# Process Design Decisions and Project Economics - Video course

## COURSE OUTLINE

This course brings together the concepts of engineering and economics for chemical plant design and optimization. This course can be termed as the pinnacle of the chemical engineering curriculum as it deals with applications of the individual aspects of chemical engineering such as fluid mechanics, mass transfer, heat transfer, chemical reaction engineering, chemical process calculations, thermodynamics, process equipment design etc. for designing of a efficient and economic chemical process. The hierarchy of decisions in synthesis and analysis of a chemical process and its alternatives is initially discussed. This is followed by shortcut procedures of designing of major equipment in the chemical process and the cost estimation for the same using correlations. Various stages of the chemical process design are addressed step by step such as input-output structure, material and energy balance calculations, design of separation processes and heat integration of theprocess (or heat exchanger network in the process). Finally, an easy procedure is described in the form of cost diagram that would give a crude yet meaningful estimation of the economic implications of various process alternatives. The structure of the course covers both theory and problems. The course is meant for final year undergraduates and also for practicing engineers (especially the management trainees in various process industries).

## CONTENTS

The broad syllabus contains 9 topics as follows:

1. Process selection, synthesis and analysis
2. Engineering Economics
3. Short-cut procedure for equipment design (Economics decision making)
4. Input information and Batch vs Continuous
5. Input – Output Structure of Flowsheet
6. Recycle Structure of Flowsheet
7. Separation Systems.
8. Heat Exchanger Networking (Heat Integration)
9. Cost Diagrams and Quick Screening of Alternatives

In each of the topic, theory and principles will be covered first, followed various examples and problems that apply these theories and principles.

## COURSE DETAIL

| Sl. No | Topic | No. of Hours |
|---|---|---|
| 1 | **Process selection, synthesis and analysis** (Aspects of process design, pre-project objectives, project classification, hierarchical approach to process design) | 02 |
| 2 | **Engineering Economics** (Elements of project cost, cost information, total capital investment and total capital cost, time value of money, depreciation, interest, project financing, measures of process profitability, simplified model for economic analysis of process design) | 06 |

NP-TEL

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## Chemical Engineering

**Pre-requisites:**

Students for this course should have completed basic chemical engineering undergraduate courses such as fluid mechanics, heat transfer, mass transfer, chemical reaction engineering, transport phenomena, chemical process calculations etc.

**Additional Reading:**

Browsing through techno-commercial magazines related to chemical engineering such as Chemical Weekly, Chemical Engineering Progress, Chemical Engineering World, Chemical Industry Digest etc. would help in understanding of the concepts of process design and optimization covered in the course.

**Coordinators:**

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| 3 | **Short-cut Procedure for Equipment Design and Economic Decision Making** (Basic design of absorber, distillation columns, cost model for distillation column, sizing and costing of equipment, Gutheries correlation, distillation column sequencing, energy integration of distillation columns, case study for economic decision making for an absorber) | 04 |
| 4 | **Preliminary Process Design** (Batch versus continuous processes, comparative analysis, input information) | 02 |
| 5 | **Input-Output Structure of Flowsheet** (Hierarchy of decisions for Input-Output structure, overall material balance, stream costs, process alternatives) | 04 |
| 6 | **Recycle Structure of Flowsheet** (Hierarchy of decision for the recycle structure, materials and energy balance for recycle structure, equilibrium limitations, modifications of reactor design for recycle, equipment costs associated with recycle, overall economic potential of process with recycle) | 04 |
| 7 | **Separation Systems** (General structure of the separation system, location of vapor and liquid recovery system in the process, sequencing of non-integrated distillation columns for minimum vapor load, sequencing of columns with more than 2 products, thermal coupling of columns, azeotropic distillation, residue curve maps, azeotropic systems at total and minimum reflux, distillation with entrainer) | 10 |
| 8 | **Heat Exchanger Networking** (Composite curves, heat recovery pinch, threshold problems, problem table algorithm, process constraints, number of exchanger units, heat exchanger area target, capital and total cost target, pinch design method, design of threshold problems, stream splitting, design for multiple pinches) | 08 |
| 9 | **Cost Diagrams and Quick Screening of Process Alternatives** (Concept of cost diagram, quick assessment of cost distribution with design heuristics, cost allocation procedures, lumped cost diagram, cost allocate diagram for stream flows, screening of process alternatives with cost diagrams) | 04 |
| | **Total** | **44 Hrs** |

**References:**


1. Douglas, James M., Conceptual Design of Chemical Processes, McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (1988).

2. Biegler, L.T., I.E. Grossmann and A.W. Westerberg, Systematic Methods of Chemical Process Design, Prentice Hall (Pearson Education), New Jersey, USA (1997).

3. Peters, Max S., K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003).

4. Mahajani, V.V., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005).

5. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK (2005).