Department of Chemical Engineering
DUET, Gazipur

B.Sc. in Chemical Engineering

Summary of Course Plan

Sl. No.	Year/ Semester	Theory		Sessional		Contact Hour/Week	Total Credits
		No. of Course	No. of Credits	No. of Course	No. of Credits		
1.	1st/1st	4	12	4	3.75	19.5	15.75
2.	1st/2nd	5	17	4	3.75	24.5	20.75
3.	2nd/1st	5	16	4	4.5	25	20.5
4.	2nd/2nd	5	16	4	3	22	19
5.	3rd/1st	5	16	4	3	22	19
6.	3rd/2nd	5	16	4	3.75	23.5	19.75
7.	4th/1st	5	15	6	7.5	27	22.5
8.	4th/2nd	5	16	4	6	23.5	22
Total:		39	124	34	35.25	187	159.25

1. Syllabus effective from the session 2022-2023
2. 1st year 1st semester courses are exempted because of the candidates 4 years Diploma in engineering background after 10 years of schooling.

Course designation and numbering system:

A. For Departmental courses of Chemical Engineering:

Considering an example, let,

ChE 1705: Fundamentals of Chemical Engineering

Where,

ChE: Department identification code

1: First digit signifies year number

7: Second digit is reserved for departmental use to indicate the major branches

05: Third and fourth digits signify course designation of which the fourth digit will be odd for theoretical courses and even for sessional courses

Fundamentals of Chemical Engineering indicates course title.

Major Branches:

B. For all courses other than Departmental courses of Chemical Engineering:

Considering an example, let,

ME 2835: Heat Transfer

Where,

ME: Department identification code

2: First digit signifies year number

8: Second digit **'8'** is reserved for any course from other departments.

35: Third and fourth digits signify course designation of which the fourth digit will be odd for theoretical courses and even for sessional courses

Heat Transfer indicates course title.

1st Year 1st Semester (Exempted)

Sl. No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 1701	Introduction to Industrial Safety	3.00	3.00
2.	ME 1831	Basic Mechanics	3.00	3.00
3.	ME 1832	Basic Mechanics Sessional	1.50	0.75
4.	EEE 1831	Basic Electrical and Electronic Engineering	3.00	3.00
5.	EEE 1832	Basic Electrical and Electronic Engineering Sessional	1.50	0.75
6.	ChE 1703	Introduction to Engineering Management	3.00	3.00
7.	ME 1834	Workshop Practice Sessional	1.50	0.75
8.	ME 1836	Engineering Drawing-I	3.00	1.50
		Sub Total:	**19.50**	**15.75**

1st Year 2nd Semester

Sl. No.	Course No.	Course Title	Contact hours/week	Credits
1.	Math 1833	Differential and Integral Calculus	4.00	4.00
2.	ChE 1705	Fundamentals of Chemical Engineering	3.00	3.00
3.	ChE 1706	Fundamentals of Chemical Engineering Sessional	1.50	0.75
4.	Ch 1831	Inorganic and Organic Chemistry	3.00	3.00
5.	Ch 1832	Inorganic and Organic Chemistry Sessional	1.50	0.75
6.	Ph 1831	Solid State Physics, Oscillations and Nanophysics	4.00	4.00
7.	Ph 1832	Solid State Physics, Oscillations and Nanophysics Sessional	1.50	0.75
8.	HSS 1831	Economics and Accounting	3.00	3.00
9.	ME 1840	Engineering Drawing-II	3.00	1.50
		Sub-total:	**24.50**	**20.75**

2nd Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	Math 2831	Vector Analysis, Laplace Transform and Matrices	4.00	4.00
2.	ChE 2701	Materials and Energy Balance	3.00	3.00
3.	ChE 2702	Materials and Energy Balance Sessional	1.50	0.75
4.	HSS 2831	Government and Bangladesh Studies	3.00	3.00
5.	HSS 2833	Professional English	3.00	3.00
6.	HSS 2834	Professional English Sessional	3.00	1.50
7.	EEE 2831	Electrical Circuits and Machines	3.00	3.00
8.	EEE 2832	Electrical Circuits and Machines Sessional	1.50	0.75
9.	ChE 2706	Computer Programming and Information Technology Sessional	3.00	1.50
		Sub-Total	**25.00**	**20.50**

2nd Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 2703	Thermodynamics in Chemical Engineering	3.00	3.00
2.	ChE 2707	Numerical Methods and Statistics for Engineering Application	4.00	4.00
3.	ChE 2708	Numerical Methods and Statistics for Engineering Application Sessional	1.50	0.75
4.	Ch 2831	Physical Chemistry	3.00	3.00
5.	Ch 2832	Physical Chemistry Sessional	1.50	0.75
6.	ME 2835	Heat Transfer	3.00	3.00
7.	ME 2836	Heat Transfer Sessional	1.50	0.75
8.	ChE 2709	Fluid Mechanics and Machineries	3.00	3.00
9.	ChE 2710	Fluid Mechanics and Machineries Sessional	1.50	0.75
		Sub-Total	**22.00**	**19.00**

3rd Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 3701	Mass Transfer	3.00	3.00
2.	ChE 3702	Mass Transfer Sessional	1.50	0.75
3.	ChE 3703	Unit Operation in Chemical Engineering	4.00	4.00
4.	ChE 3704	Unit Operation in Chemical Engineering Sessional	1.50	0.75
5.	ME 3831	Mechanics of Solids	3.00	3.00
6.	ChE 3707	Fuel and Energy Engineering	3.00	3.00
7.	ChE 3708	Fuel and Energy Engineering Sessional	1.50	0.75
8.	ChE 3709	Environmental Management and Control	3.00	3.00
9.	ChE 3710	Environmental Management and Control Sessional	1.50	0.75
		Sub-Total	**22.00**	**19.00**

3rd Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 3711	Process Design	4.00	4.00
2.	ChE 3713	Reaction Engineering and Reactor Design	3.00	3.00
3.	ChE 3714	Reaction Engineering and Reactor Design Sessional	1.50	0.75
4.	ChE 3705	Corrosion Science and Engineering	3.00	3.00
5.	ChE 3706	Corrosion Science and Engineering Sessional	1.50	0.75
6.	ChE 3717	Solution Thermodynamics	3.00	3.00
7.	ChE 3719	Separation Process Engineering	3.00	3.00
8.	ChE 3720	Separation Process Engineering Sessional	1.50	0.75
9.	ChE 3724	Simulation and Optimization Methods for Industrial Processes Sessional	3.00	1.50
		Sub-Total	**23.50**	**19.75**

4th Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 4701	Process Control and Dynamics	3.00	3.00
2.	ChE 4702	Process Control and Dynamics Sessional	1.50	0.75
3.	ChE 4703	Chemical Plant Design	3.00	3.00
4.	ChE 4704	Chemical Plant Design Sessional	1.50	0.75
5.	ChE 4705	Particle Technology	3.00	3.00
6.	ChE 4706	Particle Technology Sessional	1.50	0.75
7.	ChE 4732	Engineering and Professional Ethics Sessional	1.50	0.75
8.	ChE 4000	Project/ Thesis	3.00	3.00***
9.	ChE 4700	Process Design Sessional	3.00	1.50***
10.	Two elective subjects from the following courses*		6.00	6.00
		Sub-Total	27.00	22.50

*Elective: (2 courses of 3 credit each from the following courses)

1.	ChE 4713	Natural Gas and Petroleum Engineering	3.00	3.00
2.	ChE 4715	Fertilizers, Pulp & Paper Technology	3.00	3.00
3.	ChE 4717	Polymer Science and Technology	3.00	3.00
4.	ChE 4719	Introduction to Renewable Energy	3.00	3.00
5.	ChE 4733	Biochemical Engineering	3.00	3.00
6.	ChE 4725	Process Modeling and Optimization	3.00	3.00

*** indicates continuation of the same course in the next semester.

4th Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 4707	Engineering Economics and Management	4.00	4.00
2.	HSS 4831	Sociology and Industrial Law	3.00	3.00
3.	ChE 4711	Transport Phenomena	3.00	3.00
4.	ChE 4712	Transport Phenomena Sessional	1.50	0.75
5.	ChE 4709	Chemical Process Safety	3.00	3.00
6.	ChE 4000	Project/ Thesis	3.00	3.00***
7.	ChE 4700	Process Design Sessional	3.00	1.50***
8.	ChE 4720	Industrial Attachment**		0.75
9.	One elective subject from the following courses*		3.00	3.00
		Sub-Total	23.50	22.00

*Elective: (1 course of 3 credit each from the following courses)

1.	MME 4831	Fundamentals of Metallurgy	3.00	3.00
2.	TE 4831	Textile Engineering and Technology	3.00	3.00
3.	ChE 4727	Refinery Engineering	3.00	3.00
4.	ChE 4729	Sustainable Development in Chemical Engineering	3.00	3.00
5.	ChE 4731	Water and Waste Management in Industries	3.00	3.00

** A 4-week industrial training programme will be performed by all students in chemical industries to be aware about chemical processes and machineries.

Course distribution

⊕ LANGUAGE AND GENERAL EDUCATION [21.25 Credits, 13.34%]

Category	Course	Credit
Language	HSS 2833: Professional English	3.00
	HSS 2834: Professional English Sessional	1.50
Social Science	HSS 4831: Sociology and Industrial Law	3.00
Art and Humanities	HSS 2831: Government and Bangladesh Studies	3.00
	ChE 4732: Engineering and Professional Ethics Sessional	0.75
Business	ChE 1703: Introduction to Engineering Management	3.00
	HSS 1831: Economics and Accounting	3.00
	ChE 4707: Engineering Economics and Management	4.00
	Total	**21.25**

⊕ BASIC SCIENCES AND MATHEMATICS [25.00 Credits, 15.70%]

Category	Course	Credit
Physics	Ph 1831: Solid State Physics, Oscillations and Nanophysics	4.00
	Ph 1832: Solid State Physics, Oscillations and Nanophysics Sessional	0.75
Chemistry	Ch 1831: Inorganic and Organic Chemistry	3.00
	Ch 1832: Inorganic and Organic Chemistry Sessional	0.75
	Ch 2831: Physical Chemistry	3.00
	Ch 2832: Physical Chemistry Sessional	0.75
Mathematics	Math 1833: Differential and Integral Calculus	4.00
	Math 2831: Vector Analysis, Laplace Transform and Matrices	4.00
	ChE 2707: Numerical Methods and Statistics for Engineering Application	4.00
	ChE 2708: Numerical Methods and Statistics for Engineering Application Sessional	0.75
	Total	**25.00**

⊕ OTHER ENGINEERING [23.25 Credits, 14.60%]

Category	Course	Credit
Computer Science and Engineering	ChE 2706: Computer Programming and Information Technology Sessional	1.50
Electrical Engineering	EEE 1831: Basic Electrical and Electronic Engineering	3.00
	EEE 1832: Basic Electrical and Electronic Engineering Sessional	0.75
	EEE 2831: Electrical Circuits and Machines	3.00
	EEE 2832: Electrical Circuits and Machines Sessional	0.75
Mechanical Engineering	ME 1831: Basic Mechanics	3.00
	ME 1832: Basic Mechanics Sessional	0.75
	ME 1834: Workshop Practice Sessional	0.75
	ME 1836: Engineering Drawing-I	1.50
	ME 1840: Engineering Drawing-II	1.50
	ME 2835: Heat Transfer	3.00
	ME 2836: Heat Transfer Sessional	0.75
	ME 3831: Mechanics of Solids	3.00

	Total	**23.25**

⊕ CORE COURSES [73.25 credits, 46.00%]

Category	**Course**	**Credit**
Basic Chemical Engineering Courses	ChE 1705: Fundamentals of Chemical Engineering	3.00
	ChE 1706: Fundamentals of Chemical Engineering Sessional	0.75
	ChE 2701: Materials and Energy Balance	3.00
	ChE 2702: Materials and Energy Balance Sessional	0.75
	ChE 3703: Unit Operation in Chemical Engineering	4.00
	ChE 3704: Unit Operation in Chemical Engineering Sessional	0.75
Thermal Sciences	ChE 2703: Thermodynamics in Chemical Engineering	3.00
	ChE 3717: Solution Thermodynamics	3.00
Fluids	ChE 2709: Fluid Mechanics and Machineries	3.00
	ChE 2710: Fluid Mechanics and Machineries Sessional	0.75
Safety	ChE 1701: Introduction to Industrial Safety	3.00
	ChE 4709: Chemical Process Safety	3.00
Transport	ChE 3701: Mass Transfer	3.00
	ChE 3702: Mass Transfer Sessional	0.75
	ChE 3719: Separation Process Engineering	3.00
	ChE 3720: Separation Process Engineering Sessional	0.75
	ChE 4705: Particle Technology	3.00
	ChE 4706: Particle Technology Sessional	0.75
	ChE 4711: Transport Phenomena	3.00
	ChE 4712: Transport Phenomena Sessional	0.75
Design courses	ChE 3711: Process Design	4.00
	ChE 3713: Reaction Engineering and Reactor Design	3.00
	ChE 3714: Reaction Engineering and Reactor Design Sessional	0.75
	ChE 3724: Simulation and Optimization Methods for Industrial Processes Sessional	1.50
	ChE 4703: Chemical Plant Design	3.00
	ChE 4704: Chemical Plant Design Sessional	0.75
	ChE 4700: Process Design Sessional	3.00
Instrumentation and Control	ChE 4701: Process Control and Dynamics	3.00
	ChE 4702: Process Control and Dynamics Sessional	0.75
Corrosion	ChE 3705: Corrosion Science and Engineering	3.00
	ChE 3706: Corrosion Science and Engineering Sessional	0.75
Project/Thesis	ChE 4000: Project/ Thesis	6.00
Industrial Attachment	ChE 4720: Industrial Attachment**	0.75
	Total	**73.25**

⊕ TECHNICAL ELECTIVES [16.50 Credits, 10.36%]

Category	**Course**	**Credit**
	ChE 3707: Fuel and Energy Engineering	3.00

	ChE 3708: Fuel and Energy Engineering Sessional	0.75
	ChE 3709: Environmental Management and Control	3.00
	ChE 3710: Environmental Management and Control Sessional	0.75
2 courses from	ChE 4713: Natural Gas and Petroleum Engineering	6.00
	ChE 4715: Fertilizers, Pulp & Paper Technology	
	ChE 4717: Polymer Science and Technology	
	ChE 4719: Introduction to Renewable Energy	
	ChE 4733: Biochemical Engineering	
	ChE 4725: Process Modeling and Optimization	
1 course from	MME 4831: Fundamentals of Metallurgy	3.00
	TE 4831: Textile Engineering and Technology	
	ChE 4727: Refinery Engineering	
	ChE 4729: Sustainable Development in Chemical Engineering	
	ChE 4731: Water and Waste Management in Industries	
	Total	**16.50**

1st Year, 1st Semester (Exempted)

Sl. No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 1701	Introduction to Industrial Safety	3.00	3.00
2.	ME 1831	Basic Mechanics	3.00	3.00
3.	ME 1832	Basic Mechanics Sessional	1.50	0.75
4.	EEE 1831	Basic Electrical and Electronic Engineering	3.00	3.00
5.	EEE 1832	Basic Electrical and Electronic Engineering Sessional	1.50	0.75
6.	ChE 1703	Introduction to Engineering Management	3.00	3.00
7.	ME 1834	Workshop Practice Sessional	1.50	0.75
8.	ME 1836	Engineering Drawing-I	3.00	1.50
		Sub Total:	**19.50**	**15.75**

Contact Hours : 19.50 per week
Total Credit : 15.75
No. of Theory Course : 4
No. of Sessional Course: 4

ChE 1701: Introduction to Industrial Safety

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand basic concepts of industrial safety.
- To impart knowledge about common industrial safety procedures.

Indicative Syllabus:

Demonstrate and practice hand washing procedure; Identify hazard in your workplace using checklist; Identify chemical, biological and physical hazards during chemical processing and storage; Operate a fire extinguisher; Demonstrate hygiene practice when handling, preparing of chemical product; Practice cleaning of plant floor and equipment; Demonstrate and apply first aid kit; Participate and observe a fire training/rehearsal arrange by fire service.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand basic concepts related to industrial safety.
- Apply basic industrial safety procedures and manage safety in industry.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Friend, Mark, et al. Fundamentals of occupational safety and health. Rowman & Littlefield, 2023.
2. Wilson, Laird, Doug McCutcheon, and Marilyn Buchanan. *Industrial safety and risk management*. University of Alberta, 2003.

ME 1831: Basic Mechanics

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students to understand basic concepts of mechanics.
- To impart knowledge about statics and dynamics of particles and rigid bodies.
- To make the students understand inertia and impact on different shapes of bodies.

Indicative Syllabus:

Basic concepts of mechanics; Statics of particles and rigid bodies; Coulomb friction; Centroids of lines; Areas and volumes; Moments of inertia of area and mass.
Axially loaded members; statically indeterminate problems; Stresses in thin walled cylinders and spheres.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand the concept of particles and rigid bodies under stress.
- Calculate inertia and stress on certain geometric entities.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested reading:

1. Hibbeler, R. C. (2022). Engineering Mechanics: Statics, SI Units. Pearson Higher Ed.
2. Beer, F. P., Johnston Jr, E., Russell, M., David, F., & Eisenberg, E. R. (2019). Vector Mechanics for Engineers: Statics (SI Units). McGraw Hill Higher Education, 9th Revised edition (October 2010), Capítulo, 3, 75.

ME 1832: Basic Mechanics Sessional

Credit hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students, understand basic concepts of mechanics.
- To impart knowledge about statics and dynamics of particles and rigid bodies.
- To make the students understand inertia and impact on different shapes of bodies.

Indicative Syllabus:

Experiments based on **ME 1831**.

Intended Learning Outcomes (ILO):

- Understand the concept of particles and rigid bodies under stress.
- Calculate inertia and stress on certain geometric entities.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/Viva-voce	40%
Performance/Report	50%
Total	**100%**

EEE 1831: Basic Electronic and Electrical Engineering

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To familiarize the basic electrical quantities & laws and to apply them in solving problems of electrical circuits.
- To develop comprehensive knowledge and skill on special diodes and devices.

Indicative Syllabus:

Electrical units and standards; Electrical networks and circuits theorems; Introduction to measuring instruments; Alternating current, RLC series, Parallel circuits, Magnetic concepts and magnetic circuits.

Principles of operation and applications of semiconductor diodes, transistors, operational amplifiers (OPAMs), silicon-controlled rectifiers (SCRs); Oscilloscopes; Temperature, pressure, flow-rate, speed and torque measurements using transducers.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand electrical networks and mechanism of circuits.
- Understand electrical and electronic fundamentals.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%

Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Salam, M. A., & Rahman, Q. M. (2018). Fundamentals of electrical circuit analysis (pp. 1-463). New York: Springer. Keneth, Wark, Thermodynamics; (Publ.-McGraw Hill).

EEE 1832: Basic Electrical and Electronic Engineering Sessional

Credit hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students, understand circuits and measuring instruments.
- To impart knowledge about electrical and electronic engineering.

Indicative Syllabus: Experiments based on EEE 1831

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand electrical networks and mechanism of circuits.
- Understand electrical and electronic fundamentals.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/Viva-voce	40%
Performance/Report	50%
Total	**100%**

ChE 1703: Introduction to Engineering Management

Credit hours: 3 hours/week

Course Credit: 3.00

Course objectives:

- To make the students learn about the scopes and importance of management.
- To understand planning and importance of personnel management.

Indicative Syllabus:

Basic concepts of management; Principles of management; Planning, Organization, Scientific management; Span of supervision; Motivation; Personnel management and human relation; Staffing and manpower planning; Training of staff; Concept of leadership; Concepts and techniques of decision making; Concept of trade union; Inventory control; Economic lot size; Break even analysis; Trade Union and industrial dispute, Marketing.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Demonstrate scopes and importance of management from engineering view point.
- Perform planning within an organization.
- Understand the concepts of leadership and decision making.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector

- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

ME 1834: Workshop Practices Sessional

Credit hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To make the students understand measurement concepts, measuring and gauging instruments and their uses
- To impart knowledge about turning, shaping, planning, drilling, grinding, welding etc
- To learn about different types of shops and machines

Indicative Syllabus:

Measurement concepts, Fits and tolerance, Measuring and gauging instruments and their uses, Nondestructive testing and inspection. Metal Working Processes. Metal Working Principles: Turning, Shaping, Planning, Drilling, Grinding, Welding and allied processes; Threads and thread cutting; Hot and cold working of metal. Basic Machine tools elements: Machine frame, Drive, Work-holding devices, Methods of feed and depth control. Machines: Lathe, shaper, milling, jigs and fixtures, grinding machine and planning machines. Identification and use of various measuring and gauging instruments. Identification of various components, processes and operation of metal working machines, Cutting tool shaping and fitting, Cutting speed and feed, cutting time. Safety and protection in the workshop.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand measurement concepts, measuring and gauging instruments and their uses
- Demonstrate metal working Principles including turning, shaping, planning, drilling, grinding, welding etc.
- Know about different types of shops and machines

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem-based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes/Viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Readings:

1. Begeman, M. L., & Oswald, P. F. Amstead, BH, 1979, Manufacturing Process 7th Edition, New York: JohnWiley & Sons.

2. Doyle, L. E., & Keyser, C. A. (1961). Manufacturing processes and materials for engineers.
3. Chapman, W. (2019). Workshop Technology Part 1. Routledge

ME 1836: Engineering Drawing-I

Credit hours: 3 hours/week

Course Credit: 1.50

Course Objectives:

- To enable the students, understand first and third angle projections; orthographic drawings; isometric views
- To understand missing lines and views, sectional views and auxiliary views

Indicative Syllabus:

Introduction; Instruments and their uses; First and third angle projections; Orthographic drawings; Isometric views; Missing lines and views, Sectional views and conventional practices; Auxiliary views. Pipe lines and fittings.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand First and third angle projections; orthographic drawings; isometric views.
- Demonstrate missing lines and views, sectional views and auxiliary views.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

1st Year 2nd Semester

Sl. No.	Course No.	Course Title	Contact hours/week	Credits
1.	Math 1833	Differential and Integral Calculus	4.00	4.00
2.	ChE 1705	Fundamentals of Chemical Engineering	3.00	3.00
3.	ChE 1706	Fundamentals of Chemical Engineering Sessional	1.50	0.75
4.	Ch 1831	Inorganic and Organic Chemistry	3.00	3.00
5.	Ch 1832	Inorganic and Organic Chemistry Sessional	1.50	0.75
6.	Ph 1831	Solid State Physics, Oscillations and Nanophysics	4.00	4.00
7.	Ph 1832	Solid State Physics, Oscillations and Nanophysics Sessional	1.50	0.75
8.	HSS 1831	Economics and Accounting	3.00	3.00
9.	ME 1840	Engineering Drawing-II	3.00	1.50
		Sub-total:	**24.50**	**20.75**

Contact Hours : 24.50 Per Week
Total Credit : 20.75
No. of Theory Course : 5
No. of Sessional Course : 4

Math 1833: Differential and Integral Calculus

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- To apply the concept of limits and continuity to understand the principles of differentiation, apply differentiation to determine the rate of change and its applications.
- To integrate different types of functions using different techniques; apply the definite integral to obtain the area under curves.
- To classify different types of matrices, find the inverse rank of a matrix, and solve the different problems using the matrix method.

Indicative Syllabus:

Differential calculus: Function, Limit, Continuity and differentiability, Successive differentiation. Leibnitz's theorem. Expansion of functions; Rolle's theorem; Mean value theorem; Taylor's theorem and Maclaurin's theorem (proof not required). Maxima and minima for functions of one and two variables, Tangent and normal, Partial differentiation, Euler's theorem and applications of partial differentiation.

Integral calculus: Review of indefinite integrals, Integration by reduction. Definite integrals, properties of definite integrals and related area problems, Gamma and Beta functions.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- understand differential calculus and its theories to solve the problems related to rate of change.
- evaluate integrals using various techniques of integration and solve the related problems.
- solve the various problems using calculus.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Anton, H., Bivens, I. C., & Davis, S. (2009). Calculus: early transcendentals. John Wiley.
2. Penney, D. E., & Edwards, C. H. (1994). Calculus and Analytic Geometry. Prentice-Hall International.
3. Das, B. C., & Mukherjee, B. N. (1996). Integral calculus including differential equations. UN Dhur.
4. Stewart, J. (2009). Calculus: Concepts and contexts. Cengage Learning.

ChE 1705: Fundamentals of Chemical Engineering

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To identify unit operations involved in a chemical process
- To draw process flowcharts, and develop relationships between chemical process variables.
- To perform simple mass balance and energy balance of basic chemical processes.

Indicative Syllabus:

Scope of chemical engineering: Introduction to chemical engineering scope and profession, Overview of unit operations, units and dimensions.

Principles of chemical engineering calculation: Process description and flow sheets, Unit conversion, Basic engineering calculations related to chemical engineering.

Material balance: Overall component balance, Material balance on non-reactive systems: Single and multiple unit, recycle and bypass.

Energy Balance: Forms of energy; First law of thermodynamics; Mechanical energy balance; Heat capacities; Steam tables; Energy balance on simple non-reactive systems;

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Study the scope of chemical engineering
- Gain knowledge on different types of chemical processes.
- Perform calculations related to component balance in various types of chemical processes.
- Perform basic energy balance.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Rousseau, R. W. (2000). Elementary principles of chemical processes. Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT Press.

ChE 1706: Fundamentals of Chemical Engineering Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To explain the interconnection between experimental foundation and underlying theoretical principles.
- To perform basic chemical engineering hand calculations covering a wide range of principles.
- To communicate in written reports, the results of their work in a concise manner.

Indicative Syllabus:

- Problem solving based on the concept of unit conversion.
- Hand on orientation with pressure reading and flow reading problems.
- Problem solving based on the concept of error analysis.
- Problem solving based on basic material and energy balance.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Improvement understanding about unit conversions.
- Understand about interactive chemical process principles.
- Gain knowledge about the material balance around important process units in chemical engineering industries.
- Demonstrate various chemical reactions associated with chemical engineering.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Rousseau, R. W. (2000). Elementary principles of chemical processes. Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT Press.

Ch 1831: Inorganic and Organic Chemistry

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand chemical equilibrium, electrochemistry and its laws.
- To impart knowledge about precipitation, solubility and properties of solutions.
- To make the students understand colorimetric analysis and its application.
- To understand organic compounds and their associated reactions.

Indicative Syllabus:

Inorganic chemistry:
Modern concept of atomic structure: The periodic table of elements, Oxidation and reduction, Modern theories of acids and bases; Donor-acceptor chemistry.
Concept of chemical bond: Conditions and properties of ionic, covalent, coordinate and metallic bond; Fajan's rules, Theory of covalent bonding: Valence bond theory, hybridization, valence shell electron pair repulsion (VSEPR) model, and molecular shape, compounds; Application of stabilities of complex compounds.
Introduction to organometallic and bioinorganic chemistry. Diffraction methods and microscopy in inorganic chemistry.
Organic Chemistry: Types of reactions and applications in industrial and biological processes of aliphatic hydrocarbons and their homologues. Aromatic compounds and aromaticity: Preparation, properties, reactions and industrial applications of benzene and its derivatives in industrial and biological processes. Heterocyclic compounds and their applications in industrial and biological processes.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Demonstrate chemical equilibrium, colloids, electrochemistry and its laws
- Understand principles of precipitation, solubility and properties of solutions
- Demonstrate colorimetric analysis and its application
- Acquire the knowledge on air, water pollution and the water treatment

Learning and Teaching Methods:
Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Readings:

1. Lewis, D., & Glasstone, S. (1960). Elements of physical chemistry. Macmillan.
2. Ebbing, D. D., Gammon, S. D., & Wentworth, R. A. D. (2005). General chemistry (p. 497). Boston: Houghton Mifflin.
3. Tuli, G. D., & Bahl, B. S. (2010). Essentials of Physical Chemistry. S Chand & Co Ltd.
4. Manahan, S. (2017). Environmental chemistry. CRC press.

Ch 1832: Inorganic and Organic Chemistry Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students to prepare standard solutions of different chemical compounds.
- To perform acid-base titration, redox titration, complexometric titration.
- To determine organic compounds in different complexes and solutions.

Indicative Syllabus:

- Preparation of standard solution of different compounds like Na_2CO_3, H_2SO_4, $H_2C_2O_4$ and $KMnO_4$;
- Acid-base titration.
- Complexometric titration.
- Identification of alkane, alkene, alcohol, benzene, and amides.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Prepare standard solution of different compounds
- Perform acid-base titration, redox titration, complexometric titration and identify different organic compounds.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Reading:

1. Vogel, A. I. (1961). Text-book of quantitative inorganic analysis including elementary instrumental analysis.

Ph 1831: Solid State Physics, Oscillations and Nanophysics

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- To enable the students, understand the general properties of matter.
- To make the students understand thermodynamic cycles and processes.
- To impart knowledge on various properties of materials.
- To impart knowledge about electricity and magnetism.
- To understand modern physics, atomic structure and nuclear physics.

Indicative Syllabus:

Solid State Physics

Band theory of solids: Crystal periodicity and Bloch functions; Nearly free electron approximation; Tight-binding approximation; E-K curves for band gaps; Distinction of metal, insulators and semiconductors.

Semiconductors: Intrinsic and Extrinsic semiconductors; Transport property of semiconductors; Frequency-dependent conductivity; Contact phenomena; p-n junction; p-n-p and n-p-n type semiconductor junctions and their characteristic properties.

Superconductivity: Meissner effect; London's theory; Type-I and Type-II superconductors; Thermodynamics of superconducting.

Oscillations

Differential equation of a simple harmonic oscillator; Total energy and average energy; Combination of simple harmonic oscillations; Lissajous figures; Spring-mass systems; Calculation of the time period of a torsional pendulum; Damped oscillations; Determination of damping coefficient; Forced oscillations; Resonance; Two-body oscillations; Reduced mass; Differential equation of a progressive wave; Power and intensity of wave motion; Stationary waves; Group velocity and phase velocity; Architectural acoustics; Reverberation and Sabine's formula.

Nanophysics:

Postulates of quantum mechanics; Schrödinger's equation; Uncertainty principle; Expectation value; Particle in a zero potential; Calculation of energy; Concepts of nanomaterials; Synthesis and characterization of nanomaterials; Applications of nanostructured materials; Production, characterization, and applications of thin films; Defects in thin films; Electron transport in thin films; Optical properties of thin films.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Demonstrate general properties of matter including elasticity, surface tension and viscosity.
- Understand heat and thermodynamics and properties in various processes.
- Demonstrate electricity and magnetism-theories and applications in engineering fields.
- Understand modern physics, atomic physics and nuclear physics and their engineering applications.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:.

1. Lal, B., & Subrahmanyam, N. (2006). Heat and thermodynamics. S. Chand Limited.
2. Avadhanulu, M. N. (1992). A textbook of engineering physics. S. Chand Publishing.
3. Gaur, R. K., & Gupta, S. L. (1987). Engineering physics. Dhanpat Rai and Sons.
4. Halliday, D., Resnick, R., & Walker, J. (2013). Fundamentals of physics. John Wiley & Sons.
5. Wark, K. (1995). Advanced thermodynamics for engineers (p. 194). New York: McGraw-Hill.

Ph1832: Solid State Physics, Oscillations and Nanophysics Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students to understand different properties of matters.
- Verification of combination of resistances and others.

- To enable the students to study thermal properties of good and bad conductor.

Indicative Syllabus:

- Determination of the thermal conductivity of a bad conductor by Lee's method.
- Determination of the specific heat of a liquid by the method of cooling.
- Determination of the mechanical equivalent of heat (J) by electrical method.
- Determination of the moment of inertia of a fly-wheel about its axis of rotation.

*Any relevant experiment related to the corresponding theory.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Gather knowledge about different matters and their properties.
- Determine thermal behavior of conductor.
- Verify laws of combination of resistance

Learning and Teaching Methods:
Statements about the various types of learning and teaching methods that are used in the delivery of lecture module. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Readings:

1. Ahmed G., & Ahmed M.S., Practical Physics.

HSS 1831: Economics and Accounting

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand engineering economics and its theories.
- To impart knowledge about financial accounting and financial management.
- To make the students understand cost accounting.

Indicative Syllabus:

Economics: Definition & scope of economics and engineering economics; its utility; importance, different theories and terminology; theory and law of utility & demand and supply; the law of diminishing marginal utility; and its measurement; consumer's surplus; production; factors and cost of production; division of labor; localization of industries; market; investment; concept of National Income and calculation; fiscal policy and instruments; monetary policy & their relative applicability in Bangladesh; small & large scale production considering natural, human and capital resources; commodity product marketing; and agricultural problems and policies; Bangladesh five year plan.

Financial Accounting: Basic accounting concept, rules and principles and its benefits and uses in decisions, recording procedures (journal) and posting (ledger) of accounting transactions; cash book, adjusting entries, Trial Balance, Final account,

Financial Management: Financial statement analysis; Ratio analysis, liquidity ratio, leverage ratio, profitability ratio, activity ratio;

Capital budgeting; Discounted cash flow, NPV, IRR, ARR, payback period method: working capital management theory and application;

Cost and Management Accounting: Basic concept, rules, classification and principles costing and its benefits and uses in decisions, recording procedures as preparation of cost statement. Costing Methods; material and labor costing; overhead costs, cost volume profit analysis; job order costing and segment reporting.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand the methods and principles of microeconomic theory to make a rational choice using economic principles.
- Explain how markets work and how market prices are determined using principles of supply and demand.
- Conduct a literature review appropriate for the discipline of economics.
- Perform basic quantitative analysis using tools appropriate for the discipline.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Dewett, K.K. (2001), Modem Economics Theory, S. Chand & Company LTD. Pub. Ram Nagar, New Delhi.
2. Park, C. S., Kim, G., & Choi, S. (2007). Engineering economics. New jersey: Pearson Prentice Hall.
3. Maheshwari, S. N., Maheshwari, S. K., & Maheshwari, S. K. (2013). Financial Accounting, 6e. Vikas Publishing House.
4. Caplan, D. (2006). Management accounting concepts and techniques.
5. Kimmel, P. D., Weygandt, J. J., & Kieso, D. E. (2010). Accounting: Tools for business decision makers. John Wiley & Sons.
6. Wild, J., Shaw, K. W., & Chiappetta, B. (2010). Fundamental accounting principles. McGraw-Hill Education.

ME 1840: Engineering Drawing-II

Contact hours: 3 hours/week

Course Credit: 1.50

Course Objectives:

- To make the students realize the orthographic and isometric view.
- To enable the students, understand the isometric to orthographic drawing and vice-versa and dimension them properly.
- To impart knowledge about auxiliary and cross-sectional view of solid object.
- To make the students understand working drawings; gears and cams; agricultural machineries and assemblies.

Indicative Syllabus:

Dimensioning: Use of arrowheads, extension line, dimension line, direction of dimensions, dimensioning of angles, dimensioning in limited space, circular features, cylindrical holes, slotted holes, and oblique dimensioning.
Orthographic Projection: Definition, principles, surfaces of solid sections, first and third angle projection, method of projecting views, drawing procedure and uses.
Sectional View: Generating sectional view, section lining, types of section, parts not sectioned, ribs in section, spokes in sections, lugs in section.
Auxiliary View: Generating auxiliary view, auxiliary view with circular feature, multiple auxiliary views.
Pictorial Drawing: Isometric projection, oblique projection.
Introduction to computer aided drawing using AutoCAD
Drawing of elementary geometric objects with AutoCAD

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand orthographic and isometric view, orthographic drawing and sketching
- Comprehend working drawings; gears and cams; agricultural machineries and assemblies.
- Understand auxiliary and cross-sectional views of solid objects.
- Acquire concepts regarding various design software i.e. AutoCAD, and SolidWorks.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Reading:

1. French, T. E. (1924). A manual of engineering drawing for students and draftsmen. McGraw-Hill Book Company, Incorporated.
2. McMullin, D., & Parkinson, A. C. (2016). An Introduction to Engineering Mathematics. Cambridge University Press
3. Simmons, C. H., & Maguire, D. E. (2012). Manual of engineering drawing: Technical product specification and documentation to British and International Standards. Butterworth-Heinemann.

2nd Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	Math 2831	Vector Analysis, Laplace Transform and Matrices	4.00	4.00
2.	ChE 2701	Materials and Energy Balance	3.00	3.00
3.	ChE 2702	Materials and Energy Balance Sessional	1.50	0.75
4.	HSS 2831	Government and Bangladesh Studies	3.00	3.00
5.	EEE 2831	Electrical Circuits and Machines	3.00	3.00
6.	EEE 2832	Electrical Circuits and Machines Sessional	1.50	0.75
7.	HSS 2833	Professional English	3.00	3.00
8.	HSS 2834	Professional English Sessional	3.00	1.50
9.	ChE 2706	Computer Programming and Information Technology Sessional	3.00	1.50
		Sub-Total	**25.00**	**20.50**

Contact Hours : 25.00 Per Week
Total Credit : 20.50
No. of Theory Course : 5
No. of Sessional Course : 4

Math 2831: Vector Analysis, Laplace Transform and Matrices

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- To enable the students, understand the various aspects of vector analysis
- To impart knowledge about Laplace Transform, Inverse Laplace Transform
- To understand the basics of Matrices

Indicative Syllabus:

Vector Analysis: Scalars and vectors, equality of vectors. Addition and subtraction of vectors. Multiplication of vectors by scalars. Position vector of a point. Resolution of vectors, Scalar and vector product of two vectors and their geometrical interpretation. Triple products and multiple products Application to geometry and mechanics. Linear dependence and independence of vectors. Differentiation and integration of vectors together with elementary applications. Definition of line, surface and volume integrals. Gradient, divergence and curl of point functions. Various formulae. Gauss's theorem, Stoke's theorem, Green's theorem and their applications.

Matrices: Definition of matrix. Different types of Matrices. Algebra of matrices. Adjoint and inverse of a matrix. Rank and elementary transformations of matrices, Normal and canonical forms. Solution of linear equations. Quadratic forms. Matrix polynomials. Caley-Hamilton theorem. Eigenvalues and eigenvectors.

Laplace Transform: Definition. Laplace transforms of some elementary functions. Sufficient conditions for existence of Laplace transforms. Inverse Laplace transforms. Laplace transforms of derivatives. The unit step function. Periodic function. Some special theorems on Laplace transforms. Partial fraction. Solutions of differential equations by Laplace transforms. Evaluation of improper integrals.

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to

- Demonstrate Vector analysis and its application
- Understand Laplace Transform & Inverse Laplace Transform
- Understand the basics of Matrices

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Spiegel, M. R. (1966). Schaum's outline series theory and problems of complex variables: with an introduction to conformal mapping and its applications. Schaum..
2. Kreyszig, E., Stroud, K., & Stephenson, G. (2008). Advanced engineering mathematics. Integration, 9, 4.

ChE 2701: Materials and Energy Balance

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To write simple phase equilibrium relationships and use phase diagrams.
- To extract data for pure compounds and mixtures from tables, charts, graphs, or phase diagrams, and estimate these through theoretical formulae.
- Determine enthalpy and internal energy changes associated with changes in temperature, pressure, mixing, phase change, and chemical reaction
- Solve material and energy balances simultaneously on chemical processes.

Indicative Syllabus:

Review of selected topics of fundamentals of chemical engineering course

Single phase and multi-phase systems: Liquid and solid densities; Equations of state for ideal and non-ideal gas. Multiphase systems: Phase equilibrium; The Gibbs phase rule; Vapor pressure; Gas-liquid equilibrium for single and multi-component systems; Operations involving condensation, vaporization, drying and humidification; Solutions of solids in liquids.

Energy balances on non-reactive systems: Heat capacities; Energy balance involving change of temperature, pressure and phases; Phase change operations; Psychrometric chart for air-water system; Enthalpy-composition diagrams; Heats of solutions and mixing.

Energy balances on reactive systems: Heats of formation and reaction; Hess's Law; Energy balances on reactive systems; Combined material and energy balance; Fuels and combustion; Adiabatic flame temperature.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Write simple phase equilibrium relationships and use phase diagrams.
- Extract data for pure compounds and mixtures from tables, charts, graphs, or phase diagrams.
- Determine enthalpy and internal energy changes associated with changes in temperature, pressure, mixing, phase change, and chemical reaction

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Rousseau, R. W. (2000). Elementary principles of chemical processes. Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT Press.

ChE 2702: Materials and Energy Balance Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students to understand the basics of the single and multi-phase process.
- To know how to calculate power and energy load in chemical processing industries.
- To make the students understand the functions of thermodynamic data in chemical engineering calculation.

Indicative Syllabus:

- Problem solving on Material balance around reactive systems
- Problem solving on Energy balance around non-reactive systems.
- Graphical energy balance problems.
- Problem solving on Energy balance around reactive systems

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Accumulate knowledge about the basic single and multi-phase processes.
- Understand the functions and uses of thermodynamic data in chemical industries.
- Calculate power and energy load in chemical industries.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments

- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Rousseau, R. W. (2000). Elementary principles of chemical processes. Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). Basic principles and calculations in chemical engineering. FT Press.

HSS 2831: Government and Bangladesh Studies

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

This course will introduce the students to the history of Bangladesh and the structure of its government, organs of government-legislature, executive, judiciary, etc. It will also discuss its Vision 2021 and Vision 2041, Fifth Year Economic Plan, progress to the Sustainable Development Goals (SDGs) and Bangladesh Delta Plan 2100 (BDP 2100), etc.

Indicative Syllabus:

Basic concepts of government and politics: form and structure of government, organs of government-legislature, executive, judiciary, Theory of democracy; socialism, bureaucracy State, government, nation and nationality etc.

Political views on government structure: cabinet form and presidential form of government, unitary form and federal form of government, main organs of government, characteristics and functions of Government and good governance, Public Administration in Bangladesh, E-government; Government and Politics of Bangladesh, Constitution and laws for Government, local government, NGOs, public law, principal, rule and policies for Administration and Government

Public Opinion and foreign policy of Bangladesh, Major Administrative Systems of Developed Counties.

Introduction to Bangladesh: Geo-political and socio-economic history of Ancient Bengal, Origin and development of Bengal Civilization from early and medieval periods to pre-Bangladesh period, Important places and sculptures, Socioeconomic and political contexts in the period of Liberation War

Backgrounds of her Independence: six points demands, Agartala Conspiracy, General Election 1970, Operation searchlight.

Economic development and its transformation, Economic and social inequality, Social and cultural transformation,

Industrial development from the first industrial to the fourth industrial revolution

Bangladesh and its Vision 2021 and Vision 2041, Fifth year economic plan

Progress to the Sustainable Development Goals (SDGs), Bangladesh Delta Plan 2100 (BDP 2100).

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand the history of Bangladesh through the ancient, medieval, colonial and post-colonial periods alignment with form and structured of government.
- Analyze the structural features of the Bangladeshi history, economy and patterns of development processes and the nature of administrative challenges for good governance.
- Apply the way of different constitutional bodies and socio-political government organs rolling their behavior on governance and people in Bangladesh.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

TEXTBOOKS

1. Mrs. Nasrin Sultana & Tauhidul Islam, A comprehensive Study on Bangladesh, Prominence Publications
2. Guy Peters, The Future of Governing (Studies in Government and Public Policy), University Press of Kansas

REFERENCE BOOKS

Sumon Das & M.N. Mohabbat, Bangladesh Studies and Culture, Rodela Prokashani

EEE 2831: Electrical Circuits and Machines

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students to understand basic electrical circuits and industrial machines.
- To make the students understand different power electronics circuit and their industry application.
- To know how to calculate power and energy load in processing industries.
- To make the students capable to gather knowledge related to electrical wiring system.

Indicative Syllabus:

Basic electrical quantities, **D.C. circuits**: Kirchhoff's laws, Network theorms, Thevenin, Norton, superposition theorem, **AC circuit:** Single phase A.C. circuits, RMS and average quantities, vectorial or phasor representation of AC quantities, A.C. series, parallel and parallel -series circuits.

Power Electronics Device: DIAC, TRIAC, SCR, Power MOSFET, IGBT I-V Characteristics and their applications in industrial purposes, Variable Frequency Drive (VFD) application.

DC generator: principle, types, performances and characteristics.

DC motor: principles, types of motor and its application, performances, speed control, starters and characteristics.

Transformer: Introduction to single-phase transformer, single-phase transformer equivalent circuit and laboratory testing

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Accumulate knowledge about the basic electrical circuit theories
- Understand the functions and uses of electrical machineries in industry
- Understand different power electronics circuit and their industry application for controlling.
- Calculate power and energy load in processing industries.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Alexander, C. K. (2009). Fundamentals of electric circuits. McGraw-Hill..
2. Theraja, B. L., & Theraja, A. K. A Text Book of Electrical Technology, Volume 2, AC & DC Machines in SI. Systems of Unit, S. Chand & Company Ltd, Ram Nagar, New Delhi, India.
3. Chapman, S. (2005). Electric machinery fundamentals. Tata McGraw-Hill Education.
4. Kerchner, R. M., & Corcoran, G. F. (1960). Alternating-current circuits. John Wiley.

EEE 2832: Electrical Circuits and Machines Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the students to understand basic electrical circuits and industrial machines.
- To make the students understand different power electronics circuit and their Industry applications
- To know how to calculate power and energy load in processing industries
- To make the students understand the functions and uses of electrical machineries

Indicative Syllabus:

1. Familiarization with DC generator characteristics and its output power measurement.
2. Study on DC motor and its speed control techniques.
3. Experiment on a single-phase transformer's open & short circuit characteristics and its load power factor analysis.
4. Determination of the I-V characteristics of SCR.
5. Observation the speed control of AC motor using Variable Frequency Drive (VFD)

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Accumulate knowledge about the basic electrical circuit theories
- Understand the functions and uses of electrical machineries in industry
- Understand different power electronics circuit and their industry application for controlling.
- Calculate power and energy load in processing industries.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Readings:

1. Alexander, C. K. (2009). Fundamentals of electric circuits. McGraw-Hill..
2. Theraja, B. L., & Theraja, A. K. A Text Book of Electrical Technology, Volume 2, AC & DC Machines in SI. Systems of Unit, S. Chand & Company Ltd, Ram Nagar, New Delhi, India.
3. Chapman, S. (2005). Electric machinery fundamentals. Tata McGraw-Hill Education.
4. Kerchner, R. M., & Corcoran, G. F. (1960). Alternating-current circuits. John Wiley.

HSS 2833: Professional English

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To improve student's communicative competence that they will apply in their core courses as well as later in their career development.
- To enhance student's proficiency in reading, grammar, vocabulary, writing and listening.

Indicative Syllabus:

Grammar:

Word classification-content word & function word categories, Techniques of word formation process-affixation and conversion of words, Explanation of homonyms, homophones, homographs, and heteronyms; Determiners; Preposition and its usage; Structure of syntax; Changing sentences as per the context; Real-life application of tense; Right form of verbs; usage of modal auxiliaries; subject-verb concord; clauses and conditional sentences; Parallelism, misplaced and dangling modifiers, fragments, run-ons, correction of sentence; mechanics of writing

Writing:

Academic paragraph writing, Cohesion & Coherence; academic essay writing and its classification -narrative, descriptive, process analysis, comparative & contrastive, cause & effect, usage of transitional words; Formal letter, E-mail writing; cover letter and CV writing; Business letter-quotation writing, purchase and sales letter, claim letter adjustment letter, inter-office memorandum; paraphrasing; information transfer; routine report writing; E-tender notice; Amplification writing contextualized in the field of Chemical Engineering

Reading:

Reading skills: inferring, guessing meaning, skimming, scanning, identifying main idea, summary and precis writing based on contextualized reading; Vocabulary: Techniques of vocabulary development, academic word list (AWL) Phonetics and Pronunciation: Introduction of international phonetic alphabets (IPA) and its classification, organ of speech sounds; manner of articulating English sounds, IPA symbols-vowel and consonant, elementary phonemic transcription of word & sentence.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to:

- Understand the features of target language to meet various communication needs

- Analyze the linguistic and grammatical aspects of contextual source materials in target language
- Apply grammatical and communicative knowledge in other related courses and areas for effective communication individually and in groups
- Evaluate information from different reading sources for contextual and lexicographical meanings associated with professional and ethical responsibility
- Create various practical samples following appropriate criteria and applying knowledge of the target language

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested reading:

1. Language and Communication, by G.A. Miller,.
2. Business Correspondence and Report Writing A Practical Approach to Business and Technical Communication by R C Sharma, Krishna Mohan
3. Fundamentals of Technical English for Engineering Students by Abdullah Al Mijan & Shafiqul Islam Sohel.
4. English Skills by John Langan, 7th edition, McGraw-Hill Publications.
5. Phonetics and Phonology by Peter Roach.
6. Practical English Usage by Michael Swan.
7. From Paragraph to Essay by Maurice Imhoof and Herman Hudson.
8. College Writings with Readings by John Langan

HSS 2834: Professional English Sessional

Contact hours: 3 hours/week

Course Credit: 1.50

Course Objectives:

- To enable the students to develop their English language ability over speaking, reading, listening and writing skills
- To develop communication skill.
- To make the students to know about the standard English tests available

Indicative Syllabus:

Listening:

Listening to relevant audio texts to supply missing information, verb forms & fill-ins; listening to authentic audio texts for gist and main ideas; taking notes from sample interview & meetings natural conversation to supply the synonyms/ antonyms; Ted-talk &

inspiring speeches for summary writing, tape scripts for detailed information; listening to conversation based on compare-contrast, cause-effect, process analysis & argumentative issues

Speaking and Presentation Skills:
Ice breaking with self-introduction; Keywords & expressions in contextualized conversation; Extempore speeches on contemporary topics; Story-telling; Public speaking focusing on stress and intonation; Giving opinions, Asking question & giving answer, Offering suggestions, Role play, Group Discussion (GD), Do's & Don'ts of Presentation skills, Techniques of PowerPoint presentation; Individual and collaborative presentations; Poster presentation; Debate; Practicing turns, using colloquial and formal expressions in speaking; Simulating mock professional interview

Reading:
Macro and Micro skills of reading: understanding text with skimming, & scanning; Reading comprehension; Inferring the meaning of unfamiliar words; Identifying the same words but different meaning and frequently confused words, synthesizing, annotating, identifying keywords and main ideas, SQ3R, summary based on contextualized reading; Critical reading

Writing:
Mechanics of writing: planning, organizing; Rearranging ideas: short composition; completing story; Argumentative writing on contemporary issues; Academic and general essays with cohesion and clarity; Statement of Purpose (SoP) writing; Proposal writing, Drawing inferences from the text clues; Text mapping; Flow-charting; Anaphora and cataphora; Interpreting tables and bar charts; Note-taking; Annotation

Intended Learning Outcomes (ILO):
On completion of this module, the learner will be able to:

- Develop their proficiency of English speaking, reading, listening and writing skills.
- Develop their communication skill
- Know about the standard tests available

Learning and Teaching Methods:
Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and power point through multimedia projector
- Problem- based group work activities
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Reference Books:

1. Communicative English for Engineers and Professionals by Nitin Bhatnagar, Mamta Bhatnagar
2. Take-off: Technical English for Engineering Course Book with Audio CDs by David Morgan, Nicholas Regan, pubished-2008
3. Longman Guide for Writers and Readers by Chris M. Anson and Robert A. Schwegler
4. The Concise Adair on Communication and Presentation Skills by John Adair
5. Perfect Presentation by Peter Levin and Graham Topping
6. Presentation and Public Speaking by S M Wahiduzzaman (Author)
7. Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds by Carmine Gallo (Author).
8. The Complete Presentation Skills Handbook by Suzy Siddons (Author)

ChE 2706: Computer Programming and Information Technology Sessional

Contact hours: 3 hours/week

Course Credit: 1.50

Course Objectives:

- To impart knowledge about information technology and its various uses
- Enable the students to understand and use of the MATLAB and Excel to solve the real-world problems.

Indicative Syllabus:

Information Technology:

Introduction: Defining information technology and ICT, basic components of IT, application of ICT.

Computer fundamentals: Defining computer, types of computers, computer organization, input-output devices, computer memories (RAM and ROM).

Number systems: Introduction of different types of number system.

Data base management: Introduction to data base management systems (DBMS) and query.

Network: Defining network and data connections, data communication media, application of networks, network topology.

Computer Programming and Excel:

MATLAB: Expressions, operators, classification of operators, precedence and associativity of operators, The simple if statement, compound statements, the if/else statement, and switch statement, While, do-while, for, nested loops, break statement, goto statement, continue statement, infinite loops, Introduction and necessity of functions, passing arguments, function prototypes, recursion, and library function, Defining arrays, pros and cons of arrays, different types of arrays, (one dimensional and two-dimensional arrays).

Excel: Excel functions, Excel Statements, Linear and nonlinear equation solver, Basic Differential equation solver, Processing data and analysis in Excel.

Intended Learning Outcomes (ILO):

On completion of this course, the students will be able to-

- solve the real-world problems using MATLAB and Excel
- familiar with information technology and its various uses

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoints through multimedia projector
- Problem-based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Reading:

1. Balagurusamy E, Programming in ANSI C (Fifth edition), Tata McGraw-Hill Publishing company Limited, New Delhi.
2. McMaster, K., Rague, B., Sambasivam, S., & Wolthuis, S. (2016, October). Coverage of CS1 programming concepts in C++ and Java textbooks. In 2016 IEEE Frontiers in Education Conference (FIE) (pp. 1-8). IEEE.
3. Balagurusamy E., Object Oriented Program with C++, Tata McGraw-Hill Publishing company Limited New Delhi.

2nd Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 2707	Numerical Methods and Statistics for Engineering Application	4.00	4.00
2.	ChE 2708	Numerical Methods and Statistics for Engineering Application Sessional	1.50	0.75
3.	Ch 2831	Physical Chemistry	3.00	3.00
4.	Ch 2832	Physical Chemistry Sessional	1.50	0.75
5.	ME 2835	Heat Transfer	3.00	3.00
6.	ME 2836	Heat Transfer Sessional	1.50	0.75
7.	ChE 2709	Fluid Mechanics and Machineries	3.00	3.00
8.	ChE 2710	Fluid Mechanics and Machineries Sessional	1.50	0.75
9.	ChE 2703	Thermodynamics in Chemical Engineering	3.00	3.00
		Sub-Total	**22.00**	**19.00**

Contact Hours : 22.00 Per Week
Total Credit : 19.00
No. of Theory Course : 5
No. of Sessional Course : 4

ChE 2707: Numerical Methods and Statistics for Engineering Applications

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- To enable the students, demonstrate numerical analysis with application in chemical engineering.
- To impart knowledge about numerical differentiation and integration etc.
- To understand basics of statistics and statistical analysis

Indicative Syllabus:

Numerical Analysis: Interpolation with equal and unequal intervals, Newton's forward and backward formula, central difference formulae, trapezoidal and Simpson's rule; solution of algebraic and Gausses' method, cramer's rule, transcendental equations; Bisection and Regulafalsi method, initial approximation and convergence criteria of iteration method, Newton-Raphson method, solution of simultaneous linear algebraic equations, Gauss elimination method, Gauss Jordan method, Jacobi method, Gauss Seidal method.

Numerical Solution of Ordinary and Partial Differential Equations: Euler's and Runge-Kutta method; finite difference method.

Statistics: Frequency distribution, Measure of central tendency, Measures of dispersion, Moment, Skewness, Kurtosis, Elementary probability theory, Probability distribution i.e. Binomial, Poisson and normal, Elementary sampling theory, Estimation, regression analysis, Correlation analysis, Mathematical expectation.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Determine error estimation associated with programs and numerical methods.
- Describe numerical methods used in problems of ordinary differential equations, partial differential equations and optimization.
- Demonstrate competency of creating computer programs to solve problems of ordinary differential equations, partial differential equations and optimization.
- Understand statistical methods of analysis

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Chapra, S. C., & Canale, R. P. (2011). Numerical methods for engineers (Vol. 2). New York: Mcgraw-hill.
2. Hamming, R. (2012). Numerical methods for scientists and engineers. Courier Corporation.
3. Hildebrand, F. B. (1987). Introduction to numerical analysis. Courier Corporation.
4. Steel, R. G. D., & Torrie, J. H. (1960). Principles and procedures of statistics. Principles and procedures of statistics

ChE 2708: Numerical Methods and Statistics for Engineering Applications Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course objectives:

- To enhance the problem-solving skills of Chemical engineering students using numerical methods
- To develop a computer program for analyzing real life problems in Chemical engineering by numerical techniques.

Indicative Syllabus:

- Interpolation with equal and unequal intervals of the argument
- Findings roots of non-Linear equations by computer program
- Numerical solution of an ordinary differential equation
- Numerical solution of a partial differential equation
- Analyzing model fitting approaches

Intended Learning Outcomes (ILO):

On completion of this course students will able to:

1. Understand numerical techniques to find the roots of non-linear equations and solution of systems of linear equations.
2. Understand the difference operators and the use of interpolation.
3. Understand numerical differentiation and integration and numerical solutions of ordinary and partial differential equations.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies

Assessment Methods:	**Weighting (%)**

Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Fausett, L. V., Fausett, L. V., Fausett, L. V., & Fausett, L. V. (1999). Applied numerical analysis using MATLAB (Vol. 1). Upper Saddle River, NJ:: Prentice hall.
2. Karris, S. T. (2007). *Numerical analysis using MATLAB and Excel*.Orchard Publications.
3. Kharab, A., & Guenther, R. B. (2011). *An introduction to numerical methods: a MATLAB approach*. Chapman and Hall/CRC.
4. Cooper, J. M. (2012). *Introduction to partial differential equations with MATLAB*.Springer Science & Business Media.
5. Coleman, M. P. (2016). *An introduction to partial differential equations with MATLAB*.Chapman and Hall/CRC.

Ch 2831: Physical Chemistry

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To apply knowledge of physical chemistry.
- To propose reaction mechanisms from experimental kinetic data.
- To allow selection of the appropriate analytical technique for a particular analyte, analyte concentration and analytical situation.

Indicative Syllabus:

Solutions: Types of Solutions, Properties of solutions; Solution of Gas in Liquids, Effect of Temperature, Influence of Pressure, Raoult's law and measures of composition; Validity and Limitations of Henrys Law, Solubility and solubility diagrams; Distribution law and its applications; Dilute solution and colligative properties.
Electrochemical cells: Galvanic Cell, Measurement of E.M.F of Electrochemical Cells, Types of Half-Cells, Single Electrode Potential; Determination of Standard Electrode Potential (SEP), Effect of Concentration and Temperature on Electrode Potential; The Nernst Equation, Thermodynamics and E.M.F. of Cells, Types of Galvanic Cell, Application of E.M.F. Measurements, Lead Storage Cell, Dry Cell, Fuel Cell, Polarization and Overvoltage
Chemical kinetics: Relative rate of reaction, power law models and elementary rate laws, non-elementary rate laws, reversible reactions, molecularity and order of reaction, rate constant and its temperature dependence, interpretation of activation energy, and Arrhenius plot and molecular simulations of kinetics phenomena and present status of our approach to a reactor sizing and design.
Catalysis: Catalyst properties, catalyst gas-solid interactions, classification of catalysts, steps in a catalytic reaction, synthesizing a rate law, mechanism, and rate limiting steps, Enzyme catalysis.
Phase Equilibria: definition of Terms, Deduction of the Phase Rule, Liquid-Liquid Systems, Fractionating Column, Completely Miscible Liquid Pairs Showing Deviation from Raoults Law, of Non-ideal Solutions: Azeotropic Mixture, Liquid—Liquid Equilibria in Partly Miscible Systems: Critical Solution Temperature (CST), Immiscible Liquid Pairs: Steam Distillation

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Explain concepts of solutions, mixture, complete and limited solubility.
- Interpret basic results of calorimetry, e.g. for the determination of melting point, specific heat capacity and heat of reaction.
- Illuminate surface tension phenomena, catalysis and ion-exchange.
- Interpret simple spectra of IR, UV-Vis, voltammetry, gas chromatography and HPLC.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation

- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Lewis, D., & Glasstone, S. (1960). Elements of physical chemistry. Macmillan.
2. Rajagopalan, R., & Hiemenz, P. C. (1997). Principles of colloid and surface chemistry. Marcel Dekker, New-York, 8247, 8.
3. Ball, D. (1998). Kinetics of consecutive reactions: first reaction, first-order; second reaction, zeroth order. *Journal of Chemical Education*, *75*(7), 917..
4. Christian G.D. (2008). Analytical Chemistry, 6th edition, Wiley,.

Ch 2832: Physical Chemistry Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To analyze, exploit and discuss experimental data.
- To understand the theoretical principles and practical applications of a variety of classical and spectrophotometric techniques.
- Describe the essential stages of the analytical processes.

Indicative Syllabus:

- Determination of the Specific Rate Constant of a Reaction
- Determination of Distribution Coefficient
- Spectrophotometry
- Potentiometric titration
- pH metric titration
- Conductometric titration
- Electrogravimetry

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Select and justify the analytical method to be used for an analytical sample.
- Evaluate and validate the selected method.
- Assess the results and define the criteria for accuracy and precision.
- Select and set up the appropriate chromatographic column for separation of a given mixture.
- Select and justify the appropriate analytical spectroscopic technique (IR, UV, AA) to analyze a sample.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)

Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Lewis, D., & Glasstone, S. (1960). Elements of physical chemistry. Macmillan.
2. Rajagopalan, R., & Hiemenz, P. C. (1997). Principles of colloid and surface chemistry. Marcel Dekker, New-York, 8247, 8.
3. Ball, D. (1998). Kinetics of consecutive reactions: first reaction, first-order; second reaction, zeroth order. *Journal of Chemical Education*, *75*(7), 917.
4. Christian G.D. (2008). Analytical Chemistry, 6th edition, Wiley,

ME 2835: Heat Transfer

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objective:

- to achieve idea about heat energy and their modes of transmission
- to have knowledge about the various laws of heat transfer.
- to have idea about heat transfer devices like heat exchangers in chemical process industries
- to make understand the students how to design heat exchangers in chemical process industries
- to make students understand how to select suitable processing equipment in chemical process industries.

Indicative Syllabus:

Concept of heat energy, Various Modes of heat transfer and basic laws. 3D Laplace equations for unsteady and steady state conditions. One dimensional steady state heat conduction in plane wall, radial and spherical systems. Heat transfer with heat generation source in various systems.

Two-dimensional steady state conduction: graphical and numerical method of analysis, heat transfer from extended surfaces.

Natural convection: Development of various correlations, dimensional analysis of natural convection and formulae for prediction of natural convection in industries.

Forced convection: Development of various correlations, boundary layer principles, Reynolds analogy and dimensional analysis. Forced convection and application of formulae for prediction of heat energy transmission in industries.

Boiling heat transfer and condensations: Boiling phenomena, various types of boiling. Condensations: Phenomena, condensation on horizontal and vertical flat plates and pipe condensations.

Combine heat transfer: Types of heat exchangers, heat exchanger performance; design of heat exchanger using various methods, like LMTD, NTU etc. Fouling and scaling in industrial systems of heat transfer.

Radiation Heat Transfer: Physical mechanism and radiation properties, the radiation shape factor and relation between shape factors. Radiation exchange between black surfaces. Grey-body radiation exchanges and solar radiation.

Heat exchangers: Mean temperature difference in different flow arrangements; Thermal and mechanical design; Heat transfer across extended surfaces. Types of heat transfer equipment.

Intended Learning Outcomes (ILO):

- Achievement of ideas about heat energy transmission in various modes
- Achievement of idea about heat transmission in various industrial systems
- Achievement of ideas about heat transfer devices like heat exchangers and learning how to design heat exchangers in chemical process industries.
- Learning the technique about how to Select suitable processing equipment

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Holman, J. P. (1989). Heat Transfer [SI Metric Ed.]. McGraw-Hill.
2. Çengel, Y. A., Turner, R. H., Cimbala, J. M., & Kanoglu, M. (2001). Fundamentals of thermal-fluid sciences (Vol. 703). New York: McGraw-Hill.
3. Incropera, F. P., Lavine, A. S., Bergman, T. L., & DeWitt, D. P. (2007). Fundamentals of heat and mass transfer. Wiley.

ME 2836: Heat Transfer Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To enable the student to gather practical knowledge on heat transfer
- To understand the Importance of thermal fluid sciences.
- To impart knowledge to select and design suitable processing equipment for efficient heat transfer

Indicative Syllabus:

- Study of concentric tube heat exchanger
- Study of cross flow heat exchanger
- Study of shell and tube heat exchanger
- Study of heat transfer in boiling liquid
- Study of radiation heat transfer

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to

- To Have clear idea about heat transfer
- To learn how to select suitable processing equipment

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%

Total	**100%**

Suggested Reading:

1. Holman, J. P. (1989). Heat Transfer [SI Metric Ed.]. McGraw-Hill.
2. Çengel, Y. A., Turner, R. H., Cimbala, J. M., & Kanoglu, M. (2001). Fundamentals of thermal-fluid sciences (Vol. 703). New York: McGraw-Hill.
3. Incropera, F. P., Lavine, A. S., Bergman, T. L., & DeWitt, D. P. (2007). Fundamentals of heat and mass transfer. Wiley.

ChE 2709: Fluid Mechanics and Machineries

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives

- To provide knowledge to the students about fluids, fluids properties and flows
- To understand different pressure and flow measuring devices
- To enable the students, understand the means of pressure loss in fluid systems
- To provide adequate knowledge about transportation of fluid through different types of pipes, fittings & valves, and pumps.

Indicative Syllabus:

General: Properties and classification of fluids; Rheological properties; Fluid statics; Kinematics of fluid flow.

Energy considerations in steady flow: Energy forms and head; General energy equation; Energy equations for incompressible and compressible fluids; Bernoulli's theorem; Energy lines. Laminar and turbulent flow: Flow development; Velocity and stress distributions; Friction factors; Frictional energy loss; Minor energy losses; Pipelines in series and parallel. Similarity and dimensional analysis.

Dimensional analysis: Fundamental and derived units; Dimensional homogeneity; Buckingham's PI theorem; Application of it in fluid flow problems.

Fluid and flow measurements: Measurements of density, viscosity, pressure, velocity and discharge. Application of equations of motion (Navier-Stokes equation) and continuity in common multidirectional flows. Basic concept of CFD. Basics of steady compressible flow and multi-phase flow.

Fluid moving machinery: Definition, classification, working principle and application of Reciprocating pump and Centrifugal pump.

Introduction to transport phenomenon: Analogy among mass and momentum transfer equations, Shell Momentum Balances and Velocity Distributions in Laminar Flow

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to-

- demonstrate fluids, fluids properties and flows
- different pressure and flow measuring equipment
- understand the theories of fluid flow
- demonstrate transportation of fluids-pipe fittings and valves, Pumps-types, design criteria

Teaching-Learning Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of the module:

- Whiteboard and PowerPoint through multimedia
- Problem-based group work activities
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%

Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Hibbeler, R. C. (2017). Fluid Mechanics in SI Units. Pearson Education India.
2. White, F. M. (1962). Fluid Mechanics. McGraw Hill Brasil.
3. Munson, B. R., Okiishi, T. H., Huebsch, W. W., & Rothmayer, A. P. (2013). Fluid mechanics (p. 147). Singapore: Wiley.
4. Yunus, A. C. (2010). Fluid Mechanics: Fundamentals And Applications (Si Units). Tata McGraw Hill Education Private Limited.
5. Yuan, S. W. (1970). Foundations of fluid mechanics (No. BOOK). Prentice-Hall.
6. Lewitt, E. H. (1970). Hydraulics and Fluid Mechanics: A Text-book Covering the Syllabuses of the B. Sc. (Eng.), ICE and I. Mech. E. Examinations in this Subject. Pitman.

ChE 2710: Fluid Mechanics and Machineries Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives

- To provide practical knowledge about fundamentals of different types of fluid flow and their applications in the real world.
- To enable the students, understand different types of pressure and flow measuring equipment.
- To make the students understand the means of pressure and its losses practically at various points of the fluid flow system.

Indicative Syllabus:

- Study of location of center of pressure
- Verification of Bernoulli's equations
- Study of flow measurement devices: pitot tube, Venturi meter, orifice meter
- Study of losses in pipes; Laminar and Turbulent flow observation
- Study of Centrifugal and reciprocating pumps.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to-

- gather knowledge about fluids, fluids properties and flow through close conduits.
- conceive knowledge of different pressures and flow measuring equipment
- understand the theories of fluid flow and how to apply in fluid flow systems.
- understand the transportation of materials through pipe lines when being processed, pipe fittings and actuation of valves, use of pumps and its types, characteristics etc.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of the module:

- Whiteboard and power point
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes/Viva-voce	40%
Performance/Report	50%
Total	**100%**

Suggested Reading:

1. Hibbeler, R. C. (2017). Fluid Mechanics in SI Units. Pearson Education India.
2. White, F. M. (1962). Fluid Mechanics. McGraw Hill Brasil.
3. Munson, B. R., Okiishi, T. H., Huebsch, W. W., & Rothmayer, A. P. (2013). Fluid mechanics (p. 147). Singapore: Wiley.
4. Yunus, A. C. (2010). Fluid Mechanics: Fundamentals And Applications (Si Units). Tata McGraw Hill Education Private Limited.
5. Yuan, S. W. (1970). Foundations of fluid mechanics (No. BOOK). Prentice-Hall.
6. Lewitt, E. H. (1970). Hydraulics and Fluid Mechanics: A Text-book Covering the Syllabuses of the B. Sc.(Eng.), ICE and I. Mech. E. Examinations in this Subject. Pitman.

ChE 2703: Thermodynamics in Chemical Engineering

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand the laws of thermodynamics and their application
- To impart knowledge about the thermodynamic cycles and processes
- To make the students understand steam properties and steam table

Indicative Syllabus:

General: The scope of thermodynamics; Fundamental and secondary quantities. Extensive and intensive properties; Heat, work and their path dependence; Equation of state and its applications. The first law and other basic concepts.

Properties of pure substances: P-V-T behavior of pure substances; Ideal and non-ideal gas; Equations of state and its applications.

Heat effects: Heat capacities; Phase changes of pure substances; Standard heat of reaction and effect of temperature.

The second law of thermodynamics: Alternative statements; Heat engine; Entropy changes and irreversibility. The third law of thermodynamics.

Thermodynamics properties: Single phase and two-phase systems; Thermodynamic diagrams. Conversion of heat into work by power cycles: Vapor cycles; Steam power plant; Internal combustion engines and gas turbines; Cogeneration, Combined gas-vapor cycle, refrigeration cycles.

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to-

- understand the laws of thermodynamics and their application
- demonstrate thermodynamic cycles and processes
- understand steam properties and steam table

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Cangel, Y. A., & Boles, M. A. (2002). Thermodynamics: An Engineering Approach 4th Edition in SI Units. Singapore (SI): McGraw-Hill
2. Wark, K. (1995). Advanced thermodynamics for engineers (p. 194). New York: McGraw-Hill.
3. HOYLE, R. (1967). Rogers, Gfc-Engineering Thermodynamics-Work and Heat Transfer (Si Units).
4. Khurmi, R. S., & Gupta, J. K. (2008). TB of Refrigeration & Air conditioning (ME). S. Chand..
5. Nag, P. K. (2013). Engineering thermodynamics. Tata McGraw-Hill Education.
6. Polson, J. A. (1931). Internal combustion engines. Oxford and IBH Publishing.
7. Rao, Y. V. C. (2004). An introduction to thermodynamics. Universities Press.

3rd Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 3701	Mass Transfer	3.00	3.00
2.	ChE 3702	Mass Transfer Sessional	1.50	0.75
3.	ChE 3703	Unit Operation in Chemical Engineering	4.00	4.00
4.	ChE 3704	Unit Operation in Chemical Engineering Sessional	1.50	0.75
5.	ME 3831	Mechanics of solids	3.00	3.00
6.	ChE 3707	Fuel and Energy Engineering	3.00	3.00
7.	ChE 3708	Fuel and Energy Engineering Sessional	1.50	0.75
8.	ChE 3709	Environmental Management and Control	3.00	3.00
9.	ChE 3710	Environmental Management and Control Sessional	1.50	0.75
		Sub-Total	22.00	19.00

Contact Hours : 22.00 per Week
Total Credits : 19.00
No. of Theory Course : 5
No. of Sessional Course : 4

ChE 3701: Mass Transfer

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Students will gain an understanding of the basic laws of mass transfer.
- Students will be able to analyze the concept of vapor liquid equilibrium and mass transfer in reaction.
- Students will be familiar with the basics of distillation, solvent extraction and gas-liquid absorption systems.

Indicative Syllabus:

Introduction to Mass Transfer: Introduction, Mass Transfer Rate and Mass Transfer Flux, Mass Transfer Mechanisms.

Fick's Law: Introduction; Composition and Velocity Scales: Composition Scales, Mass Transfer Fluxes; Fick's Law for Binary Mixtures.

Diffusivity: Introduction; Experimental Diffusivities; Prediction of Diffusivity: Gas-Phase Diffusivities, Liquid-Phase Diffusivities, Diffusion in Porous Media.

One-Dimensional Diffusion, **Multidimensional and Transient Diffusion**: Introduction; General Differential Component Material Balance: Rectangular Coordinates.

Convective Mass Transfer: Introduction: Forced Convection in Laminar Flow; Forced Convection in Turbulent Flow.

Vapor liquid equilibrium: Introduction; Concept of VLE; Tabular and graphical representation of VLE data: Bubble point and Dew point calculations.

Mass Transfer with Reaction: Introduction; Mass Transfer with Reaction with Generalized Kinetics; Expressions for the Film Model Based on reaction in a Reactor.

Distillation, Absorption, Extraction, and Adsorption: Introduction; Basic Method of Flash Distillation; Absorption and Stripping Equilibria; Extraction Processes and Equipment.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Understand the principles of molecular diffusion and basic laws of mass transfer.
- Earn the ability to determine diffusion coefficients.
- Gain knowledge regarding convective mass transfer and vapor liquid equilibrium.
- Understand the basics of distillation, extraction, absorption and adsorption systems.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smart board and PowerPoint
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Treybal R.E, Mass Transfer Operations, 3rd Edn., International Student Edition, McGraw Hill International, 1981.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6th Edn., McGraw Hill, New York, 2001.
3. C.J. Geankoplis, "Transport Processes and Separation. Process Principles", 4th ed., Prentice Hall, NJ, 2003.
4. Sherwood T.K., Pigford R.L and White C.R, Mass Transfer, McGraw Hill, New York, 1975.

ChE 3702: Mass Transfer Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of mass transfer principles and phase equilibrium.
- To inform the students about the basic concept of chromatography and distillation.

Indicative Syllabus:

- Determination of Liquid-diffusion coefficient.
- Determination of gas-diffusion coefficient
- Study of Vapor-Liquid Equilibrium Diagram.
- Study of Mass Transfer in Chromatography.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to mass transfer principles and phase equilibrium.
- Gain practical knowledge regarding chromatography and distillation using laboratory scale units.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Treybal R.E, Mass Transfer Operations, 3rd Edn., International Student Edition, McGraw Hill International, 1981.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6th Edn., McGraw Hill, New York, 2001.
3. C.J. Geankoplis, "Transport Processes and Separation. Process Principles", 4th ed., Prentice Hall, NJ, 2003.
4. Sherwood T.K., Pigford R.L and White C.R, Mass Transfer, McGraw Hill, New York, 1975.

ChE 3703: Unit Operation in Chemical Engineering

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- Students will gain knowledge on chemical process equipment selection.
- Students will analyze the detailed equipment design.
- Students will be familiar with the current industrial practices.

Indicative Syllabus:

Mechanical separation: Gravity settlers; Impingement and centrifugal separators; Scrubbers.

Pressure relieving devices: Principles; Relief device location; Relief devices and applications; Relief sizing.

Mixing and agitation: Theory of mixing; Types of impeller; Flow patterns; Power requirements of agitated vessels; Range of operation; Inline static mixer; Jet mixer.

Ejectors and other vacuum systems: Types of ejector load; Performance factor of ejectors; Operating ranges of different vacuum systems.

Crystallization: Theory; Design of crystallizers; Crystallization equipment.

Drying: Mechanism; Drying curve; Design; Types of dryers and applications.

Evaporation: Basic concepts; Performance; Maintenance; Design; Types of evaporator; Auxiliary equipment.

Filtration: Basic Theory of Filtration; Types of Filtration Equipment; Filter Media and Filter Aids; Filtration Equations for Constant-Pressure Filtration; Filtration Equations for Constant-Rate Filtration.

Cooling Tower: Theory and Calculations for Cooling-Water Towers; Design of Water-Cooling Tower Using Film Mass-Transfer Coefficients; Design of Water-Cooling Tower Using Overall Mass-Transfer Coefficients.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Understand the fundamentals in characterization and classification of solids and solid handling machineries.
- Acquire complete knowledge about pressure relieving devices.
- Acquainted with theories of crystallization, drying, cooling tower, filtration and evaporation.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smart board and PowerPoint
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. C.J. Geankoplis, "Transport Processes and Separation. Process Principles", 4th ed., Prentice Hall, NJ, 2003.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6th Edn., McGraw Hill, New York, 2001.
3. Perry, R.H. and Green, W.D., Perry's Chemical Engineers' Hand Book, 7thEdn., McGraw Hill International Edn., New York, 2000.

ChE 3704: Unit Operation in Chemical Engineering Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of different types of unit operations used in the chemical industries.
- To inform the students about the basic components of unit operation equipment used in the chemical industries.

Indicative Syllabus:

- Study of Spray Dryer.
- Study of the operation of Water Cooling Tower.
- Investigation of the effect of approach on cooling tower performance
- Study of Constant Pressure Filtration.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concept related to spray dryer, evaporator, water cooling tower and filter press.
- Gain practical knowledge regarding spray dryer, evaporator, water cooling tower and filter press using laboratory scale units.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smart board and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. C.J. Geankoplis, "Transport Processes and Separation. Process Principles", 4th ed., Prentice Hall, NJ, 2003.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6th Edn., McGraw Hill, New York, 2001.
3. Perry, R.H. and Green , W.D., Perry's Chemical Engineers' Hand Book, 7thEdn., McGraw Hill International Edn., New York, 2000.

ME 3831: Mechanics of Solids

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Demonstrate basics of strength of materials, different types of stresses and their combined applications.
- Demonstrate ideas for designing the circular shafts for power transmission.
- Draw shear force and bending moment diagrams in beams under various loadings perpendicular to the axis.
- Demonstrate deflection of beams, buckling of column and struts.

Indicative Syllabus:

Introduction: Elasticity, deformation, Poison's ratio, mechanical properties, stress-strain relationship.
Stress: simple shear and normal stresses; combined stresses; nature and causes of failure, allowable and working stresses, circumferential and longitudinal stresses in hollow cylinders; hoop-stresses; various stress relations.
Torsion: Stresses due to couples on circular shafts; torsion in circular and hollow shafts. Means of power transmission.
Helical Spring: Stresses in various types of helical springs. Spring deflections and Wahl's law. Types of strings. Spring design.
Shear force and Bending moment: Point and distributed loading; inclined loading on horizontal and inclined beams, thrust diagram.
Deflection of beams: stress in beams and deflection of beams. Double Integration method, Area-moment methods of computing beam deflection; Super-position method.
Principal stresses: stress-strains; combined stresses; Mohr's circle for calculation of various stresses; analytical and graphical solutions for stress system in horizontal and inclined plains.
Column and Strut: Difference between column and strut; Euler's formula for critical loading, Secant formula, various Empirical formulae.
Joints: Riveted and welded joints.

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to grasp ideas on

- basics of strength of materials, different types of stresses

- drawing shear force and bending moment diagram
- beam deflections, critical loading of various types of columns and struts
- designing of few of the machine elements

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smartboard and PowerPoint
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Singer, F. L. (1975). Strength of Materials. HarperCollins Publishers.
2. Harbola, M. K. (2014). Engineering Mechanics.
3. Hibbeler, R. C., & Fan, S. C. (2004). Statics and mechanics of materials (Vol. 2). Upper Saddle River: Prentice Hall.
4. Bansal, R. K. (1998). Engineering Mechanics and Strength of materials. Laxmi Publications.
5. Khurmi, R. S., & Sedha, R. S. (2008). Materials science. S. Chand.

ChE 3707: Fuel and Energy Engineering

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Students will learn about the current energy scenario and statistics of Bangladesh.
- Students will gain basic knowledge about fuels.
- Students will perform elementary calculations for combustion, boiler and burner.
- Students will be familiar with different types of advanced combustion technologies.

Indicative Syllabus:

Energy: Current energy scenario and statistics regarding Bangladesh and the whole world.

Fuels: Origin, different types of fuels, fuel sense, fuel characteristics and fuel specifications.

Combustion: Elementary calculations of combustion, thermodynamics, calculation of equilibrium based on Gibb's free energy, reaction kinetics, heat transfer in fuels and heating values.

Advanced Combustion Techniques: Fast pyrolysis, catalytic gasification, Oxy-fuel combustion and chemical looping combustion

Applications of Combustion: Types of boiler, efficiency of boiler, types of flames and burners, cogeneration and waste heat recovery, environmental and economic consideration.

Gasification: Techniques, gasifiers, reaction mechanisms, kinetic models, steps in the gasification reactions.

Thermochemical conversion of biomass: Hydrothermal technologies, Supercritical water gasification, Pyrolysis, Concept of bio refinery.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Acquire complete knowledge about Bangladesh's current energy scenarios and statistics.
- Perform basic calculations regarding fuel combustion.
- Gather knowledge about fuels, combustion and advanced techniques.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smart board and PowerPoint
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Edwards, J. (1974). Combustion. Ann Arbor, Mich.: Ann Arbor Science Publishers.
2. Singh, A. P., Sharma, N., Agarwal, R., & Agarwal, A. K. (2019). Advanced Combustion Techniques and Engine Technologies for the Automotive Sector. Springer.
3. Baukal Jr, C. E. (2003). Industrial burners handbook. CrC press.

ChE 3708: Fuel and Energy Engineering Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of fuel properties.
- To inform the students about the basic concept and equipment used for various fuel analysis.

Indicative Syllabus:

- Determination of Flash Point and Fire Point.
- Determination of Calorific Value.
- Proximate Analysis of a Solid Fuel.
- Thermogravimetric Analysis of Liquid Fuel Sample.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to fuel properties.
- Gain practical knowledge regarding fuel analyzers used in the laboratory.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%

Total	**100%**

Suggested Reading:

1. Edwards, J. (1974). Combustion. Ann Arbor, Mich.: Ann Arbor Science Publishers.
2. Singh, A. P., Sharma, N., Agarwal, R., & Agarwal, A. K. (2019). Advanced Combustion Techniques and Engine Technologies for the Automotive Sector. Springer.
3. Baukal Jr, C. E. (2003). Industrial burners handbook. CrC press.

ChE 3709: Environmental Management and Control

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Students will learn about the fundamentals of pollution and the environment.
- Students will identify the possible sources of industrial pollution.
- Students will recognize a convincing remedy of pollution prevention.

Indicative Syllabus:

General: Introduction to environmental systems; Environmental laws, regulations and quality standards; Environmental ethics.

Water pollution: Sources and characteristics; Effects of contaminants; Wastewater microbiology; Primary, secondary, and tertiary wastewater treatment; Nitrogen and phosphorous removal; Sludge treatment and disposal.

Air pollution: Origin and fate of air pollutants; Effects on humans and environment; Air pollution meteorology; Atmospheric dispersion and modeling; Stationary and mobile sources; Source control.

Solid waste management: Physical and chemical characterization of solid waste; Resource conservation and recovery; Treatment and disposal methods including pyrolysis & incineration, sanitary landfill and composting.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Acquire knowledge about pollution and its relationship to the environmental ecosystems.
- Gather knowledge about pollution prevention techniques.
- Perform basic calculations regarding water and air treatment technologies.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smart board and PowerPoint
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

- Bishop, P. L. (2000). Pollution prevention: fundamentals and practice (No. Ec1286). Waveland Press.
- Davis, M. L., & Masten, S. J. (2013). Principles of Environmental Engineering. McGraw-Hill Education.

ChE 3710: Environmental Management and Control Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of water and air quality parameters.
- To inform the students about the basic concept and equipment used for various water and air quality parameters analysis.

Indicative Syllabus:

- Determination of pH, Turbidity, TDS, TSS, TS.
- Determination of COD and BOD_5.
- Determination of various water quality parameters using Spectrophotometry.
- Determination of various air quality parameters using HAZ-SCANNER.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to water and air quality parameters.
- Gain practical knowledge regarding water and air quality parameters analyzers used in the laboratory and outdoors.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

- Bishop, P. L. (2000). Pollution prevention: fundamentals and practice (No. Ec1286). Waveland Press.
- Davis, M. L., & Masten, S. J. (2013). Principles of Environmental Engineering. McGraw-Hill Education.

3rd Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 3705	Corrosion Science and Engineering	3.00	3.00
2.	ChE 3706	Corrosion Science and Engineering Sessional	1.50	0.75
3.	ChE 3711	Process Design	4.00	4.00
4.	ChE 3713	Reaction Engineering and Reactor Design	3.00	3.00
5.	ChE 3714	Reaction Engineering and Reactor Design Sessional	1.50	0.75
6.	ChE 3717	Solution Thermodynamics	3.00	3.00
7.	ChE 3719	Separation Process Engineering	3.00	3.00
8.	ChE 3720	Separation Process Engineering Sessional	1.50	0.75
9.	ChE 3724	Simulation and Optimization Methods for Industrial Processes Sessional	3.00	1.50
		Sub-Total	**23.50**	**19.75**

Contact Hours : 23.50 Per Week
Total Credit : 19.75
No. of Theory Course : 5
No. of Sessional Course : 4

ChE 3705: Corrosion Science and Engineering

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To provide an understanding of the corrosion principles.
- To deliver an idea about types of corrosion techniques.
- To demonstrate ideas for modern technology of corrosion protection.

Indicative Syllabus:

Basic concepts: definition and importance, Electrochemical nature and forms of corrosion, corrosion rate and its determination.

Electrochemical thermodynamics and kinetics: electrode potentials, potential-pH (Pourbaix) diagrams, reference electrodes and experimental measurements, faraday's laws, instrumentation and experimental procedure.

Galvanic and concentration cell corrosion: basic concepts, experimental measurements, and determination of rates of galvanic corrosion, concentration cells.

Corrosion measurement through polarization techniques: Tafel extrapolation plots, polarization resistance method, commercial corrosion probes, other methods of determining polarization curves.

Passivity: basic concepts of passivity, properties of passive films, experimental measurement, applications of potentiostatic anodic polarization, anodic protection.

Pitting and crevice corrosion: mechanisms of pitting and crevice corrosion, secondary forms of crevice corrosion, localized pitting, metallurgical features and corrosion: Intergranular corrosion, weldment corrosion, de-alloying and dezincification.

Environmental induced cracking: stress corrosion cracking, corrosion fatigue cracking, hydrogen induced cracking, methods of prevention and testing, erosion, fretting and wear.

Environmental factors and corrosion: corrosion in water and aqueous solutions, corrosion in Sulphur bearing solutions, microbiologically induced corrosion, corrosion in acidic and alkaline process streams.

Atmospheric and elevated temperature corrosion: atmospheric corrosion and its prevention, oxidation at elevated temperatures, alloying, oxidizing environments.

Prevention and control of corrosion: cathodic protection, coatings and inhibitors, material selection and design.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Solve problems involving various types of corrosion.
- Select corrosion resistant materials for a given application.
- Select technique for corrosion prevention.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and smartboard PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Fontana, M. G. (2005). *Corrosion engineering*. Tata McGraw-Hill Education.
2. Jones, D. A. (1996). *Principles and prevention of corrosion prentice hall*. Saddle River.

ChE 3706: Corrosion Science and Engineering Sessional

Credit hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives:

- To know about the corrosion rate of different metals.
- To show the effectiveness of the use of inhibitors to protect metals from corrosion.
- To apply various environment principles to describe corrosion processes.

Indicative Syllabus:

- Study of the effect of pH of the solution on the rates of corrosion.
- Study of the variation in oxygen concentration on the rates of corrosion.
- Investigation of metallic corrosion due to stray voltage between metals.
- Study of corrosion control using impressed current.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Measure corrosion rate for metals.
- Determine the effectiveness of the inhibitors to reduce corrosion.
- Recognize the best suitable environment for corrosion.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%

Total	100%

Suggested Reading:

1. Fontana, M. G. (2005). *Corrosion engineering*. Tata McGraw-Hill Education.
2. Jones, D. A. (1996). *Principles and prevention of corrosion prentice hall*. Saddle River.

ChE 3711: Process Design

Contact hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- Students will analyze the detailed equipment selection, specification and design.
- Students will be familiar with the selection of materials of construction.
- Students will acquire complete knowledge about economic evaluation.

Indicative Syllabus:

Design considerations: Design basis; Calculations and solution strategy for mass and energy balances; Process flow Diagram (PFD); Piping and instrumentation diagram (P&ID).
Equipment selection, specification and design: Fluid transport in pipelines; Pumps & compressors, heat transfer equipment, separation columns, reactors, pressure vessels and solid handling equipment.
Selection of materials of construction for equipment and services.
Economic evaluation: Estimation of investment, capital and operating costs. Estimation of product cost.
Optimization in design: Optimum design and economic design criteria; Heat integration and pinch analysis; Energy efficient design.

Intended Learning outcomes (ILO):

After completion of this module, the student will be able to:

- Analyze the chemical plant design consideration.
- Evaluate equipment selection techniques.
- Investigate the selection of materials of construction for equipment and services.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Rosaler, R. C. (2002). Standard handbook of plant engineering. McGraw-Hill.
2. Koolen, J. L. (2001). Design of simple and robust process plants. John Wiley & Sons.
3. Douglas, J. M. (1988). Conceptual design of chemical processes (Vol. 1110). New York: McGraw-Hill.

ChE 3713: Reaction Engineering and Reactor Design

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students to understand the fundamental material and energy balance around an ideal reactor.
- To offer practice to understand and define problems on reaction kinetic and reactor design.
- To provide the basic knowledge of non-ideal reactors.

Indicative Syllabus

Introduction: Homogeneous reactions in ideal reactors, Stoichiometry and basic material balances around a reactor
Kinetics of reactions: Homogeneous and heterogeneous reaction kinetics, Concentration and temperature dependency
Introduction to reactor design: Constant and varying volume batch reactor, Rate equations
Ideal reactors for single reactions: Steady state mixed flow and plug flow reactors, Autocatalytic reactions, parallel reactions
Reaction Mechanism: Elementary reactions, molecularity and order, Steady-state assumptions, determinations of rate equations from given mechanisms, chain reactions.
Multiple reactions: Irreversible first order reaction in series, Successive irreversible reactions of different orders, Reversible reactions, Series-parallel reactions
Selection of reactors: Temperature and pressure effects
Heterogeneous reactions: Introduction, Solid catalyzed reactions, Deactivating catalyst, Mechanism of catalyst deactivation.

Intended Learning Outcomes (ILO):

After completion of this course, the students will be able to:

- Identify and characterize different reactors and different flow patterns.
- Carry out design for ideal reactors.
- Select suitable reactors based on the constraints.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Levenspiel, O. (1999). Chemical reaction engineering. *Industrial & engineering chemistry research*, *38*(11), 4140-4143.
2. Hill, C. G., & Root, T. W. (1977). *An introduction to chemical engineering kinetics & reactor design* (pp. 245-316). New York: Wiley
3. Missen, R. W., Mims, C. A., & Saville, B. A. (1999). *Introduction to chemical reaction engineering and kinetics*. J. Wiley.
4. Fogler, H. S., & Brown, L. F. (2006). Distributions of residence times for chemical reactors. *Elements of chemical reaction engineering*, *4*.

ChE 3714: Reaction Engineering and Reactor Design Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of reaction kinetics and its dependency.
- To inform the students about the basic concept of CSTR and PFR.

Indicative Syllabus:

- Determination of the reaction rate constant in a Continuous Stirred Tank Reactor.
- Effect of varying the temperature, mixing speed and feed rate on reaction rate.
- Determination of the Residence Time using tracer techniques.
- Determination of the Residence Time Distribution of a Plug Flow reactor.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to reaction kinetics and its dependency.
- Gain practical knowledge regarding the basic concept of CSTR and PFR using laboratory scale units.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Levenspiel, O. (1999). Chemical reaction engineering. *Industrial & engineering chemistry research*, *38*(11), 4140-4143.
2. Hill, C. G., & Root, T. W. (1977). *An introduction to chemical engineering kinetics & reactor design* (pp. 245-316). New York: Wiley
3. Missen, R. W., Mims, C. A., & Saville, B. A. (1999). *Introduction to chemical reaction engineering and kinetics*. J. Wiley.
4. Fogler, H. S., & Brown, L. F. (2006). Distributions of residence times for chemical reactors. *Elements of chemical reaction engineering*, *4*.

ChE 3717: Solution Thermodynamics

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Students will gain knowledge on phase equilibria and chemical reaction equilibria.
- Students will be familiar with the thermodynamics of flow processes.
- Students will acquire complete knowledge about economic evaluation.
- Students will learn about refrigeration and liquefaction.

Indicative Syllabus:

Thermodynamic properties: Relationships among the thermodynamic properties for systems of variable composition; Partial molar properties; Fugacity and fugacity coefficients; Fugacities in

ideal solutions; Property changes upon mixing; Activity and activity coefficients; Heat effects of mixing processes.

Phase equilibria: Nature and criteria of equilibrium; Phase rule and Duhem's theorem; Vapour-liquid equilibrium calculations for miscible systems; Gibbs- Duhem equation.

Chemical reaction equilibria: The reaction coordinate; Criteria of equilibrium; Equilibrium constant and effect of temperature; Phase rule and Duhem's theorem.

Thermodynamics of flow processes: Conservation of mass and energy; Mechanical energy balances; Maximum velocity in pipe flow; Metering and throttling processes; Nozzles, compressors and ejectors.

Refrigeration and liquefaction: Carnot, air, and vapour-compression refrigeration cycles and their comparison; Absorption refrigeration; Heat pump; Liquefaction processes.

Intended Learning Outcomes (ILO):

After completion of this course, the students will be able to:

- Analyze the thermodynamic properties for various systems.
- Understand the phase equilibria and chemical reaction equilibria.
- Investigate the thermodynamics of flow processes.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Cangel, Y. A., & Boles, M. A. (2002). Thermodynamics: An Engineering Approach 4th Edition in SI Units. Singapore (SI): McGraw-Hil.
2. Nag, P. K. (2013). Engineering thermodynamics. Tata McGraw-Hill Education.
3. Rao, Y. V. C. (2004). An introduction to thermodynamics. Universities Press.

ChE 3719: Separation Process Engineering

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand the fundamental separation techniques used in chemical plants.
- To provide basic knowledge of graphical and analytical solution procedure of separation processes.
- To develop problem solving skills in a structured way of various separation processes.

Indicative Syllabus:

Flash distillation: Binary flash distillation, Sequential and simultaneous solution procedure, Size calculation.

Column distillation: Developing a distillation cascade, Distillation equipment, External column balance. Internal stage by stage balance, CMO, Lewis method, McCabe-Thiele method, Feed line, Profiles, Advanced distillation processes

Multicomponent distillation: Introduction**;** Total Reflux: Fenske Equation; Minimum Reflux: Underwood Equations; Gilliland Correlation for Number of Stages at Finite Reflux Ratio.

Absorption and stripping: Equilibrium and operating line formation, Column diameter, Analytical solution- Kremser equation.

Extraction: Immiscible and partially miscible extraction, Countercurrent and cross flow extraction

Extension of McCabe-Thiele method: Generalization of various separation procedure, Washing, Leaching.

Membrane Separation Processes: Separation of Gases; Separation of Liquids: Dialysis, Membranes for Liquid-Liquid Extraction; Pervaporation; Reverse Osmosis.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Explain how separation procedures are used in a chemical plant.
- Define concepts of equilibrium stages
- List the steps in the structured problem-solving approach and start applying them.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Wankat, P. C. (2006). *Separation process engineering*. Pearson Education.
2. Henley, E. J., & Seader, J. D. (1981). *Equilibrium-stage separation operations in chemical engineering*. Wiley.
3. Petlyuk, F. B. (2004). *Distillation theory and its application to optimal design of separation units*. Cambridge University Press.
4. Geankoplis, C. J. (2003). Transport Process and Unit Operation.

   Cussler, E. L., & Cussler, E. L. (2009). *Diffusion: mass transfer in fluid systems*. Cambridge university press.

ChE 3720: Separation Process Engineering Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide basic practical knowledge of separation processes.
- To inform the students about the basic concept and equipment used for separation in chemical process industries.

Indicative Syllabus:

- Determination of the efficiency of a Distillation Column.
- Study of Batch Distillation with Total Reflux.
- Study of Batch Distillation with Constant Reflux.
- Extraction of Oil from Oil Cake by Soxhlet Extractor.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to separation process engineering.

- Gain practical knowledge regarding separation process engineering and apply these techniques in the laboratory.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Wankat, P. C. (2006). *Separation process engineering*. Pearson Education.
2. Henley, E. J., & Seader, J. D. (1981). *Equilibrium-stage separation operations in chemical engineering*. Wiley.
3. Petlyuk, F. B. (2004). *Distillation theory and its application to optimal design of separation units*. Cambridge University Press.
4. Geankoplis, C. J. (2003). Transport Process and Unit Operation.
   Cussler, E. L., & Cussler, E. L. (2009). *Diffusion: mass transfer in fluid systems*. Cambridge university press.

ChE 3724: Simulation and Optimization Methods for Industrial Processes Sessional

Contact hours: 3 hours/week

Course Credit: 1.50

Course Objective:

- To provide basic concepts of simulation packages.
- To learn about construction of complex chemical processes using ASPEN HYSYS

Indicative Syllabus:

- Determination of Thermodynamic Properties and Complex Phase Equilibrium with Suitable Models in Simulation Packages.
- Perform Analysis of Chemical Processes using HYSYS.
- Calculation of major unit operation equipment of chemical plants using ASPEN HYSYS.
- Studying recycle, balance and optimization criteria of reactive system.

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- Understand basic concepts related to simulation packages e.g. HYSYS and ASPEN.
- Construct processes consisting of major units employed in chemical industries.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard, smartboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments

- Use of industrial software such as AutoCAD and ASPEN HYSYS.
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Required Textbooks and Software:

1. Haydary, J. (2019). Chemical process design and simulation: Aspen Plus and Aspen Hysys applications. Hoboken, NJ: American Institute of Chemical Engineers.
2. ASPEN Software Manual
3. HYSYS Software Manual

4th Year 1st Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 4701	Process Control and Dynamics	3.00	3.00
2.	ChE 4702	Process Control and Dynamics Sessional	1.50	0.75
3.	ChE 4703	Chemical Plant Design	3.00	3.00
4.	ChE 4704	Chemical Plant Design Sessional	1.50	0.75
5.	ChE 4705	Particle Technology	3.00	3.00
6.	ChE 4706	Particle Technology Sessional	1.50	0.75
7.	ChE 4732	Engineering and Professional Ethics Sessional	1.50	0.75
8.	ChE 4000	Project/ Thesis	3.00	3.00***
9.	ChE 4700	Process Design Sessional	3.00	1.50***
10.	Two elective subjects from the following courses*		6.00	6.00
		Total	**27.00**	**22.50**

*Elective: (2 courses of 3 credit each from the following courses)

1.	ChE 4713	Natural Gas and Petroleum Engineering	3.00	3.00
2.	ChE 4715	Fertilizers, Pulp & Paper Technology	3.00	3.00
3.	ChE 4717	Polymer Science and Technology	3.00	3.00
4.	ChE 4719	Introduction to Renewable Energy	3.00	3.00
5.	ChE 4733	Biochemical Engineering	3.00	3.00
6.	ChE 4725	Process Modeling and Optimization	3.00	3.00

*** indicates continuation of the same course in the next semester.

Contact Hours : 27.00 per week
Total Credit : 22.50
No. of Theory Course : 5
No. of Sessional Course: 6

ChE 4701: Process Control and Dynamics

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To enable the students, understand basic concepts of process behavior and control systems.
- To provide knowledge of different types of control systems implemented in the industries.
- To introduce students with common instrumentation in control systems.

Indicative Syllabus:

Introductory Concepts: Introduction to process control, Hierarchy of process control activities, Rationale of dynamic process model, General modeling principles

Dynamic Behavior of Processes: Laplace transform of representative functions, Development of transfer functions, Linearization of nonlinear models, Response to first order and second order processes

Dynamic Response to More Complicated Processes: Poles and zeros, Processes with time delays, Interacting and noninteracting processes.

Feedback Controllers: Basic control models, PID controllers, On-off controllers, Response of feedback control systems

Control System Instrumentation: Transducers and transmitters, Final control elements, PID controller design, Tuning and troubleshooting, Guidelines to common control loops.

Dynamic Behavior of Closed-loop Control System: Block diagram representations, Closed loop transfer functions, Root locus diagram.

Frequency Response Analysis: Sinusoidal forcing a nth order process, Bode diagrams, Nyquist diagrams, Stability criterions, Robustness analysis.

Feedforward Controllers: Feedforward controllers based on steady state and dynamic models, Ratio control.

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to

- demonstrate various tools and equipment used in control system
- have a fair knowledge about dynamic behavior of processes and their response to control systems.
- test stability of controlled processes using stability criteria

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle III, F. J. (2010). *Process dynamics and control*. John Wiley & Sons.
2. Stephanopoulos, G. (1984). *Chemical process control: an introduction to theory and practice*.
3. Townshend, A. (1970). Galen W. Ewing, instrumental methods of Chemical analysis: 3rd edn., McGraw-Hill, New York, 627 pp., price 117.

ChE 4702: Process Control and Dynamics Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To provide knowledge of different types of control systems implemented in the industries.
- To inform the students about the basic components of a process control unit and its operation.
- To enable students to use software to develop block diagrams of simple control loops and observe their responses.

Indicative Syllabus:

- Development of an FOPTD model
- Designing and tuning of a conventional PID controller.
- Investigation of a basic proportional control where the flow is controlled by either valve or pump.
- Study of level control of a process vessel
- Study of temperature control of a heater tank.

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- understand basic process control practically with small scale unit.
- gain knowledge about control loops implemented in industries with computational methods.
- Learn the use of software to develop basic process models and control systems.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Readings:

1. Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle III, F. J. (2010). *Process dynamics and control*. John Wiley & Sons.
2. Stephanopoulos, G. (1984). *Chemical process control: an introduction to theory and practice*.
3. Townshend, A. (1970). Galen W. Ewing, instrumental methods of Chemical analysis: 3rd edn., McGraw-Hill, New York, 627 pp., price 117.

ChE 4703: Chemical Plant Design

Contact hours: 3.0 hours/week

Course credit: 3.00

Course Objectives:

- To provide a basis for students to function effectively in teams on a major project.
- To equip students to conceptualize and develop a Chemical engineering process.
- To equip students to design the essential elements of a Chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety).

Indicative Syllabus:

Engineering project management processes: Time and cost management; Project quality issues; Risk management. Project definition, technical specifications, design basis, process licensing, and engineering studies; Basic & detailed engineering, and codes & standards; Procurement; Engineering document preparation; Contract negotiation; Vendors, inspection and performance tests.

Team dynamics and interpersonal relationships, Conceptual design, Process drawings and analysis, Energy integration, Safety and environment, Process simulation, Equipment function and sizing, Equipment design, Materials of construction, Process economics, Intellectual property issues, Ethics, Team meetings with instructor and Technical communication.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- research Chemically related technical and business-related information

- assemble a logical sequence of interconnected unit operations for an effective Chemical engineering process
- determine sizes, materials, and capital and operating costs of equipment commonly used in the Chemical processing industries

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Rosaler, R. C. (2002). *Standard handbook of plant engineering*. McGraw-Hill,.
2. Koolen, J. L. (2001). *Design of simple and robust process plants*. John Wiley & Sons.
3. Douglas, J. M. (1988). *Conceptual design of Chemical processes* (Vol. 1110). New York: McGraw-Hill.
4. Peters, M. S., & Timmerhaus, K. D. (1980). Plant design and economics for Chemical engineers.

ChE 4704: Chemical Plant Design Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objectives:

- To understand general design considerations involving Chemical plant design development.
- To provide in-depth knowledge about major equipment in a Chemical processing plant.
- To create a professional environment for Chemical plant design representation.

Indicative Syllabus:

- Preparation of a plant layout
- Economics and feasibility analysis of a plant
- Equipment specifications and design criteria for Chemical plant design.
- Problem solving based on designs of different industries and equipment

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Obtain the engineering and scientific data required for formulating and solving the fundamental design equations of important unit operations.
- Prepare and deliver a professional oral presentation with appropriate visual aids.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Turton, R., Bailie, R. C., Whiting, W. B., & Shaeiwitz, J. A. (2008). *Analysis, synthesis and design of Chemical processes*. Pearson Education.
2. Seider, W. D., Seader, J. D., & Lewin, D. R. (2009). *Product & Process Design Principles: Synthesis, Analysis And Evaluation, (With CD)*. John Wiley & Sons.
3. McCabe, W. L., Smith, J. C., & Harriott, P. (1993). *Unit operations of Chemical engineering* (Vol. 5, p. 154). New York: McGraw-hill.
4. AutoCAD software manual

ChE 4705: Particle Technology

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To gain knowledge about characteristics of solid particles.
- To provide knowledge about the unit operations that involves particulate systems.
- To expand technical knowledge of designing equipment involving particulate systems

Indicative Syllabus:

Properties of particulate solids: particle size and shape: mean diameter, screen analysis, analytical size distribution function, size distribution of feed and products of crystallizers and size reduction equipment, bulk properties of particulates, Mohr stress diagram, storage of solids, and bin design.

Fluid-solid momentum transport: flow past a sphere, drag coefficient, terminal setting velocity, pressure drop in packed beds, fluidization and sedimentation, slurry transport and pneumatic conveying, fluid-solid separation based on momentum transport, classification, pretreatment of solid-liquid mixture, theory of coagulation, flocculation and flotation, suspension of particles, Batch settling, thickeners.

Particle size reduction: Particle fracture mechanism, Energy requirement for size reduction, comminution equipment.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Characterize particle solids.
- Design unit operations which involve particulate systems.
- Manipulate related equations for different conditions (i.e., constant pressure, etc.).
- Apply the correct equations in designing equipment involving particulate systems.

- Evaluate the suitability of the solution obtained in theoretical calculation.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Rhodes, M. J. (1990). *Principles of powder technology*.
2. Rhodes, M. J. (Ed.). (2008). *Introduction to particle technology*. John Wiley & Sons.
3. Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., & Andersen, L. B. (2008). *Principles of unit operations*. John Wiley & Sons.

ChE 4706: Particle Technology Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objectives:

- To perform particle size analysis and to manipulate particle size distribution data by using the particle technology.
- To model particle flow and fluidized beds by applying the knowledge of motion and fluid mechanics of single particle and multi-particle assemblies.
- To conduct experimental procedures on particulate solids and derive information using the fundamentals of particle technology acquired in the unit.

Indicative Syllabus:

- Study of Pressure on Masses of Particles
- Study of Crushing and Grinding
- Sieve Analysis of Grinded Product.
- Investigation of Liquid-solid Fluidized Bed
- Observation of Gas-solid Fluidized Bed

*Any relevant experiment related to the corresponding theory

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Illustrate particle characterization techniques.
- Manipulate particle size distribution data.
- Develop an appreciation for the complexities of powder handling and processing.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments

- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Suggested Reading:

1. Rhodes, M. J. (1990). *Principles of powder technology*.
2. Rhodes, M. J. (Ed.). (2008). *Introduction to particle technology*. John Wiley & Sons.
3. Foust, A. S., Wenzel, L. A., Clump, C. W., Maus, L., & Andersen, L. B. (2008). *Principles of unit operations*. John Wiley & Sons.

ChE 4732: Engineering and Professional Ethics Sessional

Contact hours: 3/2 hours/week

Course Credit: 0.75

Course Objectives: The objectives of this course are to provide students of engineering with:

- An understanding of their duties and responsibilities as professionals through gaining knowledge of the philosophies of ethics, professional practice, and world culture.
- Basic knowledge to make informed ethical decisions when confronted with problems in the working environment.
- Improved awareness of potential ethical issues within an engineering context.

Indicative Syllabus:

- Problem Solving and Case Study related to Basics of Ethical Analyses and Decision-Making.
- Problem Solving and Case Study associated with Fundamentals of Moral Analyses and Decision-Making.
- Problem Solving and Case Study connected to Essentials of Conflicts of Interests.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Provide ethical/moral situations that might be encountered in their engineering careers.
- Understand the professional and ethical responsibilities.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	**100%**

Required Textbooks and Software:

1. Seebauer, E. G., & Barry, R. L. (2001). Fundamentals of ethics for scientists and engineers/Edmund G. Seebauer, Robert L. Barry.
2. Luegenbiehl, H. C. (2009). Ethical principles for engineers in a global environment. In *Philosophy and Engineering:* (pp. 147-159). Springer, Dordrecht.
3. Murphy, C., Gardoni, P., & Harris, C. E. (2011). Classification and moral evaluation of uncertainties in engineering modeling. *Science and engineering ethics*, *17*(3), 553-570.
4. Whitbeck, C. (2011). *Ethics in engineering practice and research*. Cambridge University Press.

ChE 4000: Project/ Thesis

Course credit: 3.00***

Course Objectives:

- To help the students understand research work and associated necessary steps such as writing a well-thought research proposal, conducting experimental work etc.
- To make the students understand how to design a research work and analyze derived data.

The students are required to undertake projects in a group of three under the supervision of a teacher of the Department of Chemical Engineering. The students shall present seminars on the topic selected for him for getting the grade on **ChE 4000**. The course will include literature survey and complete plan of work for the research to be undertaken in **4th year 1st semester** in the field of Chemical engineering and/or Chemical technology.

The same project will be continued to the next semester with the course number **ChE 4000.**

Intended Learning Outcomes (ILO):

The students will be able to learn how to

- Write a research proposal
- Design a research work
- Write a project report
- Give a presentation.

Assessment Methods:	**Weighting (%)**
Viva Voce (A committee of minimum 3-members will be constituted by the Examination Committee for viva voce)	30%
Supervisor (Internal Examiner) *(Assessment based on the works done during this semester and presentation)*	50%
External Examiner (any other teacher of the department/examination committee) *(based on slide show presentation and evaluation of report)*	20%
Total	**100%**

ChE 4700: Process Design Sessional

Course credit: 1.50***

Course Objectives:

- To acquaint students with a broad framework of design.
- To select and design Chemical processing equipment based upon design heuristics, guidelines, or rules of thumb.
- To apply Chemical engineering principles to design Chemical processes.

Indicative Syllabus:

Integrated design of a Chemical plant based on related design considerations and cost estimation. (A student will work for 3 hours per week in both the 4th year 1st semester and 4th year 2nd semester for the completion of the course.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Assemble a logical sequence of interconnected unit operations for an effective Chemical engineering process.
- Determine sizes, materials, and capital and operating costs of equipment commonly used in the Chemical processing industries.
- Recognize professional situations requiring ethical decisions.
- Work in an industrial-type based team environment.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Viva Voce (A committee of minimum 3-members will be constituted by the Examination Committee for viva voce)	30%
Supervisor (Internal Examiner) *(Assessment based on the works done during this semester and presentation)*	50%
External Examiner (any other teacher of the department/examination committee) *(based on slide show presentation and evaluation of report)*	20%
Total	**100%**

Suggested Reading:

1. Sinnott, R., & Towler, G. (2019). Chemical engineering design: SI Edition. Butterworth-Heinemann.
2. Peters, M. S., & Timmerhaus, K. D. (1980). Plant design and economics for Chemical engineers.
3. Turton, R., Bailie, R. C., Whiting, W. B., & Shaeiwitz, J. A. (2008). Analysis, synthesis and design of Chemical processes. Pearson Education.
4. Couper, J. R., Penney, W. R., & Fair, J. R. (2009). Chemical Process Equipment-Selection and Design (Revised 2nd Edition). Gulf Professional Publishing.

Electives

ChE 4713: Natural Gas and Petroleum Engineering

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To acquire the basics of the oil & gas industry.
- To get familiar with concepts used in natural gas and petroleum Engineering.
- To become accustomed with the different majors in natural gas and petroleum engineering.
- To obtain the basic knowledge in exploration, drilling and production.

Indicative Syllabus:

Natural Gas: Fundamentals, industry overview (wellhead-to-burner tip), gas quality, processing, well site logistics, natural gas storage, corrosion, integrity management, automation and control, U.S. regulatory environment, well/pipeline siting, well site construction, project management, environmental/water management, buying, selling and marketing.

Petroleum: Overview and history of the petroleum industry and petroleum engineering, petroleum reserves, production and consumption statistics of the world, structure of the petroleum industry, composition, origin, migration and accumulation of petroleum, oil traps, petroleum exploration methods, nature of oil and gas wells, drilling history, types of drilling rigs, drilling equipments, introduction to drilling fluids, special problems in drilling, cost, data acquisition during drilling, reservoir properties, reservoir pressure and evaluation, properties and behaviors of reservoir fluids, oil and gas production, the production system, methods of oil production, fundamentals of oil refining.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Fully explain the process and parties involved to move gas and oil from the wellhead to market.
- Determine appropriate requirements and associated processing options to make gas and oil marketable.
- Identify regulatory requirements, environmental and social concerns, logistical considerations and basic construction techniques and practices for well site development.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Lyons, W. C., & Plisga, G. J. (2011). *Standard handbook of petroleum and natural gas engineering*. Elsevier.
2. Hilyard, J. (2012). *The oil & gas industry: A nontechnical guide*. PennWell Books.
3. Terry, R. E., Rogers, J. B., & Craft, B. C. (2015). *Applied petroleum reservoir engineering*. Pearson Education.

ChE 4715: Fertilizer, Pulp & Paper Technology

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Introduce students to the use of fertilizers to improve soil productivity and crop yield.
- Familiarize students to different organic and inorganic fertilizer production methods.
- To introduce students to the basic pulp and papermaking processes from virgin and recycled raw materials.

Indicative Syllabus:

Fertilizer Technology: Need for fertilizer in crop production, nutrients and their classification, organic and inorganic fertilizers, fundamentals of fertilizer application, raw materials and their availability, fertilizers classification, types and application methods fundamentals of the type and manufacture of nitrogen, phosphorus and potassium fertilizers, the manufacture and properties of mixed fertilizers, numerical exercises in the compounding of fertilizers.

Pulp and Paper Technology: Introduction to basic pulp and paper technology, wood harvesting, wood as a raw material, wood-yard operations, mechanical and Chemical pulping processes, stock preparation paper machine wet end additives, paper machine wet and dry end operations, other paper and paperboard formers and products, surface treatments, finishing operations, paper end uses, process control, properties and testing of pulp and paper, an introduction to quality, mill services, water pollution control and air pollution control.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Understand the basic concepts of fertilizer and its industries.
- Understand the various methods of production and the processes involved in the manufacture of various fertilizers.
- Apply the fundamental Chemical principles of making pulp and paper in the industry.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Austin, G. T. (1984). *Shreve's Chemical process industries*. McGraw-Hill Companies.
2. Wolf, B., Fleming, J., & BatChElor, J. (1985). Fluid fertilizer manual. *Fluid fertilizer manual.*
3. Max Appl. (1999). *Ammonia: principles and industrial practice*. VchVerlagsgesellschaftMbh.
4. Smook, G. A. (2002). *Handbook for pulp & and paper technologists*. Angus Wilde Publ..

ChE 4717: Polymer Science and Technology

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To gain knowledge about polymer science.
- To provide an introductory knowledge about polymer synthesis and its properties.
- To expand technical knowledge of polymer types, degradation and environment.

Indicative Syllabus:

Introduction to polymer science: Classification of polymers, polymer structure, molecular weight.

Polymer Synthesis: Step-growth polymerization, chain growth polymerization, polymerization techniques, polymer reactivity, Chemical structure determination.

Conformation, Solution, and Molecular weight: Polymer conformation and chain dimensions, thermodynamics of polymer solution, measurement of molecular weight.

Solid State Properties: The amorphous state, crystalline state, thermal transitions and properties, mechanical properties, solid state characterization methods.

Viscoelasticity and Rubber Elasticity: Introduction to viscoelasticity and rubber elasticity.

Polymer Degradation and the Environment: Polymer degradation and stability, management of plastics in the environment.

Additives, Blends, Block Copolymers, and Composites: Additives, polymer blends and interpenetrating networks block copolymers, composites, nano-composites.

Types: Biopolymers, natural polymers, and fibers, thermoplastics, elastomers, and thermosets.

Polymer Processing: Basic processing operations, introduction to polymer rheology, analysis of simple flows, rheometry, modeling of polymer processing operations.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Classify polymers, polymer structure and polymer synthesis.
- Relate about various characteristics of polymers.
- Illustrate degradation related problems of the polymer in the environment.
- Learn fundamentals of advanced technology using polymer.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Odian, G. (2004). *Principles of polymerization*. John Wiley & Sons.
2. Cowie, J. M. G., & Arrighi, V. (2007). *Polymers: ChEmistry and physics of modern materials*. CRC press.
3. Billmeyer, F. W., &Billmeyer, F. W. (1984). *Textbook of polymer science* (Vol. 19842, pp. 361-484). New York: Wiley.

ChE 4719: Introduction to Renewable Energy

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To understand basic characteristics of renewable source of energy and technologies for their utilization.
- To give review on utilization trends of renewable sources of energy.
- To provide review on legislative and regulatory rules related to utilization of renewable sources of energy.

Indicative Syllabus:

Introduction: Energy, environment, generation and consumption of energy, emissions of carbon dioxide, renewable sources of energy – review, technologies, and statistics and new technologies.

Solar Energy: Basic properties of solar energy, applications of solar energy, transformation of solar energy, solar heat collectors, solar photovoltaic collectors, application of solar collectors – examples, solar power plant, economics of solar collectors, trends in solar energy utilization.

Wind Energy: Basic properties of wind energy, applications of wind energy, transformation of wind energy, wind turbines, operative characteristics of wind turbines, wind power plant, utilization of wind power – examples, economics of wind turbines, trends in wind energy utilization.

Hydrogen Energy: Basic properties of hydrogen, technologies of hydrogen production, transformation of hydrogen energy – hydrogen economy, fuel cells – operating principle, main parts, properties, applications of hydrogen and fuel cells – examples, economics of hydrogen, trends in hydrogen utilization.

Biomass Energy: types of biomass and their basic properties, transformation of biomass energy, applications of biomass, technologies for utilization of biomass – examples, economics of biomass, Trends in biomass energy utilization, geothermal energy, heat pumps, financial models, legislative framework, administrative procedures.

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Define basic properties of different renewable sources of energy and technologies for their utilization.
- Describe main elements of technical systems designed for utilization of renewable sources of energy.
- Interpret advantages and disadvantages of different renewable sources of energy.
- Undertake simple analysis of energy potential of renewable sources of energy.
- Explain the correlation between different operational parameters.
- Select engineering approach to problem solving when implementing the projects on renewable sources.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Nelson, V. C., &StarChEr, K. L. (2015). *Introduction to renewable energy*. CRC press.
2. Hagen, K. D. (2015). *Introduction to Renewable Energy for Engineers*. Pearson.

ChE 4733: Biochemical Engineering

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- Students will gain knowledge on microorganisms and biomolecules.
- Students will analyze the detailed enzyme catalyzed reactions.
- Students will be familiar with the biological reactors.

Indicative Syllabus:

Microorganisms: Nature of microorganisms, their importance and classification; industrially important microorganisms.

Biomolecules: Amino acids and proteins; Metabolic stoichiometry and energetics; Molecular genetics and control systems.

Kinetics of enzyme catalyzed reactions: Michaelis-Menten equation; Immobilized enzyme technology; Enzyme-linked Immunosorbent Assay; Immobilized enzyme kinetics.

Batch fermentation: Biomass yield and product formation; Rates of reaction; Growth; Limiting substrate concentrations; Monod's equation.

Biological reactors: Design and analysis; Ideal reactors; Reactor dynamics; Reactors with non-ideal mixing; Sterilization reactors; Multiphase bioreactors.

Intended Learning Outcomes (ILO):

After completion of this module, the student will be able to:

- Understand the basic importance and need for biochemical engineering.
- Acquire complete knowledge about enzyme catalyzed reactions.
- Gets knowledge about different types of bioreactors, its industrial applications and scale up criteria.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard, smart board and PowerPoint
- Problem- based group work activities
- Use of chemical engineering case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. James M.Lee- Biochemical Engineering, Prentice Hall, 1992.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn. McGraw Hill International, 1986.
3. Michael L. Shuler and FikretKargi, Bioprocess Engineering, Basic Concepts, 2nd Edn., Prentice Hall of India, New Delhi, 2002.

ChE 4725: Process Modeling and Optimization

Contact hours: 3 hours/week

Course credit: 3.00

Course Objective:

- To enable the students, understand the basic principles of mathematical modeling in chemical process industries
- To inspire the students, implement the learned techniques to develop suitable mathematical models.
- To demonstrate the simulation of chemical processes using modeling techniques.

Indicative Syllabus:

Mathematical models of chemical engineering systems: use of mathematical models, scope, principles of formulation, fundamental laws, continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics

Modeling of systems: Classification of models, modeling of complex system in chemical engineering through lumped parameter models, continuum models, population balance models, stochastic models, Monte Carlo methods, network models, percolation concepts, and fractal analysis of complex geometries.

Illustration of mathematical modeling with suitable chemical processes: Examples and simulation of mathematical models of chemical engineering systems, introduction, isothermal, constant hold up CSTRs, CSTRs with variable hold, ups, two heated tanks, gas phase pressurized CSTR, non, isothermal CSTR, single component vaporizer, multi, component flash drum, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with hold up, pH systems.

Intended learning Outcome (ILO):

On completion of this module, the learner will be able to

- Understand the important physical phenomena from the problem statement
- Formulate a mathematical model equation for the given system
- Demonstrate the model solving ability for various processes/unit operations

Suggested Readings:

1. Bequette, B.W., Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall, 1998.
2. Hangos K.M and Cameron M.T., Process Modeling And Model Analysis, Academic Press, 2001.
3. Chapra S.C. and Canale R.P , Numerical Methods for Engineers, McGraw Hill, 2001.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

4th Year 2nd Semester

SI No.	Course No.	Course Title	Contact hours/week	Credits
1.	ChE 4707	Engineering Economics and Management	4.00	4.00
2.	HSS 4831	Sociology and Industrial law	3.00	3.00
3.	ChE 4711	Transport Phenomena	3.00	3.00
4.	ChE 4712	Transport Phenomena Sessional	1.50	0.75
5.	ChE 4709	Chemical Process Safety	3.00	3.00
6.	ChE 4000	Project/ Thesis	3.00	3.00***
7.	ChE 4700	Process Design Sessional	3.00	1.50***
8.	ChE 4720	Industrial Attachment**		0.75
9.	One elective subject from the following courses*		3.00	3.00
		Total	23.50	22.00

*Elective: (1 course of 3 credit each from the following courses)

1.	MME 4831	Fundamentals of Metallurgy	3.00	3.00
2.	TE 4831	Textile Engineering and Technology	3.00	3.00
3.	ChE 4727	Refinery Engineering	3.00	3.00
4.	ChE 4729	Sustainable Development in Chemical Engineering	3.00	3.00
5.	ChE 4731	Water and Waste Management in Industries	3.00	3.00

** A 4-week industrial training programme will be performed by all students in chemical industries to be aware about chemical processes and machineries.

***indicates continuation of the same course from the previous semester

Contact Hours : 23.50 per week
Total Credit : 22.00
No. of Theory Course : 5
No. of Sessional Course: 4

ChE 4707: Engineering Economics and Management

Credit hours: 4 hours/week

Course Credit: 4.00

Course Objectives:

- To enable the students, understand engineering economics and its theories
- To prepare the students for evaluation of alternative projects with feasibility study.
- To provide the students basic knowledge about managerial activities and organizational hierarchy.

Indicative Syllabus:

Investment cost and interest calculation: Types of interest; Present worth and discount; Annuities, perpetuities and capitalized costs; Concept of equivalence.

Applications of money-time relationships: Determining MARR; PW, FW, AW, IRR, ERR and Payout Period for investment projects. Comparing alternatives: The study period; Alternatives having useful lives equal and different to the study period; Capitalized worth method; Mutually exclusive combinations of projects.

Dealing with risk and uncertainty: Sources of uncertainty; breakeven analysis; Sensitivity graphs; Estimating O-M-P; Risk adjusted MARR and reduction of useful life.

Evaluating projects with B/C ratio method: Differences between private and public projects; Self-liquidating and multipurpose projects; Difficulties in evaluating public sector projects; Interest rate for public projects; Evaluating independent projects and mutually exclusive alternatives by B/C ratios. Value chain concept. Elements of input-output analysis. Cost of Capital. Taxes and Insurance.

History of origin and development of management.

Basic concepts: Meaning of management; Elements of management; Functions of a good manager; Organization for management
Decision Making: Decision making process, Committee, Role of creativity, Planning, Elements and characteristics of a plan.
Communication: Lateral and vertical communication, Communication patterns, Decentralization, Bureaucracy, Controlling
Organizing and staffing: Functional organization, Staff authority, Organogram, Delegation, Organizational SWOT (strength, weakness, opportunity and threats) analysis
Quantitative Methods in Decision Making: Network analysis, Critical path analysis (CPM), PERT.
Managing Information: Information and data, Technological management, S-curve framework, Technology life cycle in international trade.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to

- understand basic concepts of economics, productivity theories, input-output analysis etc.
- evaluate engineering projects using various techniques
- understand organizational hierarchy and roles of employees
- manage time of work in a project using CPM and PERT methods.

Learning and Teaching Methods:

Statements about the various types of learning and teaching methods that are used in the delivery of lecture modules. Teaching equipment and methods may be of the following:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities
- Use of case studies
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Reading:

1. Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2009). *Engineering economy*. Prentice Hall.
2. Couper, J. R. (2003). *Process engineering economics*. CRC Press.
3. Peters, M. S., Timmerhaus, K. D., West, R. E., Timmerhaus, K., & West, R. (1968). *Plant design and economics for Chemical engineers* (Vol. 4). New York: McGraw-Hill.
4. Massie, J. L., & Hepworth, K. (1987). *Essentials of management*. Englewood Cliffs, NJ: Prentice-Hall.
5. Hill, B. (2014). *An introduction to economics: Concepts for students of agriculture and the rural sector*. CABI.
6. Ritson, C. (1977). Agricultural economics. Principles and policy.

HSS 4831: Sociology and Industrial Law

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objective: The overall objective of this course is

- To learn sociology and industrial law issues and understand them.
- To earn sociological knowledge to work within the society.
- To understand people and laws that drive the industry.

Indicative Syllabus:

Definition; Basic concepts, Scope & its importance from Engineering point of view. Family; Society; Groups; Association; State;Government; Nation; Nationality; Community, Culture & Civilization.Oriental & occidental societies; Population & world resources; Contribution of biology; Geography; Group life & culture to develop-personality; Living habits; Working habits in Bangladesh. Social evaluation; Techniques of production and transportation in Bangladesh. Social systems;Social Problems; Technology and social changes of Bangladesh. Principles of law of contract; Agency; Partnership; Sales of goods.General principles of company law relating to formation; Management and winding up.Industrial law in Bangladesh-various legislation affecting labor Factories Act. Industrial relations ordinance; Payment of wages;Legislation regarding employment in Industries, Factories; Shops; Transport and agriculture. Trade Union Act, Workmen';s compensation Act, Arbitration & Conciliation; The Industrial court. The Policy of the state in relation to labor; ILO and other international bodies affecting labor welfare.The law of social insurance; Legislation for the control of industries.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to

- Understand the basic concept of sociology & laws regarding engineering and industrial view.
- Analyze the different social and legal issues, behavior and its activities with impact for engineers.
- Apply to acquire knowledge in social systems and industrial legal and standard practice.
- Evaluate techniques of existence systems to develop the humanistic society and legal justification of industrial activities.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

TEXTBOOKS

1. Heather Griffiths, Introduction to Sociology, Openstax College (Saylor Academy)

2. M C Kuchhal & Vivek Kuchhal, Business and Industrial Laws, Vikas

Publishing

REFERENCE BOOKS

1. An Introduction to Sociology, American Sociological Association

2. Dr. Joanna Hadjicostandi, Introduction to Sociology

3. Company Act 1994, Bangladesh

4. Factory Act 1965, Bangladesh

5. Wages Act 1923, Bangladesh

ChE 4711: Transport Phenomena

Credit hours: 3 hours/week

Course Credit: 3.00

Course Objective:

- To train the student to create Chemical engineering knowledge using transport phenomena

- To enable the students, develop problem solving skills with focus on combined transport processes
- To inform the students of the analogies among various transport processes

Indicative Syllabus:

Unified approach to the study of fluid dynamics, heat transfer and mass transfer.

Momentum transport: Viscosity and momentum flux; Shell momentum balances; Velocity distribution in laminar & turbulent flows and with more than one independent variable; Equations of change for isothermal systems.

Heat transport: Thermal conductivity and heat flux; Shell energy balances; Temperature distributions in solids, in laminar flow and with more than one independent variable; Equations of change for non-isothermal systems.

Mass transport: Diffusivity and mass flux; Shell mass balances; Concentration distributions for multi-component systems in solids and laminar flow; Equations of continuity for multi-component systems.

Analogy equations relating momentum, energy and mass transfer.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to

- identify transport properties and analyze the mechanisms of various transports.
- formulate the different forms of the equation of change.
- compare among the transport processes through the knowledge of analogies.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Bird, R. B., Stewart, W. E., & Lightfoot, E. N. (2006). *Transport phenomena* (Vol. 1). John Wiley & Sons.
2. G. Kirczenow, J. Marro (1974): Transport Phenomena
3. Belfiore, L. A. (2003). *Transport phenomena for Chemical reactor design*. John Wiley & Sons.

ChE 4712: Transport Phenomena Sessional

Contact hours: 3/2 hours/week

Course credit: 0.75

Course Objective:

- To develop structured problem-solving skills with emphasis on fluid flow pattern observed in industries
- To enable the students carry out measurements of properties and understand their significance
- To enable the students to carry out experiments in sophisticated equipment.

Indicative Syllabus:

- Analysis of free and forced convection heat transfer
- Study of viscosity of different mediums at different temperatures.
- Experimental Investigation of axial and radial heat transfer
- Study of radiation heat transfer

*Any relevant experiment related to the corresponding theory

Intended Learning Outcome (ILO):

After completion of this course, the students will be able to

- understand transport phenomena practically with small scale operation.
- gain knowledge about complex engineering technology with computational methods.
- carry out measurement of fluid properties.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Quizzes	40%
Viva voce	30%
Performance/Report	20%
Total	100%

Suggested Readings:

1. Phenomena, T. (2002). R. Byron Bird, Warren E. Stewart & Edwin N. Lightfoot.
2. G. Kirczenow, J. Marro (1974): Transport Phenomena
3. Belfiore, L. A. (2003). *Transport phenomena for Chemical reactor design*. John Wiley & Sons.

ChE 4709: Chemical Process Safety

Contact hours: 3 hours/week

Course Credit: 3.00

Course Objectives:

- To inform the students of various safety laws and regulations and importance of maintaining those.
- To provide basic knowledge of machineries used in chemical processes to ensure safety
- To inform the students of major accidents in history and provide information to analyze their causes, effects and steps taken following those accidents.

Indicative Syllabus:

Introduction: Safety programs, Engineering ethics, Inherent safety

Toxicology: Effects of toxics on biological organisms, Dose vs. response, Threshold limit values.

Industrial hygiene: Government regulations, OSHA, EPA, Industrial hygiene identification, evaluation and control.

Fires and explosion: The fire triangle, Flammability characteristics of liquids and vapors, Ignition energy, Auto-oxidation, Explosions, Designs to prevent fire and explosions.

Relief systems: Concepts and types, Relief locations, Sizing of reliefs

Hazard and risk assessment: Hazard and operability studies, Event trees, Fault trees, QRA and LOPA.

Accidental investigation: Learning from accidents, Layered investigations, Aids for diagnosis, Aids for recommendations

Intended Learning Outcomes (ILO):

After completion of this course, the students will be able to:

- Perform hazard assessment and complete HAZOP table.
- Investigate an incident that has resulted or could have resulted in an accident.
- Understand applicability of various materials and equipment in a given process through case studies.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

Suggested Readings:

1. Crowl, D. A., & Louvar, J. F. (2001). *Chemical process safety: fundamentals with applications*. Pearson Education.
2. Flynn, A. M., & Theodore, L. (2001). *Health, Safety, and Accident Management in the Chemical Process Industries: A Complete Compressed Domain Approach*. CRC Press.
3. Sanders, R. E. (2015). *Chemical process safety: learning from case histories*. Butterworth-Heinemann.

ChE 4000: Project/ Thesis

Course credit: 3.00***

Course Objectives:

- To help the students understand research work and associated necessary steps such as writing a well-thought research proposal, conducting experimental work etc.
- To make the students understand how to design a research work and analyze derived data.

Continuation from 4th year 1st semester

Intended Learning Outcomes (ILO):

The students will be able to learn how to

- Write a research proposal
- Design a research work
- Write a project report
- Give a presentation.

Assessment Methods:	**Weighting (%)**
Viva Voce (A committee of minimum 3-members will be constituted by the Examination Committee for viva voce)	30%
Supervisor (Internal Examiner) *(Assessment based on the works done during this semester and presentation)*	50%
External Examiner (any other teacher of the department/examination committee) *(based on slide show presentation and evaluation of report)*	20%
Total	**100%**

ChE 4700: Process Design Sessional

Course credit: 1.50***

Course Objectives:

- To acquaint students with a broad framework of design.
- To select and design Chemical processing equipment based upon design heuristics, guidelines or rules of thumb.
- To apply Chemical engineering principles to design Chemical processes.

Indicative Syllabus:

Integrated design of a Chemical plant based on related design considerations and cost estimation. (A student will work for 3 hours per week in both the 4th year 1st semester and 4th year 2nd semester for the completion of the course.

Continuation from 4th year 1st semester

Intended Learning Outcomes (ILO):

After completion of this course, the student will be able to:

- Assemble a logical sequence of interconnected unit operations for an effective Chemical engineering process.
- Determine sizes, materials, and capital and operating costs of equipment commonly used in the Chemical processing industries.
- Recognize professional situations requiring ethical decisions.
- Work in an industrial-type based team environment.

Learning and Teaching Methods:

Various types of teaching and learning methods and tools that are used in the delivery of lecture module are given below:

- Whiteboard and PowerPoint through multimedia projector
- Problem- based group work activities, brainstorming, presentation
- Use of case studies, assignments
- Virtual learning environment supported by internet including discussion boards

Assessment Methods:	**Weighting (%)**
Viva Voce (A committee of minimum 3-members will be constituted by the Examination Committee for viva voce)	30%
Supervisor (Internal Examiner) *(Assessment based on the works done during this semester and presentation)*	50%
External Examiner (any other teacher of the department/examination committee) *(based on slide show presentation and evaluation of report)*	20%
Total	**100%**

Suggested Reading:

1. Sinnott, R., & Towler, G. (2019). Chemical engineering design: SI Edition. Butterworth-Heinemann.
2. Peters, M. S., & Timmerhaus, K. D. (1980). Plant design and economics for Chemical engineers.
3. Turton, R., Bailie, R. C., Whiting, W. B., & Shaeiwitz, J. A. (2008). Analysis, synthesis and design of Chemical processes. Pearson Education.
4. Couper, J. R., Penney, W. R., & Fair, J. R. (2009). Chemical Process Equipment-Selection and Design (Revised 2nd Edition). Gulf Professional Publishing.

ChE 4720: Industrial Attachment

Course Credit: 0.75

Course Objectives:

- To enable students gain practical knowledge on different areas of Chemical processes in industrial level
- To impart knowledge on quality assurance, transportation, handling, distribution etc.

The students undertake practical training in different chemical industries for a period of 4 weeks in Chemical process industries and learn about their units, raw materials, production quantity and quality, preservation, packaging, operation and maintenance of machineries and management aspects of the concerned Chemical industries.

The students are required to submit reports to the seminar after completion of the training in the industries based on the above-mentioned areas.

Intended Learning Outcomes (ILO):

On Completion of this module, the learner will be able to

- gain practical knowledge of Chemical processes in industrial level
- enrich their knowledge on quality assurance, transportation, handling, distribution etc.

Assessment Methods:	**Weighting (%)**
External evaluation (based on feedback from industrial personnel)	40%
Internal evaluation (based on viva and presentation)	40%
Performance/Report	20%
Total	**100%**

Elective Courses (3 Credits)

MME 4831: Fundamentals of Metallurgy

Contact hours: 3 hours/week

Course credit: 3.00

Course Objectives:

- To enable the students comprehend metallurgical processes and history
- To analyze material properties and phase changes
- Gain in-depth knowledge of various metals and alloys, their applications

Indicative syllabus:

History of the development of Metallurgy. Production of pig iron and steel. Extraction of copper and aluminum. Mechanical and Physical Properties of Metals. Crystalline Structure of Metals. Metallography. Phase diagram of the Fe- C system. Heat treatment of steel. Metal and metallic alloys such as cast iron, plain carbon steels, low alloy steels, stainless steels, copper and copper alloys, aluminum, lead, nickel alloys, titanium and titanium alloys. Numerical designation of alloy steels. High temperature alloys. Metal Forming, non – destructive testing.

Intended Learning Outcomes (ILO):

On completion of this module, the learner will be able to

- demonstrate a historical understanding of metallurgy
- analyze and predict the mechanical properties, crystalline structures, phase transformations
- differentiate between various metals and alloys, explain their respective applications

Suggested Readings:

1. James M.Lee- Biochemical Engineering, Prentice Hall, 1992.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn. McGraw Hill International, 1986.
3. Michael L. Shuler and FikretKargi, Bioprocess Engineering, Basic Concepts, 2nd Edn., Prentice Hall of India, New Delhi, 2002.

Assessment Methods:	Weighting (%)
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

TE 4831: Textile Engineering and Technology

Contact hours: 3 hours/week

Course credit: 3.00

Course Objective:

- To enable the students, understand the basic principles of mathematical modeling in chemical process industries
- To inspire the students, implement the learned techniques to develop suitable mathematical models.
- To demonstrate the simulation of chemical processes using modeling techniques.

Indicative Syllabus:

Textile raw materials: Selection of fibrous materials; Yarn manufacturing technology; Types, characteristics and selection of dyes; Pigments and their classifications; Color and its different theories. Fabric structure, design and manufacturing technology.

Textile wet processing: Pre-dyeing, dyeing & post-dyeing stages, washing, and printing. Textile testing and quality control.

Environmental management: Pollution Control in Textile Industry; Caustic recovery; Cleaner production options.

Intended learning Outcome (ILO):

On completion of this module, the learner will be able to

- gain knowledge on laws and regulation associated with textile industry
- Understand the various manufacturing processes in the textile industry with real examples.
- Have the preliminary idea of designing a textile plant maintaining complacency with the rules.

Suggested Readings:

1. Bequette, B.W., Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall, 1998.
2. Hangos K.M and Cameron M.T., Process Modeling And Model Analysis, Academic Press, 2001.
3. Chapra S.C. and Canale R.P , Numerical Methods for Engineers, McGraw Hill, 2001.

Assessment Methods:	Weighting (%)

Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

ChE 4727: Refinery Engineering

Contact hours: 3 hours/week

Course credit: 3.00

Course Objective:

- To enable the students, understand the basic principles of the crude oil distillation process.
- To inform the students about different characterization properties of petroleum
- To discuss the function of the fractionation column and further treatment into usable fractions in detail.

Indicative Syllabus:

Petroleum Refining Overview: Crude oil, Feed and product characterization

Important Characterization Properties: API gravity, Sulfur content, ASTM distillation curves, Viscosity, Pour point, Aniline point, Crude Chemistry.

Refining Process: Refinery process block and flow diagram, Desulphurization, Crude distillation unit, Thermal cracker, Hydrotreater, Catalytic cracker, Alkylation and isomerization, Blending pools

Crude distillation: Crude desalter, Furnace, Primary and Secondary distillation column, Heat exchanger networks.

Cracking: Cracking Chemistry, Operating conditions and catalysts, Process technology, Naphtha stabilization, Thermal and catalytic cracking, Catalytic regenerator.

Reforming and Isomerization: Chemistry, Operating conditions, Catalysts, Hydro processing, Hydrocracking, Hydrotreating,

Other Reactions in Gas Processing: Alkylation, HF process technology, Visbreaking and coking, Polymerization

Refinery Supporting Processes: Hydrogen production, Claus Sulphur recovery,

Intended learning Outcome (ILO):

On completion of this module, the learner will

- have introductory information about petroleum and refinery
- be able to recognize the mechanism of distillation process
- understand further treatment processes of petroleum oil and their necessity

Suggested Readings:

1. Chang, A. F., Pashikanti, K., & Liu, Y. A. (2013). *Refinery engineering: Integrated process modeling and optimization*. John Wiley & Sons.
2. Nelson, W. L. (2018). *Petroleum refinery engineering*. McGraw-Hill.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

ChE 4729: Sustainable Development in Chemical Engineering

Contact hours: 3 hours/week

Course credit: 3.00

Course Objective:

- To provide information about the advancement in the Chemical engineering sector.
- To introduce the students with innovative technologies and their sustainability.
- To enable the students, develop a practical understanding of newer technologies with the help of case studies

Indicative Syllabus:

Sustainable Development Strategies: Renewable energies, Process intensification, Soil and water remediation.

Strategies for Increasing Electrical Energy: Penetration of renewable energies into the electricity market, Innovative solar technology, Combined production of hydrogen and electricity, Plant configurations and mathematical models, Case study

Process Intensification: Introduction and definition, PI in Chemical industry, PI in petrochemical industry, Membrane reactors, Future trends

Production of Bio-based Fuels: Production of bioethanol and biodiesel, Renewable diesels from biomass.

Biochemical Advancement: Bioplastic production and environmental impact, Biosurfactants production, recovery and application fields, Bioremediation of water, Membrane separation in bioremediation, enzyme technology and application, biosensor.

Eco-compatible Practices: Effective remediation of contaminated solids by biological, physicochemical and Chemical methods.

Nanoparticle Technology: Silica, Magnetic and Titania Nanoparticle, Future prospects

Intended learning Outcome (ILO):

On completion of this module, the learner will

- have introductory information about sustainable development
- know about recent advancement in Chemical technology
- be able to evaluate the efficiencies of these newer technologies in treatment processes.

Suggested Readings:

1. Piemonte, V., De Falco, M., & Basile, A. (Eds.). (2013). *Sustainable development in Chemical engineering: Innovative technologies*. ChiChEster: Wiley.
2. Engels, H. W., Pirkl, H. G., Albers, R., Albach, R. W., Krause, J., Hoffmann, A., ... & Dormish, J. (2013). Polyurethanes: versatile materials and sustainable problem solvers for today's challenges. *Angewandte ChEmie International Edition*, *52*(36), 9422-9441.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**

ChE 4731: Water and Waste Management in Chemical Industries

Contact hours: 3 hours/week

Course credit: 3.00

Course Objective:

- To enable the students understand pollutions and pollution control techniques

- To provide knowledge of waste management using examples of pharmaceutical and textile industry
- To inform the students about proper treatment of wastes keeping EIA in mind.

Indicative Syllabus:

Wastewater Treatment Fundamentals: Water quality standards, Wastewater characterization,Major treatment methods,

Treatment Techniques: Primary, Secondary and advanced techniques, Physical, Chemical and biological technique,Screening, neutralization, Equalization, Aeration, Coagulation and flocculation, Activated sludge, MBBR and FBBR, Sand filter, activated carbon adsorption, RO, Ultra filtration process, Sedimentation.

Effluent Treatment Plant (ETP): Selection of ETP, Existing ETP in pharmaceutical and textile plant, Performance analysis of ETP, Optimization of ETP, Flow segregation, Alternative production option.

Solid Waste Disposal: Land disposal, Landfill, Incineration, Solidification and stabilization.

Environmental Impact Assessment: Aims and objectives, Key principles, Benefits, Generalization of EIA, Case studies.

Gas Treatment Methods: Gravity settlers, Cyclones, Bag house filters, Electrostatic precipitators, Scrubbers

Air Pollution Control: Fertilizer Industry, Cement Industry, Pulp and paper industry, Refinery industry, Power plant and steel industry.

Intended Learning Outcome (ILO):

On completion of this module, the learner will be able to

- analyze the sources of waste generated from various industries
- learn the measurement techniques of various pollutants
- apply control technologies for pollution management

Suggested Readings:

1. Woodard, F. (2001). *Industrial waste treatment handbook*. Elsevier.
2. Metcalf, W. (2003). Metcalf and Eddy wastewater engineering: treatment and reuse. In *Wastewater engineering: treatment and reuse*. McGraw Hill, New York, NY.
3. David, C. C., & Alley, F. C. (2011). Air Pollution Control a Design Approach.
4. De Nevers, N. (2010). *Air pollution control engineering*. Waveland press.

Assessment Methods:	**Weighting (%)**
Class participation and attendance	10%
Class tests/Spot tests (3 out of 4)	20%
Examination at the end of semester	70%
Total	**100%**