UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VIII SEMESTER

BIOTECHNOLOGY & BIOCHEMICAL ENGINEERING

SCHEME -2013

VIII SEMESTER

BIOTECHNOLOGY & BIOCHEMICAL ENGINEERING (B)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/P				
13.801	Bioprocess Plant and Equipment Design (B)	5	3	2	-	50	4	100	150
13.802	Economics and Management of Process Industries (B)	4	2	2	-	50	3	100	150
13.803	Environmental Pollution, Monitoring and Control (B)	4	3	1	-	50	3	100	150
13.804	ELECTIVE III	4	3	1	-	50	3	100	150
13.805	ELECTIVE IV	4	3	1	-	50	3	100	150
13.806	Bioinformatics Laboratory (B)	3	-	-	3	50	4	100	150
13.807	Project and Viva Voce (B)	5	-	-	5	200		100	300
	Total	**29**	**14**	**7**	**8**	**500**		**700**	**1200**

13.804 Elective III

13.804.1	Bio-entrepreneurship (B)
13.804.2	Bio-fuel Technology and Engineering (B)
13.804.3	Research Methodologies (B)
13.804.4	Modeling and Scale Up of Bioreactors (B)
13.804.5	Project Engineering (B)

13.805 Elective IV

13.805.1	Process Optimization (B)
13.805.2	Bioengineering and Nanotechnology (B)
13.805.3	Commercialization, Marketing and Management of Biotech Products (B)
13.805.4	Total Quality Management (B)
13.805.5	Mathematical Modeling and Simulation of Bioprocesses (B)

13.801 BIOPROCESS PLANT AND EQUIPMENT DESIGN (B)

Teaching Scheme: 3(L) - 2(T) - 0(P) **Credits**: 5

Course Objective:

This course is aimed at providing adequate training on the basic aspects of mechanical and process design of industrial equipments. The concepts built from preceding courses on momentum transfer, heat transfer and mass transfer shall find increased applications in this course.

Module – I

General design considerations; Design codes; Design pressure; Design temperature; Design stress; materials; welded joint efficiencies; corrosion allowances; Design loads, liquid storage tank codes, classification, Storage tanks for liquefied gases, Horizontal, cylindrical storage tanks with flat head, design of shell, bottom plates, self supported, and column supported roofs, wind girder, nozzles and other accessories.
Bolted Flanges: Types of Flanges, and selection, Gaskets-Design and selection of gasket, gasket seating, bolt diameter. Design of non-standard flanges.

Unfired pressure vessel: Pressure vessel codes, classification of pressure vessels, Design of cylindrical and spherical shell under internal and external pressures; Selection and design of flat plate, torispherical, ellipsoidal, and conical closures, compensations of openings.
Tall vertical & horizontal vessels: Pressure dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses, Shell design of skirt supported vessels. Vessel supports; Design of skirt, lug, and saddle supports.
Design of Pipes: Pipe thickness, pipe diameter for condensate piping, pipe diameter for steam, pipe supports.

Module – II

Design Of Heat Transfer Equipments: Design and sketching of Heat Transfer Equipments such as Double pipe heat exchangers, shell and tube heat exchangers, condensers- tubular horizontal and tubular vertical, evaporators- single effect and multiple effect, crystallizers.

Design Of Mass Transfer Equipments: Design and sketching of mass transfer equipments such as distillation columns, absorption columns, dryers.

References:

1. Bhattacharya, B.C.,"Introduction to Chemical Engineering Design – Mechanical Aspects", Chemical Engineering Education Development Centre, IIT, Madras.
2. Joshi, M.V., "Process Equipment Design", Macmillan India.
3. Brownell & Young, "Process Equipment Design", John Wiley.

4. Perry, Robert H., Green Don W "8th Edn- Perry's Chemical Engineering Handbook"- McGraw Hill New
5. Delhi E. E. Ludwig – "Applied Process Design in Chemical Petrochemical Plants" – Gulf Publishing Co. 1964 Vol. – 2.
6. Coulson J.M. Richardson J.F. – "Chemical Engineering Vol-6th Edn". Pergamon.
7. Standards : IS 403 (1967), 803 (1963) & 2825 & TEMA

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 4 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (50 marks) - Candidates have to answer one full question out of the two from First Module. Each question carries 50 marks.

Part B (50 Marks) - Candidates have to answer one full question out of the two from Second Module. Each question carries 50 marks.

***Note:** IS Codes mentioned in the reference (item no. 4) are permitted for the examination.*

Course Outcome:

This course shall provide adequate training on the design of industrial equipments for heat, mass and momentum transfer. The knowledge acquired herein shall be applied to any appropriate process engineering situation, leading to a successful career as a bioprocess engineer

13.802 ECONOMICS AND MANAGEMENT OF PROCESS INDUSTRIES (B)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course objectives:

This course shall cover the economic aspects of operation of process industries. It shall cover various aspects of financial management and could be much beneficial to those who aspire to start up new ventures in process engineering.

Module – I

Introduction to Engineering economy,- Engineering Decision - makers, Problem solving Decision making. Interest and Interest Factors - Interest rate, simple interest & Compound interest factors.

Equivalence and cost comparisons : Time value of money and equivalence, Equations that are used in economic analysis, Compound interest as an operator, Unacost, Hoskolds formula, Cost comparisons, Present Worth Comparison, Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Unacost and capitalised cost.

Depreciations and taxes: Purpose of Depreciation as cost, Nature of depreciations - Methods for determining depreciation - Straight line method - sinking fund method - Declining balance method - Double declining balance method - Sum of digits methods - Units of production method. Taxes and depreciation method - Comparison of depreciation methods - Cost comparison after taxes, Present worth after taxes three continuous interest and discounting, Logic for continuous interest, Continuous interest as an operator, Uniform flow, Flow changing at an exponential rate, flow declining in a straight line to Zero - Discounting with improving performance, Unaflow - Capital recovery factor, Capitalised cost-taxes.

Module – II

Technical advancement and inflation : Displacement Vs replacement, One year more of existence, More than one year of existence, Uniform gradient series delay value of an existent inflation, Cost comparison under inflation, unaburden, high inflation rates, Inflation and technological advancements.

Capital requirements and cost of production for process plants - Equipment for process plants, cost index, Nelson refinery construction index - Material cost indices - Process equipment cost index - Material cost indices - Process equipment cost index - Labour cost index – equipment costs - Williams six-tenths factor.

Cost Estimation: Capital investments, Factors affecting investment & production costs, Fixed capital investment and working capital, Estimation of capital investment, direct cost and indirect costs, Types of capital cost estimates, Order of magnitude estimates, study estimates, preliminary estimate definitive estimate and detailed estimate,

Cost factors in capital investment, Cost and installation of purchased equipment, Estimating equipment costs by scaling 6/10 Factor Rule, insulation costs, Instrumentation and controls, Piping, Electric installation, Building, Yard improvements, Service facilities, Land design engineering and supervision, construction expenses contractors fee, Contingencies, Start up expenses, Methods for estimating capital investment. Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant. Estimation of total product cost, Manufacturing costs, general expenses - Direct production costs, Fixed costs, plant over head cost, administration expenses - Distribution and marketing expenses.

Module – III

Financial statements: Balance sheet and profit and loss accounts - Ratios used for comparing the balance sheet and profit and loss account.

Break even and minimum cost analysis, Types of costs, Cost analysis, Economic production charts, Differential analysis of economic production charts, criteria in the use of break-even and minimum cost analysis.

Module – IV

Profitability: Investment evaluation, Profitability standards, mathematical methods for profitability evaluation: pay out time, pay out time with interest, rate of return on original investment, return on average investment, discounted cash flow, Net Present worth, Venture worth.

References

1. Peters and Timmerhaus, *"Plant Design and Economics for Chemical Engineers"* McGraw Hill , New York , 4th Edition (2003)
2. Davies, G.S. *Process Engineering Economics"* CEED IIT Madras.
3. Kenneth King Humphrey, *Jelen's Cost and Optimization Engineering,* McGraw Hill, Third Edition, 1991
4. Robert S. Aries and Robert D.Newton, *"Chemical Engineering Cost Estimation "* Chemonomics, New York, 1951
5. John Happel and Donald G. Jordan, *"Chemical Process Economics"*, Marcel Decker (1975)
6. Vibrandt, F C, *Chemical engineering plant design,* McGraw Hill
7. Holand , E.A., Watson, F.A. and Wilkinson, J.K., *" Introduction to Process Economics",* John Wiley & Sons.
8. Paneerselvam R, *Engineering Economics,* PHI, Eastern Economy Edition

9. Tuesen.G. *Engineering economy*, PHI, 2002
10. Ulrich , G D,*"A Guide to Chemical Engineering Process Design and Economics",* John Wiley (1984)
11. Guthrie K M, *" Process Plant Estimation, Evaluation and Control",* Craftsman Solano Beach, California (1974)
12. Douglas, " *Conceptual Design of Chemical Processes",* McGraw Hill (1998)
13. Valle Riestra , *"Project Evaluation in Chemical Process Industries",* McGraw Hill
14. Schweyer, "Process Engineering Economics", McGraw Hill, 1955

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: Part B questions should have at least 60 % numerical problems. There could be numerical problems in part A also.

Course outcome:

Economics of production is a key factor that determines the sustained profitable operation of any process plant. Financial management and economic analysis are to be incorporated at the very inception of any new idea for setting up a process industry. This course is likely to benefit young entrepreneurs who aspire to establish their own enterprises in process engineering. It could also benefit practicing process engineers, who are concerned with the sustained economic production of their plants.

13.803 ENVIRONMENTAL POLLUTION, MONITORING AND CONTROL (B)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course objectives:

This course is intended at providing a general picture of the various types of pollution and the measures which could be adopted for their abatement. It also aims to provide information on the statutory guidelines relating to pollution control.

Module – I

A brief overview of the Parameters and standards of water and waste water. Major physico-chemical parameters; Need of standards for major pollutants; Types of pollutants; Significance of various parameters; Standards adopted by CPCB and SPCB; Drinking water quality standards; Effluent discharge standards for disposal on land, rivers and streams.

Water Pollution: Water pollution sources and classification of water pollutants - Wastewater sampling and analysis, Bacteriological measurements. Water Pollutants, Effects, Monitoring and Quality standards: Pollution of water and soil, effect of pollutants on environment and health, water pollution laws and minimum national standards, monitoring, compliance with standards, Analysis.

Water Treatment Methods: Methods of water treatment; Optimized design; Plant control and operational variables; Preliminary treatment process; Clarification; Coagulation; Aerobic oxidation; Anaerobic oxidation; Disinfection of water; Water softening; Reverse osmosis; Electrodialysis and other treatment methods.

Waste water Treatment: Physical treatments – Principle; Flow measurement; Screening; Grit removal; Chemical treatments; Principles of chemical treatment: coagulation, flocculation, sedimentation. Overview of treatment principles and theory of aeration, Municipal Sewer and Industrial Wastewater Treatment –Principles, operation and design aspects of: Activated Sludge process, Extended Aeration, Nitrification-denitrification, Trickling Filter, Mechanically aerated lagoons, Concepts of Waste stabilization ponds, Aquatic plant systems, Ranking of waste water treatment processes, common effluent treatment plant.

Biological treatments - Principles of biological treatment; Microbial growth and their kinetics for substrate removal; Biological unit processes: Aerobic suspended - growth treatment processes, aerobic attached-growth treatment processes, anaerobic suspended – growth treatment processes, anaerobic attached- growth treatment processes.

Reuse and recycle of water and waste water: Primary, secondary and tertiary treatments; Sludge dewatering and its disposal; Water reclamation and reuse; Removal of impurities; Removal of residual impurities; Effluent recycle and disposal.

Design and functioning of ETP: Concept of Effluent Treatment Plants (ETP); Need of ETP in industry; Concept of Common ETP (CETP); Major units in ETP and their functions; Design aspects of major ETP units.

Module – II

Air and noise pollution control technologies: A brief overview of the Parameters and standards of noise, air pollutants. Standards adopted by CPCB and SPCB; Primary pollutants- particulate matter, dust, smoke fumes, mist, fog and aerosol, oxides of sulphur , nitrogen oxides. Secondary pollutants -sulphur trioxide, Peroxyacetyl nitrate, ozone, aldehydes etc. Meteorology and plume Dispersion; Lapse rate: Temperature lapse rate, adiabatic lapse rate. atmospheric stability- inversion, radiation inversion, subsidence inversion, double inversion .plume behaviour. Laws governing behavior of air pollutants; Thermodynamics of major air pollutants; Air Pollution Control Methods and Equipment: Primary and secondary air pollutants, standards, sampling, Particulate matter control equipment; Settling chamber; Cyclones; Fabric filter; Electrostatic precipitator; Wet scrubber- Design aspects; Control of gaseous pollutants; Control technologies for controlling oxides of sulphur and nitrogen and carbon. Principle, design and working of catalytic converters; Use of catalytic converters in vehicular pollution control;

Noise Pollution and Control: Sound pressure, Power and Intensity - Measures of Noise- Outdoor noise propagation- Indoor Noise propagation- Noise Control Principle and working and use of noise meter; Legislative control of noise; Noise reduction and control techniques.

Module – III

Innovative techniques for prevention and control of Pollution: Use of solar radiation in industrial effluent treatment; Solar detoxification process; carbon adsorption; Adsorption media filters; Micro-screening and other low cost treatment methods; Removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents.

Specialized aspects: Oil pollution – treatment with micro-organisms, xenobiotics, degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons, .Anaerobic and aerobic composting, Vermiculture, Wetland Management, Membrane based waste water treatment processes – case studies.

Module – IV

Introduction to Bioremediation, Types of Bioremediation, Environmental Nanotechnology Research – Nanotechnology for Bioremediation of Heavy metals – New Bioremediation Technologies to Remove Heavy Metals and Radionuclides using Fe (III), Sulfate and Sulfur Reducing Bacteria - Bioremediation of Petroleum Sludge using Bacterial Consortium and Biosurfactant - Biofilms in Porous Media

Bioremediation of surface soil and sludges, Bioremediation of subsurface material, In situ technologies, Ex-situ technologies, Phytoremediation, Bioaugmentation of naturally occurring microbial activities:- Environmental modification- use of co-substrates, oxygen supplementation (Composting and aerobic bioreactors, in situ aeration).

References:

1. Mackenzie Davis, Susan J. Masten, *Principles of Environmental Engineering and Science,* 1st Edition, McGraw-Hill College, 2003.
2. MacKenzie L. Davis, David A. Cornwell, *Introduction to Environmental Engineering,* 4th Edition, McGraw-Hill College, 2006.
3. Joseph A. Salvato, *Environmental Engineering and Sanitation*, 4th Edition, Wiley, 1992.
4. Tom D. Reynolds, Paul Richards, *Unit Operations and Processes in Environmental Engineering,* 2nd Edition, Thomson Learning, 1995.
5. Gilbert M. Masters, *Introduction to Environmental Engineering and Science,* 2nd Edition, Prentice Hall publication, 1997.
6. Gerard Kiely, *Environmental Engineering,* McGraw-Hill College, International Edition, 1997.
7. Jerry Nathanson, *Basic Environmental Technology: Water Supply, Waste Management and PollutionControl,* 5th Edition, Prentice Hall, 2003.
8. W. W. Nazaroff, William W. Nazaroff, Lisa Alvarez-Cohen, *Environmental Engineering Science,* John Wiley and Sons Inc, 2000.
9. Howard S. Peavy, George Tchobanoglous, Donald R. Rowe, *Environmental Engineering,,* McGraw-Hill College, 1985.
10. Jerry A. Nathanson, *Basic Environmental Technology: Water Supply, Waste Management and Pollution Control,* 5th Edition, Prentice Hall, 2007.
11. Verma Y.B.G, Brauer. H, *Air Pollution Control Equipment,,* Springer, Verlag Berlin, 1981.
12. *M.N. Rao and H.V.N. Rao, Air Pollution,* Tata McGraw Hill, New Delhi, 1993.
13. Rao C.S, *Environmental Pollution Control Engineering, 2nd Edition,* New Age International Publishers, 2006.
14. Sincero A. P. and Sincero G.A, *Environmental Engineering: A Design Approach,* Prentice Hall of India PvtLtd, N.Delhi.1996
15. Mahajan S.P, *Pollution Control in Process Industries,* Tata McGraw Hill, New Delhi, 1985
16. Tchbanoglous and F.L. Burton*, Metcalf and Eddy's Wastewater Treatment-Disposal And Reuse* (Third Ed.),TMH publishing Co Ltd, N. Delhi, 1996.
17. Jogdand S.N, *Environmental biotechnology,* 1995. Himalaya Publishing House, Bombay, Delhi, Nagpur.
18. Baker, K.H.and Herson, D.S, *Bioremediation,* 1994 McGraw Hill, Inc.New York.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: *Part B questions should have at least 30 % numerical problems. There could be numerical problems in part A also.*

Course Outcome:

Upon successful completion of this course, students shall become aware of the gravity and extent of the environmental pollution problem. They shall be motivated to seek newer methods for pollution control or apply existing strategies for pollution control in their daily lives , such as to fulfill their societal commitment in this direction.

13.804.1 BIO-ENTREPRENEURSHIP (B) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

The growth of Biotechnology is strongly dependent on the establishment of newer ventures. Bio-entrepreneurship is aimed at providing the students a strong motivation for taking up entrepreneurship as an alternative career option, thereby transforming themselves from job- seekers to job- givers.

Module – I

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of entrepreneur, Intrapreneur – an emerging class, Concept of Entrepreneurship-Evolution of Entrepreneurship; Development of Entrepreneurship; The entrepreneurial Culture; Stages in entrepreneurial process. Concepts of Entrepreneur, Manager, Intrapreneur/Corporate. Entrepreneur–comparative study-Roles, Responsibilities, Career opportunities. Entrepreneurship as a career, Entrepreneurship as a style of management. The changing role of the entrepreneur: mid career dilemmas–Closing the window:

Creativity and Innovation: Creativity, Exercises on Creativity, Source of New Idea, Ideas into Opportunities. Creative problem solving: Heuristics, Brainstorming, Synectics, Value Analysis Innovation and Entrepreneurship: Profits and

Innovation, Globalization, Modules of Innovation, Sources and Transfer of Innovation, Why Innovate, What Innovation, How to Innovate, Who Innovates.

Business Planning Process: Meaning of business plan, Business plan process, Advantages of business planning, Marketing plan, Production/operations plan, Organizational plan, financial plan, Final project report with Feasibility study, preparing a model project report for starting a new venture.

Module – II

Institutions supporting entrepreneurs - Small industry Financing developing countries, A brief overview of financial institutions in India, Central level and state level institutions, SIDBI, NABARD, IDBI, SIDO, Indian Institute of Entrepreneurship, DIC, Single window, Latest Industrial policy of Government of India

Family Business: Importance of family business, Types, History, Responsibilities and rights of shareholders of a family business, Succession in family business, Pitfalls of the family business, strategies for improving the capability of family business, Improving family business performance.

Module – III

International Entrepreneurship Opportunities: The nature of international entrepreneurship, Importance of international business to the firm, International versus domestic entrepreneurship, Stages of economic development, Entrepreneurship entry into international business, exporting, Direct foreign investment, barriers to international trade.

Informal risk capital and venture capital: Informal risk capital market, venture capital, nature and overview, venture capital process, locating venture capitalists, approaching venture capitalists.

Managing growth: Using external parties to help grow a business, franchising, advantages and limitations, investing in a franchise, joint ventures- types, Acquisitions and mergers.

Module – IV

Novel entrepreneurship opportunities in the Biotech sector: Biotech Parks, Government Initiatives, Regulatory requirements, Organic Farming, Biofertilizers, Microbial biopesticides, Micropropagation, Enzymes , Pearl Culture, Fresh Water Prawn culture, Fresh Water Prawn hatchery, Medical Plant extracts, Immunodiagnostics.

References:

1. David H. Holt, *Entrepreneurship-new venture creation,* Prentice Hall of India
2. Poornima Charantimath, *Entrepreneurship Development-Small Business Enterprise*, Pearson Education, 2007
3. Robert D Hisrich, Michael P Peters and Dean A Shepherd, *Entrepreneurship,* 6th Edition, McGraw-Hill, 2007
4. Mathew J. Manimala, *Entrepreneurship theory at crossroads,* Biztantra, 2007
5. Vasant Desai, *Entrepreneurial Development and Management*, Himalaya Publishing House, 2007
6. Maddhurima Lall and Shikha Sahai, *Entrepreneurship*, Excel Books, 2006
7. Kurakto, *Entrepreneurship-Principles and practices*, 7th Edition, 2007, Thomson publication
8. Satish Taneja and S.L.Gupta, *Entrepreneurship Development New Venture Creation*
9. Marc J. Dollinger, *Entrepreneurship: Strategies and Resources*
10. Brigitte Berger , *The Culture of Entrepreneurship*, ICS Press, Sanfrancisco
11. Peter F. Drucker, *Innovation and Entrepreneurship*
12. Dale Meyer G and Kurt A. Heppard, *Entrepreneurship as Strategy*
13. Sahay A. and.Chhikara M.S, *New Vistas of Entrepreneurship: Challenges and Opportunities*

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

The course shall provide self-motivated students who possess an aptitude for entrepreneurship, sufficient knowledge to choose the right path for achieving their goals. This shall help them in identifying prospective areas in biotechnology, which offer adequate opportunities for starting up an enterprise, thereby helping them to contribute towards creation of a proficient work force for sustaining the growth of Biotechnology in the days ahead.

13.804.2 BIO-FUEL TECHNOLOGY AND ENGINEERING (B) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

With a rapid decline in the availability of fossil fuels, substantial research is being focused currently for development of alternative energy routes, which includes biomass energy. This course is aimed at offering an understanding about the basic technology underlying the production of biofuels, and their utility for a spectrum of domestic and industrial applications.

Module – I

Biomass Sources, Characteristics and Preparation: Biomass Sources and classification. - Chemical composition and properties of different biomass materials and bio-fuels – Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels- Energy plantations -Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass.

Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno- cellulose biomass - Biomass processing for liquid fuel production - Pyrolysis of biomass – Pyrolysis regime, effect of particle size, temperature and products obtained. Thermo-chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen.

Clean Coal Technology: Biotechnology and Microbiology of Coal Degradation – Aerobic and Anaerobic pathway of coal degradation- Characterisation/identification of bioconversion substrates and products – Biosolubilization and bioliquefaction of coal- Biodesulfurisation of coal and oil- Mechanisms of coal biosolubilization- Enzymes that depolymerise coal – Recent Advances in Bioprocessing of coal.

Module – II

Biogas, Technology: Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues. Microbial and biochemical aspects- Operating parameters for biogas production. Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application - High rate digesters for industrial waste water treatment. KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes – development in energy routes.

Bio-Ethanol and Bio-Diesel Technology: Production of Fuel Ethanol by Fermentation of Sugars. Gasohol as a Substitute for Leaded Petrol. - Trans-Esterification of Oils to Produce Bio-Diesel.

Module – III

Green Technology – Microbial Fuel Cell: Types of Biological fuel cells – Working Principle - Applications of biological Fuel cells. A brief study of the principle, construction of different types of fuel cells.

Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation; Microbial recovery of petroleum by biopolymers (Xanthum gum), biosurfactants.

Module – IV

Design and operation of Fixed and Fluidized Bed Gasifiers. Combustion of Biomass and Cogeneration Systems:

Combustion of Woody Biomass: Theory, Calculations and Design of Equipments. Cogeneration in Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration.

References:

1. Chakravarthy A, Biotechnology *and Alternative Technologies for Utilization of Biomass or AgriculturalWastes*, Oxford and IBH publishing Co, 1989.
2. Yogi Goswami D, Frank Kreith and Jan. F .Kreider, Principles of Solar Engineering, 2nd Edition, Taylor and Francis, 2000, Indian reprint, 2003.
3. Mital K.M, *Biogas Systems: Principles and Applications,* New Age International publishers (P) Ltd., 1964.
4. Nijaguna, B.T, *Biogas Technology*, New Age International publishers (P) Ltd., 2002.
5. Venkata Ramana P and Srinivas S.N, *Biomass Energy Systems*, Tata Energy Research Institute, 1996.
6. Rezaiyan. J and N. P. Cheremisinoff, *Gasification Technologies, A Primer for Engineers and Scientists,* Taylor and Francis, 2005
7. Khandelwal. K. C. and Mahdi S. S, *Bio-Gas Technology*, Tata McGraw-Hill Pub. Co., 1986.
8. Smith J.E, *Biotechnology*, 3rd ed. Cambridge Univ Press.
9. Sarkar S, *Fuels and combustion*, 2nd ed., University Press.
10. Pandya S.B, *Conventional Energy Technology - Fuels and chemical Energy,* Tata McGraw Hill, 1987

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

The concepts developed from this course shall enable the students to develop alternate energy routes, particularly biomass energy routes for overcoming the existing energy crisis. They should be able to design and construct biomass to energy conversion systems, which is a promising area in green energy technology.

13.804.3 RESEARCH METHODOLOGIES (B) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course has been designed with focus on students who aspire to take up research career in their future. It also aims to instruct students about the systematic approach to research in engineering, which shall enable them to pursue productive research activities, while ensuring optimal utilization of available resources.

Module – I

Introduction to research: The hallmarks of scientific research, the building blocks of science in research, relevance to preliminary information, the research process for applied and basic research. Hypothesis development, Laboratory safety, bio safety, recombinant material safety.

Experimental designs: The laboratory and the field experiment, internal and external validity, factors affecting internal validity. Measurement of variables, scales and measurements of variables.

Developing scales: rating scale and attitudinal scales. Validity testing of scales developed. Reliability concept in the scales being developed. Stability measures. In vitro, in vivo and clinical trial designs, rules and regulation for animal and human experiments.

Module – II

Data collection methods: Interviewing questionnaires etc. secondary sources of data collection. Guidelines for questionnaire design – electronic questionnaire design and surveys. Special date sources: focus groups, static and dynamic panels. Review of the advantages and disadvantages of various data collection methods and when to use each.

Sampling techniques. Probabilistic and non – probabilistic samples. Issues of precision and confidence in determining sample size. Hypothesis testing. Determination of optimal sample size. Data relevance to intellectual property rights (IPR), bookkeeping.

Module – III

Biostatistics: Definition and scope, Types of biological data – Collection and presentation of data (Table, Graphs,

Diagrams). Measures of central tendency, Dispersion : Skewness and Kurtosis; Probability analysis, Testing of significance, Goodness of fit (chi2 test) , Student's test. Simple and multiple regression – Correlation: Canonical Correlation – Correlation coefficient, ANOVA (one way and two way analysis). Factor analysis, Cluster analysis, Discriminant analysis. Application of SPSS package.

Module – IV

The Research Report: The purpose of the written report – concept of audience – Basics of written reports. The integral parts of a report, the little of a report, the table of contents, the synopsis, the introductory section, method section, results section , discussion section, recommendations and implementation section and reference section.

References:

1. Donald R. Cooper and Remela S. Schindler, *Business Research Methods*, Tata McGraw Hill publishing company limited, New Delhi, 2000.
2. Uma Sekaran, *Research Methods for Business*, John Wiley and Sons Inc., New York, 2000.
3. C.R. Kothari, *Research Methodology,* Wishva Prakashan, New Delhi, 2001
4. Donald H. McBurney, *Research Methods,* Thomson Asia Pvt. Ltd. Singapore, 2002
5. Ticehurst G.W. and Veal A.J, *Business Research Methods*, Longman, 1999.
6. Ranjit Kumar, *Research methodology,* Sage Publications, London, New Delhi, 1999.
7. Raymond, Alain Thie' tart, et al., *Doing Management research*, Sage publications, London, 1999.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

The development of any engineering discipline is dependent on progress of research in the field, and process engineering is no exception. This course shall enable students to take up a challenging and rewarding research career, by training them on the prerequisites for pursuing any productive research activity.

13.804.4 MODELING AND SCALE UP OF BIOREACTORS (B) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course is aimed at providing the basic theoretical background required for mathematical modeling of various physico-chemical and biochemical process occurring in a biochemical reaction system. It also aims to describe the various criteria and methods for transforming successful laboratory experiments into profitable industrial practice through scale up.

Module – I

A brief outline of types and structure elements of bioreactors: Reactors with mechanical and compressed air energy input, membrane reactors for bubble free aeration; modes of operation of a bioreactor- Batch, fed-batch, continuous cultivation, cultivation with cell retention, repeated (cyclic batch) cultivation; aerobic , anaerobic and micro aerobic processes.

Modeling basics: Definition of a model; types of models (physical, mathematical and verbal); the need for modeling and control in biotechnical processes; steps in model building. Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models. Stochastic model for thermal sterilization of the medium.

Module – II

Bioreactor Models: *Stirred tank reactors*- Description of physical processes in the stirred tank reactor, Modeling of gas/liquid flow in stirred tank reactors, single phase flow-transport equations; gas /liquid flow- multiphase conservation equations, interfacial forces, drag force, virtual mass force- turbulence and impeller models; Bubble column bioreactors. Recirculation and compartment models; *Bubble column and Airlift tower loop reactors*-description of physical processes, Flow models, Reactor models. Basic equations of motion-fundamental laws (mass conservation, momentum conservation, Navier Stoke's equation system); Two fluid model, Euler- Lagrange approach- Dynamics of dispersed gas phase, effective viscosity, Mass transfer with chemical reaction, mixing due to bubble rise, Problems of bubble coalescence and redispersion; modeling particular aspects of bubble column reactors- velocity patterns, fate of individual cells, influence of tilted columns, oxygen distribution-design procedure for bubble columns.

Sub models of bioreactor processes: Engineering components- Temperature control system, Pressure behavior,

Aeration behavior; pH model, reaction model (A brief introduction is only desired).

Module – III

Principles of similarity, pilot plants and models: Introduction to scale-up methods, pilot plants and models and principles of similarity. Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering.

Scale up and scale down issues: Regime analysis of bioreactor processes. Correlations for oxygen transfer Effect of

scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale-up of stirred tank bioreactors.

Module – IV

Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale down related aspects.

References:

1. Schugerl K., Bellgardt K.H, *Bioreaction Engineering- Modeling and contro*l, Springer.
2. Harvey.W. Blanch, Douglas. C. Clark, *Biochemical engineering,* Marcel Dekker.
3. K.Schugerl, M*easuring, Modeling and Control* in Biotechnology- a multivolume comprehensive treatise (Rehm and Reed eds.) VCH, Weinheim.
4. Johnstone and Thring, *Pilot Plants Models and Scale-up methods in Chemical Engg*., McGraw Hill, New York, 1962
5. Marko Zlokarnik, *Dimensional Analysis and Scale-up in Chemical Engg.,* Springer Verlag, Berlin, Germany, 1986.
6. Donald G. Jordan, *Chemical Process Development (Part 1 and 2)*, Interscience Publishers, 1988.
7. Nauman Bruce, *Handbook of Chemical Reactor Design, Optimization and Scale up* McGraw Hill, 2002
8. Nauman, E. B, *Chemical Reactor Design, Optimization and Scale up, 2nd ed.*, John Wiley and Sons. 2008
9. Pauline. M. Doran, *Bioprocess engineering principles,* Academic press, 1995.
10. Najafpour, G. D, *Biochemical Engineering and Biotechnology,* Elsevier, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

This course shall enable students to become acquainted with the tools and techniques for mathematical modeling of processes occurring in a bioreactor. They shall also be able to apply the concepts of modeling to the design of bioreactors. A theoretical back ground of scale up shall equip students to face the challenge of obtaining profits in the large scale based on data from laboratory scale experiments.

13.804.5 PROJECT ENGINEERING (B) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course is aimed at providing a general idea about the design of projects for establishment of process plants. The emphasis is primarily on the theoretical aspects of project engineering, and is intended only to provide a general introduction of the subject to beginners.

Module – I

Scope of project engineering: the role of project engineer-Rand D-TEFR-plant location and selection-preliminary data for construction projects-process engineering-flow diagrams-plot plans-engineering design and drafting. Company formation process license, statutory sanctions contracts, financing with special reference to financial institutions in India, personnel recruitment and training.

Module – II

Planning and scheduling of projects-bar chart and network techniques-procurement operations-effective procedures, contracts and contractors- project financing- statutory sanctions.

Module – III

Details of engineering design and equipment selection I- (design calculations excluded)- vessels- heat exchangers process pumps- compressors and vacuum pumps- motors and turbines- other process equipment.

Module – IV

Details of engineering design and equipment selection II- (design calculations excluded)- piping design – thermal insulation and buildings – safety in plant design – plant construction, start-up and commissioning.

References:

1. Rase and Barrow, *Project Engineering of Process Plants,* John Wiley.
2. Peters and Timmerhaus, *Plant Design and Economics for Chemical Engineers* McGraw Hill, New York, 4th Edition, 2003
3. Valle Riestra, *Project Evaluation in Chemical Process Industries,* McGraw Hill
4. Anilkumar, *Chemical process synthesis and engineering design* Tata McGraw Hill, 1981.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

This course shall serve as a prefatory for students who aspire to take up higher studies in the relevant area. The knowledge acquired herein should be expanded several fold prior to productive application of the same in developing any feasible project related to process engineering.

13.805.1 PROCESS OPTIMIZATION (B) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

Maximizing profits with minimal investment is the key to success of any commercial establishment; and the process industry is no less different. This course shall provide the necessary background on the techniques available for optimization, with focus on the process industries. Examples and case studies shall be presented to provide a clear picture of the application of various optimization techniques in specific industrial situations.

Module – I

Nature and organization of optimization problems: what optimization is all about, Why optimize, scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization. Classification of models, how to build a model, fitting functions to empirical data, the method of least squares, factorial experimental designs, fitting a model to data subject to constraints.

Basic concepts of optimization: Continuity of functions, unimodel versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function, interpretation of the objective function in terms of its quadratic approximation.

Module – II

Optimization of unconstrained functions: one-dimensional search: Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni-dimensional search, region elimination methods, polynomial approximation methods, how the one- dimensional search is applied in a multi-dimensional problem, evaluation of uni-dimensional search methods.

Unconstrained multivariable optimization: Direct methods, random search, grid search, uni-variate search, simplex method, conjugate search directions, Powell's method, indirect methods- first order, gradient method, conjugate method, indirect method- second order: Newton's method forcing the Hessain matrix to be positive definite, movement in the search direction, termination, summary of Newton's method, relation between conjugate gradient methods and Quasi-Newton method.

Module – III

Linear programming and applications: Basic concepts in linear programming, Degenerate LP's – graphical solution, natural occurrence of linear constraints, the simplex method of solving linear programming problems, standard LP form, obtaining a first feasible solution, the revised simplex method, sensitivity analysis, duality in linear programming, the Karmarkar algorithm, LP applications.

Module – IV

Genetic Algorithms (GA): (Qualitative treatment) Working principles, differences between GAs and traditional methods, similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, real coded GAs, Advanced Gas.

References:

1. Edgar T.F and Himmelblau D.M, *Optimization of chemical processes*, McGraw. Hill. 2001.
2. Deb Kalyanmoy, O*ptimization for Engineering Design Algorithms and Examples*, Prentice-Hall of India, New Delhi,
3. Hadley G, *Non-linear and Dynamic Programming*, Addison Wesley, New York, 1964.
4. Rao S S, *Optimization Theory and Applications,* Wiley Eastern, New Delhi, 1991.
5. Reklaitis G V, Ravindran A and Ragsdell K M, *Engineering Optimizations*: *Methods and Applications*, Wiley, New York, 1983.
6. Beveridge G.S and Schechter R.S, *Optimization Theory and Practice,* Mc Graw Hill, New York, 1970.
7. Rekllitis, G.V, Ravindran, A and Ragdell, K.M, *Engineering Optimization- Methods and Applications,* John Wiley, New York, 1983
8. Mital K.V and Mohan C, *Optimization Methods in Operations Research and systems Analysis*, New Age International (P) Limited, Publishers, 3rd edition, 1996.
9. Taha H.A, *Operations Research: An Introduction,* Prentice Hall of India, 6th edition.
10. Kasene H.S. and Kumar, K.D*, Introductory Operations Research,* Springer.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

The concepts developed from this course, shall confer the basic skills for performing optimization exercises at any scale of work- ranging from the laboratory to the industry. Students shall be able to apply their knowledge of optimization at an advanced level provided they are offered a modest degree of supplementary hands-on- training on appropriate software packages available for the purpose.

13.805.2 BIOENGINEERING AND NANOTECHNOLOGY (B) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course introduces nanotechnology, with emphasis on its applications to biological systems. The course is of introductory nature and shall serve as a foundation for pursuing advanced courses in the field.

Module – I

Introduction to; Nanotechnology. its emergence and challenges classification of nano-materials: Zero, one, two and three dimensional nano-structured materials. Supramolecular Chemistry: Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures. Types of Nanomachines and nanotechnology-periodic table-Atomic structure molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space-Top down and bottom up. Instrumentation for nanoscale characterization: Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

Module – II

Methods of Synthesis of Nanometerials: Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches. Biologically-Inspired nanotechnology basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans. Synthesis of nano particles through homogenous and heterogeneous nucleation, kinetically confined synthesis of nanoparticles synthesis of nano-wire, rod, tubes and thin films. Special nano-materials: carbon, carbon fulrenes and carbon, nano tubes, nano and microporous materials, core shell structure and nano-composites.

Module – III

Electrical, magnetic, optical, thermal and mechanical properties of nano-structured materials. Applications of nano-materials in molecular electronics, nano-electronics, catalysis, photoelectrochemical cells, photonics, quantum well, quantum dot and quantum wire devices.

Module – IV

Introduction to Nanobiotechnology: Introduction to Bio-Nanotechnology, Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles), Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and biopolymeric nanoparticles), carbon nanotubes, polymeric nanofibers, Implications in neuroscience, tissue engineering and cancer therapy and Environmental and safety aspects of bio-nanotechnology. Introduction to Nanotechnology, Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules, LbL self-assembly, Colloids and Colloid Assemblies for Bio-nanotechnology, Nanoengineered biosensors, Fiber Optic Nanosensors in medical care, Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology.

References:

1. Jean-Marie Lehn, *Supramolecular Chemistry,* Wiley VCH, 1995
2. Jonathan Steed and Jerry Atwood, Supramolecular Chemistry, John Wiley and Sons, 2004
3. Jacob Israelachvil, *Intermolecular and Surface Forces*, Academic Press, London, 1992.
4. Rao C.N.R., Muller A., Chutham A.K, *The Chemistry of Nanoparticles Synthesis, Properties and Applications, Vol 1 and Vol 2,* WILEY-VCH
5. Challa Kumar, *Tissue, Cell and Organ Engineering*, Vol 9, WILEY-VCH, 2006
6. Challa Kumar, *Nanomaterials for Medical Diagnosis and Therapy,* Vol 10, WILEY VCH,
7. William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate, *Handbook of Nanoscience, Engineering and Technology,* CRC Press Taylor and Francis Group, 2007
8. Bhushan*, Handbook of Nanotechnology,* Springer–Springer,2007
9. Challa Kumar, *Nanomaterials for Cancer Diagnosis and Therapy, Vol 6 and 7*, WILEYVCH, 2007
10. Challa Kumar, *Nanodevices for Life Sciences, Vol 4*,WILEY-VCH, 2006
11. Gero Decher and Joseph B. Schlenoff, *Multilayer Thin Films*, Wiley-VCH Verlag GmbH and Co. KGaA, 2003
12. David S. Goodsell, *Bionanotechnolog, Lessons from Nature*, Wiley-Liss, 2004.
13. Kenneth J. Klabunde, *Nanoscale Materials in Chemistry*, John Wiley and Sons, Inc., 2001
14. Christof M. Niemeyer and Chad A. Mirkin, *Nanobiotechnology: Concepts, Applications and Perspectives* by Wiley-VCH; 1 edition, 2004
15. Guozhong A.O, *Nano structure and nano-materials,* Imperial College Press, London
16. Poole P, Jr and Frauk J. Owens, *Introduction to Nano technology*, Charles P, Wiley Interscience, New Jersey, 2003.
17. Carl C. Koch. Noyes, *Nano-structured materials: Processing, properties and Potential Applications*, William Andrew Publishing New York.
18. David S. Goodsell, *Bionanotechnology: Lessons from Nature,* Wiley
19. Pradeep.T, *Nano: The Essentials,* Tata McGraw-Hill Publishing Company Ltd, 2007.
20. Nicholas A.Kotov , *Nanoparticles Assemblies and Superstructures,* 2006, CRC.
21. Ralph et al, (Eds), *Nanoscale Technology in Biological Systems,* 2005, CRC.

22. Fujita H, *Micromachines as Tools for Nanotechnology*, Springer Verlag, 2003
23. Niemeyer C.M. and Mirkin C.A, *Nanobiotechnology Concepts, Applications and Perspectives* 2004, Wiley VCH Verlag GMBH and Co.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

This course shall provide an insight into the emerging area of nanotechnology, and its applications in bioengineering. The course shall provide adequate background for interested students to pursue higher studies in related areas, thereby paving way for a successful research oriented career.

13.805.3 COMMERCIALIZATION, MARKETING AND MANAGEMENT OF BIOTECH PRODUCTS (B) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course is a sequel to an earlier course on Bio-entrepreneurship. It aims at instructing students about the practical considerations in commercialization and marketing of biotech products. Adoption of appropriate marketing strategies is inevitable to the success of any new or existing industry, and hence this course is likely to benefit any student who has a zest towards biotech based business.

Module – I

Need to commercialize biotechnology. discovery, market needs development process, success rates and costs etc. Creating and marketing the image of the biotechnology company. Art of negotiation and effective communication.

Module – II

Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up. How to portray management and role of a biotechnology manager, technology decision making and resource decision-making etc., Product marketing decision.

Module – III

Role of Research and development University-industry technology transfer arrangements, how and why a biotech company can benefit.

Module – IV

Positioning, power and importance of positioning of a company name and product, Workable marketing and the strength of distribution.
Effective advertising and marketing. Opportunities international, marketing and lessons to be learned. Indian and foreign prospective of biotechnology and current challenges for the biotechnology based products.

References:

1. Al Rise and Jack Trout, *Positioning: The Battle for your Mind, Mc Graw Hill 2000/* Warner Books, 1986
2. V. Moser and R.E. Cape, *Biotechnology: The science and the business,* Harwood, 1999.
3. Michael, J. E., Bruce, J. W. and Williom, J. S, *Marketing Management*. Tata McGraw Hill, New Delhi, 2004.
4. *Latest review articles and papers on the subject.*

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

This course shall be of substantial benefit to prospective entrepreneurs and others who plan to venture into biotech based business. Knowledge of marketing strategies is important for establishing any new business, and this course shall impart this knowledge to students, thereby helping them to become successful entrepreneurs.

13.805.4 TOTAL QUALITY MANAGEMENT (B) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

''Quality is never an accident, but the outcome of a sincere effort''. This course aims to introduce students to the concept of quality in its true perspective. It also aims to instruct students about the methods for quality control, while providing them the necessary background knowledge to specify the benchmarks for quality in diverse industrial situations.

Module – I

INTRODUCTION: Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM PRINCIPLES: Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

Module – II

STATISTICAL PROCESS CONTROL: The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

Module – III

TQM TOOLS: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

Module – IV

QUALITY SYSTEMS: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Total Quality Environment Management and EMS 14000: Municipal pollution prevention Programmes – Environment Management System-14000- Systematic, Structured and Documented Response to Environmental Issues – Auditable and Time Targeted Environmental Improvement Programs.

Hierarchy of Environment Management Practices**:** Waste-specific pollution prevention: Waste pre - generation focus on minimization / recycling, Waste-specific pollution control treatment: pre - generation focus on disposal/ recycling- Waste-specific Post-release-to environment focus: recycling/ remediation.

References:

1. Dale H. Besterfiled et at., *Total Quality Management*, Pearson, Indian reprint, 2002.
2. James R.Evans and William M.Lidsay, *The Management and Control of Quality*, 5th Edition, South- Western (Thomson Learning), 2002
3. Feigenbaum A.V. *Total Quality Management,* McGraw-Hill, 1991.
4. Oakland.J.S, *Total Quality Management*, Butterworth Heinemann Ltd., Oxford. 1989.
5. Narayana V and Sreenivasan, N.S*. Quality Management–Concepts and Tasks*, New Age International 1996.
6. Zeiri, *Total Quality Management for Engineers* Wood Head Publishers, 1991.
7. Bishop P, *Pollution Prevention: Fundamentals and Practice*, McGraw-Hill, 2000.
8. Roy K, *(Ed), Chemical Technology for better Environment,* Allied Publishers Ltd, Chennai, 1998
9. El Halwagy, M. M, *Pollution Prevention through Process Integration: Systematic Design Tools,* Academic Press, N.Y. (1997)
10. Anastas P.T and Warner J.C, *Green Chemistry: Theory and Practice,* Oxford University Press. N.Y.1998

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

This course shall provide the necessary background knowledge required for assessment of quality and to ensure proper quality management in process industries. The students shall be able to equip themselves with a variety of tools and techniques required to serve as successful quality engineers in a process plant, once they are successful in completing this course.

13.805.5 MATHEMATICAL MODELING AND SIMULATION OF BIOPROCESSES (B) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

This course is aimed at introducing students to the concept of mathematical modeling and simulation in the context of bioprocesses. The course shall be delivered by following a systematic approach through case-studies and shall eventually equip the students with necessary tools and techniques for carrying out modeling and simulation exercises.

Module – I

Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models, Shu's segregated models for Lactic acid fermentation.

Module – II

Structured kinetic models: Compartmental models (two and three), Product formation, Unstructured and structured models, Genetically structured models.

Module – III

Stochastic model for thermal sterilization of the medium, Modeling for activated sludge process, Model for anaerobic digestion, Model for antibiotic production.

Module – IV

Process simulation techniques, Equation oriented approach, Equation oriented simulators (SPEED UP, ASCEND, FLOWSIM, QUASILIN, DYNSIM), simulation programs based on Euler's methods, Newton – Raphson methods, Runga – Kutta methods, Simulation of biochemical system models.

References:

1. Shyam S. Sablani et al (Eds*), Handbook of food and bioprocess Modeling techniques,* CRC
2. Haerder A and Roels J. A, *Application of simple structured Bioengineering,, Advances in Biochemical Engineering* Vol21, A. Fiechts (ed) Spring Verlag , Berlin, 1982.
3. Bailey J.E and Ollis D.F, *Biochemical Engg Fundamentals,* 1986, McGraw Hill
4. Zeigler, B.P. *Theory of Modeling and Simulation*,: Wiley, New York 1975.
5. Francis G, *Modelling and Simulation*

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

Upon successful completion of this course, the students shall be able to assimilate the principles underlying modeling and simulation in their true perspective. The students shall be able to contribute effectively to this area, provided they take up advanced courses on the subject, and acquire the requisite hands-on training with the common software packages meant for the purpose.

13.806 BIOINFORMATICS LAB (B)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objectives:

This course is aimed at providing hands-on training on the practical aspects of bioinformatics and computational biology. It shall serve as a supplement to the theory course on Bioinformatics which was completed in an earlier semester.

LIST OF EXPERIMENTS

1) Demonstration of BLAST, FASTA and other search engines
2) Retrieval of sequences using ENTREZ
3) Sequence analysis using BLAST, Align, Lalign
4) Multiple sequence alignment and Phylogenetic analyzing using Clustal, ClustalW
5) Clustering and contig assembly tools
6) Restriction site analysis tools
7) Studying 3D structure using RasMol
8) Prediction of secondary structure of proteins
9) Prediction of tertiary structure (fold recognition, homology search)
10) Molecular modeling and dynamics: using small oligonucleotides and small proteins with known crystal structure (available from data bank)
11) Homology Modeling using Swiss PDB – Hb, Protease
12) Calculation of Phi and Psi angle - Hb, Protease
13) Docking: protein-protein; protein-small molecules
14) Potential energy calculation of regular structures
15) To mutate protein and energy minimization using Swiss PDB viewer
16) Gene prediction – Gene Finder
17) Comparative proteomics and genomics – Proteome calculator
18) Drug designing – using available data

Note: Minimum 12 experiments shall be offered.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test
40% - Class work and Record
20% - Regularity in the class

University Examination Pattern:

Examination duration: 4 hours *Maximum Total Marks: 100*

80% - Procedure, conducting experiment, results, tabulation and inference

20% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

This course shall provide sufficient training on practical bioinformatics. Students should be able to apply the knowledge acquired from this course in any applied area of biotechnology such as gene sequencing, genetic level characterization, metagenomics research etc. in the course of their career in future.

13.807 PROJECT AND VIVA- VOCE (B)

Teaching Scheme: 0(L) - 0(T) - 5(P) **Credits**: 5

Course Objectives:

The project is a prime component of the undergraduate engineering curriculum. The project shall be executed in the backdrop of necessary background information collected during the mini-project stage. The project shall in its full sense be an application of the knowledge acquired from the complete curriculum, extending over four years. The work shall serve the purpose of motivating students to take up a research career in future. if they so desire.

Every student will be required to submit a project report in a typed form, on a topic selected by the student, but specifically approved by the faculty member, who will guide the student or on a topic to be assigned by one or more faculty members.

The project work on the topic will consist of some investigational work, computer simulation or design problem or experimental set up of some development work or prototype equipment. Every student will be orally examined in the topic incorporated in the project and in the related area of specialization.

The student will be required to submit three copies of his/her typed copy of the project report to the department office for record (One copy each for the department library, participating faculty and students own copy).

The marks distribution for final semester project and comprehensive viva- voce will be as follows:

Project (200 marks) : *Internal assessment*

- *Guide's share:* *100 marks (50 marks for student's performance during the course of work and 30 marks for the report, Involvement/Participation:20 marks))*
- *Evaluation committee:* *100 marks (based on a three stage evaluation with marks distribution as follows, for each stage: Stage – I: 20 marks, Stage- II: 30 Marks, Stage- III: 50 marks*

Comprehensive- viva- voce (100 marks): **University Examination**

- *Course viva: 50 marks*
- *Project viva: 50 marks*

Course outcome:

The project and viva voce shall be a comprehensive test of the overall knowledge acquired by the student in the course of the four year B. Tech course. It shall enable him/her to gauge his/her skill sets and probe possible avenues for application of the same in future, with the objective of building a successful career.