Advanced Elective-II

UG	Department: **Chemical Engineering**
Course Code: **CH412**	Course Name: **Advanced Process Control**
Credit: **3**	L-T-P: **3-0-0**
Version: **1**	Approved on:
Prerequisite Course: **Nil**	

Control systems with Multiple loops: Cascade control, split range control, Feed-forward and Ratio control. Adaptive and Inferential control systems.
Multiple input multiple output (MIMO) control systems; Interaction and Decoupling of control loops; Digital Control systems, Z- Transforms, Discrete-time response of Dynamic Systems, Design of Digital feedback control systems, Process Identification and Adaptive control; Model predictive control.

Books

1. Stephanopoulos, G., "*Chemical Process Control*", Prentice Hall of India, New Delhi, 1990.
2. Seborg, E., Edgar, J. F. and Mellichamp, D. A., "*Process Dynamics and Control*", John Wiley, 1989.
3. Astron, K. J. and Wittenmark, B., "*Computer Controlled Systems*", Prentice Hall, 1994.
4. Coughanowr, D. R., "*Process Systems Analysis and Control*", 2nd Ed., McGraw Hill, NY, 1991.

UG Department: **Chemical Engineering**
Course Code: **CH414** Course Name: **Applied Statistics for Chemical Engineers**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Elementary concept of statistics, significance tests, Linear regression, hypothesis testing, analysis of variance.

Design of experiments, Nonlinear parameter estimation, Model building and model discrimination.

Books

1. Box, G.E.P., Hunter, W.G., and Hunter, J.S., "*Statistics for Experimenters*," John Wiley and Sons, 1978.

2. Draper, N.R. and Smith, H., "*Applied Regression Analysis*", Volume 1, Wiley, 1998.

3. Holman, J.P."*Experimental Methods for Engineers*", 7th edition, McGraw-Hill, Singapore, 2001.

4. Himmelblau, D.M., "*Process Analysis by Statistical Analysis*," John Wiley and Sons, 1970.

5. Montgomery, D.C., "*Design and Analysis of Experiments*," John Wiley and Sons, 1984.

6. Feller, W., "*An Introduction to Probability Theory*," Vols. 1 and 2, 3rd ed., John Wiley and Sons, 1968.

UG Department: **Chemical Engineering**
Course Code: **CH416** Course Name: **Catalytic Processes**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Review of Heterogeneous Catalysis.

Transport Processes: Analysis of external transport processes in heterogeneous reactions in fixed bed, fluidized bed and slurry reactors. Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous mass and heat transfer with chemical reaction.

Catalyst Selectivity: Effect of intrapellet diffusion on selectivities in complex reactions, effect of external mass transfer on selectivities.

Catalyst Deactivation: Modes of deactivation – poisoning, fouling and sintering. Determination of deactivation routes, combined effect of deactivation and diffusion on reaction rates, effect of deactivation on selectivity.

Reactor Design: Design calculation for ideal catalytic reactor operating at isothermal, adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed-bed, fluidized bed and slurry reactors. Thermal stability of packed bed and fluidized bed reactors.

Books

1. Smith, J. M., "*Chemical Engineering Kinetics*," 3rd ed., McGraw-Hill, 1981.
2. Carberry, J. J., "*Catalytic Reaction Engineering*," McGraw-Hill, 1977.
3. Lee, H. H., "*Heterogeneous Catalytic Reactors*," Butterworth.
4. Tarhan, M. O., "*Catalytic Reactor Design*," McGraw-Hill, NY, 1983.
5. Anderson, J. R. and Boudart, M., "*Catalysis, Science and Technology*," Vol. SpringerVerlag,NY.
6. Thomas, J. M. and Thomas, W. J., "*Introduction to the Principles of Heterogeneous Catalysis*," Academic Press, 1967.
7. Gates, B.C., "Catalytic Chemistry," Wiley, New York , 1992.

UG Department: **Chemical Engineering**
Course Code: **CH418** Course Name: **Process Modifications for Green Technology and Energy Integration**
Credit: **3** L-T-P: **3-0-0**
Version: **1** Approved on:
Prerequisite Course: **Heat Transfer, Mass Transfer, Chemical Technology, Pollution Control, Chemical Reaction Engineering**

Different types of contactors and their characteristic features, sections and subsections of a typical chemical plant, start-up and shut-down procedures, typical trouble shooting options associated with different sections. Demonstration of a collection of typical raw materials, intermediates and finished products.

Critical review of industrial contactors; Solvent selections: economic considerations and process requirements for specific cases. Cooling and chilling processes used in various industries, adsorbent selection for specific use, significance of various parts of binary and multi-component (crude) distillation columns, absorption towers, dryers etc. Design variations for drying of milk, fertilizer powder and granules, soap-lye, bricks, cloth, paper etc.

Introduction to Heat Exchanger Networks- Minimum heating and cooling requirements, Minimum number of exchangers, area estimates, Design of minimum-energy Heat Exchanger Networks, Loops and Paths, Reducing the number of exchangers, Stream splitting, Heat and power integration, Heat and distillation.

Process intensification with ultrasound waves: ultrasound, cavitation, sonochemistry, enhancement of chemical reaction, emerging areas, applications and advantages over conventional processes, scale-up issues and limitations,

Exothermic, catalytic and non-catalytic reactors: design methodology and heat recovery options with reference to specific industries, e.g., SO_2 and NH_3 converters, fluid-bed pyrite roaster, kneeder, etc. Design methodology and mode of heat supply to endothermic reactors: cement kiln, lime kiln, reformer, naphtha cracker, water-gas reactor, etc. Process modifications in chlor-alkali industries. Economic and environmental considerations for ethanol production based on petrochemical and agro feed stocks.

Natural gas and its usage for favorable economic and environmental considerations. Variations in the reactor configurations for polyethylene (HDPE and LLDPE) production. Design considerations of a polypropylene reactor for product particle size control.

Books

1. Rao, M. G. and Sittig, M., "Dryden's Outlines of Chemical Technology", Affiliated East West Press, 1997.
2. Douglas, J. M., Conceptual Design of Chemical Processes, McGraw Hill, 1988.
3. Austin, G.T., "Shreve's Chemical Process Industries", 5th Edn., McGraw-Hill, 1985.
4. Levenspiel, O., "Chemical Reaction Engineering," 3rd Edn., John Wiley, 1999.
5. Smith, J. M., "Chemical Engineering Kinetics," 3rd Edn., McGraw-Hill, 1981.
6. Peters, M. S. and Timmerhaus, K. D., Plant Design and Economics for Chemical Engineers, 3rd ed., 1981.