Syllabi of the Modules in Revised Curriculum

B.Sc. Engineering Honours Degree Programme
Chemical and Process Engineering Specialization
Department of Chemical and Process Engineering

LEVEL 1

Module Code	CH1012	**Title**	Biological Science Fundamentals			GPA
Credits	2.5	**Hours/ Week**	**Lectures**	2	**Pre-requisites**	None
			Lab/Tutorials	3/2		

Learning Outcome
By the end of the course the student will be able to Understand and discuss basic biological principles and techniques in molecular biology and biochemistry relevant to biochemical engineering.

Outline Syllabus

Lectures
Microbiology – Microbial classification, structure and their functions, microbial food spoilage and control,
Stoichiometry of microbial growth
Food chemistry, cereal chemistry. Structure and properties of carbohydrates, fats, proteins and other minor food components and enzymes
Microbial biochemistry. Major metabolic pathways and bioenergetics

Module Code	CH 1022	**Title**	Chemistry for Engineers			GPA
Credits	2.5	**Hours/ Week**	**Lectures**	2	**Pre-requisites**	None
			Lab/Tutorials	3/2		

Learning Outcome
To appreciate the laws of nature when designing engineering operations
To get familiar with basic concepts in specific areas of chemistry and their industrial applications

Outline Syllabus

Lectures

Properties of solutions	(04 hrs)
Electrochemistry	(06 hrs)
Applied organic chemistry and reaction mechanisms	(03 hrs)
Natural products and industrial applications	(03 hrs)
Analytical chemistry: Spectroscopy; Chromatography; Gravimetry	(12 hrs)

Module Code	CH1032	**Module Title**	Process Engineering Fundamentals			
Credits	2.0	**Hours/Week**	**Lectures**	1.5	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- Students will gain basic knowledge on principles & calculations and basic design criteria for process industry.
- Students will learn how to develop process flow sheets

Outline Syllabus

Introduction to Process Engineering (04 hours)
Flow sheeting (02 hours)
Process Engineering Calculations (10 hours)
Qualitative line diagrams (02 hours)
Quantitative line diagrams (04 hours)

Industrial development methodologies (02 hours)
Common industrial process flow sheets (04 hours)
Industrial visits

Module Code	CH 1962	**Module Title**	Engineering Skill Development			
Credits	1.5	**Hours/Week**	**Lectures**	1	**Pre – requisites**	
GPA/NGPA	NGPA		**Lab/Assignments**	6/1		

Learning Outcomes

- Develop skills that are important to an engineer other than theoretical knowledge gain
- To develop a clear understanding of workshop practices that is essential in maintaining and managing an industry

Outline Syllabus

Lectures
None

Practicals/Assignments

Engineering Drawing
Auto CAD
Workshop practical

<table>
<tr><td>Module Code</td><td>CH1952</td><td>Module Title</td><td colspan="4">Engineering Design</td></tr>
<tr><td>Credits</td><td>1.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2</td><td rowspan="2">Pre – requisites</td><td rowspan="2">Semester 1 modules</td></tr>
<tr><td>GPA/NGPA</td><td>NGPA</td><td>Lab/Assignments</td><td>03/1</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
After completing this course, the students will be able to,
• Demonstrate the ability to understand Design Principles
• Demonstrate the ability to understand various aspects of design in several selected design case studies.
• Carrying out a group based product design assignment addressing issues such as manufacturability, marketability, creativity, team work, meeting dead lines.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Module 1: Design principles
• Introduction to Engineering Design
• Life Cycle of Engineering Products and Processes
• Design process and Design Tools
• Concurrent Engineering
• Creativity and Reasoning
• Analysis, synthesis, simulation, evaluation and decision making

Module 2: Case studies

Several simple but comprehensive design case studies selected from different disciplines of engineering addressing following topics:
• Design for manufacturing
• Mechanical and material aspect in design
• Electrical, Electronic and IT aspects in Design

Module 3: Design assignments

Group based design assignments

(Topics for design assignments will be selected by Engineering Design Centre in consultation with all departments concerned.)</td></tr>
</table>

LEVEL 2

Module Code	CH 2042	**Module Title**	Fuels and Lubricants			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

Students will be able to

- Identify the relationship between air quality, automotive emissions and fuel quality
- Select the required refining processes for specified fuel specifications
- Evaluate the alternative options for petroleum fuels Incorporate tribology fundamentals in design

Outline Syllabus

Lectures

Properties of fuels – density, viscosity, vapour pressure, boiling points and distillation curves, burning of hydrocarbons

Petroleum science – distillation, cracking :thermal, catalytic, hydro, fluid, visbreaking, coking , reforming :alkylation, isomerization and polymerization, Treating :hydro treating, desalting and sweetening

Wood -combustion, gasification, coal - classification, properties, liquefaction, properties of peat

Nuclear reactions – fission, fusion, binding energy, nuclear energy

Tribology – functions of lubricants, mechanism s and lubrication, types and properties of lubricants

Module Code	CH2052	**Module Title**	Transport Phenomena I			
Credits	3.5	**Hours/Week**	**Lectures**	3.0	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- To enable students to understand different systems of units, dimensional consistence, flow patterns, hydrodynamic flow meters and apply energy balances
- To give students an understanding of the fundamentals of fluid flow
- To enable them to analyze and solve problems encountered in fluid flow

Outline Syllabus

Dimensionless Groups; similarity, scale-up, dimensional analysis	(05 hours)
Viscosity, laminar and turbulent flow. Types of fluids,	(08 hours)
Two Dimensional inviscid flow	(12 hours)
Viscous flow; flow in pipes and channels, boundary layer theory	(12 hours)
Compressible flow	(12 hours)

Module Code	CH2062	Module Title	Transport Phenomena II			
Credits	3.5	**Hours/Week**	**Lectures**	3.0	**Pre – requisites**	CH2052
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- To enable students to understand different mode of heat transfer and apply the gain the knowledge to calculate heat transfer coefficients for a given process equipment
- To enable students to analyze and solve problems encountered in mass transfer

Outline Syllabus

Energy transport by Conduction	(10 hours)
Energy by convection	(09 hours)
Energy transport by radiation	(06 hours)
Heat transfer with change in phase	(04 hours)
Mass transfer by molecular diffusion	(08 hours)
Mass transfer by convection	(06 hours)
Interface mass transfer	(06 hours)

Module Code	CH 2072	Title	Chemical Kinetics and Thermodynamics			
Credits	3.0	**Hours/ Week**	**Lectures**	2.5	**Pre-requisites**	-
			Lab/Tutorials	3/2		

Outline Syllabus

Lectures

Chemical Thermodynamics: First law of thermodynamics, Heat capacities, Calculation of heat, work, enthalpy, internal energy, etc. for various thermodynamic processes, Thermochemistry, Second law of thermodynamics, Determination of entropy changes, Clausius inequality, Gibbs and Helmholtze free energies, Gibbs equations, Maxwell relations, Chemical potential, Chemical equilibria, Third law of thermodynamics.

Chemical Kinetics: Rate law, Determination of the order of a reaction; Complex reactions, Chain reactions, Influence of temperature on reaction rates; Collision theory, Arrhenius equation, Transition state theory.

Heterogeneous catalytic reactions: Physisorption and chemisorption, Adsorption isotherms, Noncompetitive and nondissociative adsorption, Competitive adsorption, Adsorption with dissociation.

<table>
<tr><td>Module Code</td><td>CH 2082</td><td>Title</td><td colspan="3">Mass Transfer Operations I</td><td>GPA</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">4.5</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>4</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Lab/Tutorials</td><td>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcome:</u>
By the end of the module student should be able to apply stage wise calculations to make preliminary design calculations for a wide range of binary distillation, absorption and extraction applications. Select suitable equipment for mixing and determine power consumption and carry out scale up calculations. Select suitable membrane separation process and membrane and carry out preliminary calculations for a given process.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Lectures
Distillation of binary systems
Absorption and Stripping
Extraction; liquid/liquid extraction, leaching
Mixing

Membrane separation processes</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH2952</td><td>Module Title</td><td colspan="4">Technical Report Writing and Presentation Skills</td></tr>
<tr><td>Credits</td><td>2.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1.0</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 course module, the students should be able to:

• Effectively communicate technical information in written format.
• Prepare technical documents depending on the target audience.
• Demonstrate the ability to deliver effective technical presentations,
•</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Document design

• Technical writing process
Audience analysis, Topic ideas, brainstorming, narrowing and outlining, Note taking and rough-drafting, Power-revision techniques, Referencing, Strategies for peer-reviewing and team-writing.

• Technical writing guidelines
Basic patterns and elements of a sentence, common grammar, usage and punctuation problems, Common spelling problems.

• Critically evaluating document
Explaining a point, Agreeing to a point, Disagreeing to a point, Defending a decision.

• Effective use of software tools for document formatting

• Technical writing scenarios & applications
Types of technical reports and different types of content, Project proposals, Progress reports, instructions, User guides, Feasibility, evaluation and recommendation reports, Business plans, Writing abstracts, introductions and conclusions.

• Academic writing skills – Thesis, research papers etc.

• Presentation skills – slide preparation, pre planning, knowing the audience, structure of a presentation, strategies for capturing the attention of the audience, basic etiquette in presentations</td></tr>
</table>

Module Code	CH 3092	**Module Title**	Environmental Science			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	none
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

At the end of this module students will have a knowledge on:
The science behind environmental pollution, how pollution can be monitored and estimate chemical and physical quality parameters of water and air basic physico-chemical relationships.

Outline Syllabus

Lectures

- Water Chemistry 6 hours
  Atmospheric Chemistry 4 hours
  Wastewater Characterization and Water Pollution 4 hours
  Wastewater related environmental problems 2 hours
- Atmospheric Pollutants and Air Pollution 4 hours
  Air pollution related environmental problems 2 hours
- Environmental Monitoring Systems 6 hours

Module Code	CH3102	**Module Title**	Polymer Science and Technology			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

Students will gain the ability to find the exact polymerization mechanisms and processes to obtain maximum efficiency and the yield. They will also gain the knowledge on compounding of polymers with suitable additives for given applications.

Outline Syllabus

Lectures

Introduction to polymer science and technology (02 hours)
Synthesis of polymers (06 hours)
Polymerization processes (03 hours)
Degradation and stabilization of polymers (02 hours)
Rubber compounding (04 hours)
Additives to Plastics (03 hours)
Stabilization destabilization of lattices (04 hours)
Surface coatings and adhesives (01 hours)
Polymer blends and composites (01 hours)

LEVEL 3

<table>
<tr><td>Module Code</td><td>CH 3112</td><td>Title</td><td colspan="3">Particulate Systems</td><td>GPA</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">3.5</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>Lab/Tutorials</td><td>3/2</td></tr>
<tr><td colspan="7">Learning Outcomes:
Understanding the applicability and limitations of various solid/fluid systems
Develop skills to design unit operations that has particulate matter
Ability to apply the knowledge to develop the laboratory scale solid/fluid separating processes on an industrial scale</td></tr>
<tr><td colspan="7">Outline Syllabus
Lectures
Introduction
Motion of particles in fluids
Particle statistics and size analysis
Classification of particles
Solid/liquid separation-Thickening
Flow through granular beds and packed columns
Fluidization
Solid/liquid separation-Filtration, Centrifugation
Gas cleaning
Nano-technology</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH3122</td><td>Title</td><td colspan="4">Plant and Equipment Design 1</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">4</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>Lab/Tutorials</td><td>3/1</td></tr>
<tr><td colspan="7">Learning Objectives
By the end of this course, a student should be able to:
demonstrate practical working knowledge and skills in process equipment design principles, procedures and practices

• understand the impact of design options on installed costs, operability, maintainability and safety of the plant
• work with the codes and standards for process equipment including ASME, BS and API etc
• enhance knowledge in stress analysis for better appreciation of its significant role in avoiding failures.
• interpret pressure vessel designations and designs
• identify and justify appropriate materials for use in process plant equipment fabrication in specific operation environments</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Concepts of plant design
Concepts in process equipment design
Mechanical design of process equipments
Design standards
Material selection for various equipment types
Design of an internal pressure vessel (unfired types)
Design of an external vessel (unfired types)
Design of shells for internal pressure
Design of shells for external pressure
Design of closures for process vessels
Design of Compensations for openings, non standard flanges, supports
Process of Instrumentation</td></tr>
</table>

Module Code	CH3142	**Module Title**	Reactor Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre – requisites**	none
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

At the end of this module students will be able to:

- Design Chemical Reactors for the chemical process industry;
- Optimize reactors and operate reactors economically

Outline Syllabus

Mole balances: Batch reactors Continuous- flow reactors, Continuous stirred tank reactors, Tubular reactor, Industrial reactors.
Conversion and reactor sizing: Design equations, Batch systems, Flow systems, Reactors in series
Rate laws and stoichiometry: The reactor rates constant, The reaction order, Constant-Volume reaction systems, Reactions with phase change.
Isothermal reactor design: Design structure for isothermal reactors, Scale-up of liquid-phase batch reactor data to the design of a CSTR.
Catalysis and catalytic reactors: Catalysts, Surface reaction, Desorption.
Non-elementary homogeneous reactions: Active intermediates, Polymerization.
Non-isothermal reactor design
Multiple reactions: Conditions for maximizing the desired product in parallel reactions
Diffusion and reaction in porous catalysts
Multiphase reactors
Distributions of residence times for chemical reactors
Analysis of non ideal reactors

Module Code	CH3212	**Module Title**	Polymer Process Engineering			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

Students will gain the knowledge on rubber, plastic and latex processing techniques, and on operating the processing equipments in manufacturing polymer products.

Outline Syllabus

Lectures

Heat transfer in polymer systems (04 hrs)
Rubber Processing techniques – mastication, mixing, cross-linking, forming/shaping; extrusion, calendering and moulding (06 hrs)
Plastic Processing techniques – moulding, extrusion, calendering, casting and forming (06 hrs)
Latex processing techniques – dipping, foaming, casting, thread manufacturing (06 hrs)
Basic calculations of selected polymer processing equipment (04 hrs)

Module Code	CH3222	Module Title	Polymer Physics			
Credits	2.5	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

Students will be able to understand the underlying principles associated with physical tests undertaken on polymers in solid and liquid states and their relevance to polymer processing

Outline Syllabus

Lectures

Deformation behaviour of polymers (06 hrs)
Rubber elasticity and viscoelasticity (04 hrs)
Polymer Rheology (04 hrs)
Fracture mechanics (04 hrs)
Determination of mechanical and rheological properties (06 hrs)

Module Code	CH3232	Title	Bioprocess Technology			GPA
Credits	2.5	Hours/ Week	Lectures	2	Pre-requisites	None
			Lab/Tutorials	3/2		

Learning Outcome

Students will be able to obtain a fundamental knowledge on use of cells and enzymes in the process industry.

Outline Syllabus

Lectures

Introduction to Biological Engineering – use of cells in production systems, range of products (02 hrs)
Development of fermentation processes (04 hrs)
Microbial growth kinetics (06 hrs)
Fermentation systems (06 hrs)
Enzyme kinetics and use of enzymes in process industry (08 hrs)
Biohazards and Biosafety (04 hrs)

Module Code	CH3252	Module Title	Environmental Engineering			
Credits	2.5	Hours/Week	Lectures	2.0	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	1.5		

Learning Outcomes

- At the end of this module students will be able to select environmental pollution control systems based on engineering principles
-

Outline Syllabus

Lectures :

Wastewater Engineering	8 hours
Air Pollution Control	6 hours
Solid Waste Engineering	8 hours
Hazardous Waste Management	8 hours

Module Code	CH3132	Module Title	Energy Efficiency and Conservation			
Credits	2.5	Hours/Week	Lectures	2.0	Pre – requisites	ME1822 CH2062
GPA/NGPA	GPA		Lab/Assignments	1.5		

Learning Outcomes

Students will gain the knowledge in

- Evaluation of energy projects
- Methods of energy conversion
- Performing an energy audit
- Methods of energy recovery
- Energy management practices

Outline Syllabus

Introduction – Energy Problem	(4 hours)
Economics of energy saving schemes	(4 hours)
Energy conversion	(6 hours)
Energy Recovery	(8 hours)
Energy in buildings	(4 hours)
CHP	(6 hours)
Energy management	(3 hours)

<table>
<tr><td>Module Code</td><td>CH3702</td><td>Module Title</td><td colspan="4">Computer Aided Chemical Engineering</td></tr>
<tr><td>Credits</td><td>2.5</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>2</td><td rowspan="2">Pre – requisites</td><td rowspan="2">MA3022</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>
• Students will be able to simulate unit operations and overall chemical processes
• Students will gain knowledge on simulation of flow problems using CFD tools</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
• This module introduces fundamentals needed to simulate unit operations and chemical process plants
• Reactor simulation is introduced using dynamic simulator Aquasim 2.1f. Experimental specific parameter estimation and sensitivity analysis are also studied parallel with laboratory practical classes conducted for reaction engineering.
• Techniques for simulation of process plants are introduced using static simulator called Super pro.
• Basics for computational fluid dynamics will be taught. Theoretical background for finite volume method is presented for convective and diffusion related problems.
• Grid generation and strategies for selecting appropriate boundary conditions are also discussed.
• By applying computational fluid dynamics code called STAR-CD, flow problems are simulated for simple geometries such as pipe flow, mixing tank. etc</td></tr>
</table>

Module Code	CH3242	Module Title	Food Process Engineering			
Credits	2.5	Hours/Week	Lectures	2	Pre – requisites	
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

- Students will gain knowledge on common food processing and preservation techniques used during production of safe and quality foods.
- Students will develop an awareness of the modern food chain- supply chain process, food legislation and the various techno economic issues involved
- Students will gain a simple understanding of nutrition and dietetics

Outline Syllabus

- Food Engineering operations: Introduction, Preparative operations, Preservation and shelf life, MA Storage, Freeze drying , Thermal process operations, Size reduction, Emulsification, Extrusion, Membrane operations, Electrical Heating methods, Irradiation, High Pressure processing, Packaging
- Future trends in Food Processing: Probiotics/ Prebiotics, Food nano biotechnology
- Food Plant Operations and Supply Chain Issues
- Basic principles of human nutrition: Foods and food groups, nutrient content of foods, function of nutrients, digestion of food, metabolism, meeting energy needs, food allergies

Module Code	CH 3262	Title	Renewable Energy Engineering			GPA
Credits	2.5	Hours/ Week	Lectures	2	Pre-requisites	-
			Lab/Tutorials	3/2		

Learning Outcomes

Ability to analyze and evaluate alternative energy production options

Outline Syllabus

Lectures

Classification of Renewable energy sources based on origin
Characterization resources and devices
Bio-energy
Wind Energy
OTEC
Energy economics of renewable energy systems

LEVEL 4

Module Code	CH 4152	**Title**	Mass Transfer Operations II			GPA
Credits	4.5	**Hours / Week**	**Lectures**	4	**Pre-requisites**	CH 2082
			Lab/Tutorials	3/2		

Learning Outcomes
By the end of the module the student should be able to: Make preliminary design calculations, Use knowledge of a number of design methods, selecting the appropriate approach for a range of new situations for unit operations listed.

Outline Syllabus

Lectures
Introduction
Multi-Component Distillation
Complex distillation methods
Gas-liquid contact column design
Humidification, Dehumidification, Cooling
Crystallization
Adsorption
Evaporation
Drying

Module Code	***CH 4202***	**Title**	Comprehensive Design Project			GPA
Credits	8.0	**Hours/ Week**	**Lectures**	None	**Pre-requisites**	None
			Lab/Tutorials	None		

Learning Outcome

The students will be able to appreciate comprehensiveness of design assignments in Chemical Engineering and learn on skills for effective project reporting

Outline Syllabus:

A. Group Design

Literature survey, Process selection and economic aspects, Process description and flow sheet, Site selection, layouts, EIA, Safety, Mass balance calculation, Material flow sheet, Heat balance calculation, Tabulated heat balance

B. Individual Design

Unit design, Selection, Mass balance *, Energy balance * (*if not done in A), 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, Start up – Shut down, Safety and Control, Others - Economic aspects etc.

<table>
<tr><td>Module Code</td><td>CH 4962</td><td>Title</td><td colspan="3">Research Project</td><td>Non GPA</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">2</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>Lab/Tutorials</td><td></td></tr>
<tr><td colspan="7"><u>Learning Outcome</u>
The students will gain the ability to identify and handle technical problems/issues in local process industry. They should be able to transfer knowledge effectively, to write papers in local engineering journals and/or to present them in open forums based on research projects.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus:</u>
Collect data on the specific project that address social, industrial and environmental issues
Identify the problems and find alternative solutions
Develop experimental rigs, demonstration models and/or calculation models
Analyze the results

<u>Lectures</u>
None

<u>Practicals/Assignments</u>
A report/research paper
Presentation</td></tr>
</table>

<table>
<tr><td>Module Code</td><td>CH 4172</td><td>Module Title</td><td colspan="4">Process Dynamics and Control</td></tr>
<tr><td>Credits</td><td>3.5</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>3/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
By the end of this course, a student should be able to:
1. Understand and discuss the importance of process control in process operation and the role of process control engineers
2. Recognize and fit various simple empirical models that are used for designing controllers.
3. Analyze linear dynamical systems using mathematical tools such as Laplace transforms etc

4. Design and tune feedback controllers on real systems.
5. Analyze stability and performance of feedback loops using Laplace and frequency domain techniques.
6. Understand and design basic control strategies.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Design of single- Loop Feed Back Control systems
Mathematical tools for control systems analysis
Additional control techniques
Modeling and simulation of Process Control System
Instrumentation Symbols and Labels
Sensors, Transmitters, and Control Values
First order and higher order dynamic systems

Basic components of control systems</td></tr>
</table>

Module Code	CH4182	**Module Title**	Safety and Loss Prevention			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	none
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

At the end of this module students will be able to:

Appreciate the relationship between health and environmental hazards from work

Apply preventive and protective measures for hazard mitigation

Outline Syllabus

Lectures

Introduction to occupational hazards, work, health and productivity
Toxicity and chemical safety
Fire, Flammability and Explosion
Ergonomics
Personal protective equipment
Industrial diseases
Noise and ventilation
Plant design for safety
Safety in plant operation, maintenance and modification
Identification and quantification of hazards in process plants
Legal background: Health and safety at work
Precautionary principle, responsible care and human factors in safety

Module Code	CH4192	**Module Title**	Plant and Equipment Design II			
Credits	2.0	**Hours/Week**	**Lectures**	1.5	**Pre – requisites**	CH2052 CH2062
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- Students will gain basic knowledge on selection of pumps, compressors etc.
- Students will learn how to design and/or select heat and mass exchanging equipment for a given application
- Students will be able to design pipe networks for process plants and other

Outline Syllabus

Design of Turbo machinery; pumps, compressors, turbines, blowers	(07 hours)
Design of pipe networks	(04 hours)
Design of Heat transfer equipment; heat exchangers, boilers, furnace	(06 hours)
Design of Mass transfer equipment; absorption and stripping columns	(04 hours)

Module Code	CH 4202	**Title**	Comprehensive Design Project			GPA
Credits	8.0	**Hours/ Week**	**Lectures**	None	**Pre-requisites**	None
			Lab/Tutorials	None		

Learning Outcome

The students will be able to appreciate comprehensiveness of design assignments in Chemical Engineering and learn on skills for effective project reporting

Outline Syllabus:

A. Group Design

Literature survey, Process selection and economic aspects, Process description and flow sheet, Site selection, layouts, EIA, Safety, Mass balance calculation, Material flow sheet, Heat balance calculation, Tabulated heat balance

B. Individual Design

Unit design, Selection, Mass balance *, Energy balance * (*if not done in A), 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, Start up – Shut down, Safety and Control, Others - Economic aspects etc.

Module Code	CH4272	**Module Title**	Design and Characterization of Polymer Products			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

Student will gain knowledge on

- Designing and assembling of commodity and Engineering polymer Products
- Structure -property relationship of polymers
- Basic theory and experimental background of characterization of polymeric materials with regard to various properties

Outline Syllabus

Basic design concepts (02 hours)
Design with rubbers (06 hours)
Design with plastics (06 hours)
Solution, thermal, electrical and mechanical properties of polymers and determination of the properties (06 hours)
Characterization of polymer morphology (02 hours)
Surface Characterization (01 hours)
Analysis of Polymers by chromatographic and spectroscopic methods (03 hours)
Determination of processing characteristics (02 hours)

<table>
<tr><td>Module Code</td><td>CH4702</td><td>Module Title</td><td colspan="4">Process Modeling and Simulation</td></tr>
<tr><td>Credits</td><td>2.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1.5</td><td rowspan="2">Pre – requisites</td><td rowspan="2">MA3022
CH4152</td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Lab/Assignments</td><td>3/2</td></tr>
<tr><td colspan="7">Learning outcome:

• Students will be able to develop dynamic models applied in chemical engineering and solve resultant differential and algebraic equations using numerical techniques. They will also learn how to apply fundamentals of transport phenomena to develop such models.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Matlab introduction course [08hrs]
System and model, main elements of dynamic modeling [02 hrs]
Classification of models, spatial description and mass balance [02 hrs]
Chemical reaction and reaction kinetics, modeling CSTR, PFR [04hrs]
Energy balance for thermal systems and modeling. [04 hrs]
Momentum balance and modeling [02 hrs]
Numerical differentiation and integration. Numerical solution of ordinary Differential equations and systems of equations. Boundary-value problems for ordinary differential equations. [04 hrs]
Analysis of models [04 hrs]</td></tr>
</table>

Module Code	CH 4282	**Module Title**	Hygienic Plant Design			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

Students will gain knowledge to design plant and equipment which is in agreement with standards and guidelines for hygienic design. They will also gain the ability to apply hygienic standards in operations and maintenance

Outline Syllabus

- **Hygienic plant design:**
  - **Sources of contamination**: Physical contaminants, Chemical contaminants, Microbiological contamination, Controlling contamination
  - **Plant design:** The factory site; The factory building; General design issues for the factory interiors
  - **Control of airborne contamination:** Sources of airborne contaminants; Dust control; Environmental air quality control; Process air control; Air disinfection systems
- **Hygienic equipment design**
  - **Key criteria in hygienic design:** Risk assessment in equipment design; Regulatory requirements for hygienic equipment design;
  - **Equipment construction materials:** Metals; Passivation of stainless steel; Plastics and composites; Elastomers; Lubricants; Other materials
  - **Piping systems, seals and valves:** Materials; Surfaces; Pipe couplings; Seals; Valves; Mixproof valves
  - **Cleaning in place:** Principles of CIP systems; Cleaning tanks; Avoiding product contamination; Types of CIP system; Centralised/decentralised CIP systems and automation
- **Hygienic Practices**
  - **Cleaning and disinfection:** Principles; Cleaning chemicals; Disinfectants; Testing disinfectants; Water quality; Sanitation programs
  - **Personal hygiene:** Sources of contamination; Direct and indirect routes of contamination; Controlling contamination: medical screening; Personal hygiene practices; Hand hygiene; Training; Control of indirect contamination from people
  - **Pest control: insects and mites:** The spread of pests; Physical control of pests; Chemical control of pests; Biological control of pests; Threats to successful control
- **Verification and certification of hygienic food processing plants (8 hours)**
  - **HACCP:** HACCP Steps; Identification of Potential Hazards; Identify CCP; Establish CCP; Establish Monitoring Procedures; Establish Corrective Actions; Record Keeping Procedures; Verification Procedures;
  - Any other quality systems

Module Code	CH4312	**Title**	Biochemical Engineering			GPA
Credits	2.5	**Hours/ Week**	**Lectures**	2	**Pre-requisites**	None
			Lab/Tutorials	3/2		

Learning Outcome
Students understand applications of engineering principles in biological production systems.

Outline Syllabus
Lectures

Preparation of fermentation media	(02 hrs)
Sterilization	(04 hrs)
Fermenter Design, Operation and scale up	(06 hrs)
Fermentation Control and Instrumentation	(04 hrs)
Aeration and agitation in fermenters	(04 hrs)
Bioproduct Recovery and Purification	(04 hrs)
Recombinant DNA technology	(06 hrs)

Module Code	CH4322	**Module Title**	Clean Technology			
Credits	2.5	**Hours/Week**	**Lectures**	2.0	**Pre – requisites**	CH3252 CH4292
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- Apply cleaner production techniques in the industry
- Carryout a cleaner production audits
- The students will learn how to incorporate environmental issues to product and process design
- Appreciate the advantages of pollution prevention over pollution control
-

Outline Syllabus

Introduction to the Concept of Cleaner Production and Clean Technology	(02 hours)
Source Reduction and Waste Minimization	(04 hours)
Cleaner Production Assessment	(04 hours)
Energy Efficiency Improvements	(04 hours)
Process integrated solutions for waste avoidance	(06 hours)
Eco Design	(02 hours)
Life Cycle Assessment	(02 hours)
Clean Technology Case Studies	(02 hours)

Module Code	CH4292	**Module Title**	Sustainable Engineering			
Credits	2.5	**Hours/Week**	**Lectures**	2.0	**Pre – requisites**	CH3252 CH3262
GPA/NGPA	GPA		**Lab/Assignments**	1.5		

Learning Outcomes

- A knowledge on Green technologies for energy and environmental conservation
- Applicable technologies for recycling

Outline Syllabus

- Biological aerobic treatment systems
- Biological anaerobic treatment systems
- Waste to energy conversion
- Resource recovery from waste
- Recycling technologies
- Membrane treatment for wastewater recycling
- Electrochemical treatment
- Bio energy systems
- Bio based feed stocks, energy fuels and materials
- Bioresource based sustainable solutions
- Carbon foot print, water foot print
- Process / Technology selection

Module Code	CH4302	**Module Title**	Mould and Die Design for Polymer Products			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	CH3212
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

- Students will learn how to design moulds and dies to manufacture simple polymer products.
- Students will gain basic knowledge on use of software in mould design and fabrication.

Outline Syllabus

Features of moulds and dies	(04 hrs)
Design of moulds and dies	(12 hrs)
Material Selection for moulds & dies and fabrication processes	(04 hrs)
Cost analysis	(02 hrs)
Computer aided design and fabrication of moulds	(06 hrs)

Module Code	CH4712	**Module Title**	Chemical Process Design and Integration			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	CH3122
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

- Students will be able to design new chemical process using systematic tools
- Students will gain knowledge on simulation of process flow sheet

Outline Syllabus

- This module aims to educate students with systematic approach to design chemical plants starting with an overview of different approaches to process designing.
- Conceptual designs of continuously operating chemical processes are studied. Choice of reactor conditions and configuration are studied.
- Choice of separator for heterogeneous mixtures and homogeneous liquid mixtures are studied. Recycle systems including pumping and compression are studied. Heat integration of reactors, distillation columns, evaporators and dryers are studied in the context of overall process design.
- Role of process economics including capital investment and overhead costs are also investigated.
- Course presents knowledge to build process flow sheet in dynamic simulation software as Hysis/Superpro and study varying process conditions

Module Code	CH4722	**Module Title**	Total Environmental Quality Management			
Credits	2.5	**Hours/Week**	**Lectures**	2	**Pre – requisites**	none
GPA/NGPA	GPA		**Lab/Assignments**	3/2		

Learning Outcomes

At the end of this module students will be able to:
Understand the concept of Environmental Management
Carryout an Environmental Impact Assessment

Outline Syllabus

Lectures

History of Environmental Management
Development of Quality Management
Environmental Impact Assessment Principles and Process
Inherent Environmental Friendliness concept
Identification and Quantification of Environmental Impacts
Dispersion and Distribution of Pollutants in the Environment
Environmental Management Systems - ISO 14000
Greening of the supply chain, Eco efficiency, Factor 4/10, Triple Bottom Line,
Good Manufacturing practices, Product stewardship
International Protocols related to Global Environmental Problems
Basics of Environmental Accounting

Syllabi of Service Modules

<table>
<tr><td>Module Code</td><td>CH2802</td><td>Title</td><td colspan="3">Process Engineering</td><td>GPA</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">2.0</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>1.5</td><td rowspan="2">Pre-requisites</td><td rowspan="2">None</td></tr>
<tr><td>Lab/Tutorials</td><td>3/2</td></tr>
<tr><td colspan="7">Learning Outcome
After completing this module students should be able to,
• Analyze various chemical and physical operations involved in process industries.
• Apply the basic concepts of flow sheeting for process development.
• Calculate material and energy balances.
• Appreciate existing environmental issues and suggest corrective measures to overcome them.
• Apply basic concepts in plant design.</td></tr>
<tr><td colspan="7">Outline Syllabus

Lectures
• Process Development and unit operations
• Material and Energy resources
• Process Engineering calculations
• Transport phenomena
• Mass Transfer by conduction and convection
• Mass Transfer Equipment
• Environmental issues, Pollution
• Cleaner Production, Environmental Management
• Concepts of Plant Design
• Industrial Case Studies

Practicals/Assignments
Separation of IPA from water using batch distillation
TSS, TS, VS
Air Quality
Mixing
Heat transfer equipment</td></tr>
</table>