the Process Industries (Third edition)*
2. Daniel A Crowl *Chemical process safety fundamentals with applications (Second edition).*
3. CCPS *Guidelines for Hazard Evaluation Procedures - With Worked Examples (Second edition)*
4. John R. Ridley *Safety at work (Seventh edition)*

Course Code: CEP 0712 4275*	**Credit:** 3	**Year:** Fourth	**Semester:** Second
Course Title: Environmental Engineering		**Course Status: Theory (Core)**	

Rationale of the Course:

For sustainable development, pollutants resulting from different sources must be treated before exposing to the environment. In order to monitor and mitigate the environmental pollution, engineers must possess in depth knowledge in different waste treatment methods. This course will provide knowledge to graduates with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities

The objectives of this course are to:

- introduce the students with the basic of different sources of pollutants and estimate the extent of pollution.
- provide concepts on wastewater characteristics, treatment principles and their practical applications.
- make the students acquaint with potential causes of air pollution and its remediation.
- provide knowledge on solid waste treatment management.

Course Content

Environmental Engineering principles: Environment**,** human interaction with environment, causes of environmental pollution (Population and human population growth, economic growth, industrialization, urbanization and energy-use). Environmental systems balance for steady state and unsteady state conditions. Resource consumption, types of pollutions.

Water pollution: Water resources, hydrologic cycle, water pollutants, Oxygen Demanding wastes, Water quality management (Dissolved oxygen, Chemical oxygen demand, biological oxygen demand, total organic carbon, color, turbidity, pH etc.) in Lakes and Reservoirs and oxygen SAG curve.

Water Treatment: Introduction, sources and characteristics of portable water, Coagulation and Flocculation, Softening, settling/Sedimentation, Filtration, Disinfection, Adsorption. **Wastewater Treatment:** Wastewater characteristics, Unit operations of pretreatment, Unit operations of Primary, Secondary and Tertiary treatments, Advanced wastewater treatment, activated sludge treatment, Sludge disposal and Membrane Technology (MBR).

Wastewater treatment plant design and calculation

Air pollution: Air pollutants- nature, sources and types, criteria of pollutants. sampling, controlling, global warming potential (GWP). Indoor air quality, Point source Gaussian Plume Model.

Solid Waste Management: Perspective, waste characterization collection, treatment, solid waste disposal -incineration, sanitary landfill. Waste to energy, Resource conservation and recovery. **Soil Pollution:** Nature and types, controlling method. **Environmental problems in Bangladesh**

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: describe the basic of different sources of pollutants and estimate the extent of pollution.

CO2: characterize water and wastewater, and select and design water and wastewater treatment plant

CO3: analyse air pollutant and their ultimate effect on human and on earth, and their treatment technology

CO4: explain the scenario of solid waste generation, disposal techniques and resource recovery from the waste as a sustainable alternative.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	2											
CO 2	2	3	3	3			3		2	2		
CO 3	1	2	1	3			3		2			
CO 4	3	3	3	3			2		1	2		

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, assignment and group work.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment and presentation.	Class evaluation, Assignment, quiz test, Midterm, and final Exam

CO 3	Classroom lecture, tutorial, group work/ assignment and presentation, field visit.	Class evaluation, Assignment, quiz test, Midterm, and final Exam
CO 4	Classroom lecture, tutorial, group work/assignment, field visit.	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Davis & Cornwell — *Introduction to Environmental Engineering*
2. Gerard Kiely — *Environmental Engineering*
3. Peavy, Rowe &Tchobanoglous — *Environmental Engineering*
4. W. Strauss — *Air pollution.*
5. A. S. Stoker — *Air and Water pollution*
6. Bailey and Clark — *Chemistry of the Environment.*
7. J.N. Duffus — *Environnemental Toxicology*

Course Code: CEP 0031 4278*	**Credit:** 1	**Year:** Fourth	**Semester:** Second
Course Title: Oral Examination - IV		**Course Status: Sessional (Core)**	

Rationale of the Course:
The oral exam allows students to show their understanding on theory and sessional courses, and the subject as a whole. It provides students with an opportunity to demonstrate their communication skills in a professional manner. It also allows the faculty to evaluate the students' skill and understanding of the courses offered in Level 4.

The objectives of this course are to:
- develop students' oral communication and presentation skills.
- help them to develop the ability to respond to a question from a scientific perspective.

Course Content:
Based on Level 4 theory and sessional courses

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: speak fluently in both formal and informal context
CO2: demonstrate problem-solving skills adapting and linking audience
CO3: provide a solution to a problem from scientific point of view

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1					3			3				
CO 2					3					3	2	
CO 3	3	3	3	2				3				

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Provide information/ideas to demonstrate knowledge/skills in the field of engineering.	Oral examination
CO 2	Provide information/ideas to demonstrate knowledge/skills in the field of engineering.	Oral examination
CO 3	Provide information/ideas to demonstrate knowledge/skills in the field of engineering.	Oral examination

Recommended Books:
All the books recommended in Level 4 theory and sessional courses.

Course Code: CEP 0711 4270**#	**Credit:** 4	**Year:** Fourth	**Semester:** Second
Course Title: Project		**Course Status: Sessional (Core)**	

Rationale of the Course:
The project work allows students to apply their knowledge of Chemical Engineering and Polymer Science to design project plan in context of both existing practical and industrial applications. It allows student to show their ability to formulate a research problem and plan the experiments with scientific approach.

The objectives of this course are to:
- develop students' ability to solve industrial problems appear in the production process.

Course Content
Based on the field of Chemical Engineering and Polymer Science.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: identify and demonstrate appropriate techniques and tools, and know when to use them.

CO2: identify and find out a solution of industrial problems

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3	3	2		2	2	1		3		3
CO 2			3			3	3	3		3		2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Provide ideas to design, calculate and solve problem, group discussion.	Discussion based on findings/ outcomes, Report evaluation, Oral/poster presentation.
CO 2	Provide ideas to design, calculate and solve problem, group discussion.	Discussion based on findings/ outcomes, Report evaluation, Oral/poster presentation.

Course Code: CEP 0711 4280**#	**Credit:** 4	**Year:** Fourth	**Semester:** Second
Course Title: Thesis		**Course Status: Sessional (Core)**	

Rationale of the Course:
The thesis work allows students to apply their knowledge of Chemical Engineering and Polymer Science to design research plan in context of both existing theoretical and practical applications. It allows student to show their ability to conduct experiments as well as to analyze and interpret data.

The objectives of this course are to:

- develop students' ability to conduct independent research.

Course Content
Based on the field of Chemical Engineering and Polymer Science.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: identify and demonstrate appropriate research methodologies and know when to use them.

CO2: use library, database and other tools to search for existing resources for research, and analyse and interpret acquired data.

CO3: identify and find out a solution of industrial problems

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	3									
CO 2		3							3			
CO 3	3	3	3	3		2	3	3				3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Literature survey, defining research problem, set objectives/goal of the research, setting up experiments or modelling platform, group discussion, academic writing, Presentation.	Discussion based on findings/outcomes, Report evaluation, Oral/poster presentation.
CO 2	Literature survey, defining research problem, set objectives/goal of the research, setting up experiments or Modelling platform, group discussion, academic writing, presentation	Discussion based on findings/outcomes, Report evaluation, Oral/poster presentation.
CO 3	Literature survey, defining research problem, set objectives/goal of the research, setting up experiments or modelling platform, group discussion, academic writing, presentation	Discussion based on findings/outcomes, Report evaluation, Oral/poster presentation.

ELECTIVE COURSES:

Course Code: CEP 0711 4281	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Transport Phenomena		**Course Status: Theory (Core)**	

Rationale of the Course:
A chemical engineering student acquires adequate knowledge on transport processes through a number of courses as a preparation for work as an industrial engineer. In our country, however, a significant number of chemical engineering graduates go for higher education and research, and an advanced level of understanding of transport processes would make them well-prepared for that in

home and abroad.

The objectives of this course are to:

- provide advanced level knowledge in mathematical description of momentum transport processes
- provide advanced level knowledge in mathematical description of heat transport processes
- provide advanced level knowledge in mathematical description o mass transport processes

Course Content:
Viscosity and the Mechanism of Momentum Transport: Newton's Law of Viscosity, analogy among heat, mass and momentum transport laws, Non-Newtonian Fluids, Pressure and Temperature Dependence of Viscosity
Velocity Distributions for flow through/around object with standard geometry: Shell Momentum Balances: Boundary Condition, Flow of a Falling Film, Flow through a Circular Tube, Flow through an Annulus, Adjacent flow of two immiscible flow, Creeping Flow Around a Solid Sphere,
Interphase Transport on Isothermal Systems: friction factors for flow in tubes, friction factors for packed column.
The Equations of Change for Isothermal Systems: The Equation of Continuity, The Equation of Motion, The Equation of Change in Curvilinear Coordinates, use of the equations of change to set Up Steady flow Problems, The equations of change for incompressible non-Newtonian Flow
Energy transport: Shell energy balances and temperature distributions in laminar flow, heat conduction with an electrical heat source, heat conduction with a nuclear heat source
Diffusion transport: Diffusivity and mechanism of mass transport, diffusion through stagnant gas film, Diffusion with heterogenous and homogeneous chemical reactions.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: calculate the distribution of stresses and velocity for flow in laminar regime
CO2: describe the distribution of temperature for steady state heat flow
CO3: calculate the concentration distribution for steady state mass flow

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2	2								2	
CO 2	3	2	2								2	
CO 3	3	2	2								2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

R. B. Bird, W. E. Stewart, E.N. Lightfoot, *Transport Phenomena, 2nd Edition, John Wiley & Sons, Inc., New York, 2002*

Course Code: CEP 0723 4283	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Fundamentals of Textile Engineering		**Course Status: Theory (Core)**	

Rationale of the course:

In Bangladesh, in many occasions, a chemical engineer has to serve textile sectors dealing with textile raw materials (fibers) to fabrication of final apparels, safely handling of textile chemicals, and dying processes. This course is designed to provide thus some basic theoretical knowledge on textile industry related matters.

The objectives of this course are to:

- introduce the textile fibers and different apparels making technologies.
- provide the knowledge of different dyestuff and their chemical properties.
- make them acquainted with the dying processes and selectivity of dying processes towards some specific fibers.

Course Content:

Study of textile fibers: classification, production, structure and properties of the main textile fibers-natural and man-made.
Short overview of spinning, weaving and knitting technologies. Yarn numbering systems. Basic characteristics of yarns, woven and knitted fabrics. Pre-treatment processes of textile materials.
Classification of the dyestuff and its relation with the textile fibers. Study of the main properties of fastness and its relation with dyestuff and used fibers.
Study of the direct, vat, reactive, sulphureous, dispersed, acid and cationic dyestuff.
Study of the dyeing processes of cellulosic, polyester, polyamide, acrylic, wool fibers and the mixtures of polyester with cellulosic.

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: explain the different types of textile fibers with their structure, properties and production method.

CO2: distinguish among different types of yarn and fabric making technologies.

CO3: describe the different types of dyestuff and understand their corresponding relation, for instance, fastness, with fibers.

CO4: illustrate and draw flow diagrams of the contemporary dying processes for some specific types of fibers or fabrics.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3			3							2	
CO 2	3											
CO 3	3			2								
CO 4	3											

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 4	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. Peters, R.H. *Textile Chemistry*

Course Code: CEP 0711 4285	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Contemporary Industrial Processes In Bangladesh		**Course Status: Theory (Core)**	

Rationale of the Course:

For being well aware about recent upgradation in industrial level, this course is designed to aid to cope up with the newest technology, innovation and machineries before starting the professional career.

The objectives of this course are to:

- provide knowledge about the overall progress of chemical industries in Bangladesh
- introduce students with latest technology, machineries, equipment and accessories of chemical field
- widen the knowledge about man, material and machineries.
- acquaint students with the industrial problems and troubleshooting.
- make the students aware of the future prospects of Chemical Engineering in Chemical Fields

Course Content:

Overview: Basis of installing current chemical production plants, Site Selection Criteria, Advantages and Limitations of existing Chemical Industries. Organogram and Job Responsibilities of Employees in Chemical Industries. Essential Soft Skills of Chemical Engineers (Simulation, CAD drawing, MS Project etc.).

Inventory of Chemical Industries in Bangladesh: Fertilizer Industries (Urea, TSP, DAP), Refinery Industries (Crude Oil, Edible Oil), Process Industries (Chlor-Alkali, Hydrogen Peroxide, Sulphuric Acid). Technology Licensor, BEP (Basic Engineering Package), DEP (Detailed Engineering Package), GC (General Contractor) of individual plants.

Flow of Materials: List and amount of Raw Materials, Products, Utilities in individual industries. Effluent List and Management System in present chemical industries in Bangladesh.

Review of Unit Operations, Valves, Instruments, Pipes and Fittings: List of Unit Operations, Valves, Instruments, Pipes and Fittings using in chemical industries in Bangladesh. Justification and GAP Analysis of these equipment (Reactors, Filters (Ion- Exchange, Candle Filter etc.), Purification Units (Evaporator, Clarifier etc.) and accessories for specified function.

Chemical Projects under Construction: Process Industries, Refining Projects, Active Pharmaceutical Ingredients (API) Projects, and Polymer Projects (PVC, HIPS, PET, PE).

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: apply the basic knowledge on existing chemical industries

CO2: list the installed chemical industries along with contributors

CO3: demonstrate improved brainstorming through real case scenario

CO4: think creatively via GAP Analysis

CO5: be apprised of upcoming chemical projects in Bangladesh

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1		2	2					3		3		
CO 2									2	2		
CO 3			2					2			3	
CO 4	3						4			2		
CO 5											2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming, Field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming, Field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming, Field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 4	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming, Field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 5	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming, Field visit	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

Materials suggested by course teacher

Course Code: CEP 0711 4287	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Natural gas and petroleum reservoir engineering		**Course Status: Theory (Core)**	

Rationale of the Course:

In many occasions, a chemical engineer serves in plants dealing with petroleum mining, operating process and transport of production. This course is designed to provide some introductory knowledge about these matters.

The objectives of this course are to:

- introduce the students with petroleum reservoir and transport of petroleum through rock.
- provide the knowledge about primary process and transport.
- make them acquainted with the methods of estimation of petroleum reserves and problem facing during transport of petroleum product.

Course Content:

Basic concepts in reservoir Engineering: Branches of petroleum industry, Petroleum trap & reservoir, Types of trapping mechanisms, Analysis of Hydrocarbon phase behavior, Classification of reservoir, reservoir fluid properties, Laboratory analysis of reservoir fluids.

Properties of rocks: Types of rocks, porosity, relative and effective permeability; fluid saturations, capillary characteristics, compressibility, rock stress; and fluid-rock interaction, net pay thickness, reservoir heterogeneity.

Reservoir fluid flow & well performance: Darcy's law, fluid flow regime, Basic fluid flow equation for unsteady state, pseudo steady state and steady state conditions, constant terminal rate solution, General flow equation in dimensionless forms, skin factor, turbulent flow factor, wellbore storage effect, Partial penetrated wells, Superposition principle and its application, Reservoir drive mechanism.

Reservoir Models: Oil & gas reserves- volumetric method, material balance method.

Drilling and completion of wells: Introduction to Petroleum Drilling Systems, drilling rig components, drilling fluids, pressure loss calculation, casing, well cementing, and directional drilling, Stimulation of well productivity, Gas fracturing, Acidizing, operations, Well logging: Introduction to modern well logging methods.

Gas Well Testing: Deliverability tests, Test for determining reservoir parameters- drawdown test, pressure build up test.

Gas Hydrates & Their Prevention: Natural gas hydrates, Conditions promoting hydrate formation, Use of methanol to prevent hydrates, Importance of dehydration of natural gas. Natural Gas Processing: Objectives, Types of plants, Basic processes, Process description, Condensate, NGL

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: identify rocks and interpret petroleum transport mechanism.

CO2: estimate the petroleum reserve and laws governing the process.

CO3: define the basic knowledge on drilling and operation related component and the formation of logging used in petroleum extraction.

CO4: describe the reasons and prevention for the solid crystal formation during gas transport and processing steps of a natural gas.

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	1								1		
CO 2	3	2	2				2		3	2		2
CO 3	3		1			2			3	2		2
CO 4	3	2	2			2						

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 4	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. L.P Dake *Fundamentals of reservoir engineering*
2. Tarek Ahmed *Reservoir Engineering Handbook*
3. Katz D. L. et al. *Natural Gas Engineering (production & storage)*
4. B.C Craft et al. *Applied petroleum reservoir engineering*
5. John M. Campbell *Gas conditioning and processing, Vol 1 & 2*

Course Code: CEP 0711 4289	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Mathematical Modeling in Chemical Engineering Processes		**Course Status: Theory (Core)**	

Rationale of the Course:

A chemical engineering student acquires adequate knowledge on transport processes through a number of courses as a preparation for work as an industrial engineer. In our country, however, a significant number of chemical engineering graduates go for higher education and research. In higher research, they are very frequently involved in modeling and simulation. For doing research at advanced level, the researchers must have knowledge about the formation of a mathematical model, its validation, determination of model parameters and clear understanding of the physical significances of the parameters, and the course is indented to provide basic preparation for that**.**

The objectives of this course are to:

- provide basic preparation to identify course of a process and propose a mathematical formulation to describe it
- provide basic preparation to assume mechanism of a process observing experimental kinetic and equilibrium data
- make the students acquainted with the mathematical models developed in recent years for describing advanced level transport process and their contradictory elements
- teach the students how to optimize parameters of process with inadequate knowledge of the mechanism

Course Content:

Introduction: Theoretical and empirical approach of mathematical description of processes, Acquaintance with standard algebraic equations and their geometric representations

Empirical models: Finding suitable model equations to describe experimentally obtained data. Linearization of curvilinear function to determine model parameters.

Mathematical models of polymer deformation: Models in combination with elastic and viscous components

Gas transport through polymer material: Solubility and diffusibility of gases, dual model of sorption and diffusion, data treatment and analysis

Facilitated transport: Modeling of mass transport through liquid and polymers augmented by chemical reaction, contradictory theories and models in literature

Adsorption in liquid phases: modeling of kinetics and equilibrium processes, data treatment and analysis

Design of experiments: factorial design and regression analysis

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: propose empirical models to describe a process and validate it

CO2: view critically the assumptions made in the development of models available in literature and follow its development

CO3: demonstrate the capability to optimize industrial process parameters

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3					3		2		1	
CO 2	3	3					3		2		1	
CO 3	3	3	3				3		3			

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/ assignment, presentation, and brainstorming	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment, presentation, and brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/assignment, presentation, and brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. S.L. Akhnazarova & V Kafarov — *Experiment Optimization in Chemistry and Chemical Engineering*
2. R.B. Bird & W.E Stewart — *Transport Phenomena*
3. G. Stephanopolas — *Chemical Process Control*
4. Luyben W. L. — *Process Modeling, Simulation & Controlfor Chemical Engineers*
5. Živorad R. Lazić — *Design of Experiments in ChemicalEngineering: a practical guide*

Course Code: CEP 0531 4291	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Polymer Composites		**Course Status: Theory (Core)**	

Rationale of the Course:

Polymer composite materials have been discovered as being beneficial for various applications, but a poor understanding of these materials greatly handicapped their usage. Today's manufacturing engineer should be aware of these new materials, and it is going to open new market for future employment. In this course, the student will achieve the knowledge on the range of polymer composites and polymer blends, will be familiar with its processing technologies, as well as the methods for determining the structure and properties.

The objectives of this course are to:

- provide in-depth knowledge on the development and design principles of polymer composites and blends
- develop the skills to apply the appropriate technologies and methods for processing, as well as characterization of polymer composites and blends
- increase the competence in the management of the production and characterization of polymer composites

Course Content:

Fundamental Characteristics of composites: classification of composites; laminae and laminates; load sharing between reinforcement and matrix- rule of mixture; advantages, design and application of composites.

Reinforcements: Basic characteristics of fibers and fibrous reinforcements, fiber packing, fiber strength, fiber orientation and length distribution, different types of fibers,for composites, modification of fibers for composite, design of fabrics for reinforcement of composite, particulate reinforcement.

Matrices: Main polymer matrices-thermoplastic and thermosetting polymers, High temperature polymeric matrices, metal matrix composites (MMC), ceramic matrix composites (CMC)

Elastic and Thermal Properties of Composites: Stress-strain relationship and elastic constants for unidirectional lamina(UD), planar random fiber composites(PRFC) and short fiber composites; Classical Laminate theory(CLT), selected laminate configurations, interlaminar stress and edge effect, thermal behavior of composite.

Interface Region: Complexity in the near fiber region, bonding mechanisms- adsorption and wetting, interduffusion, chemical reaction, electrostatic attraction and mechanical keying; experimental measurements of interfacial strength, coatings of fiber, coupling agents.

Polymer Nano-composites: Carbon nanotube composite, structure, properties, purification, characterization and functionalisation of carbon nanotubes, interaction of carbon nanotubes with polymer matrix; layered silicate nanocomposites- structure, manufacture and application.

Course Outcomes (COs): At the end of the course, student will be able to-

- **CO1:** describe basic knowledge of the properties of polymer composites, the common application of such materials and the engineering principles including material selection, fundamental relations, analysis methods and manufacturing methods.
- **CO2:** identify, describe, and evaluate the elastic and thermal properties of fiber reinforcements, polymer matrix materials and commercial composites.
- **CO3:** develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of composite products
- **CO4** apply knowledge of composite mechanical performance and manufacturing methods to a composites design project
- **CO5** communicate technological topics related to polymer composites and shall be able to answer questions on feasibility related to these materials

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12

CO 1	2	2										
CO 2		2					2		2			
CO 3	2	2	3	2			2					
CO 4	2	2										
CO 5					2	3						2

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 4	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 5	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. Sabu Thomas, Kuruvilla Joseph, Sant Kumar Malhotra, Koichi Goda, and Meyyarappallil Sadasivan — *Polymer Composites: Volume 1 (First Edition)*
2. F.W. Billmeyer — *A text book of polymer Science*
3. V.R. Gowariker — *Polymer Science*
4. William — *A text Book of Polymer Science and Technology*
5. D.H.Morton-Jones — *Polymer processing*

Course Code: CEP 0531 4293	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Polymer Kinetic Theory		**Course Status: Theory (Core)**	

Rationale of the Course:

This course is intended to provide knowledge about liquid crystal and flow phenomena of polymeric liquids, and the fundamental concepts of probability theory.

The objectives of this course are to:

- provide knowledge about liquid crystal polymers
- provide lesson on flow behavior of polymeric liquids and probability theory

Course Content:

Liquid crystal and Liquid crystal polymers, Types of liquid crystal polymers.
Flow Phenomena in Polymeric Liquid; The chemical nature of polymeric liquids; non-Newtonian viscosity, Normal stress effects, other elastic effects; Material functions for Polymeric liquids, shear and shear free flows.
Basic Concepts from Probability Theory; Events and probabilities; Random variables; Expectations and moments; Joint distributions and independence; Gaussian random variables; General discussion of the random walk; Fokker- Planck equations

Course Outcomes (COs): At the end of the course, student will be able to-

CO1: explain the concept of liquid crystal polymer

CO2: describe flow behavior and kinetic theory of polymeric liquid

CO3: summarize the basic concepts from probability theory and apply them in polymer kinetics

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	**PO2**	**PO3**	**PO7**	**PO10**	**PO11**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO12**
CO 1	3											
CO 2	3									2	2	
CO 3	3	2								2	2	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/ assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. R.B. Bird, C.F. Curtiss, R.C. Armstrong and O. Hassager — *Dynamics of polymeric liquids, Volume 2: Kinetic theory (Second edition)*

Course Code: CEP 0711 4295	**Credit:** 2	**Year:** Fourth	**Semester:** Second
Course Title: Principles of Catalysis		**Course Status: Theory (Core)**	

Rationale of the Course:

This course is an introduction to important principles and methods of heterogeneous and homogeneous catalysis which are commonly practiced in chemical industries. It also increases the student's critical thinking skills and creative thinking skills that will provide students with the ability to select a suitable catalyst for catalytic reaction.

The objectives of this course are to:

- provide basic knowledge about important industrial catalytic processes and the most common catalysts.
- make the students able to interpret experimental data and suggest reaction mechanisms consistent with experimental data.
- make them familiar with synthesis methods for preparation of catalysts and important catalyst characterization methods.
- help them to know internal and external mass transfer limitations influence the kinetics of catalytic reactions.
- facilitate necessary knowledge to make them aware of the criteria of good experimental practice in kinetic measurements.

Course Contents:

Catalysis in Solutions: Introduction, acid-base, catalysis in the gas phase, catalysis in dilute aqueous solution general and specific acid and base catalysis, catalysis in concentrated strong acid solutions, catalysis by bases, stepwise and concerted reactions, catalysis by metal ions, hydrocarbon conversion.

Catalysis by Polymers: the nature of polymers, attachment of catalytic groups to polymer supports, catalysis in polymer gels, adsorption and the kinetics of polymer-catalyzed reactions, interactions of catalytic groups, the role of the support, bifunctional and multifunctional catalysis.

Catalysis on Surfaces: Introduction, adsorption, adsorption isotherms, structure of adsorbed species on single crystal metal surfaces, adsorption on complex surfaces, functionalized surfaces, olefin polymerization catalysis on titanium trichloride surfacescatalysis on metal surfaces, catalysis on metal oxide surfaces, catalysis by supported metals, catalysis by metal sulphides.,

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	2		1							1	
CO 2	3	1		1							3	
CO 3	3	2	2	1							3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 2	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.
CO 3	Classroom lecture, tutorial, group work/assignment and presentation, Brainstorming.	Class evaluation, Assignment, quiz test, Midterm, and final Exam.

Recommended Books:

1. Baerns, Manfred — *Basic Principles in Applied Catalysis*
2. Beller, Mathias, Renken, Albert — *Catalysis from Principles to Applications*

Course offers to Other Department

Course Code: CEP 0711 2101F	Credit: 3	Year: 2nd	Semester: 1st
Course Title: Fluid Mechanics and Machineries		Course Status: Core	

Rationale of the Course:
Knowledge on the general mechanics applied to fluids and study of the principles of fluid flow and measurement are essential for understanding the behavior of fluid under various forces and at different atmospheric conditions, and to control fluid for various engineering applications.

The objectives of this course are to:
- To provide the knowledgeabout fluid properties used in the analysis of fluid behaviour.
- To facilitate the basic principles of hydrostatic pressure.
- To foster the development, uses and limitations of major fluid-flow equations

Course Contents:
Properties of fluid: Fluid types and properties (fluid mass and weight, Compressibility, vapor pressure, viscosity, surface tension); Measurement of viscosity, Influence of temperature on viscosity; Non-Newtonian liquid properties; Phase diagram; Equation of state and perfect gas laws. **Principles of hydrostatic pressure:** Pascal's law; Free surface of a liquid; Atmospheric, absolute and gauge pressure; Variation of pressure with depth in a fluid; Pressure head; Vapor pressure; Manometry; Mechanical and electronic pressure measuring devices. **Flow of fluids**: Continuity principle; Energy head of a fluid; Laminar and turbulent flow; Steady and unsteady flow; Uniform and non-uniform flow. **Mechanical energy balance**: Potential energy; Kinetic energy; Pressure energy; Friction; Frictional resistance to flow of Newtonian and non-Newtonian fluids; Frictional resistance offered by pipe fittings to fluid flow. **Fluid flow equations:** Euler's equation, Bernoulli's energy equation, Application of Bernoulli's equation in one- and two-dimensional flow, Flow of fluids through orifices and simple pipes, flow time measurement.

Mapping Course Learning Outcomes (COs) with the POs

	Fundamental Skill		Social Skill	Thinking Skill	Personal Skill
Course Learning Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3			
CO 2	3			3	3
CO 3	2			3	
CO 4				3	3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO1	Lecture, and problem based learning (PBL), demonstration	Short answers/ quizzes
CO2	,,	Problem solving tasks
CO3	,,	Demonstrations/ presentation
CO4	,,	Problem solving task/design project

Recommended Books:

1. Franzini, Daugherty, Finnemore — *Fluid Mechanics with engineering applications*
2. R. S. Khurmi — *A Textbook of Hydraulics, Hydraulics Machines, and Hydraulic Machnies*
3. Dr. R. K. Bansal — *A Textbook of Fluid Mechanics and Hydraulic Machines*
4. Frank M. White — *Fluid Mechanics*
5. Streeter, Wylie, edford — *Fluid Mechanics*

Course Code: CEP 0711 2102F	Credit: 1	Year: Second	Semester: First
Course Title: Fluid Mechanics Sessional		Course Status: Sessional (Core)	

Rationale of the Course:
This course is designed to build up the knowledge and understanding of experimental methods and the basic principle of fluid mechanics and apply those concepts in different practical applications..

The objectives of this course are to:
- to develop the basic knowledge of fluid mechanics
- help the students learn principal operation and design calculation of flow measuring devices
- to discuss and practice standard measurement techniques and their applications justify the principles and theorems studied in theory by performing the experiments in laboratory.

Course Content:
Determination of the viscosity of several liquid foods.
Determination of the location of the centre of pressure.
Verification of the Bernoulli's equation

Calibration of flow measuring devices: i) Rotameter ii) Venturi meter and iii) Orifice meter
Determination of the Reynolds number

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: Explain the different flow measurement equipment's and their procedures to solve problems on fluid properties.
CO2: Identify different types of flow and determine fluid pressure.
CO3: Explain techniques for the study of flow phenomena in channels/pipes
CO4: Analyze the performance characteristics pumps..

Mapping Course Outcomes (COs) with the POs

COs	Fundamental Skills			Social Skills			Thinking Skills		Personal Skills			
	PO1	PO2	PO3	PO7	PO10	PO11	PO4	PO5	PO6	PO8	PO9	PO12
CO 1	3	3					3		2	1	3	
CO 2	3	3					3		2	3	3	
CO 3	3	2					3		1	1	3	
CO 4	3	3					3		2	2	3	

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 2	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 3	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation
CO 4	Lecture using board and Instruction materials, Demonstrate Experiment in the Laboratory, group discussion, Hands on practice	Continuous internal evaluation based on laboratory performance, Report evaluation, Oral examination, Quiz test, Presentation

Recommended Books:

1. Franzini Daugherty — *Fluid Mechanics with engineering applications*
2. R. S. Khurmi — *Hydraulics and Hydraulics Machines*
3. Supplied lab Manual

Course Code: CEP 0711 1201G	**Credit:** 2	**Year:** First	**Semester:** Second
Course Title: Chemical Process Technology (For IPE)		**Course Status: Core (Theory)**	

Rationale of the Course:
Chemical process technology is an integral component of engineering education. A production engineer must possess a general view on different types of chemical productions, processes and equipment being under operation in plants. The aim of the course is to provide knowledge about processes in various chemical industries.

The objectives of this course are to:

- familiarize the students with different types of process plants.
- help the students understand the manufacturing technology such as pulp and paper, soap and detergents, fertilizers, and cement.
- provide necessary knowledge to perceive the process flow diagram and process parameters.
- develop the skills to identify and solve engineering problems during production.

Course Content:
Glass industries: History of development of glass industries composition, raw materials, properties and uses of different types of glasses, manufacturer of glass, special glasses.
Ceramic industries: Types of ceramic products, Basic raw materials, White wares, manufacturer of porcelain, types of clay, clay preparation, firing, different stages of firing, Chemical conversion including basic ceramic industry, manufacture of refractories
Soap and Detergent Industries: Raw materials, mfg. of different types of soap, recovery of the glycerin, classification of the detergents, industrial processing for the alkyl aryl sulphonates (AAS), environmental pollution by detergents. Bio degradability of detergent.
Introduction of Chemical fertilizer: Nitrogenous fertilizer, Raw materials of ammonia production of synthesis gas in ammonia plants, technology of urea manufacturing; Process used in Urea industries of Bangladesh.
Cement industries: Raw materials, Composition, properties and uses different types of cements, Manufacture of cement by different methods, setting and hardening of cement, testing of cement.
Lubricants: Various types of lubricants, Production of lubricants, Properties of Various types of lubricants.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: discuss the basic principle of selected chemical processes
CO2: draw and analyze the flow diagram of chemical processes
CO3: analyse optimum operation of the manufacturing process.
CO4: interpret the ways of quality control.
CO5: illustrate friction, wear, and practical importance of lubrication.

Mapping Course Outcomes (COs) with the POs

According to the POs of IPE department.

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture using board/projector and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 2	Classroom lecture using board/ projector, tutorial and Assignment	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 3	Classroom lecture using board/projector, homework	Class evaluation, Assignment, Midterm Exam, and Semester- end Exam
CO 4	Classroom lecture using board/ projectors	Class evaluation, Assignment and Semester-end Exam
CO 5	Classroom lecture using board/projector, homework,	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. G.N Pandey — *A Text Book of Chemical Technology Vol. I and II*
2. N. Austin — *Chemical Process Industries.*
3. Anderson and Winzet — *Introduction to Chemical Engineering*
4. Riegl's — *Industrial Chemistry*
5. B. K. Sharma — *Industrial Chemistry*
6. S.S. Dara — *A text book of Engineering Chemistry*

Course Code: CEP 0711 3101F	**Credit:** 3	**Year:** Third	**Semester:** First
Course Title: Process Control in Food Industry (For FET)		**Course Status: Theory**	

Rationale of the Course:
After studying the course, the students will be able to identify different types of sensors and transducers and their applications in the field of instrumentation and process control used in food industry. The students will be able to select appropriate transducers relating to a process and will also get the relevant technical know how about the conditioning of a signal from a transducer for the purpose of control. This course will also enable the students to study in detail different types of control systems used in instrumentation and will provide understanding of basic control loops.

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The objectives of this course are to:

- give the knowledge of various instruments and skill in handling them,
- make the students able to control the process parameters and various operations in any food industry
- apply the knowledge to evaluate the stability of a control system.

Course Content:

Process Control Introduction: Process control; Process operation; Process Parameter Measurement; Design of control system; Control System**.**

Process control: Concept of automatic process control and its classifications. Types of controllers and their applications; Manual Control; Closed-loop Control System; Automatic Control System; On /Off controllers; Block diagrams; Laplace transform; Response of a control system; Stability; Feedback; Controller mode, Root locus plot, Modulation, Final control, Controllers, Control valve.

Application of control in heat exchangers, distillation column, Process Control in Modern Food Processing,

Frequency response: Introduction to frequency response, transportation lag, Bode diagrams, Nyquist POts. **Control system design by frequency response**: Bode stability criterion, Gain and phase margins, Ziegler-Nichols Tuning technique, Nyquist stability criterion.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: Distinguish between fundamental system of manual operated and automation control of a system..
CO2: Learn about elementary disturbance functions and their principle of measurement.
CO3: describe how controller operates in practice as mechanical and electrical devices.
CO4 assimilate how a control system reacts at different types of disturbances and determine how far it lies from stability.

Mapping Course Outcomes (COs) with the POs

	Fundamental Skills	Social Skills		Thinking Skills	Personal Skills
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	3	2		1	
CO 2	3			3	2

CO 3	3		3	3	2
CO 4	3			2	3

Mapping Course Outcomes (COs) with the Teaching-Learning & Assessment Strategy

COs	Teaching-Learning Strategy	Assessment Strategy
CO 1	Classroom lecture, group discussion, brainstorming	Class evaluation, Assignment, Midterm, and final Exam
CO 2	Classroom lecture, group discussion, brainstorming, tutorial, and Assignment	Class evaluation, Assignment, Midterm, and final Exam
CO 3	Classroom lecture, group discussion, brainstorming, homework	Class evaluation, Assignment, Midterm, and final Exam
CO 4	Classroom lecture, group discussion, brainstorming	Quiz test, Class evaluation, Assignment and Semester-end Exam

Recommended Books:

1. Hougen and Watson — *Chemical Process Principles I & II*
2. Levenspiel — *Chemical reaction engineering*
3. George Stephanopolos — *Chemical process control*
4. Donald R.Coughanowr — *Process System Analysis and Control*
5. M Gopal — *Control Systems: Principles and Design*
6. Automatic control for food processing — Rosana G. Moreira

Part D

1. Grading/Evaluation

1. Grades and Grade scales

Numeric Grades	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00

2. Grade Point Average (GPA)

Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses completed by a student in a semester.

3. Cumulative Grade Point Average (CGPA)

Cumulative Grade Point Average (CGPA) of only major and both major and second major degree will be calculated by the weighted average of every course of previous semesters along with the present semester. For clearing graduates if the roundup value of the third digit after decimal is nonzero the second digit will be incremented by one. A student will also receive a separate CGPA for his second major courses.

4. Course Withdrawal

A student can withdraw a course by a written application to the Controller of Examinations through the Head of the discipline on or before the last day of instruction. The Controller of Examinations will send the revised registration list to the disciplines before the examination. There will be no record of the course in transcript if the course is withdrawn.

5. Incomplete (I) courses

If a student has incomplete courses, he/she has to register his/her available incomplete courses from preceding levels before s/he can register courses from current or successive levels. If an incomplete course is not offered in a given semester the student has to take the courses when it is offered next time. A student will not be allowed to take 100 and 300 level and 200 and 400 level courses

simultaneously. 100 level courses mean courses of 1st and 2nd semesters, 200 level courses mean courses of 3rd and 4th semesters and so on. A student with incomplete courses will not be eligible for Distinction.

6. Retake

A student is given an "F" grade if he fails or is absent in the final examination of a course. If a student obtains an "F" grade his grade will not be counted for GPA and s/he has to repeat the course. An "F" grade will be in his/her record, and s/he will not be eligible for Distinction.

7. Grade Improvement

N/A

8. Dropout