

## **PH.D. COURSE WORK: Theory paper II**

**Lectures: 4 Hrs./Week Theory: 100 Marks**

**Note: All Units are compulsory**

### **ADVANCES IN BIOTECHNOLOGY ENGINEERING**

#### UNIT – I

Analytical Techniques - Chromatographic methods, Microscopy, Spectroscopic techniques, Radioisotopic techniques, Electrophoresis.

#### UNIT-II

Bioprocessing - Thermodynamics of biochemical reactions, Modeling of growth kinetics, Enzyme kinetics, Design of fermentation processes, Scale up of bioprocesses.

#### UNIT-III

Downstream processing - Removal of insolubles (Filtration, Centrifugation, Cell disruption), Product isolation (Extraction, Precipitation, Adsorption)

#### UNIT-IV

Product purification – Preparative chromatographic techniques, Membrane separation technologies, Product polishing (Crystallization, Drying), Formulation and stability of product.

#### References:-

1. Wilson K and Walker J "Principles and Techniques of Biochemistry and Molecular Biology" 6th Ed. Cambridge University Press, 2005.
2. Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7th Ed., Wadsworth Publishing Co., 1986.
3. Van Holde, K E, Johnson, W. and Ho, P. S., "Principles of Physical Biochemistry", Prentice Hall, 1981.
4. Cantor, C. R. and Schimmel, W.H., "Biophysical Chemistry Part-II", Freeman & Co., 1981.
5. Campbell, I.D. and Dwek, R. A., "Biological Spectroscopy", Benjamin Curmmings Publication Co. Inc., 1984.
6. Glasel, J. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press, 1995.

7. Physical chemistry by D. FriedfelderÂ WH Freeman and co., 1982.
8. Segel IH, Biochemical Calculations, Second edition.
9. Price RC, Proteins. Proteins Lafbax Academic Press 1996 .
10. Scopes R, Protein Purification.
11. Principles & Practices. Springer Verlag, 1982 - Holme D & Peck H, Analytical Biochemistry. Longman, 1983.
12. Cooper TG, The Tools of Biochemistry. Wiley Intersciences, 1977.
13. Selected readings from Methods in Enzymology, Academic Press.
14. Bioreaction Engineering Principles – J. Nielsen, J. Villadsen, G. Liden – Kluwer Academic/ Plenum Pub.
15. Handbook of separation process technology by R W Rousseau (John Wiley & Sons).
16. Large scale adsorption & chromatography by W C Wankat (Crc Press Inc).
17. Advanced membrane technology and applications by N N Li (Wiley).
18. Separation Processes in Biotechnology – J.Asenjo (ed.) – Taylor & Francis Pub.

## **PH.D. COURSE WORK: Theory paper III**

Teaching Scheme  
Lect. 3 hrs./week  
Practical/Tutorial 1 hr. /week

Examination Scheme  
Theory Paper : 80 Marks,  
Term work: 20 marks

### **1. Advanced Transport Phenomena**

#### **Unit1**

Basic concept and review of classical flow problems using shell balances. Review of mathematics: Scalar, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems, frame of reference (Eulerian and Lagrangian).

#### **Unit2**

The equations of change for isothermal flow: Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems, the equations of change for incompressible non-Newtonian fluids. The equations of change for non-isothermal flow: Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer for problems.

#### **Unit3**

The equations of change for multi component systems: The equations of continuity for a binary mixture, the equation of continuity of A in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multi component fluxes in terms of the transport properties, use of equations of change to setup diffusion problems. Velocity, temperature and concentration distributions with more than one independent variables, unsteady flow, stream function, potential flow, boundary layer theory, steady state two dimensional flow for momentum, heat and mass.

#### **Unit4**

Turbulent flow: Introduction, fluctuations and time smoothed equations for velocity,

temperature and concentration, time smoothing of equation of change , equation of energy, equation of continuity of A, Reynolds stresses. Dimensional Analysis: Introduction, momentum, heat and mass transfer.

#### References

1. R.B. Bird, W. E. Stewart and E. N. Light foot Transport Phenomena Wiley international Edition, New York 2002.
2. G.K. Batchelor An introduction to fluid dynamics, Cambridge university press, Cambridge, 1967.
3. J.C. Salterry momentum Energy and mass transfer in continua Robert e. Kridger publishing company. New York 1981.
4. James R. Welty, Charles E. Wicks and Robert E. Wilson, Fundamentals of momentum, heat and mass transfer, , John Wiley & sons, Inc New York.

## **2. Bioprocess modeling and simulations:**

### Unit-I

Perspective on modeling of physical, chemical and biological phenomena, uses and limitations of mathematical models in Bioprocess models- Basic classifications, fundamental features of models. Several examples involving algebraic equations, ordinary differential equations,

difference equations partial differential equations, integral equations and integro-differential equations.

#### Unit-II

Elements of probability theory, stochastic models parameter estimation model forms for parameter estimation, Parameter estimation using moments, design of experiments for parameter estimation. Accuracy of parameter estimates, Design of experiments for model discrimination - Regression and interpolation.

#### Unit-III

Review of numerical techniques for the solution of bioprocess models, Non linear systems analysis Phase – Plane analysis in classical bioreactor models, phase – plane plot for bioreactor with Monod kinetics.

#### Unit-IV

Introduction to nonlinear dynamics – A simple population growth model. More complex growth models, chaotic behavior, cob web diagrams, stability of fixed point solutions, Introduction to bifurcations behavior in single and two variable systems, Introduction to chaos, The Lorenz equations.

Introduction to population balance modeling in bioprocess engineering – The solution of population balance equations, Budding of yeast population – Modeling of cells with dynamic morphology – Modeling for biological populations with correlation between life spans of siblings, Modeling of Industrial sterilization processes, system Analysis Approach to the Mathematical Modeling of fermentation processes– Kinetics of Simple Processes, Stoichiometry of Microbial Processes, Physiological Aspects of Mathematical Models for fermentation Processes, Modeling of Oxygen Transfer, and The use of Simple Mixing Models for Simulation of Fermentation Processes; Mathematical Model Identification– Preliminary Analysis of Experimental data, Rate Relationship and Kinetic Parameters.

#### **Text books:**

1. Wayne Bequette.B, *Process dynamics modeling and analysis and simulation*,. Prentice Hall Inc, 2004.
2. John H. Seinfeld and Leon Lapidus., *Mathematical Methods in Chemical Engg.*, (Vol. 3), *Process Modeling, Estimations and Identification*. Prentice Hall, 1974.
3. Ramakrishna. D, *Population Balances*. Academic Press, 2000.
4. Shyam S. Sablani., *Handbook of Food and Bioprocess Modeling Techniques*. C R C Press, 2006.
5. Volesky.B and J. Votruba., *Modeling and Optimization of Fermentation Process (Process Simulation and Modelling)*. Elsevier Science and Technology, 1992.

1. B.V. Babu, "Process Plant Simulation", OXFORD University Press, 2004.

2 JAMES E. BAILEY, David F.OLLIS, "Biochemical Engineering Fundamentals", 2nd ed., McGraw Hill, International Book Company, 1986

**REFERENCE BOOK :**

1. B. VOLESKY and J. VOTRUBA, "Modeling and Optimization of Fermentation Processes", ELSEVIER, 1992.

**3.FOOD BIOTECHNOLOGY**

**UNIT-I**

## **Advanced Food Chemistry:**

Introduction, general aspects of food industry, world food demand and Indian scenario, Constituents of food, quality and nutritive aspects of food: carbohydrates, proteins, lipids, vitamins and minerals, assessment of nutritional quality of foods. Mineral and vitamins as functional constituents in human metabolism and deficiency diseases associated. Food additives, standards, deteriorative factors and their control, preliminary processing methods Effect of processing on nutritive value of food. Aroma compounds in foods, Food enzymes. Processing of milk and milk products, cereals and cereal products, fruits and vegetables and beverages.

## **UNIT-II**

### **Food Microbiology and Preservation:**

Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products and their control. Contaminants of foods- stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing. Bio chemical changes caused by micro-organisms, deterioration of various types of food products. Food poisoning and microbial toxins, microbial food fermentation, Food borne intoxicants and mycotoxins. Preservation by heat and cold dehydration, concentration, frying, irradiation, microwave heating, sterilization and pasteurization, fermentation and pickling, packing methods. Processing Systems, Microbial Survivor Curves, Influence of External Agents, Thermal Death Time and Spoilage Probability.

## **UNIT-III**

### **Food Production Technology:**

Techniques in food processing: Drying, Extraction, Solid-liquid extraction, Gas absorption , Distillation, Crystallization, Refrigeration, Novel separation techniques, Reverse Osmosis, Membrane systems, Membrane Performance , Ultra filtration, Super critical fluid extraction, Sedimentation , Centrifugation , Mixing and their applications in food processing. Process Controls in Food Processing, Systems for Heating and Cooling Food Products, **Production and utilization of food products** - soft and alcoholic beverages, dairy products, meat, poultry and

fish products, Plant products: Fruits, Vegetables, Cereals and Pulses. Enzymes used in food industries, Treatment and disposal of food processing wastes.

#### **UNIT-IV**

##### **Advanced Food Packaging and Food standards:**

Packaging - Introduction, Food Protection, Product Containment, Product Communication, Product Convenience. Functions of packaging, Special packaging methods (vacuum, gas and shrink packaging), Methods of packaging and packaging equipments. Rigid and semi rigid containers, Flexible containers. Aseptic and shrink packaging. Secondary and transport packaging, Active and intelligent packaging techniques. Current use of novel packaging techniques. Oxygen, ethylene and other scavengers: Selecting the right type of oxygen scavenger, Ethylene scavenging technology, Carbon dioxide and other scavengers, Antimicrobial food packaging: Antimicrobial agents, Constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging, Non-migrating bioactive polymers (NMBP) in Food Packaging: Advantages of NMBP, Inherently Bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, Developments in modified atmosphere packaging (MAP): Novel MAP gases, Testing novel MAP applications. Recycling packaging materials: The recyclability of packaging plastics, Green Plastics for food packaging: The problem of plastic packaging waste, the range of biopolymers, developing novel biodegradable materials. Concepts and trends in food legislation. International and federal standards: Codex alimentations, ISO series, food safety in USA. HACCP and ISO 9000 series, FPO, Agmark, BIS, FAO, WTO, TBT, GATT and Traceability issues

##### **Reference Books:**

1. Food: Facts and Principles-N. Shakuntala Manay, Shadksharawamis.
2. Fundamentals of Nutrition-L Loyd McDonald



3. Essentials of Biochemistry by U.Satyanarayana, Books and Allied (P) Ltd
4. Principles of Biochemistry-Lehninger
5. Food Science-B.Srilakshmi
6. Food Microbiology, M R Adams and M O Moss, New Age International, New Delhi (1996).
7. Food Microbiology; WC Frazier; Tata McGraw Hill, Delhi
8. Modern Food Microbiology; James M Jay; CBS Publishers, Delhi
9. Unit operations in food processing – R.L.EARLE (2 ed) Pergamon Press, 1983
10. Fundamentals of food engineering – D.G.RAO, Prentice-Hall of India, New Delhi, 2010
11. Food process engineering – D R Heldman, & RP Singh.
12. Fundamentals of food process engineering – R.T.Toledo, CBS Publishers & Distributors, New Delhi (2005)
13. A handbook of Food Packaging, F A Paine and H Y Paine, Blackie & Sons Ltd., Glasgow, UK, (1983).
14. Modern Food Packaging, Published by Indian Institute of Packaging, Mumbai (1998).
15. A Textbook of Food Science and Technology, ICAR, New Delhi (2001).
16. Food Packaging and Preservation (theory & practice) by M.Mathlouthi Elsevier Applied science publisher, London and New york.
17. Santaniello, Evenson, Ziberman, Carlson – Agriculture and Intellectual Property Rights, Univ. Press, 1998