The University of Jordan
School of Engineering & Technology
Department of Chemical Engineering
Academic Year: , Semester

Course: Chemical Engineering Lab 4 0905562 (1 Cr. – Core Course)

Catalogue Data: Selected experiments drawn from Reaction engineering & Process dynamics courses (0905482, 0905421) which include: Determination of reaction kinetics using Batch & Continuous Stirred Tank and Tubular Reactors, Development of reaction kinetics using hydraulic analogy for single (irreversible & reversible) and series reactions, Temperature measurement, Empirical modelling of concentration dynamics in a continuous stirred tank, level process control, Open loop simulation of higher order process including the effect of dead time using SIMULINK, Simulation of closed loop first-order process with P-, PI and PID controllers using SIMULINK.

Prerequisites by Course: 0905482 & 0905421

Prerequisites by topic: Students should have a good background on the following topics:

- Theory of chemical engineering reaction kinetics
- CSTR, PFR & Batch reactors
- Process dynamics and process reaction curve
- Closed loop response with different types of controllers
- Empirical methods for tuning feedback controllers

References: See the experiments' manual and the references therein

Schedule & Duration: 10 – 12 Weeks, 3 hours lab sessions

Minimum Student Material: Lab sheets

Minimum College Facilities: Chemical Engineering Reaction & Control laboratories with process simulation software

Course Objectives:

1. Determination of reaction kinetics using batch, tubular & CST reactors experiments
2. Development of the reaction kinetics for irreversible, reversible & parallel reactions using hydraulic analogue
3. Perform a steady state MB on a CSTR and plug flow reactor
6. Study the static and dynamic characteristics of various temperature measuring devices
7. Perform empirical modelling of the concentration dynamics in a CSTR reactor using the step-response method
8. Study the control elements of a closed loop level process and the effects of PID-controller parameters on the process response under set point and disturbance changes
9. Study the open loop response of higher order processes and the stability regions of P-, PI- and PID controllers of first order process using SIMULINK modules

Course Outcomes (Related to ABET A2K):
Upon successful completion of this course, the students should be able to:

1. Analyse measured experimental data obtained from batch, tubular and CST reactor experiments to determine reaction kinetics (**O6**)
2. Understand the similarity between hydraulic driving force for flow systems and the reactant concentration driving force in reacting systems (**O1)**
3. Estimate the time constant, steady state gain, connection of thermocouples and hysteresis of temperature measuring devices
4. Understand the closed loop dynamics of level process (interacting tanks) and tuning of PI controller (**O2**)
5. Model the Continuous stirred tank concentration dynamics using the FOPD model (**O1**)
6. Use SIMULINK environment to understand the behaviour of higher order system dynamics and determine the stability region of PID controller for a FOPD Process (**O2**)
7. To work effectively in team and take initiatives.(**O5**)

Course Topics:

Experiment	Description	Week
E. 1	Determination of ethylacetate saponification reaction kinetics in a CSTR	**1**
E. 2	Determination of ethylacetate saponification reaction kinetics in a batch reactor	**2, 3**
E. 3	Steady state performance of a PFR	**4**
E. 4	Hydraulic analogue	**5**
E.5	Empirical modelling of concentration dynamics in a CSTR	**6**
E.6	Static and dynamic characteristics of selected temperature measuring devices	**7**
E. 7	Control of a level process (two interaction tanks) using P & PI controller	**8**
E. 8	Simulation of open and closed loop processes & determination of PID controller stability region using SIMULINK modules	**9**

Computer Usage: Use of SIMULINK software

Attendance: Lab attendance is mandatory where the UJ policy on absence is applicable.

Assessments: Exams and assignments.

Grading policy:

Lab evaluation	10 %
Reports	30 %
Midterm Exam	20 %
Final Exam	40 %
Total	100%

Instructor:

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References: See the Experimental sheets