Study Plan Master of Science in Chemical Engineering

Year I		
Fall Semester		**9 Credits**
Code	**Course Title**	**Credit Hours**
Code	Program Core I	3
Code	Program Core II	3
Code	Program Core III	3
Spring Semester		**9 Credits**
Code	**Course Title**	**Credit Hours**
Code	Program Core IV	3
Code	Elective I	3
Code	Elective II	3

Year II		
Fall Semester		**9 Credits**
Code	**Course Title**	**Credit Hours**
Code	Elective III	3
Code	Elective IV	3
Code	Elective V	3
Code	Master Thesis Phase I	3
Spring Semester		**3 Credits**
Code	**Course Title**	**Credit Hours**
Code	Master Thesis Phase II (Thesis Option)	3

Courses Description

CHEE 6000 Advanced Chemical Engineering Thermodynamics (3credit)

Review of first and second laws of thermodynamics, General methods of deriving thermodynamic formulae; Partial molalQuantities-Gibbs-Duhem equation; Equilibrium and free energy, fugacity and activity; Chemical reaction equilibrium constants; fugacity in mixture; effect of pressure, volume, temperature on thermodynamic properties such as enthalpy, entropy, internal energy etc. chemical potential in mixtures; vapour-liquid equilibrium, Correlation of data from Van taar and other equations. Elements of irreversible and statistical thermodynamics.

CHEE 6200 Advanced Chemical Reaction Engineering (3 credits)

Basic principles, rate controlling steps, Thermodynamic aspects of chemical equilibrium calculations, Heterogeneous reactor design. Non-catalytic and catalytic heterogeneous reaction and reactor design, axial mixing phenomenon, Fluidized bed reactors, Analysis of real reactors. Multiphase flow reactors, Stirred vessel reactors, miscellaneous reactors, Multiphase flow regimes, Gas-liquid, Solid-gas, Gas-solid, liquid-solid reactors, Isothermal and adiabatic fixed bed reactors, Non-isothermal and non-adiabatic fixed bed reactors, fixable bed reactors. Classification, characterization, preparation and application of catalysts, activation & deactivation catalysts, Specific design aspects and the typical industrial reactors with their performance, Scale up of reactors.

CHEE 6300 Advanced Process Dynamics and Control (3 credits)

Process dynamics: Laplace transforms, response of lumped parameter systems

Response of distributed parameter systems, Dynamic analysis of non-linear systems, Inverse response systems, time delay systems, stability. Advance control strategies: Cascade control, Feed forward control, Ratio control, Adaptive

and inferential control, Model based control (internal model control, generic model control). Sampled data control systems: Sampling and Z-transforms, Open loop and closed loop response, Modified Z-transforms, Design of sampled data controllers. Special control topics: Nonlinear control: phase- Plane analysis, Ntroduction to statistical process Control-Emerging technologies for advanced process control.

CHEE 6400 Advanced Biochemical Engineering (3 Credits)

Enzymes Kinetics, Simple enzyme kinetics, Enzyme reactors, Enzyme inhibition, Enzyme immobilization, Various techniques of Enzyme Immobilization, Industrial applications of Enzymes

Cell Free Enzyme System, Cell free enzyme system development, Characterization techniques of cell free enzyme system, Products of cell free enzyme system, Comparison will cellular system, Industrialization of cell free enzyme system, Future of Cell free enzymes

Cell growth, Monod growth kinetics, Measurement of Cell Growth, Effects of Environment on Cell Growth, Viable Cell Growth, Medium Formulation and Yield Factors

Biopolymers, Introduction of various biopolymers, Microbial processes in biopolymer synthesis, Bio-cellulose an example of bio-polymers

Downstream Processing in Biochemical Engineering, Introduction to downstream processing, Solid-Liquid Separation, Filtration/Ultrafiltration, Centrifugation and related techniques

Sterilization, Sterilization methods, Thermal death kinetics, Design criterion, Batch and continues sterilization, Air sterilization

CHEE 6500 Solar Energy Utilization (3 Credits)

Solar radiation, its measurements and prediction. Flat plate collectors: liquid and air type. Theory of flat plate collectors, advanced collectors, optical design of concentrators, selective coatings, solar water heaters, solar dryers, solar stills, solar cooling and refrigeration. Thermal storage. Conversion of heat into mechanical energy. Active and passive heating of buildings. Solar thermal power generation. Solar photovoltaics, principle of photovoltaic conversion of solar energy. Technology for fabrication of photovoltaic devices. Applications of solar cells in PV power generation systems. Organic PV cells. Solar Photocatalysis: Mechanism; Kinetics; Nano-catalysts: Systems; Performance parameters; Applications.

CHEE 6310 Chemical Process Modeling (3 Credits)

Define the dynamics of a problem, Formulate hypotheses (in words, diagrams, and a set of model equations) as tentative explanations of problematic dynamic behavior Analyze a model´s structure to discover the endogenous source of particular dynamic patterns, Analyze and test a model to improve its reliability and usefulness, Test a model´s sensitivity to parameter assumptions, Identify and evaluate potential leverage points for improving model behavior through policy parameter analysis.

CHEE 6510 Advanced Fuel Cells and Batteries (3 Credits)

Thermodynamics of electrochemical reaction, Kinetics of electrochemical reaction, Electrochemical techniques, Electrochemical impedance spectroscopy (EIS) and its application, Cycling voltammetry and linear polarization, Galvanostatic intermittent titration, Principle of battery, Advanced rechargeable battery, Li-ion batteries, Nanostructured materials for Li-ion batteries, Principle of supercapacitor, Advanced supercapacitor technology, Difference between batteries and supercapacitors, Principle of fuel cells, Types of fuel cells, New materials for proton exchange membrane fuel cell, alkaline fuel cell and solid oxide fuel cell , Applications of fuel cells, Fuel cell, battery and supercapacitor hybrid power systems.

CHEE6600 Advanced Polymer Engineering (3 Credits)

Define polymers and chemical classification of polymers based on polymerization mechanism, Polmeric supports in organic synthesis, Configurations and crystallinity of polymeric materials, Molecular weight distributions, Configurations and crystallinity of polymeric materials, Conformation of polymer molecules, Effect of chemical structure on polymer properties, Chain-Growth polymerization, Thermodynamics of polymer mixtures, Theory of rubber elasticity, Polymer Crystallization, Mechanical properties, Polymer processing.

CHEE 6520 Materials Science for Solar Energy Conversion Systems (3 Credits)
Introduction to materials science for solar energy conversion systems. Optical properties of inhomogeneous two-component materials. Transparent insulation materials. Selectively solar-absorbing surface coatings: optical properties and degradation. Energy efficient windows: present and forthcoming technology. Materials for radiative cooling to low temperatures.

CHEE 6800 Desalination Processes (3 Credits)
Electrodialysis Technology - Theory and Applications. Water Desalination by Membrane Distillation. Desalination of Coastal Karst Springs by Hydro-geologic, Hydro-technical and Adaptable Methods. Application of Renewable Energies for Water Desalination. Seawater Desalination: Trends and Technologies. Renewable Energy Opportunities in Water Desalination. Solar Desalination.

CHEE 6110 Advance Heat transfer (3 Credits)
Study of energy transport in turbulent regime, interphase heat transfer coefficient, radiant energy transport and design of different heat transfer equipments such as heat exchangers, boilers, and condensers. Study of mass transfer including mass transfer in a turbulent regime, eddy diffusivity, turbulent concentration profile, interphase mass transport, mass transfer coefficient for forced and free convection and macroscopic balance in multi component systems.

CHEE 6610 Nanocomposites Engineering Materials (3 Credits)
The course is designed to cover the following topics: the nanotechnology, nanomaterials, synthesis of nanomaterials, applications of nanomaterials, sensors, polymeric nanocomposites materials, nanomaterials and Nano fillers and to establish a foundation for further study and research in this area. Software for nanocomposite material design will be introduced and applied to material selection and analysis of simple nanocomposite structures.

CHEE 6670 Nanomaterials (3 Credits)
Introduction, Emergence of Nanotechnology, Challenges in Nanotechnology
Synthetic techniques, Special Nanomaterials, Characterization and Properties of Nanomaterials, Applications of Nanomaterials

CHEE 6900 Special Topics (3 Credits)
Different advanced selected topics in Chemical Engineering to complement the student's program. The executive committee of the program should decide the topics to be offered each semester based on the needs

CHEE7001 Thesis I (3 Credits)
Research preparation, literature study, basic theories and simulation (if needed) and research planning. Research topics to be decided by the advisors. The student will write the introduction and literature review part of their thesis and will make a presentation of their intended work.

CHEE 7002 Thesis II (3 Credits)
Research based on the outcome of literature study during the CHEE7001 course, analysis and discussion on research results, thesis writing. The evaluation of thesis will be made based on their report, presentation of the research study and basic information about their research project.

Registration of Thesis/Project

1. Thesis shall be written in English in accordance with the Program guidelines.
2. A supervisor shall be appointed for the thesis from among the faculty, giving consideration to the student's selection as much as possible, by a decision of the department committee.
3. Thesis shall be supervised by professors, associate professors and assistant professor rank faculty members only.
4. Any faculty can supervise no more than 3 theses at one time per semester.

5. The department committee members may increase the number of theses for each supervisor in accordance with the legitimate needs of the Program and with the approval of the Graduate Studies Committee in the College.
6. The supervisor may be changed in justifiable circumstances.

General Procedure

The following steps must be followed in thesis approval:

1. The student will submit an application along with the thesis proposal on a special form prepared by the Department Committee (DC).
2. The format of thesis will be decided by DC
3. The Convener of the Committee will set a public date for the discussion of the proposal which will be attended by the supervisor, the faculty members in the Committee and the postgraduate students within one week from the date of submission.
4. The Graduate Studies Committee will approve the proposal after discussion in the presence of the supervisor to ensure that modifications required in the discussion have been complied with.
5. The department committee will approve, return or propose changes to the thesis proposal within two weeks of receiving it.
6. The student will submit the progress report to Department through supervisor.
7. The student is entitled to defend the thesis upon the completion of one semester following the approval of the thesis proposal semester.
8. The thesis title and proposal may be modified if the need arises, and reasons for modification must be cited in the same manner in which it was initially approved.

Defense of the Thesis/ Project

1. The supervisor shall submit a recommendation to the Committee Convener when the student completes the thesis in accordance with proper academic principles and guidelines for the formation of the defense committee.
2. The thesis/project may not be discussed prior to the completion of all courses including prerequisites and any other admission conditions, completion 21 credit hours and obtaining a CGPA of 75%.
3. The thesis/ project will be check with (TURNITIN) for similarity purposes. The maximum percentage of similarity is 25% for forming a defense committee.
4. The defense committee shall appoint a date for the thesis defense. The student must submit the thesis/ project to the committee members two weeks before the defense date.

Outcome of the theses evaluation process

The committee decision will be final outcome of the thesis defense and cannot be revoked. The result of the thesis can be categorized in following ways

1. Pass without modifications.
2. Pass with minor modifications: The student will be given a time-frame for the resubmission of the modified thesis.
3. Pass with major modifications: The student will be given a time-frame for the resubmission of the modified thesis.
4. Fail and the committee will write a report explaining the reasons for failure. In this case, the students will take a chance to write a new thesis within a period and the time frame will be decided by the committee members.

Note: All the rules related to the thesis defense are subjected to change by the thesis committee members.