

## **CHE-452: Chemical Process Design and Simulation**

**Credit Hours:** 2-1

**Pre-requisites:** NIL

### **Course Objectives**

- To learn fundamentals of Chemical Process Design and Simulation and get skills of using Aspen HYSYS software for designing Process Flow Diagram (PFD) of any assigned chemical engineering process.
- Additionally, basics of Matlab will be taught to have an alternative or supporting system to Aspen HYSYS for dealing with more challenging design problems.

### **Course Contents**

- i. Design & Simulation Software: Introduction to various design and simulation software e.g., HYSYS, ChemCAD etc.
- ii. A review of capabilities and limitations of the design / simulation software. Flowsheets and sub-flowsheets.
- iii. Defining process streams and use of Fluid Packages
- iv. Adding common unit operations in the flow sheet. Drawing simple Process Flow Diagrams (PFD) in HYSYS, steady state material and energy balances using graphical user interface and worksheet.
- v. Simulation of equipment from the following categories in Aspen HYSYS: Heat transfer, Separators, Pressure changers, Reactors
- vi. Energy analysis in simulation environment, Economic analysis in simulation environment
- vii. Dynamic mode analysis on temperature, pressure, flowrate, and composition of process stream/equipment
- viii. Hierarchy of process design; Process synthesis and design strategy
- ix. Strategies for decision making.
- x. Simulation of equipment from the following categories in Aspen HYSYS:
  - a. Heat transfer
  - b. Separators
  - c. Pressure changers
  - d. Reactors
- xi. Energy analysis (pinch analysis) in simulation environment
- xii. Economic analysis in simulation environment

- xiii. Dynamic mode analysis on temperature, pressure, flowrate, and composition of process stream/equipment

### **Course Outcomes**

After completing this course, the student will have the fundamental understanding of Aspen HYSYS and MATLAB. He/she will be able to use the skills of Aspen HYSYS to design a process pertaining to chemical engineering.

### **List of Practicals**

Practical exercises relating to the topics covered in theory.

- i. Tasks on Graphical User interface (GUI) of MATLAB
- ii. Tasks on
  - a. MATLAB codes for solving differential equations following a template code
  - b. MATLAB code for solving Integration problems following a template code.
  - c. Modeling streams, mixer, heaters, pumps using Aspen HYSYS
- iii. Case-studies on modeling and simulation of pressure changing equipment in Aspen HYSYS
- iv. Case-studies on modeling and simulation reactions sets and reactors in Aspen HYSYS
- v. Case-studies on modeling and simulation of heat transfer related equipment in Aspen HYSYS
- vi. Case-studies on analysis of physical and thermodynamic properties of a certain unit operation in Aspen HYSYS
- vii. Case-studies on modeling and simulation of a plantwide flowsheet of a manufacturing plant
- viii. Case-studies on analysis of dynamic modes of process equipment in Aspen HYSYS
- ix. Case-studies on Aspen HYSYS based economic analysis of plant wide models

### **Recommended Books**

- Biegler, L.T., Grossmann, I.E., & Westerberg, A.W. (1997). Systematic Methods of Chemical Process Design. Prentice Hall PTR.

- Smith, R. (2010). Chemical Process Design and Integration. Wiley (E-book).
- Dimian, A.C., Bildea, C.S., & Vasile, C. (2014). Integrated Design and Simulation of Chemical Processes. Elsevier (E-book).
- Aspen Technology. (2019). Aspen HYSYS User Guide. Aspen Technology.
- MathWorks. (2021). MATLAB User Guide. MathWorks.