Curriculum

The following description is followed.

C - Core Modules
E - Elective Modules
O - Optional Modules

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/weeks	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 1										
MA1013	Mathematics	C	3.0	1/1	3.0	-	15.0	1.0	20	80
CS1032	Programming Fundamentals	C	2.0	3/1	3.0	-			20	80
ME1032	Mechanics	C	2.0	3/4	2.0	-			20	80
MT1022	Properties of Materials	C	2.0	3/4	2.0	-			20	80
CE1022	Fluid Mechanics	C	2.0	3/4	2.0	-			20	80
EE1012	Electrical Engineering	C	2.0	3/4	2.0	-			20	80
EL1012	Language Skill Enhancement I	C	-	3/1	1.0	-			20	80
MN1012	Engineering in Context	C	1.0	-	-	1.0			30	70
Total for Semester 1							**15.0**	**1.0**		
Semester 2										
CH1070	Chemistry for Engineers	C	2.0	3/2	2.5		19.5	-	30	70
CH1060	Process Engineering Fundamentals	C	2.0	3/1	3.0				40	60
CH1050	Fundamentals of Engineering Thermodynamics	C	2.0	3/2	2.5				30	70
MT2802	Material Science	C	2.0	3/2	2.5				30	70
ME1090	Engineering Drawing & Computer Aided Modelling	C	2.0	3/1	3.0				100	-
MA1023	Methods of Mathematics	C	3.0	1/1	3.0				30	70
EN1802	Basic Electronics	C	2.0	3/4	2.0				30	70
EL1022	Language Skill Enhancement II	C	-	3/1	1.0				30	70
DE2xxx	Humanities Elective I	E	-	-	2.0		2.0	-		
MN1030	Entrepreneurship Skill Development (continuing)	O	0.5	3/2	-	1.0	-	1.0	70	30
Total for Semester 2							**21.5**			

**Total of 2 credits to be taken from optional modules in any semester*

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/weeks	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 3										
CH2100	Fluid Dynamics	C	2.5	3/1	3.5		18.5		40	60
CH2090	Chemical Kinetics and Thermodynamics	C	3.0	3/2	3.5				30	70
CH2120	Biological Science Fundamentals	C	2.0	3/2	2.5				30	70
CH2130	Polymer Science and Technology	C	2.0	3/2	2.5				30	70
CH2140	Environmental Science and Technology	C	2.0	3/2	2.5				30	70
MA2013	Differential Equations	C	2.0	-	2.0				30	70
MA2023	Calculus	C	2.0	-	2.0				30	70
MN1030	Entrepreneurship Skill Development (continuing from S2)	O	0.5	3/2	-	1.0	-	1.0	70	30
Total for Semester 3					18.5		**18.5**			
Semester 4										
CH2024	Unit Operations I	C	3.0	3/1	4.0		19.0		40	60
CH2150	Particle Technology	C	3.0	3/2	3.5				40	60
CH2014	Heat and Mass Transfer	C	3.0	3/1	4.0				40	60
CH2110	Fuel Science and Combustion Technology	C	3.0	3/2	3.5				40	60
MA2033	Linear Algebra	C	2.0	-	2.0				30	70
MA3023	Numerical Methods	C	2.0	-	2.0				30	70
DE2XXX	Humanities Elective II	E	-	-	2.0		2.0			
MN 2010	Entrepreneurial Leadership	O	1.5	3/2	2.0				50	50
Total for Semester 4							**21.0**	**0.0**		

**Total of 2 credits to be taken from optional modules in any semester*

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/weeks	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 5										
CH3143	Reactor Engineering	C	3.0	3/2	3.5		19.0		40	60
CH3060	Plant and Equipment Design I	C	4.0	3/2	4.5				40	60
CH3054	Energy Efficiency and Conservation	C	2.0	3/2	2.5				40	60
CH3044	Plant Safety and Loss Prevention	C	2.0	3/2	2.5				40	60
MN3052	Industrial Management & Marketing	C	2.5	3/2	3.0				30	70
MN3042	Business Economics & Financial Accounting	C	3.0	-	3.0				30	70
MA3013	Applied Statistics	O	2.0	-	2.0				30	70
MN3010	Multidisciplinary Design, Innovation and Venture Creation	O	1.5	3/2	2.0				50	50
Total for Semester 5							**19.0**	**0.0**		
Industrial Training										
CH3993	Industrial Training	C	-	-		6.0		6.0		
Total for Industrial Training								**6.0**		
Semester 6										
CH3070	Plant and Equipment Design II	C	1	3/1	2.0		5.0		40	60
CH3080	Computer Aided Chemical Engineering	C	1	6/1	3.0				100	
CH3950	Technical Report Writing and Presentation Skills	C	1	6/1		3.0		5.0	100	
CH3900	Research Methodology	C	1	3/1		2.0			100	
Total for Semester 6							**5.0**	**5.0**		

**Total of 2 credits to be taken from optional modules in any semester*

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/weeks	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 7										
CH4015	Comprehensive Design Project I	C	1.0	6/1	3.0		17.0		100	
CH4025	Process Modelling & Simulation	C	1.5	3/1	2.5				40	60
CH4050	Unit Operations II	C	3.0	3/2	3.5				40	60
MN4022	Engineering Economics	C	2.0	-	2.0				30	70
CH4214	Environmental Engineering and Management	E	3.0	3/1	4.0		4.0		40	60
CH4224	Food and Bio Processing	E	3.0	3/1	4.0				40	60
CH4234	Polymer Processing Operations	E	3.0	3/1	4.0				40	60
ER4810	Petroleum Geology	E	1.5	3/2	2.0				30	70
CH4350	Upstream Processing of Crude Petroleum	E	1.5	3/2	2.0				30	70
CH4330	Process Design and Integration	E	1.5	3/2	4.0				40	60
CH4730	Research Project** (continued in S8)	O	-	6/1	-				-	-
MN4062	Organization Behaviour & Management	O	2.0	-	2.0				30	70
MA4023	Operational Research	O	3.0	-	3.0				30	70
MN4030	Strategic Enterprise Management	O	1.5	3/2	2.0				40	60
MN3020	Entrepreneurship Business Basics	O	2.0	3/1	3.0				50	50
MN 4150	Project Management	O	2.0	-	2.0				50	50
Total for Semester 7							**18.0**	**0.0**		

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 8										
CH4034	Comprehensive Design Project II	C	1.0	12/1	5.0		9.0		100	
CH4044	Process Dynamics and Control	C	3.0	3/1	4.0				40	60
MN4900	Professional Ethics	C	1.0	-		1.0		1.0	100	0
CH4244	Clean Technology	E	3.0	3/1	4.0		8.0		40	60
CH4254	Renewable Energy Engineering	E	3.0	3/1	4.0				40	60
CH4264	Polymer Engineering and Mould Design	E	3.0	3/1	4.0				40	60
CH4274	Design of Polymer Products	E	3.0	3/1	4.0				40	60
CH4284	Food Engineering and Hygienic Plant Design	E	3.0	3/1	4.0				40	60
CH4390	Biochemical Engineering	E	3.0	3/1	4.0				40	60
CH4340	Natural Resource Process Engineering	E	3.0	3/1	4.0				40	60
CH4360	Downstream Processing of Oil, Gas & Petrochemicals	E	3.0	3/1	4.0				30	70
CH4370	Petroleum Process Operations, Economics, and Law	E	3.0	3/1	4.0				30	70
CH4730	Research Project** (continuing from S7)	O	-	6/1	2.0				100	-
MN4122	Human Resource Management and Industrial Relations	O	2.0	-	2.0				30	70
MN4042	Technology Management	O	2.0	-	2.0				30	70
MN4112	Production and Operations Management	O	2.0	-	2.0				30	70
MN4072	Small Business Management & Entrepreneurship	O	2.0	-	2.0				30	70
MN4170	Global Entrepreneurship	O	1.5	3/2	2.0				40	60
MN4010	Business Plan Development	O	1.5	3/2	2.0				70	30
MA4013	Linear Models and Multivariate Statistics	O	3.0	-	3.0				30	70
MN4800	Supply Chain Management	O	2.0	-	2.0				40	60
Total for Semester 8						0.0	**17.0**	**1.0**		
To be taken from Optional Modules (Any Semester)							**2.0**			
Minimum Requirement for Graduation (Total of 150 credits)							**135.0**	**13.0**		

Requirements for Focus Areas

Focus Area	Subject Code	Name	Credits
Energy and Environmental Engineering	CH4214	Environmental Engineering and Management	4
	CH4244	Clean Technology	4
	CH4254	Renewable Energy Engineering	4
Food and Biochemical Engineering	CH4224	Food and Bio Processing	4
	CH4284	Food Engineering and Hygienic Plant Design	4
	CH4390	Biochemical Engineering	4
Polymer Engineering	CH4234	Polymer Processing Operations	4
	CH4264	Polymer Engineering and Mould Design	4
	CH4274	Design of Polymer Products	4
Petroleum Engineering	ER4810	Petroleum Geology	2
	CH4350	Upstream Processing of Crude Petroleum	2
	CH4360	Downstream Processing of Oil, Gas & Petrochemicals	4
	CH4370	Petroleum Process Operations, Economics, and Law	4

Requirements for Entrepreneurship Minor

Students following the Chemical and Process Engineering program can obtain a minor in entrepreneurship by fulfilling following subject requirements.

Module Code	Module Name	Category	Lectures hrs./week	Lab/ Assignments hrs./weeks	Credits		Norm		Evaluation (%)	
					GPA	NGPA	GPA	NGPA	CA%	WE%
MN1030	Entrepreneurship Skill Development	C	1.0	3/1		2.0		2.0	70	30
MN2010	Entrepreneurial Leadership	C	1.5	3/2	2.0		2.0		50	50
MN3010	Multidisciplinary Design, Innovation and Venture creation	C	1.5	3/2	2.0		2.0		50	50
MN3020	Entrepreneurship Business Basics	C	2.0	3/1	3.0		3.0		50	50
MN4010	Business Plan Development	C	1.5	3/2	2.0		2.0		70	30
MN4022	Engineering economics	E	2.0	-	2.0				30	70
MN4030	Strategic Enterprise Management	E	1.5	3/2	2.0		2.0		40	60
MN4042	Technology Management	E	2.0	-	2.0				30	70
MN4112	Production and Operations Management	E	2.0	-	2.0				30	70
MN4170	Global Entrepreneurship	E	1.5	3/2	2.0				40	60

Modules Offered to Other Fields of Specialization

Module Code	Module Name	Category	Lectures hrs./week	Lab/ Assignments hrs./weeks	Credits		Evaluation (%)	
					GPA	NGPA	CA%	WE%
Semester 4								
CH2803	Process Engineering	E	1.5	3/2	2.0		30	70
Semester 8								
CH4350	Petroleum Refining and Petrochemical Industry	E	1.5	3/2	2.0		30	70

Modules

Semester II

<table>
<tr><td>Module Code</td><td>CH1070</td><td>Module Title</td><td colspan="4">Chemistry for Engineers</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Identify fundamentals of chemistry including atomic structure, chemical bonding and chemical & physical properties of substance
• LO2 - Describe principles of electrochemistry to evaluate the interaction between electrical energy and chemical charge
• LO3 - Describe concepts of organic chemistry to identify different organic reaction mechanisms
• Describe principles of natural product chemistry for manufacturing key industrial chemicals
• LO4 -Apply analytical chemistry knowledge in chemical compounds' quantitative analysis
• LO5 - Identify properties of solutions and calculate the solubility product constant
• LO6 - Apply fundamentals of chemical equilibria for predicting the spontaneity of reactions</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Atomic Structure and Chemical bonding: Atomic structure, Chemical Structure, Shapes of molecules
• Properties of Solids and Liquids: Intermolecular and intra-molecular interactions, Physical Properties
• Properties of Gases: Gas laws, Ideal gas equations, Gas mixtures and partial pressures, Kinetic molecular theory, Molecular effusion and diffusion, Real gases
• Phase Equilibria: Definitions of phase, Component and degrees of freedom, Phase rule and its Derivations, Definition of phase diagram, Phase equilibria for one component system Liquid vapor equilibrium for two component systems, Three component systems
• Properties of Solutions: Factors affecting solubility, solubility constant
• Chemical Equilibria: Criteria of thermodynamic equilibrium, Exoergic and endoergic reactions, Equilibrium constants and their quantitative dependence on temperature, Pressure and concentration, Free energy of mixing and spontaneity, Relations of various equilibrium constants
• Acid base Equilibria: Strengths of acids and bases, Ionization of weak acids and bases, Ionization constants, Ionic product of water
• Electrochemistry: Quantitative aspects of Faraday's laws of electrolysis, Rules of oxidation/reduction of ions based on half-cell potentials, Chemical cells, Nernst equation; Standard electrode potential
• Applied Organic Chemistry and Reaction Mechanisms: Organic Compounds, Types of organic reactions and their mechanisms, The use of organic reaction mechanisms in industrial applications
• Analytical Chemistry: Quantitative and qualitative analysis, Sampling, Sample preparation and choice of analytical method, Chromatographic techniques; GC, HPLC, Spectrometric methods; IR, UV/visible
• Natural Products and Industrial Applications: Classification of natural products on the basis of chemical structure and their applications</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH1060</td><td>Module Title</td><td colspan="4">Process Engineering Fundamentals</td></tr>
<tr><td>Credits</td><td>3.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Select unit operations necessary for a given process
• LO2 - Identify resources required for a process based on internal and external constraints
• LO3 - Select the best solving method of material balance for a given subsystem
• LO4 - Estimate resource requirements and process parameters using material and energy balance
• LO5 - Explain the importance of the steps associated with the process scaling up applying to the chemical and process industry
• LO6 - Choose the appropriate utility type for a given process.
• LO7 - Develop a process flow sheet</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Process Engineering
• Natural resources: Sources of materials; materials from geosphere, hydrosphere atmosphere and biosphere; Sources of energy- renewable and nonrenewable
• Process Development: Concept of process development, design constraints, steps involved in process design
• Unit Operations: Definitions and applications of different unit operations
• Flow sheeting: types of diagrams, instrument identification
• Material Balance: Balances for non-reacting systems and reacting systems with single and multiple reactions
• Energy Balance: Balances for non-reacting systems and reacting systems with single and multiple reactions
• Utilities and instrumentation: Steam production and distribution, types of boilers and steam traps, cooling water and tower, air compressors, positive displacement and dynamic pumps, types of valves, pipes and piping</td></tr>
</table>

Module Code	CH1050	Module Title	Fundamentals of Engineering Thermodynamics			
Credits	2.5	Hours/Week	Lectures	2.0	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 - Describe first and second laws of Thermodynamics
- LO2 - Recognize connections between thermodynamics tools and process engineering
- LO3 - Explain the concept of thermodynamic process and describe the different types of processes
- LO4 - Estimate heat and work quantities and thermal efficiency and the difference between various forms of energy
- LO5 - Evaluate and distinguish thermal energy conversion in engineering cycles and devices
- LO6 - Apply thermodynamics for energy balance and designing of processes

Outline Syllabus

- **Introduction to Engineering Thermodynamics**: The anatomy of thermodynamics, Thermodynamic equilibrium and equilibrium state, Reversible processes
- **The First Law of Thermodynamics**: Internal energy, Enthalpy, Heat capacity, Application of first law for open systems
- **Behavior of Fluids**: PVT behavior of fluids, Ideal gas, Compressibility factor
- **The Second Law of Thermodynamics**: Heat engines and Carnot cycle, Ideal gas Carnot cycle, Absolute temperature scale, Entropy function, Entropy and spontaneity of natural processes, Entropy change, Introduction to open systems, Applications of second law, The third law of thermodynamics
- **The Thermodynamic Network:** Free energy functions, Clausius inequality and the fundamental equation, Thermodynamic network, Measurable quantities, Calculation of Enthalpy (H) and Entropy (S) as functions of P and T
- **Heat Effects**: Computational path, Heat effect due to change of Temperature and Pressure, Heat effect due to change of Phase, Mixing heat effect, Enthalpy concentration diagrams, Heat of formation in solution
- **Thermodynamics of Pure Substances**: Phase diagram, Solid liquid equilibrium, Liquid vapor equilibrium, Thermodynamic property data,
- **Refrigeration Cycle:** Thermodynamic approach towards refrigeration

Semester III

<table>
<tr><td>Module Code</td><td>CH2120</td><td>Module Title</td><td colspan="4">Biological Science Fundamentals</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Describe major areas and applications in biotechnology
• LO2 - Describe major metabolic pathways and identify the properties of macro/micro molecules in food chemistry
• LO3 - Describe main classification, structures and functions of microorganisms and their applications in biotechnology
• LO4 - Describe growth requirements and methods of measuring microbial growth
• LO5 - Identify basic techniques in microbiology/food chemistry
• LO6 - Identify microbial food spoilage methods and apply appropriate control techniques
• LO7 - Describe applications of microbes in process industries</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Biotechnology: Definitions, Major areas and Applications
• Techniques in microbiology/food chemistry: Sterile techniques, Culture media, Methods of obtaining pure cultures, Equipment and Instruments
• Food chemistry and metabolic pathways
o Carbohydrates: Classification, Structure and Function of carbohydrates
o Proteins: Classification, Structure and Function of proteins
o Lipids: Classification, Structure and Function of lipids
o Vitamins & Minerals: Classification, Structure and Functions
o Enzymes: Classification, Structure, Mechanism of action
• Microbial classification: Naming and Classification of microorganisms
• Structure of microorganisms I: Characteristics and Structure of bacteria, Characteristics and Structure of fungi
• Structure of microorganisms II: General characteristics of virus, Viral structure, Viroid, Prions
• Microbial growth: Growth requirements, Bacterial division, Generation time, Phases of growth, Measurement of growth
• Microbial food spoilage and control methods: Factors influencing growth of microorganisms in food, Food borne diseases, Food preservation
• Application of microbes in process industries I: Fermentation technology, Industrial products- Vitamin production, Enzyme production, Food and beverage production, Antibiotics production, Organic acids production, Amino acids production, Production of single cell proteins
• Application of microbes in process industries II: Biosensors, Bioethanol, Biodiesel, Microbial fuel cells, Bioremediation, Soil microbiology and biogeochemical cycles, Bio pesticides, Biofertilizers, Biofilms, Bio- preservation, Bioterrorism, Bioleaching</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2130</td><td>Module Title</td><td colspan="4">Polymer Science and Technology</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Define the basic parameters of polymer science
• LO2 - Categorize polymers into elastomers thermoplastics, thermosets and further into types to homopolymers and copolymers
• LO3 - Describe a suitable polymerization mechanism for synthesis of a given polymer
• LO4 - Identify the most suitable polymer/s for a given application
• LO5 - Distinguish the type of latex using their characteristics
• LO6 - Match the product specifications by selecting correct loading of compounding ingredient/s
• LO7 - Prepare a rubber compound for a given formulation
• LO8 - Explain the importance of using polymer blends and composites over a single polymer for specific applications</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Classification of polymers
• Polymerization
• Coordination polymerization, ring opening polymerization, polymerization with special catalysts (metallocene)
• Polymerization processes
• Polymer Types
• General characteristics of polymers
• Degradation and stabilization of polymers
• Latex technology
• Structure and property relationships of rubbers
• Rubber Compounding
• Plastic technology
• Surface coatings and adhesives
• Polymer blends and composites</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2090</td><td>Module Title</td><td colspan="4">Chemical Kinetics and Thermodynamics</td></tr>
<tr><td>Credits</td><td>3.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Explain basic principles of chemical thermodynamics and chemical processes
• LO2 - Describe and understand the chemical equilibrium
• LO3 - Describe and use the concepts of free energy and chemical potential
• LO4 - Understand the application of partial molar quantities
• LO5 - Analyze chemical equilibrium in ideal and non-ideal systems
• LO6 - Apply chemical engineering thermodynamics to chemical engineering unit operations</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Chemical Thermodynamics
• The First Law of Thermodynamics
• Thermodynamics Analysis of Process
• Principles of Phase Equilibrium
• Phase Equilibrium
• Properties of Solutions
• Fugacity
• Chemical Reaction Equilibrium</td></tr>
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<table>
<tr><td>Module Code</td><td>CH2100</td><td>Module Title</td><td colspan="4">Fluid Dynamics</td></tr>
<tr><td>Credits</td><td>3.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Understand the general concepts of a fluid
• LO2 - Recognize different flow patterns
• LO3 - Explain the fundamentals of fluid flow, different systems of units, dimensional consistence, and hydrodynamic flow meters
• LO4 - Apply mass, momentum and energy balances
• LO5 - Analyze and solve problems in both compressible and incompressible fluid flow</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Fluid Dynamics
• Mass, Energy, and Momentum Balances
• Fluid Friction in Pipes
• Flow in Chemical Engineering Equipment
• Boundary Layer Theory
• Turbulent Flow
• Introduction to CFD</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2140</td><td>Module Title</td><td colspan="4">Environmental Science and Technology</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Identify how environment gets polluted.
• LO2 - Describe basic processes used in wastewater treatment and in air pollution control in the industry.
• LO3 - Describe basics of solid and hazardous waste management techniques
• LO4 - Identify role of authorities and the industry requirements with respect to discharge and emission of pollutants in Sri Lanka.
• LO5 - Apply the environmental monitoring systems to understand the environmental performance.
• LO6 - Analyze reasons behind environmental pollution related problems</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Water Pollution and Wastewater Characteristics
• Wastewater related environmental problems
• Introduction to wastewater treatment processes
• Air Pollution and Atmospheric Pollutants
• Air pollution related environmental problems
• Introduction to Air pollution control equipment
• Basics of Solid and hazardous waste management
• Environmental Monitoring
• National environmental protection regulations</td></tr>
</table>

Semester IV

<table>
<tr><td>Module Code</td><td>CH2014</td><td>Module Title</td><td colspan="4">Heat and Mass Transfer</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Recognize the heat and mass transfer related problems in the process industry
• LO2 - Describe basic principles of heat conduction, convection, radiation and heat transfer with phase change
• LO3 - Describe basic principles of mass transfer
• LO4 - Demonstrate the ability to design heat exchangers
• LO5 - Demonstrate the ability understand the concepts related to mass exchanger design
• LO6 - Apply mass conservation equation to analyze mass transfer problems
• LO7 - Analyze heat transfer problems using conservation equations</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Heat Conduction
• Steady State Heat Conduction
• Transient Heat Conduction
• Heat Convection
• Force Convection
• Natural Convection
• Heat Transfer with Phase Change
• Thermal Radiation
• Design of Heat Exchangers
• Mass Transfer
• Molecular Mass Transfer
• Convective Mass Transfer
• Design concepts of Mass Exchangers</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2024</td><td>Module Title</td><td colspan="4">Unit Operations I</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Identify different methods of binary distillation.
• LO2 - Summarize basic principles of liquid-liquid extraction, leaching, modes of operation and selection of solvents.
• LO3 - Apply material and energy balance to binary distillation, absorption, stripping and extraction applications.
• LO4 - Select suitable equipment for mixing and determine power consumption and carry out scale up calculations.
• LO5 - Evaluate number of theoretical stages in binary distillation, adsorption, stripping and extraction.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Mass Transfer Operations – Vapor-liquid Equilibrium
• Introduction to Binary Distillation Methods
• Multistage Batch Distillation
• Continuous Distillation with Reflux
• Number of Theoretical Stages for Separation
• Advanced Binary Distillation
• Distillation Analysis by Non-Constant Molar Overflow Methods
• Introduction to Gas Absorption & Stripping
• Determination of Number of Ideal Stages
• Introduction to Solvent Extraction
• Liquid-Liquid Extraction
• Leaching (Solid-Liquid Extraction)
• Super Critical Extraction
• Classification of Mixing Operation
• Liquid Mixing Equipment
• Mechanically Agitated Vessels</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2150</td><td>Module Title</td><td colspan="4">Particle Technology</td></tr>
<tr><td>Credits</td><td>3.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Derive governing equations for the motion of particle/s in a fluid.
• LO2 - Calculate and Analyze size, shape, size distribution of a particle system.
• LO3 - Develop equations to determine characteristics of fluid flow in packed beds and fluidized beds.
• LO4 - Design equipment for classification of particles, Solid/Liquid separation and gas cleaning through the knowledge of particle motion and flow through packed beds.
• LO5 - Describe basic fundamentals of Nano-technology and its applications.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Particle Dynamics
• Particle Statistics
• Flow of fluids through porous solid beds
• Fluidization
• Solid Liquid Separation
• Filtration
• Centrifugation
• Dust and Mist Separation from Gas Streams
• Nano Technology</td></tr>
</table>

Module Code	CH2110	Module Title	Fuel Science and Combustion Technology			
Credits	3.5	Hours/Week	Lectures	3.0	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 - Select the required refining processes for specified fuel specifications
- LO2 - Analyze the quality of a given petroleum fraction
- LO3 - Describe basics and principles associated with nuclear energy in nuclear reactors
- LO4 - Identify suitable lubricant properties required for different lubrication application conditions
- LO5 - Identify characteristics of solid fuels
- LO6 - Apply combustion theories to calculate energy production by combustion of fuels in thermal energy producing units.
- LO7 - Design of burners and furnaces

Outline Syllabus

- Properties of fuels
- Petroleum science
- Refinery processes
- Major refinery products
- Solid Fuels
- Nuclear Energy
- Lubrication
- Combustion

Semester V

<table>
<tr><td>Module Code</td><td>CH3054</td><td>Module Title</td><td colspan="4">Energy Efficiency and Conservation</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2.0</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 - Evaluate energy projects in the process industry.
• LO2 - Describe methods of energy conversion in the process industry.
• LO3 - Analyze energy systems by performing energy audits.
• LO4 - Identify Energy losses in different energy systems.
• LO5 - Apply the energy recovery methods to maximize energy efficiency of a process.
• LO6 - Utilize the energy management practices in the process industry.
• LO7 - Derive Environment friendly and sustainable Energy approaches for processes.
• LO8 - Criticize on possible solutions to the existing energy crisis in a constructive way.
• LO9 - Calculate the energy efficiencies and parameters of Energy Systems by applying the governing equations for energy engineering, Thermodynamic principles and chemical aspects.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction – Energy Problem
• Economics of energy saving schemes
• Energy Conversion
• Energy Recovery
• Energy in buildings
• Combined Heat and Power
• Energy Management Practices</td></tr>
</table>

Industrial Training

Module Code	CH3993	**Module Title**	Industrial Training		
Credits	6.0	**Hours/Week**	-	**Pre – requisites**	None
GPA/NGPA	NGPA				

Aim:

To apply theoretical knowledge satisfactorily to industrial environment, improve practical skills and learn good practices in industry

Learning Outcomes

After completing this module, the students should be able to;

- LO1 – *Apply* knowledge and principles of chemical and process engineering
- LO2 – *Understand* administration and management functions in an organization
- LO3 – *Demonstrate* self-learning ability to identify and solve industrial related problems with self-confidence
- LO4 – *Develop* engineering skills and improve soft skills used in team work, communication, time management, and leadership
- LO5 – *Obtain* awareness on ethics and the professional work culture in a multicultural environment with proper attitudes
- LO6 – *Understand* Responsibilities and Accountability of a Professional Engineer

Outline syllabus

- Organizational structure and management, personal relations
- Process Flow sheeting
- Instrumentation, plant maintenance and trouble shooting
- Safety and environmental aspects
- Energy efficiency and conservation
  Quality control and other analytical testing

Semester VI

<table>
<tr><td>Module Code</td><td>CH3070</td><td>Module Title</td><td colspan="4">Plant and Equipment design II</td></tr>
<tr><td>Credits</td><td>2.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH3060</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Describe Piping Engineering Fundamentals
• LO2 – Use Piping code for economical and safe design of piping system and its components
• LO2 – Relate the knowledge in Principals of Fluid Dynamics and Thermodynamics for designing of turbines and compressors for transmission and power generation.
• LO 4 – Recognize characteristics, capabilities and limitations of heat exchangers
• LO 5 –Select suitable heat exchangers for specified applications
• LO6 – Design heat exchangers of improved quality and profitability operation</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Piping Engineering and role of Piping engineer in various field
• Turbo Machines
• Gas Turbine Compressors
• Heat Exchangers</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH3900</td><td>Module Title</td><td colspan="4">Research Methodology</td></tr>
<tr><td>Credits</td><td>2.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>NGPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Understand research experimentation and measurement systems
• LO2 – Use computerized Data-acquisition systems
• LO3 – Apply different sampling and statistical methods
• LO4 – Analyze and interpret data
• LO5 – Plan and document Experiments</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to research experimentation
• General characteristics of measurement systems
• Computerized Data-Acquisition systems
• Sampling methods and Statistical analysis of experimental data
• Guidelines for planning and documenting experiments</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH3080</td><td>Module Title</td><td colspan="4">Computer Aided Chemical Engineering</td></tr>
<tr><td>Credits</td><td>3.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>6/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Identify limitation of analytical methods for solving chemical and process engineering problems
• LO2 – Recognize potential of using numerical methods for chemical and process engineering applications
• LO3 – Recognize suitable software tools for chemical and process engineering applications
• LO4 – Describe the concept of numerical modeling
• LO5 – Rearrange a process model into a computer model
• LO6 – Apply software tools to analyze chemical and process engineering applications</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• SCI LAB
Introduction to use open source software to solve Chemical Engineering problems. Introduction to SCILAB software and basic operations, Polynomials and Curve fitting, Solving of differential equations, Simulation tool box

• ASPEN PLUS
Introduction to the software, Mass Balance on a mixing unit, Material Balance, Modeling and Simulation of a Distillation Column, Modeling and Simulation of a Reactor, Process Economic Analysis, Introduction to Aspen Plus Dynamics</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH3950</td><td>Module Title</td><td colspan="4">Technical Report Writing and Presentation Skills</td></tr>
<tr><td>Credits</td><td>3.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>NGPA</td><td>Lab/Assignments</td><td>6/1</td></tr>
<tr><td colspan="7">Learning Outcomes
After completing this module, the students should be able to;
• LO1 – Describe the mechanism of an operation / process
• LO2 – Distinguish on informal and formal report writing
• LO3 – Develop informal and formal laboratory reports for an experiment/ research work
• LO4 – Develop feasibility reports based on the data available
• LO5 – Develop progress reports for a project describing its status
• LO6 – Summarize the content of a technical report to the audience</td></tr>
<tr><td colspan="7">Outline Syllabus
• Definition - Synonym, formal definitions, classifying the item, differentiating the item
• Describing Mechanisms - Outline for description of a mechanism, definition and purpose, overall appearance, identification of main parts
• Mechanisms in Operation - Outline for describing a mechanism in operation, definition of function, explanation of operating principle
• Describing Processes - Outline for describing a process, description of sequences of action
• Informal Reports and Memoranda - Types of informal reports, informal recommendation reports
• Formal Reports - Outline and the structure of a formal report
• Informal Laboratory Reports - Outline and the structure of an informal laboratory report
• Formal Laboratory Reports - Outline and the structure of a formal laboratory report
• Design Reports - Design reports versus lab reports, design report outline
• Technical Proposals - Technical report structure
• Feasibility Reports - Selecting criteria, feasibility report structure, presenting and interpreting data
• Progress Reports - Progress report structure
• Non – Technical Proposals - Non – technical proposal structure
• Non-Technical Reports - Non – technical report structure
• Oral Reports - Oral and written reports</td></tr>
</table>

Semester VII

<table>
<tr><td>Module Code</td><td>CH4015</td><td>Module Title</td><td colspan="4">Comprehensive Design Project I</td></tr>
<tr><td>Credits</td><td>5.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">-</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>6/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Develop, complex design problem-solving skills
• LO2- Conduct a design project with a significant degree of engineering competence
• LO 3- Conduct a process feasibility study based on a project brief.
• LO 4 – Apply mass balance, energy balance to a process plant and Prepare flow sheets and process flow diagram for the design
• LO5 – Develop technical report writing and presentation skills
• LO 6 – Develop skills on working in design teams</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Students will work in a group to perform following for the process plant studied under the CH3200 module.
• Feasibility study- Economic, risk, safety, health and environmental feasibilities of the selected design
• Site selection and Plant layout
• Material balance calculation for each unit and the complete plant
• Development of the Material flow sheet
• Energy balance calculation
• Development of Energy flow sheets</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4070</td><td>Module Title</td><td colspan="4">Research Project</td></tr>
<tr><td>Credits</td><td>2.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>-</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>6/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Review literature critically and identify research gaps/problem
• LO2 – Develop new experimental set ups/ models/strategies
• LO3 – Construct new ideas or approaches independently
• LO4 – Develop self-integrity under challenging environment
• LO5 – Analyze data obtained from experiment or modelling and drawn conclusions
• LO6 – Evaluate results in the context of related literature
• LO7 – Produce research findings as a published material</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to research methodologies
• Literature review
• Problem identification and finding alternative solutions
• Methodology development with developing an experimental rig, demonstration models and/ or mathematical models
• Results analysis</td></tr>
</table>

Module Code	CH4025	Module Title	Process Modelling and Simulation			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/1		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 – *Describe* systems and models, main elements of dynamic modelling.
- LO2 – *Identify* process parameters to develop a mathematical model of a system.
- LO3 – *Construct* state space models and *linearize* non-linear systems.
- LO4 – *Develop* numerical models of a process and *build up* computer models for simulations by using computer aided tools (MATLAB/SIMULINK).
- LO5 – *Evaluate* dynamics of the systems and processes
- LO6 – *Analyze* and *optimize* processes by using simulation studies.

Outline Syllabus

- System and Model
- Energy balance
- Spatial description and the mass balance
- Species and substances
- The momentum balances
- The energy balances
- Temperature profile from the energy balance
- Energy balance for a CSTR
- Energy balance for a gas storage and transportation.
- Comparison of energy forms
- Laplace transformation, Transfer function
- Solution of linear models
- Analysis of models
- Numerical methods

<table>
<tr><td>Module Code</td><td>CH4050</td><td>Module Title</td><td colspan="4">Unit Operations II</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2024</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Describe principles in Unit operations (multi-component distillation, humidification, crystallization, adsorption, evaporation and drying)
• LO2 – Select suitable mode of operation and equipment for a given separation process covered under the module
• LO3 – Apply material and energy balance to the process equipment
• LO4 – Analyze a given separation process and perform chemical engineering design calculations
• LO5 – Design tray and packed distillation columns and column internals</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Distillation: Multi-component Distillation Bubble point and dew point calculations of multi-component mixture, Multi-component flash Distillation., Column Distillation, Key components, Fenske equation, Underwood equation, Approximate short cut methods and exact calculation procedures, Design of tray and packed distillation columns and column internals. Azeotropic and extractive distillation principles, application and solvent selection.

Evaporation: Single and Multiple effect evaporators, area calculations, Heat and mass balance, Evaporation equipment, Vapor recompression in multiple effect evaporators.
Adsorption: Types of adsorbents, Adsorption equilibrium, modes of adsorption, single stage, cross flow, countercurrent and fixed adsorption unit design calculations, Breakthrough curves, adsorption regeneration
Humidification Operations: Mechanism for Humidification operations, Simultaneous heat and mass transfer, Adiabatic and non-adiabatic operations. Equipment used for the operation and size calculations.
Crystallization: Principles of crystallization, Nucleation, Kinetics of crystallization, Heat and mass balance, yield, equipment and design calculations
Drying: Psychometry - Use of psychometric charts. Vapor - gas mixtures and their properties, Principles of drying, Rate of drying, Constant rate period, critical moisture content and falling rate period Mechanism of drying processes, Heat and Mass transfer in drying processes, Batch and continuous drying, Equipment sizing and selection</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4214</td><td>Module Title</td><td colspan="4">Environmental Engineering and Management</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2083</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Discuss environmental management systems
• LO2 – Describe international protocols related to global environmental problems
• LO3 – Apply environmental accounting in project analysis
• LO4 – Formulate solid and hazardous waste management strategies for given cases
• LO5 – Assess environmental impacts
• LO6 – Select suitable pollution control techniques for a pollution control system
• LO7 – Design environmental pollution control equipment to meet discharge standards</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Wastewater Engineering
• Air Pollution Control
• Solid Waste Management and Engineering
• Hazardous Waste Management
• History of Environmental Management and Development of Quality Management
• Greening of the supply chain
• Environmental impact assessment principles and process;
• Methods of assessing environmental impacts
• Basics of Environmental Accounting
• Environmental Management Systems
• International protocols related to global environmental problems</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4224</td><td>Module Title</td><td colspan="4">Food and Bio Processing</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2120</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Evaluate food processing techniques and preservation methods.
• LO2 – Calculate and Model temperature, time, nutrients level, microbial destruction in different thermal technologies.
• LO3 – Derive equations on microbial and enzyme kinetics
• LO4 – Design biological reactors and processes through the knowledge of microbial kinetics.
• LO5 – Describe the use and the applications of enzymes in the industry.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to Food and Bio Processing
• Food Preservation and Shelf Life
• Thermal Processing of Food
• Thermal Process Calculations
• Thermal Process Methods
• Low Temperature Operations
• Food Packaging
• Introduction to Bioprocess Engineering
• Microbial Growth Kinetics
• Fermentation Systems
• Enzyme Kinetics
• Bio Hazards and Bio-safety</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4234</td><td>Module Title</td><td colspan="4">Polymer Processing Operations</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">-</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;
• LO 1 – Identify and describe the polymer processing operations related to latex, rubber and plastic processing
• LO 2– Discuss the influence and importance of processing parameters on polymer operations
• LO 3 – Apply rheological and heat transfer principles to optimize the polymer processing operations
• LO 4 – Recognize the machineries used for polymer processing
• LO 5–Analyze products defects that can be appeared during respective polymer processing operations
• LO 6 –Demonstrate the ability to select the most appropriate processing technique(s) for a newly design polymer product to manufacture</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Heat transfer ion polymer systems
• Rubber Processing Techniques - Mastication, mixing, cross-linking, forming/ shaping; extrusion, calendaring and moulding
• Determination of processing characteristic and rheological properties
• Plastic Processing Techniques- Moulding, Extrusion, Calendaring, Casting and forming
• Latex processing techniques- Dipping, Foaming, Casting and thread manufacturing
Basic calculations of selected polymer processing equipment</td></tr>
</table>

Module Code	CH4350	Module Title	Upstream Processing of Crude Petroleum			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 – *Explain* Formation, Composition and Characterization of Crude Petroleum
- LO2 – *Describe* Separation of Product Fluids
- LO3 – *Explain* Treatment of Produced Fluids
- LO4 – *Describe* Field Processing and Treatment of Natural Gas

Outline Syllabus

Analysis of Crude Petroleum

- Oil and Gas: From Formation to Production
- Composition and Characteristics of Crude Petroleum

Separation of Produced Fluids

- Two-Phase Gas–Oil Separation
- Three-Phase Oil–Water–Gas Separation

Treatment of Produced Fluids:

- Emulsion Treatment and Dehydration of Crude Oil
- Desalting of Crude Oil
- Crude Oil Stabilization and Sweetening
- Storage Tanks and Other Field Facilities
- Produced Water Treatment

Field Processing and Treatment of Natural Gas

- Overview of Gas Field Processing
- Sour Gas Treating
- Gas Dehydration
- Separation, and Fractionation of
- Natural Gas Liquids

<table>
<tr><td>Module Code</td><td>CH4330</td><td>Module Title</td><td colspan="4">Process Design and Integration</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 –Describe and Distinguish process design methods.
• LO2 – Conduct process economics when selecting utilities and infrastructures.
• LO3 – Apply Pinch analysis to optimize heat recovery in a process.
• LO4 – Evaluate Utility Systems.
• LO5 – Design Heat Exchanger networks.
• LO6 – Perform pinch analysis for Reactors, Distillation Columns and Evaporators.
• LO7 – Demonstrate the ability to use software tools to design processes.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Introduction to Process Design and Integration
• Introduction to Pinch Analysis
• Pinch Analysis Calculations I
• Pinch Analysis Calculations II
• Pinch analysis and Heat recovery
• Heat Exchanger Network Design I
• Heat Exchanger Network Design II
• Heat Exchanger Network Design III
• Combined Heat and Power generations
• Heat Integration of reactors
• Heat Integration of Separators
• Process Economics
• Introduction to Simulation
• Tools for Process Design</td></tr>
</table>

Semester VIII

<table>
<tr><td>Module Code</td><td>CH4034</td><td>Module Title</td><td colspan="4">Comprehensive Design Project II</td></tr>
<tr><td>Credits</td><td>5.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH4214</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>12/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Appraise key decisions to be made and relevant assessment criteria for equipment selection
• LO 2 – Design a selected process equipment in detail, including chemical, mechanical and operational aspects
• LO3 – Identify the type of material and method of fabrication suitable for the equipment
• LO4 – Select control schemes and instrumentation
• LO5 – Describe the startup, shut down, operational, and maintenance procedure
• LO6 – Analyze safety and economic aspects of the equipment
• LO7 – Develop technical report writing and drawing skills</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Students will work individually to perform detail design of a selected process equipment in the plant studied under CH3200 and CH4203 modules.

• Selection of appropriate equipment
• Revisit Mass Balance and Energy Balance
• Calculation of dimensions of the unit
• Mechanical design
• Selection of material
• Thickness calculation
• Internals, supports and others
• Description of fabrication
• Mechanical drawings
• Piping and Instrumentation
• Startup- Shut down
• Safety and Control
• Others- Economic aspects etc.</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4044</td><td>Module Title</td><td colspan="4">Process Dynamics and Control</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Describe the behavior of 1st, 2nd and higher order dynamical systems.
• LO2 – Analyze linear dynamical systems using mathematical tools such as Laplace transforms etc.
• LO3 – Set up simple feedback loops using PID controllers and development of control modules
• LO4 – Implement various PID tuning methods for controllers
• LO5 – Design and Develop feedback and feed-forward controllers and obtain a hands-on experience in doing this via simulation and experimentally on lab scale apparatus by using LabView.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Introduction to Process Dynamics & Control
• Dynamic Behavior and Linear State Space Models
• Transfer Functions and Empirical Models
• Introduction to Feedback Control
• PID Controller Tuning
• Auto-tuning Techniques
• Controller equipment
• Frequency-Response Analysis
• Various control methods and control structures
• Cascade and Feed-Forward Control
• Control-Loop Interaction
• Plant wide Control
• Fuzzy logic control system</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4244</td><td>Module Title</td><td colspan="4">Clean Technology</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Identify resource recovery techniques for waste
• LO2 – Describe recycling techniques
• LO3 – Apply source reduction, waste minimization, energy efficient improvements and process integration solutions for pollution prevention or minimization in industry.
• LO4 – Apply clean technologies in the process industry.
• LO5 – Select environmentally friendly processes and technologies.
• LO6 – Analyze environmentally friendly product and process designs
• LO7 – Assess cleaner production in the process industry</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Introduction to Clean Technology
• Energy Efficiency Improvements
• Introduction to the Concept of Cleaner Production
• Cleaner Production Assessment
• Eco design
• Source Reduction and Waste Minimization
• Resource recovery from waste; recycling techniques
• Process integration solutions for waste avoidance
• Life Cycle Assessment (LCA)
• Process and technology selection
• Carbon foot print and water foot print
• GHG emission reduction or removal enhancement
• Good manufacturing practices, Eco efficiency
• Clean Technology Case Studies</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4254</td><td>Module Title</td><td colspan="4">Renewable Energy Engineering</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Recognize renewable resources in Sri Lanka
• LO2 – Describe applications of renewable energy.
• LO3 – Demonstrate the ability to design renewable energy system for practical applications
• LO4 – Understand optimization of renewable energy utilizations with the available energy resources
• LO5 – Analyze viability of renewable energy systems
• LO6 – Design and implement of a renewable energy system</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Introduction of Biomass and biofuels
• Power from the wind
• Solar Energy
• Hydro-power
• Energy systems, storage and transmission</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH 4264</td><td>Module Title</td><td colspan="4">Polymer Engineering & Mould Design</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2130</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO 1 – Identify and describe the important engineering principles applicable to polymers.
• LO 2 – Discuss the influence and importance of engineering properties on physical testing of polymers.
• LO 3 – Apply knowledge gains on polymer engineering to optimize the manufacture of polymer products.
• LO 4 – Recognize the software used for design and fabrication of moulds for polymer products
• LO 5 – Demonstrate the ability to design simple mould/die to manufacture polymer product
• LO 6 – Design a mould and die for a defined product</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Rubber-like elasticity
• Polymer Rheology
• Viscoelastic properties of polymers
• Facture Mechanics of polymers
• Design of moulds for polymer products
• Design of extruder dies
• Computer Aided Design Analysis and Fabrication of Moulds</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4274</td><td>Module Title</td><td colspan="4">Design of Polymer Products</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2130
CH4234</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Apply the knowledge on the various properties of polymers in selecting suitable polymers.
• LO2 – Analyze the processing characteristics and optimize the required properties for polymer products
• LO3 – Select the suitable processing conditions to manufacture defect-free products
• LO4 –Identify failure mechanisms of polymer products used under different service environments.
• LO5–Describe assembly techniques required for designing and manufacturing of polymer products
• LO6–Design of simple engineering polymer products</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Basic design concepts
• Features and assemblies of commodity and engineering rubber products
• Modes of deformation (compression, shear and bending) Failure mechanics
• Basic calculation on designing of simple engineering products
• Design of plastic products
• Determination of average molar mass and molar mass distribution
• Solution properties of polymers
• Analysis of polymers by chromatography and spectroscopy
• Mechanical properties of polymers
• Determination of thermal properties of polymers
• Processing characteristics of polymers
• Surface properties and morphology of polymers
• Determination of electrical properties of polymers</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4284</td><td>Module Title</td><td colspan="4">Food Engineering and Hygienic Plant Design</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2120
CH4224</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Demonstrate knowledge on common food processing and preservation techniques for safe and quality food production
• LO2 – Develop an awareness on the modern food chain (supply chain process, food legislation, and various tech-economic issues)
• LO3 – Develop simple understanding on nutrition and dietetics
• LO4 – Design plant and equipment which is in agreement with standards and guidelines for hygienic design
• LO5 – Apply hygienic standards in operations and maintenance</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Basic principles of human nutrition
• Food engineering operations
• Food plant operations and supply chain issues
• Future trends in food processing
• Hygienic practices
• Hygienic plant design
• Hygienic equipment design
• Verification and certification of hygienic food processing plants</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4390</td><td>Module Title</td><td colspan="4">Biochemical Engineering</td></tr>
<tr><td>Credits</td><td>4</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH2120
CH4224</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1– Explain techniques used for generating genetically modified microorganisms to synthesize bio-based products
• LO 2 – Evaluate different cell cultivation methods, bioreactors and modes of operation.
• LO 3 – Estimate the sterilization requirement of media and equipment.
• LO 4 – Design suitable reactors for cell culture with mixing and determine power consumption and carry out scale up calculations.
• LO 5 – Select appropriate instrumentation and controls in cell culture
• LO 6 – Evaluate separation techniques used in bio-industry</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Isolation of industrially important microorganisms
• Gene expression and protein synthesis in microorganisms
• Genetically modified/engineered micro organisms
• Industrial applications of genetically engineered organisms
• Medium Formulation, cell nutrients
• Stoichiometry of microbial growth and product formation
• Sterilization of fermentation media and air
• Sterilization kinetics
• Cell cultivation
• Bioreactors – modes of operation, types of reactors, design of agitated bioreactors, design of agitated bioreactors, measurements, instrumentation and control, aeration and agitation in bioreactors, scale-up criteria for bioreactors
• Recovery and purification of bio-products
• Fermentation economics</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH4340</td><td>Module Title</td><td colspan="4">Natural Resource Process Engineering</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this module, the students should be able to;
• LO1 – Understand the availability of natural resources for industrial use
• LO2 – Explain currently available processes to convert natural resources to value added products
• LO3 – Develop processes to add value to natural resources available in Sri Lanka
• LO4 – Develop Socio, Economic, Technical and Financial Evaluation of Industrial Processes
• LO5 – Identify safety, health and environmental aspects of industrial processes</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• Introduction to natural resources
• Value added products
• Value addition processes
• Safety- Health and Environmental Impact
• Process feasibility
• Socio-economic impacts
• Value addition for waste by products</td></tr>
</table>

Module Code	CH4360	**Module Title**	Downstream Processing of Oil, Gas & Petrochemicals			
Credits	4.0	**Hours/ Week**	**Lectures**	3	**Pre – requisites**	CH2110
GPA/NGPA	GPA		**Lab/Assignments**	3/1		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 – *Select* suitable hydrocarbon fuels for different applications
- LO2 – *Describe* functionalities of Production Processes and Technologies to produce hydrocarbon fuels based on their applications
- LO3 – *Describe* production routes &processes for the synthesis of petrochemicals and their derivatives.
- LO4 – *Perform* material and energy balance calculations for the production processes.

Outline Syllabus

Idealization of Petroleum products

- Automotive Fuels - Volatilities, combustion characteristics
- Fuels for Power Generation - Combustion characteristics, handling properties
- Solvents – Volatilities, Characterization
- Lubrication Oils – Characterization and Applications
- Waxes and bitumen - Types properties and uses

Liquid Fuel Processing

- Petroleum Refining - Refinery Processes and Processing [Distillation – Atmospheric& vacuum, Thermal Processing, Catalytic Processing],
- Conditioning & Polishing Processes,
- Product Handling, Utilities Management,
- HSE Management Systems

Gaseous Fuel Processing

- Principles of Gas conditioning and Processing
- Transport Processes and Separation Process
- Cryogenic & Compression Operations in Gas Processing.
- Storage and Product Handling.

Petrochemical Processing

- Classes of Petrochemicals and their Production Processes
- Petrochemicals and their derivatives; Polymers, Base Chemicals and Fertilizers

<table>
<tr><td>Module Code</td><td>CH4370</td><td>Module Title</td><td colspan="4">Petroleum Process Operations, Economics, and Law</td></tr>
<tr><td>Credits</td><td>4.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>3</td><td rowspan="2">Pre – requisites</td><td rowspan="2">CH4193
CH3044</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the students should be able to;

• LO1 – Evaluate current trends in oil and gas industry
• LO2 – Analyze economics of Petroleum Processing
• LO3 – Describe Laws pertaining to Petroleum Operations
• LO4 – Design Procedures for Safe Operation of Petroleum Processing facilities</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Trends in Petroleum Industry
• National legal instruments related to petroleum oil and gas industry;
• International standards, guidelines and directives related to oil and gas industry, Exploration & Production,
• Effects of Regional Politics and Activities towards Petroleum Industry

Economics of Petroleum Processing
• Trends in Petroleum Industry-
• Financial instruments,
• Commercial Operations in Petroleum Industry

Petroleum Law
• Local Laws Pertaining to Petroleum Industry
• International Laws Pertaining to Petroleum Industry
• Case Studies

Safe Operation of Petroleum Facilities
• Introduction to Process Safety in oil & gas facilities,
• Safety Instrumented systems (SIS),
• Emergency shutdown (ESD) systems,
• Design of Systems for Safe Operations</td></tr>
</table>

Module Code	CH4350	Module Title	Petroleum Refining and Petrochemical Industry			
Credits	2.0	**Hours/ Week**	**Lectures**	1.5	**Pre – requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

After completing this module, the students should be able to;

- LO1 – *Describe* production processes for petrochemicals
- LO2 – *Select* required refining processes for specified fuel specifications
- LO3 – *Select* suitable fuels for specific applications

Outline Syllabus

Petroleum Refining

- Refinery Configurations;
- Thermal & Catalytic Processes
- Refinery Offsite Facilities
- Refining economics

Petroleum Product Characterization

- Liquid Fuel Characterization
- Gaseous Fuel Characterization,
- Transportation and Storage of Fuels

Petrochemical Processing

- Classes of Petrochemicals and their Production Processes
- Petrochemicals and their derivatives; Polymers, Base Chemicals and Fertilizers

Note: Offered to ER students