VII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	An overview of the modeling process.	2
2.	Introduction to mathematical, correlative and explanatory models. Formulation, idealization and simplification of the problems.	3
3.	Probability models, series and linear mathematical approximation	3
4.	Dynamic Mathematical Model, Analysis of Dynamic Mathematical Models, dynamic and interacting dynamic processes.	3
5.	Basic Concepts of Systems Analysis and Simulation.	2
6.	Common Heat and Mass Transfer Models Dimensional Analysis.	3
7.	Model-based techniques in food processing.	2
8.	Applications of mathematical modelling techniques to parboiling of rice, convective drying/ dehydration, deep fat drying etc.	4
9.	Applications of mathematical modelling techniques to pasteurization of milk and juices.	4
10.	Applications of mathematical modelling techniques to fermentation, aseptic processing, moisture diffusion.	4
11.	Applications of mathematical modelling techniques in shelf-life prediction of agricultural commodities.	3
12.	Applications of mathematical modelling techniques to microwave heating, infrared heating and ohmic heating.	3
13.	Stochastic finite element analysis of thermal food processes.	3
14.	Probability models, series and linear mathematical approximation	3
15.	Neural networks approach to modelling food processing operations.	3
	Total	**45**

VIII. Suggested Reading

- Fischer M, Scholten HJ and Unwin D. 1996. *Spatial Analytical Perspectives on GIS*. Taylor & Francis.
- Fish NM and Fox RI. 1989. *Computer Application in Fermentation Technology: Modelling and Control of Biotechnological Processes*. Elsevier.
- Gold HJ. 1977. *Mathematical Modelling of Biological Systems - An Introductory Guidebook*. John Wiley & Sons.
- Hunt DR. 1986. *Engineering Models for Agricultural Production*. The AVI Publ.
- Koeing HE, Tokad Y, Kesacan HK and Hedgers HG. 1967. *Analysis of Discrete Physical Systems*. McGraw Hill.
- Meyer JW. 2004. *Concepts of Mathematical Modeling*. McGraw Hill.
- Peart RM and Curry RB. 1998. *Agricultural Systems, Modelling and Simulation*. Marcel Dekker.
- Tijms HC. 1984. *Modelling and Analysis. A Congrtational Approach*. Wiley Publ.

I. Course Title : Bioprocess Engineering

II. Course Code : PFE 606

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint and equip the students with the basic principles of biochemical process engineering.

V. Theory

Unit I

Applications of engineering principles: Mass and energy balance, fluid flow principles, Unit operations of process engineering.

Unit II

Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation.

Unit III

Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors.

Unit IV

Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

VI. Practical

Kinetics of one substitute reactions, kinetics of growth in batch cultures, design consideration for bioreactors, media preparation and sterilization, microprocessor based monitoring of bioprocess parameters.

VII. Learning outcome

Student's capability to calculate the mass and energy balances in ant process operations, understanding growth kinetics and design bioreactors as per requirement of food industries.

VIII. Lectures Schedule

S.No.	Topic	No. of Lectures
1.	Basic engineering principles and their applications. Use of units and dimensions.	3
2.	Mass balance: steady and unsteady. Problem solving involving blending, separation, drying, growth, recycling etc.	3
3.	Energy balance in food processing operations. Use of steam tables in calculation of heat requirements etc.	3
4.	Fluid flow principles: Static and dynamic. Concept of viscosity. Types of flow. Flow through pipes. Mass and energy balance in fluid flow. Calculation of pressure drop in pipes.	4
5.	Fundamentals of growth kinetics, maintenance energy and yield concepts.	3
6.	Principles of media sterilization, media formulations of industrial fermentation.	3
7.	Aerobic and agitated rheology of fermentative fluids.	3
8.	Design and scale-up of bioreactors, enzyme reactors.	3
9.	Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.	5
	Total	**30**

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	To study the instruments used for measurement of temperature, relative humidity, flow rate, pressure, wind velocity, solar radiation etc.	1
2.	Use of units, dimensions and basic mathematical applications.	1
3.	To judge the students ability for solving mass balance problems.	2
4.	To judge the students ability for solving Energy balance problems.	2
5.	To study the kinetics of one substitute reactions.	1

S.No.	Topic	No. of Practicals
6.	To assess the kinetics of growth in batch cultures.	1
7.	To study the order of reactions involving single/multiple reactants/products.	1
8.	To study the various thermal and structural parameters affecting the design of bioreactors.	1
9.	To assess the student's ability for design of bioreactors by solving related numerical problems.	2
10.	To prepare various media cultures and assess their effectiveness with time.	1
11.	To study the mechanism of sterilization of cultures.	1
12.	To study the various electronic gadgets for continuous monitoring of bioprocess parameters.	1
	Total	**15**

X. Suggested Reading

- Brennan JG, Butters JR, Cavell ND and Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
- Coulson JM and Richadson JF. 1999. *Chemical Engineering*. Vols. II, IV. The Pergamon Press.
- Greanoplis JC. 1999. *Transport Process and Unit Operation*. Allyn & Bacon
- Treybal RE. 1981. *Mass Transfer Operations*. 3rd Ed. Harper & Row.