Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Chemical Engineering
(Applicable from the academic session 2018-2019)

Semester-VI

Particle & Fluid Particle Processing
CHE-PC601
3L: 0T: 0P

3 credits

Course Objectives:

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle-fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Contents:

Lecture: 10L

Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. Solid particle characterization: Particle size, shape and their distribution; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. Flow around immersed bodies: Concept of drag, boundary layer separation, skin and form drag, drag correlations.

Lecture: 10

Packed bed: Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus. Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop, Geldart plot etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Classical models of fluidization, circulating fluidized beds, Applications of fluidization. Separation of solids from fluids: Introduction.

Lecture: 15

Sedimentation: Free Settling, hindered settling, Richardson-Zaki equation, design of settling tanks. Filtration: Concepts, design of bag filters, design of electrostatic filters. Centrifugal separation, design of cyclones and hydro cyclones. Size reduction, milling, laws of communition, classification of particles. Size enlargement; Nucleation and growth of particles.

Lecture: 10

Transport of fluid-solid systems: pneumatic and hydraulic conveying. Colloidal particles: stabilization, flocculation. Introduction to nano particles: Properties, characterization, synthesis methods, applications.

Total 45 L

List of Text Books:

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition, McGraw Hill.

2. Coulson and Richardson's Chemical Engineering, Vol. 2, Butterworth-Heinemann, Fifth edition 2002.

3. Unit Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan.

4. Unit Operations Vol.-I, K. A. Gavhane, Nirali Prakashan

List of References Books:

1. Rhodes, M. J., Introduction to Particle Technology, 2nd edition, John Wiley, Chichester; New York, 2008.

2. Allen, T., Powder Sampling and Particle Size Determination, Elsevier, 2003.

3. Masuda, H., Higashitani, K., Yoshida, H., Powder Technology Handbook, CRC, Taylor and Francis, 2006.

4. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed., Wiley, 2013.

Course Outcomes:

Students will be

- Calculate drag force and terminal settling velocity for single particles
- Calculate pressure drop in fixed and fluidized beds
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage

Process Technology and Economics
CHE-PC602
3L:0T:0P
3 credits

Pre-requisites :Fluid Mechanics, Mass Transfer-I, Chemical Reaction Engineering – I
Objectives:To familiarize students with manufacturing aspects of industrially relevant chemicals

Contents :

1Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers, etc. (9 lectures)

2: Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum refining and cracking operations, syngas and hydrogen, (9 lectures)

3 Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: C1, C2, C3, C4, etc., benzene, toluene, xylene and other petrochemicals from these basic building blocks (18 lectures)

4Industrially relevant fuels, coal, coal based chemicals and fuels Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water 5Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost and their estimation. Estimation of working capital. (6 lectures)

6Analysis of working results project: Balance sheets, Project financing, concept of interest, time value of money, depreciation. Profitability Analysis of Projects (3 lectures)

Total 45 lectures

Suggested Text Books

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984

2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997

3. Chemical Process Technology, O.P. Gupta, Khanna Publishing House, 2018 (AICTE Recommended Textbook – 2018)

4. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005

5. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

Suggested References Books

1. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013

Course outcomes

Students will be able to

Describe sources and processes of manufacture of various industrially important chemicals

Draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals

Explain and calculate economic aspects of Projects involved in manufacturing of Chemicals

Nanoscience and Nanotechnology
CHE-PE604 a
3L: 0T: 0P
3 credits

Contents:

Introduction; surface effects and physical properties of nonmaterial; electrical, magnetic and optical properties; nanoscale measurement and characterization; design and synthesis of nanomaterial; nanoscale devices for various applications (photovoltaic, medical diagnostics, electronics).

Total 45L

Books:

1. Nanoscience and Nanotechnology: Fundamentals of Frontiers, M. S. Ramchandra Rao, S. Singh, Wiley, 2013.

2. Introduction to Nanotechnology, C. P. Poole Jr., F. J. Owens, Wiley, 2007.

3. Nanotechnology: Principles and Practices, S. K. Kulkarni, Springer Nature, 2014.

Polymer Science and Engineering
CHE-PE604b
3L: 0T: 0P
3 credits

Contents:

Basic concepts; polymerization mechanism and synthesis; copolymerization; polymerization techniques; polymer characterization; polymer rheology; polymer processing; properties of some commercial polymers.

Total 45L

Books:

1. Polymer Science and Technology, P. Ghosh, McGrawHill Education, 2017.
2. Fundamentals of Polymer Science and Technology, A. Srivastava, S.K. Kataria & Sons, 2012.
3. Textbook of Polymer Science, F. W. Billmeyer, Wiley, 2007.

Process Control
CHE-PC603
3L:0T:0P
3 credits

Pre-requisites : Material and Energy Balance Calculations, Chemical Reaction Engineering – I

Objectives

Objective is to introduce the fundamentals of process control with applications using P, PI, and PID controllers. The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods. The course would end with more advanced concepts like feed-forward control, ratio control, model-predictive control, ratio control, dead-time compensation, etc.

Contents :

1. Introductory Concepts: Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feedforward), process and instrumentation diagrams (3 lectures)
2. Laplace transforms, solution of ODEs using Laplace transform (4 lectures)
3. Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series (5 lectures)
4. Second order systems, higher order systems, transportation lag and dead time (4 lectures)

5. Linear closed loop systems, development of block diagrams, classical feedback controllers. (4 lectures)
6. Final control element (control valves), block diagram reduction techniques (3 lectures)
7. Closed loop response, servo and regulatory problems (2 lectures)
8. Stability analysis, Routh stability criterion, Root locus diagrams (rule based) (3 lectures)
9. Introduction to frequency response, notion of stability (4 lectures)
10. Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion (5 lectures)
11. Controller tuning: Ziegler-Nichols method, Cohen-Coon method (3 lectures)
12. Introduction to advanced controllers: cascade control, feed forward control, ratio control, Smith- predictor, IMC, MPC, dead-time compensation (3 lectures)
13. Introduction to digital control (2 lectures)

Total 45 lectures

Suggested Text Books

1. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGraw-Hill (2008).
2. D.C. Sikdar, Instrumentation and Process Control, Khanna Publishing House (2018).

Suggested References Books

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley (2003)

2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984)

Course Outcomes

Students will be able to understand the importance of process dynamics (unsteady state operation)

Tune a controller to reject disturbances or manage operating point transitions

Category Humanities and Social Science and Management Course
Course title Project Management and Entrepreneurship(HASS-IV)
Course Code CHE-HS606
2 L :0 T: 0 P
Credit: 2

Lecture Hrs: 30

Pre-requisites/ Core requisites (if any) - Fundamentals of Management, Elementary Mathematics

Course Objective:
The objectives of the course are:
1) To impart among students, the concept of project, its characteristics, and its management

subject to given constraints to successfully deliver the agreed outcomes of the project.
2) To imbibe students with the knowledge of effective project planning, project evaluating, and project scheduling with optimal resource allocation.
3) To impart among students, the legal aspect and quality aspect of project management.
4) To familiarize the students with the concept of entrepreneurship, its theoretical and practical approach.

Course Content:
MODULE-I [10 Lectures]
Project Management Concepts: Concept and Characteristics of a Project, Types of Projects, Project Management (Need, Knowledge Areas, Project Manager, Project Management Triangle, Project Scope and Scope Creep, Importance of Project Management).
Project Management Life Cycle: Project Management Life Cycle Phases, Project Management Process (Project Process, Process Group, Process Interactions, Customization, Process Group and Knowledge Area Matrix)
Project Planning: Planning Need, Importance of Planning, Planning Process, Work Breakdown Structure and Organization Breakdown Structure, Roles, Responsibility and Team Work, Feasibility Studies.

MODULE-II [10 Lectures]
Project Evaluation: Investment Analysis of Projects (Time Value of Money, Interest Rates, Compounding/Discounting, Payback Period, Average Rate of Return, Net Present Value, Profitability Index, Internal Rate of Return), Sources of Finance.
Project Scheduling: Importance of Project Scheduling, Scheduling Techniques (Gantt Chart and Line of Balance, Network Analysis – CPM/PERT, Slack and Float).
Project Cost Control: Direct and Indirect Cost, Normal Cost and Crash Cost, Time– Cost Trade-off Analysis -Optimum Project Duration, Resource Allocation and Leveling.

MODULE-III [4 Lectures]
Legal and Quality Aspects of Project Management: Project Contract (Types of Contract, Sub-Contracting, Tenders, Payment to Contractors), Project Audit. IT in Projects: Overview of types of Software for Projects, Major Features of Project Management Software like MS Project, Criterion for Software Selection.

MODULE-IV [6 Lectures]
Entrepreneurship: Meaning & Concept of Entrepreneurship, Conditions needed for Entrepreneurship (Social Factors, Economic Factors, Psychological Factors, Legal Factors, Education & Technical Knowhow, Financial Assistance), Qualities of a Prospective Entrepreneur.
Entrepreneurial Motivation: McClelland's N-Ach Theory (Need for Affiliation, Need for Power, Need for Achievement),Self–Analysis, Personal Efficacy, Culture & Values, Risktaking Behaviour, Technology Backup. Entrepreneurial Skills: Creativity, Problem Solving, Decision Making, Communication, Leadership Quality.

Textbooks:
1. P. Gopalkrishnan and R. M. Moorthy; Text Book of Project Management, Macmillan
2. K. Nagarajan; Project Management, New Age International Publishers; 5th Edn.

3. P. Chandra; Projects; Tata McGraw Hill; 6th Edn.
4. J. M. Nicholas; Project Management for Business and Technology – Principles and Practice; Prentice Hall India; 2nd Edn.
5. H. Maylor; Project Management; Pearson; 3rd Edn.
6. D. F. Kuratko and R. M. Hodgetts; Entrepreneurship; Thomson Learning; 7th Edn.
7. R. Roy; Entrepreneurship; Oxford University Press.

Reference Books:
1) S. A. Kelkar; Software Project Management: A concise Study; Prentice Hall India; 2nd Edn.
2) F. K. Levy, J. D. Wiest; A Management Guide to PERT/CPM with GERT/PDM/DCPM and other networks; Prentice Hall India, 2nd Edn.
3) J. Mantel, J. R. Meredith, S. M. Shafer, M. M. Sutton, M. R. Gopalan; Project Management: Core Text Book, Wiley India, 1st Indian Edn.
4) L. C. Jhamb; Industrial Management-II; Everest Publishing House; 10th Edn.
5) S. N. Chary; Production and Operation Management; Tata McGraw Hill
6) Clements, Gido; Effective Project Management; Thomson Learning
7) C. F. Gray, E. W. Larson; Project Management; Tata McGraw Hill; 3rd Edn.

Course Outcome (CO):
After successful completion of this course, the student will be able to:
1. Learn general concept of a project and project management, the importance of project life cycle and essential elements of project planning.
2. Analysis of project evaluation, project scheduling as well as project cost control through application of financial and mathematical tools.
3. Learn details of legal and quality aspects of project management to face various issues.
4. Study and demonstrate the features of different project management softwares with special emphasis on “MS Project” and can able to select the best PMS subject to desired requirements.
5. Develop skills of entrepreneurship both theoretical and practical approach and can take initiative of starting a new business.
6. Align the successful approach of entrepreneurship in undertaking large investment projects for the necessity and benefit of the society.

CHE-PC691
Chemical Engineering Lab - II
0L:0T: 4P
2 credits

Pre-requisites : Chemical Reaction Engineering I, Mass Transfer - II
Objectives

Chemical Engineering lab provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also serves as a bridge between theory and practice. This particular lab focuses on fluid dynamics, heat and mass transfer.

Contents :

i) 6– 7experiments on Chemical Reaction Engineering such as: residence time distribution, axial dispersion in columns, pipes and stirred tanks, plug flow and CSTR, kinetics of reactions such as dehydration of butanol, condensation polymerization, esterification and hydrolysis, degradation of dyes using photocatalysts etc. (24 lab. hrs)

ii) 6 – 7 experiments on Mass Transfer such as: batch and steam distillation, packed and plate distillation columns, adsorption and ion exchange, liquid – liquid extraction columns, drying (24 lab. hrs)

Total 48 lab. Hrs

Course Outcomes Students will be able to

 Learn how to experimentally verify various theoretical principles

 Develop experimental skills

 Visualize practical implementation of chemical engineering equipment

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Ceramic Technology
CHE-OE605 a
3L: 0T: 0P
3 credits

Module I 10 L

Introduction to Ceramics: Definition & Classification of ceramic materials based on composition, properties & applications (Refractories, cement, Glass & Whitewares, Electro-ceramics & magnetic ceramics & Fine ceramics & Glass-ceramics, Cermets);

Fundamental Structural principles, composition, properties & uses: Natural ceramic minerals & materials such as Clay family,Quartz/Quartzite, Feldspar, sillimanite, Bauxite family, Dolomite, Magnesite, etc &Synthetic Ceramic Raw Materials such as sintered Al2O3, fused Al2O3, Mullite, Mag-Al Spinel, ZrO2, TiO2/ Titanate, Ferrites, spinel etc. Importance of synthetic ceramic raw materials, Preparation & composition; General techniques of preparation: powder preparation: Sol-Gel, Co-precipitation, solvent vaporization; Characterization & uses.

Thermal changes and behaviours of ceramic materials: Bauxite family, magnesite, dolomite, chromite, graphite, clay minerals

Module II 10 L

Materials properties & behaviours: Particle mechanics and rheology, Newtonian fluid, plastic flow, dilatant liquid, thixotropy,Deflocculation, effect of electrolytes on Zeta potentials applications in ceramic processings. Beneficiation Processes, Comminution: Equipments, milling, particle size distribution. Principles of ceramic fabrication: Size reduction, size separation, Body preparation, Filtration, Methods of forming;Forming processes: Dry pressing, cold isostatic pressing, plastic forming – Extrusion, Jiggering, Jolleying; Casting process: Slip Casting, Drying –drying processes, Mechanisms in drying, defects shaping, surface finishing, and glazing. Firing – Firing system, Pre sintering processes, sintering, and vitrification and cooling.

Module III 10 L

Refractories: Introduction: raw materials, Fabrication and firing, General manufacturing techniques, Properties and applications of following refractories: Acid (Silica) Refractories, Basic Refractories, Burnt refractories – Sintered and fused refractories: -Chemically bonded and Direct bonded; Insulating Refractories; Testing of important properties of refractories: Total Porosity, gravity, C.C.S, Cold MOR, Hot MOR, PCE, RUL, Compressive Strength, Spalling Resistance, corrosion resistance.

Cement: Definition & different types of cement, Raw materials and their physico – chemical characteristics, manufacturing processes of Pozzolana, Portland cement, cement making kilns viz, Rotary and shaft kiln. Refractory used in Rotary kiln, reactions occurred in different zones of rotary kiln. Testing of different properties of cement: Hydraulicity, Soundness, Compressive strength,Heat of setting & hardening etc;

Module IV 15 L

Glass: Definition of glass: Thermodynamic study for glass formation, Glass transitions Conditions of vitrification; Glass processing: selection of raw materials, effects of different oxides on glass properties, batch preparation, melting in glass tank furnace, refining of glass, Forming process: Blowing, molding , shaping etc; Properties of glass: Optical properties of glasses namely, Refractive index, Birefringence, ultraviolet– visible absorption, Colloidal colours, Solarisation, Infra-red absorption, Photosensitive/Photo chromic glasses. Whitewares: Definition, Raw materials, compositions, Body preparation & fabrication, Drying, Firing, Glazing & decorations, Defects & remedies, Current trend & future challenges.

Powder Metallurgy: process description, Maintenance of metal powders, Blending of powders, Compaction, Pre-sintering, Sintering, Secondary operation, Products of powder metallurgy, Advantage of the process, Disadvantages & limitation, Design.

Text Books:

2. Elements of Ceramics - F.H Norton

3. Introduction to Ceramics - W.D Kingery

4. Industrial Ceramics - Singer & Singer.

Reference:

5. S. Kumar: Hand book of ceramics ; Vol – I & II

6. The Technology of Ceramics and Refractories – P.P. Budnikov.

7. Cement Chemistry by F.W. H. Taylor

8. Concrete Technology by Neville.

Project Engineering
CHE-OE605 b
3L: 0T: 0P
3 credits

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I 15 L

Role of a project engineer, Development of project- Laboratory bench scale experiment to pilot & semi-commercial plant operation, scale up and scale down techniques, pre-design cost estimation, fixed capital and working capital, Manufacturing cost , plant location factors, selection of plant site, process design development, plant lay-out.

Module II 10 L

Time value of money, simple interest, Nominal & effective interest rates, continuous interest, present worth & discount, Annuities, perpetuities and capitalized cost, Depreciation,: Types of depreciation, Depletion, Concepts of service life, Salvage value and Book value; Depreciation calculation by straight line method, Text book and double declining balance method, sum-of-the-years digit method and sinking fund method.

Module III 10 L

Profitability analysis method: Return on investment (ROI), payout period, Net present worth (NPW), Discounted cash flow rate of return, (DCFR), effect of inflation on profitability, Alternative investment,; Choices among various alternatives, Replacements, Methods of profitability evaluation for replacements.Optimum design, Break-even point, Optimum production rate, Optimum conditions in cyclic operations, optimum economic pipe diameters, optimum flow rate,& cooling water.

Module IV 10 L

Project scheduling: Bar chart, Milestone chart, Concept of network analysis,: PERT, CPM, statistical distribution associated with PERT network, Earliest expected time, and latest allowable occurrence time calculation, Slack, determination of critical path,concept of float.

Text Books:

1. Plant Design & Economics for Chemical Engineers- By M. Peter & K.D. Timmerhaus, 4rth edn, MGH

2. Chemical Engineering Plant Design-By Himmelblau.

3. PERT CPM, L. S. Srinath, East West Press