## VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION FOR
#### M.Tech- Bio-Chemical Engineering

**I Semester**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>14BCE11</td>
<td>Process Automation</td>
<td>4 Lecture 2 Practical / Field Work / Assignment/ Tutorials 3</td>
<td>50 I.A. 100 Exam</td>
<td>150 4</td>
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<td>14BCE12</td>
<td>Bioprocess Engineering</td>
<td>4 Lecture 2 Practical / Field Work / Assignment/ Tutorials 3</td>
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<td>14BCE13</td>
<td>Bio-separation &amp; Downstream Processing</td>
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<tr>
<td>14BCE14</td>
<td>Bioreactors</td>
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<tr>
<td>14BCE15X</td>
<td>Elective - 1</td>
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<tr>
<td>14BCE16</td>
<td>Lab Component</td>
<td>-- Lecture 3 Practical / Field Work / Assignment/ Tutorials 3</td>
<td>25 I.A. 50 Exam</td>
<td>75 2</td>
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<td>14BCE17</td>
<td>Seminar</td>
<td>-- Lecture 3 Practical / Field Work / Assignment/ Tutorials 3</td>
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<td>20 Lecture 16 Practical / Field Work / Assignment/ Tutorials 18</td>
<td>300 I.A. 550 Exam</td>
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### Elective – 1

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<tr>
<td>14BCE151</td>
<td>Transport Phenomena in Bioprocess System</td>
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<tr>
<td>14BCE152</td>
<td>Mathematical Modeling in Biochemical Engineering</td>
</tr>
<tr>
<td>14BCE153</td>
<td>Food Technology</td>
</tr>
<tr>
<td>14BCE154</td>
<td>Enzyme Technology</td>
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## VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
### SCHEME OF TEACHING AND EXAMINATION FOR
#### M.Tech- Bio-Chemical Engineering

**II Semester**

<table>
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<th>Duration of Exam in Hours</th>
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<tbody>
<tr>
<td>14BCE21</td>
<td>Statistical Methods</td>
<td>Lecture: 4, Practical: 2, Field Work/Assignment/Tutorials: 3</td>
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<td>50, 100, 150, 4</td>
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<tr>
<td>14BCE22</td>
<td>Safety Management in Bio-Process Industries</td>
<td>Lecture: 4, Practical: 2, Field Work/Assignment/Tutorials: 3</td>
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<tr>
<td>14BCE23</td>
<td>Chemical and Biochemical Reactions</td>
<td>Lecture: 4, Practical: 2, Field Work/Assignment/Tutorials: 3</td>
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<td>14BCE24</td>
<td>Bioreactor Design</td>
<td>Lecture: 4, Practical: 2, Field Work/Assignment/Tutorials: 3</td>
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<tr>
<td>14BCE25X</td>
<td>Elective-2</td>
<td>Lecture: 4, Practical: 2, Field Work/Assignment/Tutorials: 3</td>
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<td>50, 100, 150, 4</td>
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<td>14BCE26</td>
<td>Lab Component</td>
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<td>Seminar</td>
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<td></td>
<td><strong>Project Phase-I (6 week Duration)</strong></td>
<td>Practical: --, Field Work/Assignment/Tutorials: --</td>
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**Elective – 2**

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<tr>
<td>14BCE251</td>
<td>Total Quality Management</td>
<td>14BCE253</td>
<td>Biosensors</td>
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<tr>
<td>14BCE252</td>
<td>Nanotechnology and its application in Bioprocess Industries.</td>
<td>14BCE254</td>
<td>Process Modeling and Simulation</td>
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</table>

**Between the II Semester and III Semester, after availing a vacation of 2 weeks.**
### III Semester: INTERNSHIP

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
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<th>Duration of the Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
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<tbody>
<tr>
<td>14BCE31</td>
<td>Seminar / Presentation on Internship (After 8 weeks from the date of commencement)</td>
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<tr>
<td>14BCE32</td>
<td>Report on Internship</td>
<td>-</td>
<td>-</td>
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<td>14BCE33</td>
<td>Evaluation and Viva-voce</td>
<td>-</td>
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<td>-</td>
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* The student shall make a midterm presentation of the activities undertaken during the first 8 weeks of internship to a panel comprising Internship Guide, a senior faculty from the department and Head of the Department.

# The College shall facilitate and monitor the student internship program.

**The internship report of each student shall be submitted to the University.**

**Between the III Semester and IV Semester after availing a vacation of 2 weeks.**
## IV Semester

### Subject Code | Subject | No. of Hrs./Week | Duration of Exam in Hours | Marks for | Total Marks | CREDITS |
<table>
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<td></td>
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<td>Exam</td>
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<td>14BCE41</td>
<td>Bioenergy</td>
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<td>14BCE42X</td>
<td>Elective-3</td>
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<td>2</td>
<td>3</td>
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<td>14BCE43</td>
<td>Evaluation of Project Phase-I</td>
<td>-</td>
<td>-</td>
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<tr>
<td>14BCE44</td>
<td>Evaluation of Project Phase-II</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>14BCE45</td>
<td>Evaluation of Project Work and Viva-voce</td>
<td>-</td>
<td>-</td>
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**Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits**

**Elective – 3**
- 14BCE 421 Biological Waste Treatment
- 14BCE422 Biological Thermodynamics
- 14BCE423 Fermentation Technology
- 14BCE424 Animal Cell Culture and Tissue Engineering
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalize the topic of dissertation.

2) Project Phase – II: 16 weeks duration during III Semester. Evaluation shall be taken during the Second week of the IV Semester. Total Marks shall be 25.


   Marks of Evaluation of Project:

   • The I.A. Marks of Project Phase – I & II shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (Out of two external examiners at least one should be present).
FIRST SEMESTER M TECH – BIOCHEMICAL ENGINEERING

PROCESS AUTOMATION-14BCE11

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<th>IA Marks</th>
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<td>:</td>
<td>52</td>
<td>Exam Marks</td>
<td>:</td>
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</table>

Module 1

REVIEW OF SYSTEMS:

Module 2

STABILITY ANALYSIS:

Module 3

SPECIAL CONTROL TECHNIQUES:
Advanced control techniques, cascade, ratio, feed forward, adaptive control, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.

Module 4

MULTIVARIABLE CONTROL:
Analysis of multivariable systems, Interaction, examples of storage tanks. Review of matrix algebra, Bristol arrays, Niederlinski index – Tuning of multivariable controllers.

Module 5

SAMPLE DATA CONTROLLERS:
Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems.

TEXT BOOKS:

REFERENCES:
BIOPROCESS ENGINEERING -14BCE12

**Module 1**

**INTRODUCTION:** Bioprocess development an interdisciplinary challenge, introduction to engineering calculations, presentation of analysis of data, regulatory constraints for bioprocess engineering. Bioprocess engineering and technology. Role of a Chemical engineer in a bioprocess industry. Classification of micro-organisms, Taxonomy, Environmental and Industrial microbiology.

**Module 2**

**ENZYMES:** Introduction, definition and enzyme classification, enzyme kinetics, various models, Experimentally determining rate parameters for MM Kinetics, complex enzyme kinetics, effect of pH and temperatures, insoluble substrates,

**IMMOBILISED ENZYME SYSTEMS:** methods and limitation of immobilization, Effects of diffusion and reaction on kinetics of immobilized enzymes, Effect of other environmental parameters like pH and temperature.

**Module 3**

**GROWTH KINETICS OF MICROORGANISMS:**

**Module 4**

**MIXED CULTURES:** Introduction to mixed cultures, Major Classes of Interactions: Simple Models, Competition between two species, Prey-Predator system, Lotka-Volterra Model Web Interaction, Population dynamics in models of mass action form.

**Module 5**

**INDUSTRIAL BIOPROCESS:** Anaerobic process: Ethanol, lactic acid, acetone-butanol production. Aerobic Processes: Citric Acid, Baker’s Yeast, Penicillin, High fructose corn syrup production.

**TEXT BOOK:**

**REFERENCE BOOKS:**
BIOSEPARATION AND DOWNSTREAM PROCESSING- 14BCE13

<table>
<thead>
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<th>IA Marks</th>
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<td>Exam hours</td>
<td>03</td>
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<tr>
<td>Total No.of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
<td>100</td>
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</table>

Module 1

INTRODUCTION
Role and importance of downstream processing in biotechnological processes. Problems and requirements of byproduct purification. Economics of downstream processing in Biotechnology. Cost cutting strategies, Characteristics of biological mixtures, Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Physico-chemical basis of different bio-separation processes.

Module 2

PRIMARY SEPARATION TECHNIQUES
Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, Centrifugation (ultra and differential) and filtration methods. Solid-liquid separation with theory of batch filtration, Theories of Centrifugal force, equipments and centrifugal filtrations,

Module 3

ISOLATION AND PRODUCT PURIFICATION:

Module 4

MEMBRANE SEPARATION PROCESSES
Membrane – based separations theory; Design and configuration of membrane separation equipment; Applications: Use of membrane diffusion as a tool for separating and characterizing naturally occurring polymers; enzyme processing using ultra filtration membranes; separation by solvent membranes; reverse osmosis.

Module 5

FINISHING OPERATIONS AND FORMULATIONS
Finishing operations: crystallization: Basic concepts, crystal size distributions, batch and recrystallization. Drying: basic concepts, drying equipments, lyophilization, principle of lyophilization, working and applications of lyophilization and formulations

TEXT BOOK

REFERENCE BOOKS

BIOREACTORS -14BCE14

<table>
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<td>Exam Marks</td>
</tr>
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Module 1
INTRODUCTION TO BIOREACTORS:
Overview of biological reactors: submerged liquid fermentation, solid state fermentation, Understanding of bioreactors: Definition of bioreactor, development of bioreactors, Purpose and importance of bioreactor, Classification of bioreactors, bioreactor for animal cell, plant cell cultivation/culture.

Module 2
TRANSPORT PHENOMENA IN BIOPROCESS SYSTEMS: Gas liquid mass transfer in Cellular Systems. Determination of $O_2$ transfer rates. Mass transfer of freely rising or falling bodies. Forced Convection Mass Transfer: Overall $K_{la}$ Estimates, and power requirements (review) for sparged and agitated vessels. Other factors affecting $K_{la}$, Models, Power Consumption and Mass transfer for Non Newtonian fluids.

Module 3
BIOREACTOR OPERATIONS:
Common operations of bioreactor, selection and identifications of factors for smooth operations of bioreactors, spectrum of basic bioreactor operations, bioreactor operations for immobilizes systems, plant and animal cell bioreactors operation.

Module 4
CONTROLS IN BIOREACTORS
Control task in bioreactor system, instrumentation in bioreactors, control variables and measurement devices, advanced control technique, consistency checks on measurement, adaptive online optimizations. Online and off line measurements and analytical methods.

Module 5
STERILISATION AND SCALE UP OF BIOREACTORS:
Sterilization of Reactors, Batch Sterilization, Continuous Sterilization, filter and air sterilization. Scale up problems in bioreactors, criteria of scale up, similarity criteria; scale up methods, generalized approaches to scale up.
TEXT BOOK:  

REFERENCE BOOK  
TRANSPORT PHENOMENA IN BIOPROCESS SYSTEMS- 14BCE151

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<td>50</td>
<td>04</td>
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</table>

**Module 1**

EQUATIONS OF CHANGE: Equation of continuity Equation of motion; Navier – Stokes equation. Application of these equations in solving simple steady state problems


**Module 2**

Forced Convection Mass Transfer, General Concepts Dimensionless Groups, Correlations for Mass-Transfer Coefficients and Interfacial Area, Example: Correlations for Maximum ($D_c$) or Sauter Mean ($D_{sm}$) Bubbles or Droplet Diameters, Overall $k_a$’ Estimates and Power Requirement for sparged and Agitated vessels, Mass Transfer Across Free Surfaces

Factors Effecting $k_a$’, Estimation of diffusivities, Ionic Strength , Surface active agents, Non-Newtonian Fluids, Models and parameters for Non-Newtonian Fluids, Suspensions, Macromolecular Solutions, Power consumption and mass Transfer in Non-Newtonian Fluids. Scaling of Mass Transfer equipment

**Module 3**

TEMPERATURE DISTRIBUTION IN SOLIDS AND IN LAMINAR FLOW: Different situations of heat transfer: Heat conduction with internal generation by electrical, nuclear, viscous energy sources. Numerical problems using the equations derived in the above heat transfer situations. Heat conduction in a cooling fin: Forced and free convection heat transfer

HEAT TRANSFER: Heat Transfer co-relations , Sterilization of gases and liquids by filtration

**Module 4**


**Module 5**

temperature and pressure on transport properties of fluids. **Numerical problems on the application of Numerical problems on use of NLV, FLHC and FLD**

**TEXT BOOK:**

**REFERENCE BOOKS:**

**MATHEMATICAL MODELING IN BIOCHEMICAL ENGINEERING -14BCE152**

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<td>Exam Marks :</td>
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**Module 1**
**Numerical Techniques:** Simultaneous linear algebraic equation– Gauss Jordan, Non-linear algebraic equation, Newton Raphson, Ordinary Differential Equation, R-K Method, Numerical Integration, Simpson’s 1/3\textsuperscript{rd} Rule . Applications: Vapor, Liquid equilibria for binary mixtures, Calculation of Bubble Point Dew point for ideal binary mixture

**Module 2**
**Bioreactor:** Operational stages in a Bioprocess industry, biochemical reactor, continuous stirred tank bioreactor-process description, mathematical model, fed-batch bioreactor- model development

**Module 3**
**Design:** Double Pipe Heat Exchanger (Area, Length and Pressure drop), Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop)

**Module 4**
**Modeling:** Applications of law of conservation of mass in mixing tank system, equilibrium still and single stage extraction. Heat transfer through multiwall cylinders and spheres, heat transfer in a jacketed vessel, rate expression for series and parallel homogenous first order reactions

**Module 5**
**Mathematical Modeling and Solutions to the Following:** Basic tank model – Level V/s time, batch Distillation–Vapour composition with CSTRs in series
TEXT BOOKS:

REFERENCE BOOKS:

FOOD TECHNOLOGY- 14BCE153

<table>
<thead>
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<th>14BCE153</th>
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<tr>
<td>Total No. of Lecture Hours</td>
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<td>Exam Marks :</td>
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Module 1


Module 2
Food Processing and Preservation: Food deterioration – Causes. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations. Food irradiation; processing and preservations of milk and dairy, vegetables and fruits, cereals, legumes and nuts, meat and meat products, fats and oils, beverages, sugars, sweeteners, honey and confectionary, salt and spices.

Module 3
Module 4


Module 5


TEXT BOOKS:

REFERENCE BOOKS:
ENZYME TECHNOLOGY - 14BCE154

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<tr>
<td>Total No.of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
<td>100</td>
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Module 1
STRUCTURES AND FUNCTIONS OF PROTEINS:
Enzyme classification, based on structure classification of amino acids, classifications of proteins, specificities of enzyme action, biosynthesis and properties of proteins.

Module 2
KINETICS:
Chemical mechanisms of enzyme catalysed reactions, introduction to bioenergetics and kinetics, kinetics of multi-substrate bioreactions, investigations of active sites structures.

Module 3
CHEMICAL NATURE OF ENZYME CATALYSIS:
Sigmoidal kinetics and allosteric enzymes, co-enzymes, significance of sigmoidal behaviour.

Module 4
APPLICATIONS:
Investigation of enzymes in biological preparation, extraction and purification, enzymes as analytical reagents

Module 5
INSTRUMENTAL TECHNIQUES:
Instrumental techniques available for using enzymatic analysis, applications in medicine, industries, and biotechnological applications

TEXT BOOKS:

REFERENCES
LABORATORY COMPONENT: 14BCE16

<table>
<thead>
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Exam hours : 02  
Final Exam Marks : 50

Note: Any five experiments

List of Experiments

1. Single Tank – Step response
2. Interacting tanks- Impulse & Pulse Response
3. Non-Interacting tanks- Step Response
4. P, PI and PID controller for valve characteristics
5. Electrophoresis
6. Aqueous two phase extraction
7. Leaf filter
8. Plate and frame filter

SEMINAR-I-14BCE17

<table>
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<tr>
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The students are required to give a presentation on any topic in related field in the form of seminar. The seminar shall be evaluated as internal assessment by a committee constituted by the HoD
**STATISTICAL METHODS - 14BCE21**

<table>
<thead>
<tr>
<th>Module 1</th>
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<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
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</tr>
<tr>
<td>Scope of biostatistics, definition, data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency curve, logarithmic curves). Sampling &amp; selection bias, probability sampling, random sampling, sampling designs. Descriptive statistics: Measure of central tendency (arithmetic mean, geometric mean, harmonic mean, median, quartiles, mode); Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation).</td>
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<tr>
<td><strong>BI-VARIATE DISTRIBUTION</strong></td>
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<tr>
<td>Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).</td>
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<th>Module 3</th>
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<td><strong>PROBABILITY</strong></td>
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<td><strong>PROBABILITY DISTRIBUTIONS</strong></td>
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<tbody>
<tr>
<td><strong>STATISTICAL INFERENCE</strong></td>
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<tr>
<td>Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, simultaneous confidence intervals, parametric and non-parametric distributions (T-test, F-test, Chi Squared distribution, goodness of fit test) analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD).</td>
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<th>Module 5</th>
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<tr>
<td><strong>DESIGN OF EXPERIMENTS</strong></td>
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<tr>
<td>Sample surveys, comparisons groups and randomization, random assignments, single and double blind experiments, blocking and extraneous variables, limitations of experiments.</td>
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</table>
CASE STUDIES:
Statistical tools for setting in process acceptance criteria; T-Test based approach for confirming human antibody response to therapeutic drug; Population statistics for cases related to cigarette smoking, Lung cancer, endangered plants species, epidemics etc.

REFERENCE BOOK

SAFETY MANAGEMENT IN BIO PROCESS INDUSTRIES - 14BCE22

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Module 1

BIOTECHNOLOGY AND SOCIETY
Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Case studies/experiences from developing and developed countries. Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

Module 2

BIO-SAFETY CONCEPTS AND ISSUES
Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

Module 3

BIO-SAFETY IN THE LABORATORY
Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution.

Module 4

REGULATIONS
Biosafety assessment procedures in India and abroad. International dimensions in biosafety: Cartagena protocol on biosafety, bioterrorism and convention on biological weapons. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops, etc. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP).
Module 5

FOOD SAFETY
The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment.

AGRI AND PHARMA SECTOR
Plant breeder’s rights. Legal implications, Biodiversity and farmers rights. Recombinant organisms and transgenic crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.

TEXT BOOK

REFERENCE
4. Levine S.P and Martin, Protecting personnel at hazardous waste sites, Butterworth, 1985

CHEMICAL AND BIOCHEMICAL REACTIONS - 14BCE23

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Module 1


Module 2


Module 3

EXTERNAL DIFFUSION EFFECTS IN HETEROGENEOUS REACTIONS: Mass and heat Transfer coefficients in packed beds, Quantitative treatment of external transport effects, Modelling diffusion with and without reaction.
Module 4
INTERNAL TRANSPORT PROCESSES IN POROUS CATALYSTS:
Intra pellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction.

Module 5
DESIGN OF HETEROGENEOUS CATALYTIC REACTORS: Isothermal and adiabatic fixed bed reactors, Non-isothermal and non adiabatic fixed bed reactors. Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model.

TEXT BOOKS:

REFERENCE BOOKS:

BIOREACTOR DESIGN -14BCE24

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Module 1

Module 2
MECHANICAL ASPECTS OF BIOREACTOR DESIGN: Introduction, requirement for construction of bioreactor, guidelines for bioreactor design, bioreactor vessels, geometry of vessel, Design of flange, design procedures. Numerical problems

Module 3
DESIGN OF AGITATOR AND POWER RATING: Design of vessel sizing with agitation or mixing, types of agitators, baffles, Design of agitator shaft, power requirement calculations, Numerical problems

Module 4
DESIGN OF VESSEL CLOSURES:
Various Vessel closures such as Flat plates or covers formed, torispherical, elliptical, hemispherical and cylindrical designs. Numerical problems
Module 5

BIOLOGICAL REACTOR: Detailed process design of biological reactor: Activated sludge process, rotating biological contactor, trickling bed filters, up flow anaerobic sludge blanket digester, Numerical problems.

TEXT BOOK:

REFERENCE BOOK
TOTAL QUALITY MANAGEMENT -14BCE251

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Module 1

CONCEPTS OF TQM: Basics of total quality, Guru’s of TQM, Philosophy of TQM, customer focus, organization, quality philosophies of Deming, Crossby.

Module 2

TQM PROCESS: QC tools, problem solving methodologies, cost of quality, quality circles, benchmarking, strategic quality planning.

Module 3

TQM SYSTEMS: Quality policy deployment, quality function deployment, standardization, designing for quality, manufacturing for quality.

Module 4

QUALITY SYSTEM: Need for ISO 9000 system, advantages, clauses of ISO 9000, Implementation of ISO 9000, quality auditing, case studies.

Module 5

IMPLEMENTATION OF TQM: KAIZEN, 5s, JIT, POKAYOKE, Taguchi methods, case studies.

TEXT BOOK

1. Dale H. Besterfield, Total Quality Management, PHI, India.
NANOTECHNOLOGY AND ITS APPLICATION IN BIOPROCESS INDUSTRIES -14BCE252

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<thead>
<tr>
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Module 1

Module 2

Module 3

Module 4

Module 5

TEXT BOOK:

REFERENCE BOOK

BIOSENSORS -14BCE253

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Module 1
INTRODUCTION: A historical perspective; Definition and Expanding Needs of Biosensors; Advantages and limitations; Biosensor Economics; various components of biosensors

Module 2
TYPES OF BIOSENSORS: Biocatalysts based biosensors, bio affinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions

Module 3
TRANSDUCERS IN BIOSENSORS: Various types of transducers; principles and applications; Bio-, chemi-, and electrochemiluminescence for fiber-optic biosensors; Fluorescence-based fiber-optic biosensors

Module 4
KINETIC MODELING FOR BIOSENSORS: The purpose and practice of modeling; The flux equations, The flux diagram for the membrane/enzyme/electrode, Deriving a complete kinetic model; Kinetic modeling in other types of biosensors: Potentiometric enzyme electrodes, Optical and photometric biosensors, Immunosensors

Module 5
APPLICATION AND USES OF BIOSENSORS: Biosensors in medicine and health care, biosensors for agriculture and food; Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

REFERENCE BOOKS
1. Rajmohan Joshi, Biosensors (1e), Gyan Books, 2006
BIOPROCESS MODELING AND SIMULATION -14BCE254

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>: 14BCE254</th>
<th>IA Marks</th>
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Module-1


Module-2

MODELS FOR HEAT AND MASS TRANSFER EQUIPMENTS: Heat loss through maturing tank, counter current cooling tanks, heat transfer through extended surfaces, multiple distillation columns, multistage gas absorption, Numericals.

Module-3


Module-4

KINETIC MODELING FOR BIOSENSORS: The purpose and practice of modeling; The flux equations, The flux diagram for the membrane/enzyme/electrode, Deriving a complete kinetic model; Kinetic modeling in other types of biosensors- Potentiometric enzyme electrodes, Optical and photometric biosensors.

Module-5

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 for single and two variable systems, introduction to chaos and the Lorenz equations.

TEXT BOOKS
4. 

REFERENCE BOOKS
3. Shyam S. Sablani., Handbook of Food and Bioprocess Modeling Techniques. C R C

LABORATORY COMPONENT: 14BCE26

| Subject Code | : | 14BCE26 | IA Marks | : | 25 |
| Exam hours | : | 02 | Final Exam Marks | : | 50 |

Note: Any five experiments

List of Experiments

1. Identification of microorganisms using Shake flask reactor
2. Vacuum Distillation
3. BOD and COD analysis
4. Coagulation Jar Test
5. RTD study in plug flow reactor and Chemostat
6. Effect of concentration on enzyme activity
7. Effect of Temperature on enzyme activity

SEMINAR-II -14BCE27

| Subject Code | : | 14BCE27 | IA Marks | : | 25 |

The students are required to give a presentation on any topic in related field in the form of seminar. The seminar shall be evaluated as internal assessment by a committee constituted by the HoD

THIRD SEMESTER M.TECH – BIOCHEMICAL ENGINEERING

SEMINAR ON INTERNSHIP -14BCE31

| Subject Code | : | 14BCE31 | IA Marks | : | 25 |

The students are required to give a presentation on any INTERNSHIP in the form of seminar after 8 weeks from the date of commencement. The seminar shall be evaluated as internal assessment by a committee constituted by the HoD
REPORT ON INTERSHIP -14BCE32

| Subject Code | : | 14BCE32 | Exam Marks | : | 75 |

The student shall make an internship report of the activities undertaken during the first 8 weeks of internship to a panel comprising Internship Guide, a senior faculty from the department and Head of the Department.

• The College shall facilitate and monitor the student internship program.
• The internship report of each student shall be submitted to the University.
• The internship should be between the III Semester and IV Semester after availing a vacation of 2 weeks.

EVALUATION AND VIVA-VOCE -14BCE33

| Subject Code | : | 14BCE33 | Exam Marks | : | 50 |

The students are required to give a presentation on any INTERNSHIP in the form of seminar. The seminar shall be evaluated.
FOURTH SEMESTER M TECH – BIOCHEMICAL ENGINEERING

BIOENERGY -14BCE41

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Module 1

BIOENERGETICS: Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. – Chemical composition and properties of different biomass materials and biofuels – 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, hydrogen production and biological fuel cell

Module 2

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.

Module 3


Module 4


Module 5


TEXT BOOK

REFERENCE BOOKS
BIOLOGICAL WASTE TREATMENT AND ENGINEERING - 14BCE421

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Module - 1

Module –2

Module –3

Module –4
Biological treatment processes: Aerobic/Anaerobic attached and suspended growth treatment processes- Activated sludge process: Process analysis : Completely mix with recycle, Sequential Batch Reactor (SBR), Rotating biological contactor/disc (RBC), Trickling filter, UASB digester, aerated lagoon, stabilization ponds. – Standard type and modifications. Aeration/diffusers. With applicable numerical

Module –5

TEXT BOOKS:
1. Eckenfelder and O'Conner, Biological Waste Treatment, 2001
REFERENCE BOOKS:
2. Webber WJ, Physicochemical processes for water quality
3. Fasir GM, Geyer JG and Okun- Waste water engineering

BIOLOGICAL THERMODYNAMICS-14BCE422

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Module 1


Module 2

FUNDAMENTAL CONCEPTS OF THERMODYNAMICS: System and Surroundings, First law of thermodynamics - Internal energy, enthalpy, Heat capacity, applied examples from biochemistry.

Module 3


Module 4

GIBBS FREE ENERGY AND ITS APPLICATIONS: Gibbs free energy and equilibrium, Chemical potential, ionic solutions, Equilibrium constant, standard state in biochemistry, Acid and bases, chemical coupling and redox reactions, Gibbs free energy in photosynthesis, glycolysis citric acid cycle, Oxidative phosphorylation and ATP hydrolysis, substrate cycling, Membrane transport, Enzyme substrate interaction, Haemoglobin, Protein solubility, stability and dynamics.

Module 5

REACTION KINETICS: Rate of a reaction, rate constant and order of the reaction, effect of temperature, collision and transition state theory, Electron transfer kinetics, Enzyme kinetics and inhibition, Reaction mechanism of lysozyme, protein folding and pathological misfolding, polymerisation, muscle contraction and the molecular motors.

TEXT BOOK
FERMENTATION TECHNOLOGY 14BCE423

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**Module 1**

**INTRODUCTION TO FERMENTATION PROCESSES:** The range of fermentation Processes: Microbial Biomass, Enzymes, Metabolites and Transformation Processes; Development of fermentation Industry; Components of Fermentation Process; **Microbial Growth Kinetics – A Review:** Batch Culture; Continuous Culture; Fed-batch Culture; Applications.

**Module 2**

**ISOLATION, PRESERVATION AND IMPROVEMENT OF INDUSTRIAL MICROORGANISMS:** Isolation Methods utilizing the selection of desired characteristics; Isolation Methods not utilizing the selection of desired characteristics; Preservation Methods: At Low temperature, Dehydration, and their quality control; The selection and Isolation of induced mutants improving yields of secondary metabolites; Use of recombinant systems for the improvement of industrial microorganisms.

**Module 3**

**MEDIA FOR INDUSTRIAL FERMENTATIONS:** Typical Media and formulation; Sources of Energy, Carbon, Nitrogen, Minerals, vitamins, precursors, Oxygen and others. **Sterilization of Media:** Medium Sterilization; Design of Batch and Continuous Sterilization; Sterilization of Fermenter, Feed, Air; Filtration of Air and Design of Filters; **Development of Inocula For Industrial Fermentations:** The development of Inocula for yeast, bacterial, fungal and streptomycete processes; Aseptic inoculation of plant Fermenters

**Module 4**

**INSTRUMENTATION AND CONTROL:** Control Systems: Manual, automatic and their combination; Methods of measurement of for Process Variables: Temperature, Flow of gases and liquids, Pressure, Safety valves, Shaft Power, Rate of stirring, Foam, Weight, DO, Exit gas, pH, Redox etc.; On-line analysis of other chemical factors; Application of computers in fermentation industry.

**Module 5**

**RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS: A REVIEW:** Filtration, Centrifugation, Cell Disruption, Extraction, Chromatography, Ultra filtration, Drying, Crystallization and Whole broth processing; **Effluent Treatment:** Strength of fermentation effluents; Disposal Methods; Treatment processes: Aerobic and Anaerobic; Byproducts;
TEXT BOOK

REFERENCE BOOKS:

ANIMAL CELL CULTURE & TISSUE ENGINEERING -14BCE424

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Module 1

Module 2
Hybridoma technology; genetic engineering in animal cell culture; scale-up and large scale operation; Perfusion bioreactors, hollow fiber bioreactor, operational strategies of mass cell culture.

Module 3
Disaggregation (enzymatic and mechanical) of tissue and primary culture; Cultured cells and evolution of cell lines; Maintenance of cultures – cell lines; Cloning of cell lines; Large scale cell cultures in biotechnology ; Somatic cell fusion.

Module 4

Module 5
Tissue Engineering of Skin, Bone, tendon, Adipose Tissue Engineering Introduction, FDA Regulation, Regulation of Pharmaceutical / Medical Human Tissue Products in Europe/USA, Other considerations Relevant to Engineered Tissues.

TEXT BOOKS
1. Ruiereis, Introduction to tissue engineering, 2006
2. Tissue Engineering by Clemens Van Blitterswijk
REFERENCE BOOKS
2. Biocatalytic Membrane Reactor by Drioli, Taylor & Francis, 2005
3. Translational approaches in Tissue Engineering and regenerative medicine.

EVALUATION PROJECT PHASE I - 14BCE43

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EVALUATION PROJECT PHASE II - 14BCE44

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EVALUATION PROJECT WORK AND VIVA VOCE - 14BCE45

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Exam hours : 03 Exam Marks : 100+100

Each student will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of an internal guide. It should be relevant to the field and preferably of current research. The project work should be assigned at the beginning of the third semester. The project work should be completed at the end of the fourth semester. The project work shall be evaluated as an external examination by the committee constituted by the VTU.