Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of

B. Tech. (Chemical Engineering)

Pattern 'B22/C22/D22'

Effective from Academic Year 2022-23

B.Tech. Chemical Structure Pattern D22 (applicable w.e.f. AY 22-23)

Final Year Module -VII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	MD4206	MARKETING MANAGEMENT	2	-		2
S2	CH4203	PLANT ENGINEERING AND PROJECT ECONOMICS	2			2
S3	CH4205	TRANSPORT PHENOMENA	2	-	-	2
S4	CH4289	MAJOR PROJECT	-	20	-	10
OR						
S1	CH4293	INDUSTRY INTERNSHIP	-	-	-	16
	CH4291	RESEARCH INTERNSHIP				
	CH4294	INTERNATIONAL INTERNSHIP				
	CH4292	PROJECT INTERNSHIP				
Total						16

Final Year Module -VIII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH4259	INDUSTRIAL POLLUTION CONTROL	2	-		2
S2	CH4353	BIOPROCESS ENGINEERING	2			2
S3	CH4255	NANOSCIENCE AND NANOTECHNOLOGY	2			2
S4	CH4280	MAJOR PROJECT 2	-	20	-	10
OR						
S1	CH4293	INDUSTRY INTERNSHIP	-	-	-	16
	CH4291	RESEARCH INTERNSHIP				
	CH4294	INTERNATIONAL INTERNSHIP				
	CH4295	CAPSTONE PROJECT				
Total						16

FF No. : 654

MD4206::MARKETING MANAGEMENT

Course Prerequisites: None

Course Objectives:

1. To provide basic understanding of marketing management concepts and their relevance to business development
2. To make students aware of the questionnaire for market research
3. To provide understanding of consumer & industrial buying decision process & motives.
4. 4.To provide understanding of the concept of product management and branding in context of consumer and industrial products
5. To develop knowledge for optimizing marketing mix to get competitive advantage

Credits:2 **Teaching Scheme Theory: 2** Hours/Week

Course Relevance: This course will provide basic knowledge of Marketing for working in a business environment.

SECTION-1
1. Concepts of Marketing *Definition of Marketing, Core marketing concepts, Marketing Management philosophies, Micro and Macro Environment, Characteristics affecting Consumer behavior, Types of buying decisions, buying decision process, Classification of consumer products, Market Segmentation* ***2. Marketing Information Systems And Research*** *Components of marketing information system–benefits & uses marketing research system, marketing research procedure, Demand Estimation research, Test marketing, Segmentation Research - Cluster analysis, Discriminant analysis. Sales forecasting: objective and subjective methods*

3. Marketing of Industrial Goods

Nature and importance of the Industrial market, classification of industrial products, participants in the industrial buying process, major factors influencing industrial buying behavior, characteristics of industrial market demand. Determinants of industrial market demand Buying power of Industrial users, buying motives of Industrials users, the industrial buying process, buying patterns of industrial users.

SECTION-1I

Topics and Contents

1. Product Management

The concept of a product, features of a product, classification of products, product policies – product planning and development, product line, product mix – factors influencing change in product mix, product mix strategies, meaning of "New – product; major stages in new – product development product life cycle.

2. Branding

Reasons for branding, functions of branding features of types of brands, kinds of brand name.

3. Pricing Policies

Importance of Price, pricing objectives, factors affecting pricing decisions, procedure for price determination, kinds of pricing, pricing strategies and decisions

4. Advertising and Sales Promotion (Digital marketing)

Objectives of advertisement function of advertising, classification of advertisement copy, advertisement media – kinds of media, advantages of advertising. Objectives of sales promotion, advantages sales promotion,

5. Packaging

Meaning, growth of packaging, function of packaging, kinds of packaging.

List of Home Assignments:

Design:

1. Consumer Analysis for a firm
2. Market segmentation plan
3. Business market stakeholder analysis
4. Product line analysis
5. Pricing strategy for the product/service

Case Study:

1. How Social Media Insights Marketing
2. Impact of E-Commerce on marketing
3. Case study on societal Marketing
4. Product Development analysis
5. Personal Selling

Blog

1. Marketing through social media
2. Changing buying motives for the consumer
3. Ethics in marketing
4. Marketing & Distribution
5. Industrial engineering tools for marketing

Surveys

1. Consumer Analysis
2. Market analysis for particular Product or Service
3. Factors influencing industrial buying
4. Impact of promotion
5. 5. Impact on advertisement on the consumer preferences.

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

Assessment scheme

Sr. No	*Type of Assessment*	*Conduction*	*Marks*
1	*MCQ Exam – Section I*	*Mid Semester*	*30 Marks converted to 30 equivalent Marks*
2	*Home Assignment*	*End of Semester*	*100 Marks converted to 10 equivalent Marks*
3	*MCQ Exam – Section II*	*End of Semester*	*30 Marks converted to 30 equivalent Marks*
4	*Comprehensive Viva Voce*	*End of Semester*	*100 Marks converted to 30 equivalent Marks*

Text Books: ***(As per IEEE format)***

1. Narendra Singh; Project Management & Control; Himalaya Publishing House, Mumbai
2. S. Choudary, Project Management, Tata McGraw Hill

Reference Books: ***(As per IEEE format)***

1. Wiliam J Stanton, Fundamentals of Marketing Mcgraw Hill
2. R.S.N. Pillai and Mrs. Bagavathi , Marketing S. Chand

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

Students will be able to:

1. Learn the basic concepts of project and project management
2. Ascertain the feasibility of small and medium projects with respect to managerial, marketing, operational, financial and socio-economic perspectives
3. Plan and schedule small and medium projects to achieve the triple constraint of time, cost
4. Understand the concepts of project risk
5. Monitor the progress of projects to determine variances and recommend corrective actions

CO PO Map

CO attainment levels

Future Courses Mapping:

Mention other courses that can be taken after completion of this course

Job Mapping:
What are the Job opportunities that one can get after learning this course

FF No. : 654

CH4203:: PLANT ENGINEERING AND PROJECT ECONOMICS

Course Prerequisites: Chemical Processes, Process equipment design

Course Objectives:

The student will be able to

1. Understand capital cost estimation, product cost estimation
2. Understand different interest rates, cash flows, taxes and insurance
3. Understand depreciation and profitability analysis
4. Understand general consideration: health and safety hazards

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Tut: …0... Hours/Week

Lab: **0…...** Hours/Week

Course Relevance: The study of the subject will help to understand general design considerations, health and safety considerations, different types of cost estimations of chemical plants. Move over this subject also deals with depreciation and different types of methods for depreciation calculations.

SECTION-1

Topics and Contents

Chemical Plant Cost Estimation; Cash flow for industrial operations: Cumulative cash position, Factors Affecting Investment and Production Costs, Capital Investments: Fixed-Capital Investment, Working Capital, and Estimation of Capital Investment: Types of Capital Cost Estimates, Cost Factors in Capital Investment, Estimation of Total Product Cost: Manufacturing Costs, General Expenses. Estimation of various components of project cost as per recommended practice by India Financial Institutes, Plant & machinery estimate, Cost of Production. Cost Indexes

SECTION-1I

Topics and Contents

Depreciation: purpose of depreciation as a cost, types of depreciation, depletion, service value, salvage value, present value, depreciation in chemical project, methods for determining depreciation, appreciation of depreciation concept, depreciation rates.

Health and Safety Considerations; General Design Considerations: Health and Safety Hazards, Loss Prevention: Hazard Assessment Techniques: HAZOP, HAZAN, Fault Tree Analysis, etc.

List of Home Assignments:

Design:

1. Estimation of profitability
2. HAZOP analysis of Urea manufacturing plant
3. Fault Tree analysis of Distillation column
4. Estimation of total product cost
5. Estimation of depreciation

Case Study:

1. Personal safety and industrial safety
2. Recent trends in cost estimation of chemical plant
3. Sustainable energy sources
4. Capital cost estimation of the chemical plant
5. Safety consideration in a particular plant.

Blog

1. Safety-A major issue in chemical industry
2. New trends in chemical industries
3. Importance of pilot plant in chemical industry
4. Cash flow in the chemical industry.
5. Importance of depreciation.

Surveys

1. Market survey of a particular chemical.
2. Various cost indices used in Chemical industry cost estimation
3. Various types of annuities in India
4. Different types of taxes in India
5. Different types of methods for calculation of depreciation

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*20*	*20*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. Peters, M.S., Timmerhaus, K.D. "Plant design and economics for chemical engineers", 4th Edition, McGraw Hill, 1990.

Reference Books: ***(As per IEEE format)***

1. Mahajani V.V., Mokashi S. M. "Chemical Project Economics", Macmillan India Publication, 1st Edition, 2005.
2. Bausbacher E. and Hunt R. "Process Plant Layout and Piping Design", 1st Edition, Prentice Hall Publication, 1993.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:
The student will be able to

1. Estimate & predict capital investment of chemical plant
2. Estimate & predict total product cost of chemical plant.
3. Describe and calculate depreciation
4. Describe different health and safety measures in chemical industry

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:2	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:3	1	1	2	1	1	1	1	0	0	0	2	2	3	1
CO: 4	1	1	3	1	1	3	2	1	0	0	2	2	3	1

CO attainment levels

CO	Attainment level
CO : 1	**4**
CO : 2	**5**
CO : 3	**5**
CO : 4	**4**

Future Courses Mapping:
Project Management

Job Mapping:
All core chemical industries e.g. Oil and gas, paint, fertilizers, food, industrial chemicals manufacturing, etc

FF No. : 654

CH4205::TRANSPORT PHENOMENA

Course Prerequisites: Fluid Flow Operations, Heat Transfer and Mass Transfer

Course Objectives:

The student will learn to

1. Set up shell momentum balance for chemical engineering systems
2. Set up shell heat balance for chemical engineering systems
3. Set up shell mass balance for chemical engineering systems
4. Study various aspects of turbulent transport phenomena
5. Study various aspects of problems in boundary layer theory

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Course Relevance:.

1. Chemical engineering systems where space dimensions are considered are studied within the scope of Transport Phenomena.
2. Most of the problems considered in the prescribed textbook are systems of parabolic partial
3. differential equations.
4. In general, the problems in transport phenomena arise in allied engineering sciences such as
5. biochemical, biological, agricultural, pharmaceutical, molecular and material sciences and other

6. areas.
5. The topics focus on studies relevant to transport processes (momentum, heat and mass) and
7. obtain vector field expressions for fluid velocity, temperature and concentration of substances in
8. solids/ liquids.
6. Examples can be drawn from fluid flow operations, mass transfer operations and heat transfer
9. problems of interest in engineering applications and include problems in homogeneous and heterogeneous catalysis and general problems in chemical reaction engineering.

SECTION-1
Newton's law of viscosity, temperature and pressure dependence of viscosity for gases and liquids. Basics of momentum transport, combined momentum flux. Equation of continuity, equation of motion. Shell momentum balances and boundary conditions. Shell momentum balances for flow of falling film, flow through circular tube, flow through annulus, flow of two adjacent immiscible fluids etc. Fourier law of energy transport. Dependence of thermal conductivity on temperature, pressure. Shell energy balances for heat conduction: Heat flux and temperature distribution for heat sources such as electrical, nuclear, viscous. Heat flux through composite walls.
SECTION-1I

Fick's law of diffusion. Temperature and pressure dependence of diffusivity. Shell mass balances for diffusion through stagnant film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion and chemical reaction inside a porous catalyst etc. Turbulent transport phenomena, Boundary layer theory. Macroscopic momentum, energy and mass balances. Use of macroscopic balances to solve steady state and unsteady state problems.

List of Home Assignments:

Design:

1. Design of a viscometer.
2. Design of a spherical gas storage vessel.
3. Design of a multiphase reactor.
4. Design of a membrane bioreactor.
5. Design of a membrane separation unit.

Case Study:

1. Importance of Mass Transfer in Industries.
2. Importance of Heat Transfer in Industries
3. Advantage and Disadvantage of Laminar and Turbulent in Industries
4. Diffusion in Stagnant fluid
5. Flow through circular tubes and annulus

Blog:

1. Heat flux and temperature distribution for heat sources such as electrical and nuclear.
2. Temperature and pressure distribution of diffusivity
3. Thermal and momentum boundary layer theory
4. Equation of continuity and motion
5. Newton's law of Viscosity.

Survey:

1. Transport phenomena in Biomaterials
2. Transport phenomena during convective drying with superheated steam and moist air.
3. Heat flux through composite wall
4. A linear theory of transdermal transport phenomena
5. Problem in Food Process Engineering

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*10*	*30*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. Bird R. B, Stewart W.E., Lightfoot E.W., 'Transport Phenomena', John Wiley, 2ndEd., 2000.
2. Brodkey R. S., Hershey H. C., 'Transport Phenomena', McGraw-Hill International Edition,1988.

Reference Books: ***(As per IEEE format)***

1. Wilty J.R., Wilson R.W., Wicks C.W., 'Fundamentals of Momentum, Heat and Mass Trasport', 2nd Ed., John Wiley, New York, 1973.

Moocs Links and additional reading material:
1.www.nptelvideos.in

2. https://www.edx.org/course/the-basics-of-transport-phenomena

3. https://www.edx.org/course/advanced-transport-phenomena-2

4. https://www.edx.org/course/analysis-of-transport-phenomena-i-mathematical-met?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner

5. https://www.edx.org/course/analysis-of-transport-phenomena-ii-applications?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner

Course Outcomes:
The student will be able to

1.Solve shell momentum balance problems for simple systems.
2. Solve shell energy balance problems for simple systems.
3. Solve shell mass balance problems for simple system.
4. Set up and solve macroscopic momentum balances for a given system.
5. Set up general equations of continuity and motion.
6. Carry out dimensional analysis and scale up exercise for complex systems.

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:2	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:3	1	1	2	1	1	1	1	0	0	0	2	2	3	1
CO: 4	1	1	3	1	1	3	2	1	0	0	2	2	3	1
CO: 5	1	1	3	1	1	3	2	1	0	0	2	2	3	1

CO: 6	**1**	**1**	**3**	**1**	**1**	**3**	**2**	**1**	**0**	**0**	**2**	**2**	**3**	**1**

CO attainment levels

CO	Attainment level
CO : 1	**4**
CO : 2	**4**
CO : 3	**5**
CO : 4	**5**
CO : 5	**5**
CO : 6	**5**

Future Courses Mapping:

Students wishing to apply for higher education in Indian as well as in foreign Universities should take up this course, as they will be learning advanced transport phenomena during MS/ M.Tech. programs. The scope of transport phenomena is such that it covers all chemical engineering subdisciplines and finds applications in real life problems.

Job Mapping:

Once transport phenomena course is completed successfully by a student, s/he will be able to derive a problem statement for applications of fluid flow operations, heat transfer, mass transfer and chemical reaction engineering problems. Thus, the subject is of importance to devise and solve problems in process and plant engineering and so of relevance to industrial design practice and trouble shooting.

FF No. : 654

CH4289::MAJOR PROJECT

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The Students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 10

Teaching Scheme Theory: ….. Hours/Week

Tut: ……... Hours/Week

Lab: **20** Hours/Week

Course Relevance:.....

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.*

The external from Industry/research organization is invited to evaluate the projects done by students.

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

1. https://nptel.ac.in/courses/103/103/103103039/#watch
2. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
3. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
4. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
5. https://www.coursera.org/learn/uva-darden-project-management
6. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out research and development work.
5. Design equipments or process for chemical engineering plants.
6. Document findings or design in selected topic

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	3	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level

1	**2**
2	**3**
3	**3**
4	**5**
5	**5**
6	**4**

Future Courses Mapping:

Semester long inturnship

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

CH4353:: BIOPROCESS ENGINEERING

Course Prerequisites:

Course Objectives:

The student will be able to

1. To understand cell structure and biochemicals.
2. To understand enzymes and enzyme kinetics.
3. To understand different types of bioreactors and scale up bioreactors.
4. To understand commercially used different bioprocesses.

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Tut: …0... Hours/Week

Lab: **0…...** Hours/Week

Course Relevance:. The study of the subject will help to understand basic concepts of biochemicals, enzymes and enzyme kinetics required in the design of bioprocesses and different types of bioreactors used in bioprocesses. This subject also gives an overview of scale up of bioreactors and commercially used different bioprocesses.

SECTION-1
Topics and Contents *Introduction to structure of cells, important cell types, growth of microbial cells. Bio-chemicals: Primary, secondary, tertiary structure of biomacromolecules such as lipids, sugars and polysaccharides, nucleotides, RNA, DNA, amino acids, proteins, hybrid biochemicals etc. Enzyme substrate complex and enzyme action with examples from industrial enzymes, simple enzymes, kinetics with one and two substrates. Michaelis-Menten kinetics. Models of enzymes kinetics with brief introduction*

SECTION-1I

Topics and Contents

Major components in bioreactor, Types of bioreactors, modern bioreactors types, scale up and its difficulties, considerations on aeration, agitation, and heat transfer, Discuss manufacturing process for major products produced by biochemical reactions such as alcohol, acetic acid and vinegar, acetone, lactic acid, citric acid, wine.

List of Home Assignments:

Design:

1. Bioreactor design.
2. Michaelis-Menten kinetics
3. Enzyme kinetics with one substrate
4. Enzyme kinetics with two substrate
5. Monod growth kinetics

Case Study:

1. Scale up of bioreactor.
2. Lactic acid manufacturing.
3. Acetic acid manufacturing.
4. Ethanol manufacturing.
5. Single cell proteins.

Blog

1. Different types of bioreactors.
2. Enzyme substrate complex.
3. Different types of enzymes.
4. Different types of proteins.
5. DNA

Surveys

1. Applications of bioprocesses in the food sector.
2. Applications of bioprocesses in the healthcare sector.
3. Applications of bioprocesses in the industrial chemicals sector.
4. Applications of bioprocesses in the dairy sector.
5. Applications of bioprocesses in the agricultural sector.

Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*20*	*20*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. Bailey, James E Ollis, Davis F, "Biochemical Engineering", McGraw Hill.
2. Shuler M. L. and F. Kaegi, 'Bioprocess Engineering – Basic Concepts', Prentice Hall Publication ,2nd Edition

Reference Books: ***(As per IEEE format)***

1. Aiba A-Humphery A.E., Mills N.F , "Biochemical Engineering",., Academic Press.
2. Atkinson B, "Biochemical Reactors", Pion Ltd. London.
3. Ghosh T.K., et. Al., "Advances in Biochemical Engineering", Vol.1/3, Springer Verlag 1971-74
4. Wingard L.B., "Enzyme Engineering", Fr. Interscience N.Y. 1972.
5. Peavy H. S., Rowe D. R., Tchobanoglous G., "Environmental Engineering", McGraw-Hill, 1985.
6. P. F. Stanbury, A. Whitekar, S. J. Hall, 'Principles of Fermentation Technology', Butterworth-Heinemann An Imprint of Elsevier, 2nd Edition.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:
The student will be able to

1. Describe different types of biochemicals.
2. Derive the kinetics & describe mechanism of bio-cataysis.
3. Describe various components & types of bioreactors.
4. Describe various bioprocesses in chemical industry

CO PO Map

CO/PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO : 8	PO: 9	PO:10	PO:11	PO:12	PSO: 13	PSO: 14
CO:1	1	1	1	1	0	1	3	0	1	1	1	2	1	3
CO:2	1	1	1	1	0	1	3	0	1	1	1	2	1	3
CO:3	1	1	1	1	0	1	3	0	1	1	1	2	1	3
CO: 4	1	1	1	1	0	1	3	0	1	1	1	2	1	3

CO attainment levels

CO	Attainment level
CO : 1	**3**
CO : 2	**4**
CO : 3	**5**
CO : 4	**5**

Future Courses Mapping:
Biotechnology

Job Mapping:
Pharmaceutical industries, Water and wastewater treatment plants, Food industries, Medicine sector, Industrial chemical manufacturing, etc

FF No. : 654

CH4255:: NANOSCIENCE AND NANOTECHNOLOGY

Course Prerequisites: None

Course Objectives:

The student will be able to

1. To get an overview of the state of the art, historical development and future trends in nanoscience and nanotechnology
2. To understand the various characterization techniques which lie at the heart of the development of the field
3. To understand various methods of synthesis and industrial production of nanosystems

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Course Relevance:.

The course aims to provide an overview of the highly multidisciplinary field of nanoscience and nanotechnology which has a vast range of applications.

SECTION-1
Topics and Contents Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenge of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application.

SECTION-1I

Introduction to surface active agents. Theory and applications. Types of surfactants. Classification, synthesis of surfactant - Shape, size and structure of surfactants. Micelle, Emulsions, Microemulsions & Gels. Kraft temperature, surfactant geometry and packing. Introduction to colloidal material, surface properties, origin of colloidal particles, preparation & characterization of colloidal particles. Applications of super hydrophilic hydrophobic surfaces, self-cleaning surfaces. Intermolecular Forces, Van der Waals forces (Kessorn, Debye, and London Interactions). Dynamic properties of interfaces. Contact angle. Brownian motion and Brownian Flocculation. Surface free energy

List of Home Assignments:

Design:

1. Nanomaterials for heat exchange applications
2. Polymer based nanocomposites
3. Nanoadsorbents for contaminants remediation
4. Measuring the flow of nanoparticles using flow meters
5. Design of a carbon nanotube manufacturing plant

Case Study:

1. Materials innovation for 3D printing
2. Additive manufacturing and its benefits to aerospace industry
3. Carbon nanotube sensors for gas detection
4. Optical fiber sensor to monitor energy storage
5. Machine learning in nanotechnology

Blog:

1. Is it too soon to call 3D printing a clean technology?
2. How could Graphene be used in future optical communications?
3. Can Nanodiamonds be used for next generation energy storage?
4. How can nanophotovoltaics help in the maximum efficiency of energy generation?
5. Applications of deep learning in nanotechnology

Surveys:

1. Comparison between particle analysis techniques
2. Application of nanoparticles in the remediation of heavy metals
3. Nanomaterials in protective coatings
4. Nanotechnology in agriculture
5. Career opportunities for chemical engineers in nanotechnology

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Suggest an assessment Scheme:
Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*20*	*20*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. R. W. Kelsall et al, "Nanoscale Science and Technology", John Wiley and Sons, 2005.
2. C. P. Poole Jr, F. J. Owens, "Introduction to Nanotechnology", Wiley India, 2006.
3. D. J. Griffiths, "Introduction to Quantum Mechanics", D.J. 2nd ed. Pearson, 2005.

Reference Books: ***(As per IEEE format)***

1. B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer, 2004.

Moocs Links and additional reading material: www.nptelvideos.in

1. P. Haridoss, "Nanotechnology: Science and Applications', NPTEL, [Online]. Available: https://nptel.ac.in/courses/113/106/113106093/
2. A. Subramaniam and K. Balani, "Nanostructures and Nanomaterials: Characterization and Properties", NPTEL, [Online]. Available:

https://nptel.ac.in/courses/118/104/118104008/

Course Outcomes:
The student will be able to

1. Comprehend basics of nanotechnology and surface active agent
2. Comprehend effects of different parameters on nanoparticle synthesis size, area to volume ratio etc.
3. Understand effect of surfactants on nanoparticle synthesis
4. Comprehend several dimensions of nanoparticles and understand the behaviour of hydrophilic and hydrophobic nature of surface-active agents
5. Classify nano particle-based on shape size and structure
6. Comprehend different applications of nanoparticles and surfactants

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	3	1	1	1	0	1	1	1	1	1	1	1	1	2
CO:2	0	0	0	0	0	0	0	3	3	1	3	1	1	2
CO:3	3	1	1	1	1	1	1	1	1	1	1	1	1	2
CO: 4	3	1	1	1	0	1	1	1	1	1	1	1	1	2
CO: 5	0	0	0	0	0	0	0	3	3	1	3	1	1	2
CO: 6	3	1	1	1	1	1	1	1	1	1	1	1	1	2

CO attainment levels

CO	Attainment level

CO : 1	**4**
CO : 2	**4**
CO : 3	**4**
CO : 4	**4**
CO : 5	**4**
CO : 6	**4**

Future Courses Mapping:

Advanced materials

Job Mapping:
All core chemical industries e.g. Oil and gas, paint, fertilizers, food, industrial chemicals manufacturing, etc

CH4288::MAJOR PROJECT 2

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 10 **Teaching Scheme Theory: …..** Hours/Week

Tut: ……... Hours/Week

Lab: **20** Hours/Week

Course Relevance:.....

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.*

The external from Industry/research organization is invited to evaluate the projects done by students.

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

7. https://nptel.ac.in/courses/103/103/103103039/#watch
8. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
9. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
10. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
11. https://www.coursera.org/learn/uva-darden-project-management
12. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out research and development work.
5. Design equipments or process for chemical engineering plants.
6. Document findings or design in selected topic

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level

1	**2**
2	**3**
3	**3**
4	**5**
5	**5**
6	**4**

Future Courses Mapping:

Semester long inturnship

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH4293::INDUSTRY INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. Digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Industrial Internship.
6. Students need to submit monthly reports to Company and Institute.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipment's or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

FF No. : 654

CH4291::RESEARCH INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Research Internship.
6. Students need to submit monthly reports on Research Project.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipments or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

FF No. : 654

CH4294::INTERNATIONAL INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. digital record duly signed by competent authority.
4. Total Internship period is approximately 16 weeks or 4 months.
5. Internship undertaken to be taken outside India as Industrial Internship or Research Internship.
6. Students need to submit monthly reports on Industry Project/Research Project.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipments or process for chemical engineering plants or apply knowledge in core and multidisciplinary field though research and development
3. Work effectively as member or leader in team
4. Organize, comprehend and write technical report
5. Follow ethics and professional standards of organization/industry

FF No. : 654

CH4292::PROJECT INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and
3. Produce digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Project Internship.
6. Students need to submit monthly project report.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipment's or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

PROGRAM OUTCOMES:

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES STATEMENTS

Engineering Graduates will be able to:

1. Work in chemical engineering organizations demonstrating expertise in conventional chemical engineering design and operations.

2. Work in diverse, multidisciplinary fields such as biotechnology, nanotechnology, food, energy, environmental, product designs etc.