BMS COLLEGE OF ENGINEERING, BENGALURU
DEPARTMENT OF CHEMICAL ENGINEERING
M.TECH. BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

Department Vision

Be a globally recognized Chemical Engineering Department by imparting quality education

Department Mission

- High-quality education and experience to the budding Chemical Engineers
- Chemical Engineering graduates to assume positions in process and other allied industries
- Foster and encourage the pursuit of excellence in chemical science and engineering
- Inculcate global research potential

Program Educational Objectives of the PG program

PEO 1	Graduates pursue profession in biochemical engineering
PEO 2	Graduates work in multidisciplinary group
PEO 3	Graduates will pursue higher education & research

Program Specific Outcomes of the PG programme

The Program Specific Outcomes (PSO) of the department is decided after a series of meeting with the stake holders namely the Department Advisory Board (DAB), Board of Studies (BOS), Department Academic Committee (DAC) and all the faculty members. The PSO's are finally approved by the College Academic Council (AC).

The PSOs of M.Tech. Programme in Biochemical Engineering indicates the strength of the graduates from Chemical Engineering/Biotechnology. The department has faculty members who are qualified from premier institutes of the country with varied domain expertise. This gives the strength to the department in the major areas of Chemical Engineering and biochemical engineering. Over the years numerous guest lectures were organized for the students along with value added courses. The Value added courses were delivered by those companies who have MOU with the department. Hence, the regional inclination needed from the employers are also been taken into consideration in imparting academic strengths to our graduates.

PSO-1	Graduates will apply the knowledge in bioprocess engineering, downstream processes and bio-separations in the field of transfer processes for effective separation and purification of bio-industrial products
PSO-2	Graduates will control, mechanize and conserve processes by applying mathematics, process control, managing safety of bioprocesses
PSO-3	Graduates will design equipment viz., bioreactors, fermenters, sterilization systems for current science and technology applications

BMS COLLEGE OF ENGINEERING, BENGALURU
DEPARTMENT OF CHEMICAL ENGINEERING
M.TECH. BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

I Semester **CREDIT BASED**

Subject Code	Name of the Subject	Credits				Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		L	T	P	S		I.A.	Exam		
16CHBC1CPA	Process Automation	3	1	1	0	3	50	50	100	5
16CHBC1CBP	Bioprocess Engineering	3	0	0	0	3	50	50	100	3
16CHBC1CBD	Bio-separation & Downstream Processing	3	0	1	1	3	50	50	100	5
16CHBC1CBR	Bioreactors	3	0	0	1	3	50	50	100	4
16CHBC1EZZ	Elective – 1	3	0	0	0	3	50	50	100	3
16CHBC1EZZ	Elective – 2	3	0	0	0	3	50	50	100	3
16CHBC1IRM	Research Methodology (INSTITUTE CORE)	2	0	0	0	3	50	50	100	2
Total		**20**	**1**	**2**	**2**	**21**	**350**	**350**	**700**	**25**

Course Elective 1		**Course Elective 2**	
16CHBC1ETP	Transport Phenomena in Bioprocess System	16CHBC1EFE	Food Engineering
16CHBC1EMM	Mathematical Modeling in Biochemical Engineering	16CHBC1EET	Enzyme Technology
16CHBC1EOR	Operation Research	16CHBC1EBI	Bioinstrumentation
16CHBC1ENA	Numerical Analysis	16CHBC1EBT	Biological Thermodynamics

BMS COLLEGE OF ENGINEERING, BENGALURU
DEPARTMENT OF CHEMICAL ENGINEERING
M.TECH. BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

II Semester **CREDIT BASED**

Subject Code	Name of the Subject	Credits				Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		L	T	P	S		I.A.	Exam		
16CHBC2CSM	Statistical Methods	3	1	0	0	3	50	50	100	4
16CHBC2CBE	Bioenergy	3	0	0	1	3	50	50	100	4
16CHBC2CRE	Reaction Engineering	3	1	1	0	3	50	50	100	5
16CHBC2EZZ	Elective – 3	3	0	0	0	3	50	50	100	3
16CHBC2EZZ	Elective – 4	3	0	0	0	3	50	50	100	3
16CHBC2IZZ	Institution Elective	4	0	0	0	3	50	50	100	4
16CHBC2TS1	Technical Seminar -1	2	0	0	0	3	100	0	100	2
Total		**21**	**2**	**1**	**1**	**21**	**400**	**300**	**700**	**25**

Elective 3		**Elective 4**		**Institution Elective**	
16CHBC2EBW	Biological Waste Treatment and Engineering	16CHBC2ENT	Nanotechnology in Bioprocess Industries	16CHBC2ITQ	Total Quality Management
16CHBC2EBM	Bioprocess Modeling and Simulation	16CHBC2EBS	Biosensors	16CHBC2IPM	Project Engineering Management
16CHBC2EMS	Membrane Separation Technology	16CHBC2ESM	Safety Management in Bioprocess Industries	16CHBC2IFT	Fermentation Technology
16CHBC2EAT	Animal & Tissue Culture Engineering	16CHBC2EBP	Biopharmaceuticals	16CHBC2IBM	Biomaterials

BMS COLLEGE OF ENGINEERING, BENGALURU
DEPARTMENT OF CHEMICAL ENGINEERING
M.TECH. BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

III Semester: INTERNSHIP /INDUSTRIAL TRAINING, PROJECT –I PHASE **CREDIT BASED**

Course Code	Subject	No. of Hrs./Week		Duration of the Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work		I.A.	Exam		
16CHBC3CIN	**Internship/Industrial training: Preliminary Report** submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and the respective Head of the Department.	-		-	25		25	21
	Internship/Industrial training: Final Report submission and Evaluation after 16 week of Internship to be carried out by the Internal Guide of the college and the respective Head of the Department. Report Evaluation to be completed within two weeks of submission	-		-	25		25	
	Viva-Voce on Internship - To be conducted *internally* by the Internship Guide (from the college) and the External Guide/Examiner Within 2 weeks of Submission	-		-		50	50	
16CHBC3CIP	**Project Phase: I** – Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd semester. Preliminary work on Project Implementation.				50	50	100	04
	Total	**-**		**-**	**100**	**100**	**200**	**25**

BMS COLLEGE OF ENGINEERING, BENGALURU
DEPARTMENT OF CHEMICAL ENGINEERING
M.TECH. BIOCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017

IV Semester **CREDIT BASED**

Subject Code	Subject	No. of Hrs./Week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Field Work / Tutorials		I.A.	Exam		
16CHBC4CPR	Project Phase-II - Internal Evaluation of Project work in progress (report + presentation on progress /status of project)	-			50		50	23
	Project Phase-III - Project Demonstration /final evaluation of the project by internal guide/faculty (dissertation report final presentation and evaluation).	-			50		50	
	Final Evaluation of Project Work and Viva-voce by internal and external evaluators	–				100	100	
16CHBC4TS2	Technical Seminar-2				100		100	02
Total		**-**	**-**	**-**	**200**	**100**	**300**	**25**
Grand Total (I to IV Sem.)								**100 credits**

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
M.TECH. IN BIOCHEMICAL ENGINEERING

Overall Scheme of Instruction

I SEM	II SEM	III SEM		IV SEM	
Process Automation **3-1-1-0 (5)**	Statistical Methods **3-1-0-0 (4)**	**Internship/Industrial training: Preliminary Report**		**Project Phase-II**	
Bioprocess Engineering **3-0-0-0 (3)**	Bioenergy **3-0-0-1 (4)**	**Internship/Industrial training: Final Report**	**21**	**Project Phase-III**	23
Bio-separation & Downstream Processing **3-0-1-1 (5)**	Reaction Engineering **3-1-1-0 (5)**	**Viva-Voce on Internship**		**Final Evaluation of Project Work and Viva-voce**	
Bioreactors **3-0-0-1 (4)**	**Elective – 3** **3-0-0-0 (3)** Biological Waste Treatment and Engineering	**Project Phase: I**	04	Technical Seminar -2	02
	Bioprocess Modeling and Simulation				
	Membrane Separation Technology				
	Animal & Tissue Culture Engineering				
Elective – 1 **3-0-0-0 (3)** Transport Phenomena in Bioprocess System	**Elective – 4** **3-0-0-0 (3)** Nanotechnology in Bioprocess Industries				
Mathematical Modeling in Biochemical Engineering	Biosensors				
Operation Research	Safety Management in Bioprocess Industries				
Numerical Analysis	Biopharmaceuticals				
Elective – 2 **3-0-0-0 (3)** Food Engineering	**Institution Elective** **4-0-0-0 (4)** Total Quality Management				
Enzyme Technology	Project Engineering Management				
Bioinstrumentation	Fermentation Technology				
Biological Thermodynamics	Biomaterials				
Research Methodology (INSTITUTE CORE) **2-0-0-0 (2)**	Technical Seminar -1 **2-0-0-0 (2)**				
TOTAL 25	**25**	**25**		**25**	

GRAUDATE ATTRIBUTES FOR PG PROGRAMMES

Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The GAs of the PG programme are exemplars of the attributes expected of a graduate of an accredited programme. The Graduate Attributes of the PG programme of the NBA are as following:

1. **Scholarship of Knowledge:** Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyses and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking:** Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving:** Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. **Research Skill:** Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyses and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools:** Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work:** Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8. **Communication:** Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility:** Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning:** Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

BMS COLLEGE OF ENGINEERING, BENGALURU-19

CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2016-2017

M.TECH. IN BIOCHEMICAL ENGINEERING

FIRST SEMESTER M.TECH – BIOCHEMICAL ENGINEERING

PROCESS AUTOMATION- 16CHBC1CPA

Subject Code	:	16CHBC1CPA	LTPS	:	3-1-1-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	05			

Course Outcomes:

- CO 1 Analyze complex engineering problems and apply independent judgment for solving control problem involving open and close loops
- CO 2 Evaluate the stability for open loop systems using modern tools and apply the same for the process of modeling
- CO 3 Usage of modern tools and mathematical techniques in devising control systems involving simple alarms, relays and predict its performance
- CO 4 Evaluate the overall performance of the controllers by applying various inputs for discrete systems
- CO 5 Analyze, experiment and interpret the stability of control systems by team

Module 1	Time (hrs)
REVIEW OF SYSTEMS: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Control valve types- linear, equal percentage and quick opening valves. Transient response. Block diagrams.	07
Module 2	
STABILITY ANALYSIS: Routh Hurwitz method, Root locus method, Frequency response, design of control system, controller tuning and process identification. Zigler-Nichols and Cohen-Coon tuning methods, Bode-Nyquist Plots-Process modeling.	09
Module 3	
SPECIAL CONTROL TECHNIQUES: Advanced control techniques, cascade, ratio, feed forward, adaptive control, selective controls, Smith predictor, internal model control, theoretical analysis of complex processes.	09
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.	07
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.	07

Process Automation Laboratory

Note: Any five experiments

List of Experiments

1. Time constant of a Thermometer response
2. Second Order system U Tube Monometer
3. Single Tank – Step response
4. Interacting tanks- Step Response
5. Interacting tanks Pulse Response
6. Non-Interacting tanks- Step Response
7. Non-Interacting tanks- Pulse Response
8. P, PI and PID controller trainer
9. Valve characteristics

TEXT BOOKS:

1. Coughnour D R, *"**Process system analysis and control**"*- 2nd Edn., McGraw Hill, New York, 1991.
2. George Stephanopoules, *"**Chemical process control, An Introduction to Theory and Practical**"* - Prentice Hall, New Delhi, 1998.

REFERENCE BOOKS

1. Smith C A and Corripio A B *"**Principles and practice of automotive process control**"*- John Wiley, New York, 1976.
2. Luyben *"**Process Modelling, Simulation and Control for chemical Engineers**"*- 2nd Edn,, McGraw Hill, 1990.

BIOPROCESS ENGINEERING - 16CHBC1CBP

Subject Code	:	16CHBC1CBP	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

COURSE OUTCOME

CO 1. To provide the fundamental background of biological systems
CO 2. Emphasize areas of biochemical processes, essential to an engineer to work in the area of bioprocessing.
CO 3. To develop skills in the materials selection which can be utilized within the courses such as bioprocess equipment's design, engineering experimental investigations, process design project and experimental research project throughout the program.

Module 1	Time (hrs)
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	07

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, Numerical on enzymatic Kinetics	09
Module 3	
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. Numerical on Immobilized enzymatic Kinetics	07
Module 4	
GROWTH KINETICS OF MICROORGANISMS: Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: optimum dilution rate in an ideal Chemostat. Introduction to fed-batch reactors. Immobilized Cells: Formulations, Characterization and Applications	07
Module 5	
MIXED CULTURES: Introduction to mixed cultures, Major Classes of Interactions: Simple Models, Competition between two species, Prey-Predator system, Lotka-Volterra Model **INDUSTRIAL BIOPROCESS:** Anaerobic process: Ethanol, lactic acid, acetone-butanol production. Aerobic Processes: Citric Acid, Baker's Yeast, Penicillin, High fructose corn syrup production.	09

TEXT BOOK:

1. Shuler M. L. and Kargi F **Bioprocess Engineering**., 2nd Edition, Prentice Hall,2002.
2. Pauline M. Doran **Bioprocess Engineering -**, 2nd edition, Academic Press, 2012.

REFERENCE BOOKS:

1. James E.Bailey and David F.Ollis **Biochemical Engineering Fundamentals** by. Mc-Graw Hill International Edition, Sixth edition, 2005
2. James Lee, **Biochemical Engineering** –Prentice Hall - 1992.
3. Pelczar **Microbiology Concept and Application -**,5th Edition, McGraw Hill, 2001

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
M.TECH. IN BIOCHEMICAL ENGINEERING

BIOSEPARATION AND DOWNSTREAM PROCESSING- 16CHBC1CBD

Subject Code	:	16CHBC1CBD	LTPS	:	3-0-1-1
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	05			

Course Outcomes:

CO 1. Reinforce the knowledge of bio-separations, analyze the problems associated with bio-separation based on the physicochemical properties of the biomolecules and to apply to the real world applications.

CO 2. To inculcate critical thinking to analyze complex problems related to separation techniques as well as to evaluate and analyze the applicability of the separation techniques associated with the particular separation process.

CO 3. Assess the purity of the desired product using modern tools; select an appropriate separation process considering the economics and process feasibility.

CO 4. Design a suitable a suitable polishing and packaging operation with consideration of the market economics and shelf life of the product.

CO 5. To demonstrate the collaborative work, develop research skills by conducting experiments on isolation, separation & purification of biomolecules using modern tools.

Module 1	Time (hrs)
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.	07
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	08
Module 3	
ISOLATION AND PRODUCT PURIFICATION: Extraction: Principles of extraction, batch and staged extraction, differential extraction. Adsorption: Chemistry of adsorption, batch and continuous adsorption. Precipitation: Precipitation methods with salts, organic solvents, and polymers. Electrophoresis: Principle and Applications of Electrophoresis - their types, Iso-electric focusing	08
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	08

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 equipment's, lyophilization, principle of lyophilization, working and applications of lyophilization and formulations	08

Downstream Processing Laboratory

Note: Any five experiments

List of Experiments

1. SDS PAGE Electrophoresis
2. Aqueous two phase extraction
3. Ion exchange Chromatography
4. Ammonium sulphate precipitation of proteins
5. Leaf filter
6. Plate and frame filtration
7. Coagulation Jar Test

Demonstration of the equipment :

1. Solvent distillation using Rotovap
2. Identification of microorganism using microscope
3. Cell disruption using Deep Freezer & Sonicator
4. Cell separation using Cold Centrifuge

BOOKS:

1. Belter PA, Cussler E and Wei Shan Hu, Bioseparation –Downstream processing for biotechnology, John Wiley & Sons, New York.1988.
2. Roger G Harrison, Bioseparataions: Science and Engineering, Oxford Publications, 2006.

REFERENCE BOOKS

1. Neeraj Mishra, Akhilesh Dubey, Bioseparation Technology, CRC Press, 2012.
2. Elliott Goldberg, Handbook of downstream processing, Blackie Academic and Professional, 1997.
3. Verrall, M.S. Downstream processing of natural products: A practical handbook: John Wiley & Sons Ltd., England, UK. 1996.
4. Mulder, M. Basic principles of Membrane Technology: Kluwer Acadamic Publishers, Netherlands. 1996
5. Product Recovery in Bioprocess Technology- BIOTOL Series, VCH,1990.
6. Asenjo J and Dekker M, Separation Process in Biotechnology, Marcell Dekker Publications,1993

BMS COLLEGE OF ENGINEERING, BENGALURU-19

CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2016-2017

M.TECH. IN BIOCHEMICAL ENGINEERING

BIOREACTORS- 16CHBC1CBR

Subject Code	:	16CHBC1CBR	LTPS	:	3-0-0-1
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

Course Outcomes:

CO 1 Evaluate and analyze the suitability of a bioreactor selecting from a wide choice of spectrum of bioreactors

CO 2 Apply the concept of transport processes in biological systems involving oxygen transfer, estimate the oxygen rates and coefficient with appropriate models

CO 3 Analyze the factors influencing the performance of bioreactors and apply judgment to select control systems to stabilize the parameters effecting the bioreactor performance

CO 4 Select the suitable modern tools to estimate the performance of the scaled up bioreactors and apply ethically a suitable sterilization process

Module 1	Time (hrs)
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.	07
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.	09
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.	09
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.	07
Module 5	
STERILIZATION 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.	07

TEXT BOOK:

1. Tapabrata Panda, **Bioreactors Analysis and Design**, Tata McGraw Hill Education Pvt. Ltd, August, 2011
2. James E.Bailey and David F.Ollis **Biochemical Engineering Fundamentals** by. Mc-Graw Hill International Edition, Sixth edition, 2005

REFERENCE BOOK

1. Michael L. Shuler and FikretKargi, Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, 2002.
2. Pauline M. Doran **Bioprocess Engineering -**, 2nd edition, Academic Press, 2012.

TRANSPORT PHENOMENA IN BIOPROCESS SYSTEM - 16CHBC1ETP

Subject Code	:	16CHBC1ETP	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1 Apply continuity equations of change for real problems involving basic mass transfer systems, and problems involving determination of oxygen utilization as well as transfer rates
CO 2 Adjudge applicability of mass transfer correlation to determine coefficients for Newtonian & Non-Newtonian fluids
CO 3 Apply Modeling to estimate the distribution of temperature in solids and fluids flowing in laminar regime
CO 4 Apply appropriate techniques to predict, estimate the concentration distribution in fluids in laminar regime.
CO 5 Estimate the transfer coefficient by relating known to unknown parameters in transfer problems

Module 1	Time (hrs)
ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT: Numerical problems using Reynold's, Prandtl's and Chilton & Colburn analogies. Momentum Energy and Mass Transport Newton's law of viscosity (NLV).Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC).Fick's law of diffusion (FLD).Effect of temperature and pressure on transport properties of fluids. Numerical problems on the application of Numerical problems on use of NLV, FLHC and FLD	07
Module 2	

EQUATIONS OF CHANGE: Equation of continuity Equation of motion; Navier – Stokes equation. Application of these equations in solving simple steady state problems Gas-Liquid Mass Transfer in Cellular System, Basic Mass- Transfer Concepts, Rates of Metabolic Oxygen Utilization, Determination of Oxygen Transfer Rates, Measurement of k_la' Using Gas-Liquid Reactions, Mass-Transfer for Freely, Rising or Falling Bodies, Mass-Transfer Coefficients for Bubbles and Bubbles Swarms, Estimation of Dispersed Phase Int6erfacial Area and Holdup, Holdup Correlations	09
Module 3	
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_la' Estimates and Power Requirement for sparged and Agitated vessels, Mass Transfer Across Free Surfaces **FACTORS EFFECTING KLA:** 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	09
Module 4	
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	09
Module 5	
CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Diffusion through stagnant gas and liquid films. Equimolar counter diffusion. Numerical problems.	06

TEXT BOOK:

1. Bird, BR,, Stewart W.E.and Lightfoot **E. N., Transport Phenomena**, John Wiely and Sons, Singapore, 2nd Edition 2009.
2. James E.Bailey and David F.Ollis **Biochemical Engineering Fundamentals** by. Mc-Graw Hill International Edition, Sixth edition, 2005
3. Fruskey, Fan Yuan David F. Katz, **Transport Phenomena in Biological Systems** (Pearson Prentice Hall Bioengineering) 2nd edition, 2011

REFERENCE BOOKS:

1. Welty, J.R., C.E. Wicks and R.E. Wilson, Fundamental of Momentum, Heat and Mass Transfer, John Wiley and Sons, 1976.
2. Sissom L.E. and D.R.Pitts, Elements of Transport Phenomena, McGraw Hill, New York, 1972.
3. Brodkey R.S. and H.C.Hershey, Transport Phenomena, A United Approach McGraw Hill, 1988.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
M.TECH. IN BIOCHEMICAL ENGINEERING

MATHEMATICAL MODELING IN BIOCHEMICAL ENGINEERING
16CHBC1EMM

Subject Code	:	16CHBC1EMM	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1 To make the students understand physical systems in Chemical and Biochemical engineering.

CO 2 Develop mathematical models for Chemical and Biochemical systems.

CO 3 Solve and analyze process models using different mathematical techniques.

Module 1	Hrs
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 Rule . Applications:Vapor–Liquid equilibria for binary mixtures, Calculation of Bubble Point Dew point for ideal binary mixture	9
Module 2	
Bioreactor: Operational stages in a Bioprocess industry, biochemical reactor, continuous stirred tank bioreactor-process description, mathematical model, fed-batch bioreactor- model development	7
Module 3	
Design: Double Pipe Heat Exchanger (Area, Length and Pressure drop), Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop)	7
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	9
Module 5	
Mathematical Modeling and Solutions to the Following: Basic tank model – Level V/s time, batch Distillation–Vapour composition with CSTRs in series	7

TEXT BOOKS:

1. Jenson, V. G. and Jeffreys, F. V.,Mathematical methods in Chemical Engineering,2nd edition, Academic press, Elsevier, India, 2012.
2. Pradeep Ahuja, Introduction to Numerical Methods in Chemical Engineering, PHI Learning Pvt Ltd, New Delhi, 2010

REFRENCE BOOKS:

1. Gaikwad, R.W, and Dhirendra, Process Modelling and Simulation, 2nd Edition, Denetted& Co., 2006.
2. Grewal, B. S., Higher Engineering Mathematics, 40th edition, Khanna Publishers, Delhi, India,

2009.

3. William. L Luyben, Process Modeling Simulation and Control for Chemical Engineering 2nd Edition, McGraw Hill, 1990.
4. Jana, Aimya K., Chemical Process Modelling and Computer Simulation, 2nd edition, PHI Learning Private Limited, New Delhi, India, 2011.

OPERATION RESEARCH 16CHBC1EOR

Subject Code	:	16CHBC1EOR	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No. of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1 Get acquainted to find optimum solution for numerical problems using LPP.
CO 2 Solve assignment, transportation and sequencing problems for its optimal solutions.
CO 3 Illustrate network construction and find its feasible solutions for optimization of societal problems.

Module 1	Hrs
Introduction: Definition. Scope of operation research. Approach and limitations of O. R. Models. Characteristics and phase of O. R. Linear programming problems: Mathematical formulation of L. P. problems. Graphical solution method.	07
Module 2	
Assignment Problems: Balanced and unbalanced assignment problems. Maximization assignment problems. Travelling salesman problems.	09
Module 3	
Transportation Problems: Basic feasible solutions by different methods. Finding optimal solution. MODI method. Degeneracy. Unbalanced transportation problems. Maximization problems.	09
Module 4	
Sequencing: Johnson's algorithm. N jobs machines, n jobs – 3, machines and n jobs – machines without passing sequence. 2 job – n, machines. Graphical solutions.	06
Module 5	
PERT – CPM techniques: Network Construction. Determining time estimates and critical path. In network analysis. Variance and probability of completing the project. Calculation of different floats. Project duration. Crashing of simple networks.	08

TEXT BOOKS:

1. S. D. Sharma, Operation Research – 8th edition, Kedarnath & Co, 2003.
2. Kanti Swaroop, P. K. Gupta and Manmohan, Operation Research – 9th Edition, S Chand & Co. 1999.

REFERENCE BOOKS:

1. L. S. Srinath, Introduction to Pert and CPM – 3rd Edition, East West, 1998.
2. Hospach Buchan and Earnest Koenigberg, Scientific Inventory management – 1989.

NUMERICAL ANALYSIS – 16CHBC1ENA

Subject Code	:	16CHBC1ENA	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	3			

Course Outcomes:

CO 1 Develop ordinary and partial differential equations to solve chemical and Biochemical engineering problems.
CO 2 Apply appropriate numerical techniques to solve ODE and PDEs.
CO 3 Analyze error in the solution opt using numerical techniques and minimize the error.
CO4 Apply proper regression and curve fitting method to analyze experimental data.

Module 1	Hrs
ERROR ANALYSIS: Accuracy and precision; Truncation and round-off errors; Binary Number System; Error propagation. **REGRESSION AND CURVE FITTING:** Linear regression; Least squares; Total Least Squares; Interpolation; Newton's Difference Formulae; Cubic Splines.	09
Module 2	
SOLUTION OF ALGEBRAIC EQUATIONS: Solution of system of linear equations using Cramer's rule; Gauss Elimination; LU Decomposition; Iterative Methods. Solution of linear and nonlinear equation using Bisection, Secant, Newton-Raphson method.	09
Module 3	
NUMERICAL DIFFERENTIATION AND INTEGRATION: Forward, Backward and central difference for first and second order derivative. Trapezoidal rules; Simpson's rules; Quadrature.	07
Module 4	
ODES: INITIAL VALUE PROBLEMS: Taylor series method, Euler's methods; Modified Euler's method, Runge-Kutta methods; Predictor-corrector methods.	06
Module 5	
ODES: BOUNDARY VALUE PROBLEMS AND PDE: Shooting method; Finite differences; Over/Under Relaxation (SOR). Solution of PDE; Solution of heat conduction equation, Solution	08

of Laplace equation.	

TEXT BOOKS:

1. Kendall E. Atkinson, An Introduction to Numerical Analysis, Wiley India Private Limited; Second edition, 2008.
2. Pradeep Ahuja, Introduction to Numerical Methods in Chemical Engineering, PHI Learning Pvt Ltd, New Delhi, 2010
3. Grewal, B. S., Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, Delhi, India, 2014.

REFRENCE BOOKS:

1. Gupta S.K. Numerical Methods for Engineers, New Age International, 1995.
2. Chapra S.C. and Canale R.P. Numerical Methods for Engineers, 5th Ed; McGraw Hill, 2006

FOOD ENGINEERING - 16CHBC1EFE

Subject Code	:	16CHBC1EFE	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Comprehend the physical properties of food and its transportation.

CO 2. Identify sources of contaminants, adulterants with its prevention for safe and healthy food.

CO 3. Discern different technologies involved in food processing & preservation.

CO 4. Select biocompatible packaging and additives for food products.

Module 1	Hrs
INTRODUCTION TO FOOD ENGINEERING: Introduction, properties of food materials: Mechanical, thermal & Electrical properties of food, Rheological models, Water activity, Phase transition phenomena in foods, Properties of Liquids Handling Systems for Newtonian & Non-Newtonian Liquids, Transport of solid foods, Numericals on fluid flow in food processing.	07
Module 2	
FOOD PROCESSING AND PRESERVATION: Food deterioration – Causes. Aims and objectives of preservation and processing. Processing systems: pasteurization and blanching systems, commercial sterilization systems, ultra-high pressure systems; pulsed electric field systems; alternative preservation systems. **FOOD CONTAMINATION AND ADULTERATION:** Types of adulterants and contaminants. Intentional adulterants. Metallic contamination. Incidental adulterants. Nature and effects. Food	08

laws and standards. HACCP, FSSAI- The Food Safety and Standards Regulations, 2011	
Module 3	
HIGH-TEMPERATURE PRESERVATION: Introduction to Thermal Processing; Pasteurisation; Commercial Sterilization Kinetics of Microbial Death; Thermal Death Time; Heat Transfer in Thermal Processing; Integrated F Value; Numericals; Batch & continuous Retorts for Thermal processing; Cold sterilization: Gamma irradiation; Microwave & Ohmic heating. **LOW-TEMPERATURE PRESERVATION:** Principles of low temperature preservation; freezing rate & freezing point; physical properties of frozen food; food quality during frozen storage; freezing equipment, plate freezer, blast freezer, fluidised bed freezer, scraped surface freezer; cryogenic and immersion freezing; prediction of freezing time using Plank's equation & Nagaoka's equation	08
Module 4	
FOOD ADDITIVES: Introduction and need for food additives. Types of additives – antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti caking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH control agents. Preservatives – types and applications. Stabilizers and thickeners, other additives. Additives and food safety.	09
Module 5	
PACKAGING CONCEPTS: Introduction to packaging; food protection; product containment, commutation; convenience; mass transfer in packaging materials; permeability of packaging material to "fixed" gases; innovations in food packaging; passive packaging; active packaging; intelligent packaging; food packaging and product shelf-life. Advances in aseptic processing and packaging, nutrition labeling.	07

TEXT BOOKS

1. Paul Singh and Dennis R. Introduction to Food Engineering, Elsevier Science and Technology, 5th Edition, ISBN: 9780123985309,2013

REFERENCES:

1. HoshaliS. Ramaswamy and Michele Marcotte, Food Processing: Principles and Applications, ISBN-13:978-1587160080, CRC Press
2. ZekiBerk, Food Process Engineering and Technology, ISBN:978-0-12-373660-4, Elsevier Science and Technology 2009
3. G. Subbulakshmi and Shobha A. Udupi, 'Food Processing and Preservation', New Age International-2001.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
M.TECH. IN BIOCHEMICAL ENGINEERING

ENZYME TECHNOLOGY- 16CHBC1EET

Subject Code	:	16CHBC1EET	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes

CO 1 Understand the basics and mechanisms of enzyme catalysis
CO 2 Impart knowledge on reaction kinetics of free and immobilized enzymes
CO 3 Study about the industrial applications of enzymes in biological preparation
CO 4 Study instrumental techniques available for using enzymatic analysis.

Modules	Hours
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.	8
Module 2	
KINETICS: Chemical mechanisms of enzyme catalysed reactions, introduction to bioenergetics and kinetics, kinetics of multi-substrate bioreactions, investigations of active sites structures.	8
Module 3	
CHEMICAL NATURE OF ENZYME CATALYSIS: Sigmoidal kinetics and allosteric enzymes, co-enzymes, significance of sigmoidal behaviour.	8
Module 4	
APPLICATIONS: Investigation of enzymes in biological preparation, extraction and purification, enzymes as analytical reagents	7
Module 5	
INSTRUMENTAL TECHNIQUES: Instrumental techniques available for using enzymatic analysis, applications in medicine, industries, and biotechnological applications	8

TEXT BOOKS:

1. Trevor Palmer, **"Understanding Enzymes"**-4th edition, Prentice Hall, 1991.

REFERENCE BOOKS:

1. Bailey J.E and Ollis, D.F, **Biochemical Engineering fundamentals**, McGraw Hill, 2005.
2. John R. Whitaker, Alphons G J Voragen, and DWS Wong, **Handbook of Food Enzymology,** Marcel Dekker, NewYork, 2003.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
M.TECH. IN BIOCHEMICAL ENGINEERING

BIOINSTRUMENTATION - 16CHBC1EBI

Subject Code	:	16CHBC1EBI	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1 Apply the theoretical concepts behind the functioning analytical instrument
CO 2 Understand the impact, complexity of each instrument, its instruments based on appropriate criteria, analyses and interpret the experimental data using novel techniques
CO 3 Analyze the data from advance instruments for precise analysis of biomolecules.

Modules

Module 1	Hours
BASIC LABORATORY INSTRUMENTS: Principle and working of pH meter, Conductivity meter. **SPECTROSCOPY:** UV Spectroscopy, Principles, Instrumentation and applications. Spectroflourimetry; Principle, Stoke's shift, quantum efficiency, instrumentation and applications, Numerical on Spectroscopy	07
Module 2	
ELECTROPHORESIS: General principle, factors affecting electrophoresis – voltage, current, resistance, buffer– composition, concentration, pH. Gel electrophoresis: Types of gels: (starch, agarose, polyacrylamide), Idea of electrophoresis unit, preparation of gel, sample application, running the samples, SDS-PAGE - Principle, apparatus and methods, gradient gels, Two dimensional gels, isoelectric focusing. **MICROSCOPIC IDENTIFICATION OF VARIOUS MICROORGANISMS:** Phase contrast Microscopy, confocal microscopy Fluorescent Microscopy, Electron Microscopy, Scanning Ion Conductance Microscopy, Video Micrography, Atomic force Microscopy. Flow Cytometry.	08
Module 3	
CHROMATOGRAPHIC TECHNIQUES–I: Introduction to chromatography: General principles, column chromatography– columns, stationary phases. Packing of columns, application of sample, column development, fraction collection and analysis). Partition and adsorption chromatography (brief idea). **Affinity Chromatography:** Principle, materials matrix, selection of attachment of ligands, practical procedures, specific and non-specific elution, applications. **Ion Exchange Chromatography:** Principle, types of exchangers, materials, choice of exchangers and buffers and applications. **Gel Filtration chromatography:** Principle, idea of distribution coefficient, exclusion limit, fractionation range, bed volume, void volume, elution volume, chemical properties of gel and applications. Numerical	08
Module 4	
CHROMATOGRAPHIC TECHNIQUES II: **Gas Chromatography:** Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection systems and	08

applications. **High Performance Liquid Chromatography (HPLC):** Principle, components of HPLC system, column, column packing, chromatographic solvents, pumping systems, detectors systems and its applications. Numerical on Chromatography	
Module 5	
ATOMIC AND FLAME SPECTROPHOTOMETRY: Principles, Instrumentation and applications for flame emission / atomic absorption spectrophotometry and their comparative study. **MASS SPECTROMETRY:** Principles, Instrumentation and applications. Theory and applications of IR, NMR, Fluorescence, Atomic Absorption, Mass spectroscopy, CD, ORD, Mass, Raman Spectroscopy, ESR principles - instrumentation-applications, Beer-Lambert's law, Use of NMR in elucidation biosynthesis pathways.	08

TEXT BOOKS

1. Chatwal G R and Anand SK, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House, New Delhi, 5th Edition, 2014
2. Douglas A. Skoog, F. James Holler, Stanley R. Crouch., *Principles of Instrumental Analysis*, 6th Edition, Published by Thomson Brooks/Cole, 2007.

REFERENCES:

1. Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan., Introduction to Modern Liquid Chromatography, 3rd Edition, Wiley- Blackwell, Scholarly Publishing, 2016
2. H.H. Willard, L.L. Merritt, J.N. Dean and F.A. Settle, Instrumental methods of analysis, I.B.H. Publishing House, New Delhi, 2016.

BIOLOGICAL THERMODYNAMICS - 16CHBC1EBT

Subject Code	:	16CHBC1EBT	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1 Understand and apply the laws of thermodynamics to analyze energy flows in a biological system.
CO 2 Evaluate Gibbs free energy and calculate attainable work for engineering and biological system

Modules	Hours
Module 1	
FRONTIER OF BIOLOGICAL THERMODYNAMICS: Energy conservation in living organism, Irreversibility and life, third law and biology, entropy and protein stability, Energy, information processing and life, second law and evolution, Gibbs free energy, Equilibrium concepts	7

for biological thermodynamics.	
Module 2	
FUNDAMENTAL CONCEPTS OF THERMODYNAMICS: System and Surroundings, First law of thermodynamics -Internal energy, enthalpy, Heat capacity, applied examples from biochemistry.	8
Module 3	
ENTROPY: Second law – Entropy and universe, Concept of heat engines, protein stability and calorimetric measurements. Fundamentals of Differential scanning calorimeter and Isothermal calorimeter in biological property measurements, Third law of thermodynamics, Maxwell equations, Gibbs-Duhem Equation and the Phase Rule, Legendre Transforms.	8
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, Protien solubility, stability and dynamics.	8
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.	08

TEXT BOOK

1. Donald T. Haynie, *Biological Thermodynamics*, Cambridge press, 2008.
2. Robert A. Alberty, *Thermodynamics of Biochemical Reactions*, John Wiley publications, 2003

INSTITUTE CORE
RESEARCH METHODOLOGY - 16CHBC1IRM

Subject Code	:	16CHBC1IRM	LTPS	:	2-0-0-0
No of Lecture Hrs/Week	:	02	Exam hours	:	03
Total No.of Lecture Hours	:	26	CIE +SEE Exam Marks	:	50+50=100
Credits	:	02			

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

SECOND SEMESTER M.TECH – BIOCHEMICAL ENGINEERING

STATISTICAL METHODS – 16CHBC2CSM

Subject Code	:	16CHBC2CSM	LTPS	:	3-1-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

Course Outcomes:

CO1. Estimate the closeness of two variables and prediction of one variable from the other and to obtain the degree of relationship between two variables by performing regression analysis

CO2.Apply the basic principles of probability and probability distributions to the problems in Biochemical Engineering and to the field of genetics.

CO3. Demonstrate an understanding of sampling and its various techniques.

CO4. To draw inferences about the characteristics of population from the samples based on the parametric and non-parametric tests.

CO5. To conceive and conduct a designed experiment to characterize a process

Module 1	Hours
INTRODUCTION Scope of biostatistics, definition, data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency curve, logarithmic curves). Sampling & 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).	09
Module 2	
BI-VARIATE DISTRIBUTION Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential). **PROBABILITY** Axioms, models, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/multi-allele finger print systems.	09
Module 3	
PROBABILITY DISTRIBUTIONS Discrete probability distributions - Binomial, Poisson, geometric – derivations. Central limit theorem. Continuous probability distribution – normal, exponential, gamma distributions, beta and Weibull distributions, T & F distributions.	07
Module 4	
STATISTICAL INFERENCE 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).	07

Module 5	
DESIGN OF EXPERIMENTS Sample surveys, comparisons groups and randomization, random assignments, single and double blind experiments, blocking and extraneous variables, limitations of experiments. **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.	07

TEXT BOOKS:

1. Sokal, R. R. and F. J. Rohlf, **Biometry: the principles and practice of statistics in biological research,** W. H. Freeman and Co, Third edition: New York, 1995
2. Veer Bala Rastogi, Fundamentals of Biostatistics, Ane Books Pvt. Ltd., New Delhi, 2009

BIOENERGY – 16CHBC2CBE

Subject Code	:	16CHBC2CBE	LTPS	:	3-0-0-1
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

Course Outcomes:

CO 1. Understand the basic knowledge of biomass and its sources.
CO 2. Characterize the bioethanol and biodiesel production with its applications.
CO 3. Understand the biogas technology, pyrolysis and gasification of biomass.

Module 1	Hours
BIOENERGY RESOURCES: Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. Chemical composition and properties of different biomass materials and bio-fuels, Structural properties, Physical properties, properties of microbial biomass, Biomass resource assessment. Energy plantations -Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass, hydrogen production and biological fuel cell.	09
Module 2	
ETHANOL: Biomass constituent to liquid fuels, liquid fuel alcohol from sugar cane molasses, sweet sorghum, and other sources like corn and lignocelluloses. Lignocelluloses ethanol production technologies, conversion. Corn ethanol production technologies, chemistry of ethanol fermentation, by products from fermentation process.	07
Module 3	
BIODIESEL: Definition and properties of biodiesel Properties of Biodiesel, Catalyst used for biodiesel production. Biofuels from vegetable oil: production of vegetable oil, composition, process of extraction of vegetable oil, applications. Trans-Esterification of Oils to produce Bio-Diesel. Biofuels from algae: Microalgae growth, algae harvesting, extraction and utilization of liquid biofuels.	09

Module 4	
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.	08
Module 5	
PYROLYSIS AND GASIFICATION OF BIOMASS: Biomass conversion routes, biomass densification technologies, biomass combustion of woody biomass. Biomass pyrolysis, cogeneration in biomass Processing Industries. Guidelines for designing downdraft gasifiers. 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. Design and operation of Fixed and Fluidized Bed Gasifiers.	06

TEXT BOOK

1. Sunggyu Lee and Y T Shah, *Biofuels and Bioenergy- Process and Technology*, CRC Press, 2014.
2. VV N Kishore, *Renewable energy engineering and technology –principles and practice*, TERI Press, New Delhi, 2010.

REFERENCE BOOKS

1. Caye M. Drapcho, N.P. Nhuan and T. H. Walker, *Biofuels Engineering Process Technology* , Mc Graw Hill Publishers, New York, 2008.
2. Jonathan R.M, *Biofuels – Methods and Protocols (Methods in Molecular Biology Series)*, Humana Press, New York, 2009.
3. Lisbeth Olsson (Ed.), *Biofuels (Advances in Biochemical Engineering/Biotechnology Series*, Springer-Verlag Publishers, Berlin, 2007.
4. G D Rai, *Nonconventional Energy Sources*, Khanna Publications, 4th Edition, 2010.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

REACTION ENGINEERING – 16CHBC2CRE

Subject Code	:	16CHBC2CRE	LTPS	:	3-1-1-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	05			

Course Outcomes:

CO 1. Develop kinetic of heterogeneous reaction for catalytic and non – catalytic reaction using various models with and without consideration of effective mass and energy transport**.**

CO 2. Analyze the flow behavior, contacting, conversion and performance of non-ideal reactors using various models and comparison with ideal reactor.

CO 3. Apply knowledge of reaction kinetic and flow behavior to design heterogeneous catalytic reactors for different reaction conditions.

Module 1	Hours
KINETICS OF HETEROGENEOUS REACTIONS: Catalytic Reactions, Rate controlling steps, Langmuir - Hinshelwood model, Rideal - Eiley Mechanism, Steady State approximation, Non catalytic fluid - solid reactions, Shrinking and unreacted core model.	07
Module 2	
POPULATION BALANCE MODELS: Mixing concepts, Residence Time Distribution, Response measurements, Segregated flow model, Dispersion model, Series of stirred tanks model, Recycle reactor model, Analysis of non-ideal reactors.	09
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.	09
Module 4	
INTERNAL TRANSPORT PROCESSES IN POROUS CATALYSTS: Intra pellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction.	07
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 and Trickle bed reactor model.	07

REACTION ENGINEERING LABORATORY

List of Experiments Note: Any five experiments

1. Batch reactor
2. Isothermal continuous plug flow reactor
3. Continuous stirred tank reactor
4. Semi batch reactor
5. Packed bed reactor
6. Effect of temperature on rate of reaction
7. Effect of concentration on enzyme activity
8. Effect of Temperature on enzyme activity
9. RTD studies in tubular reactor
10. RTD studies in tank reactor

TEXT BOOKS:

1. Fogler H.S, Elements of Chemical Reaction Engineering, Prentice Hall, 1991.
2. John Villadsen, Jens Nielsen, Gunnar Lidén, Bioreaction Engineering Principles, Springer Science & Business Media, 2011
3. Bischoff and Froment, Chemical Reactor Design and Analysis, Addision Wesley, 1982.

REFERENCE BOOKS:

1. Levenspiel, O., Chemical Reaction Engineering , (Third Edtion), 2005.
2. Smith J.M, Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill, 1984.

BIOLOGICAL WASTE TREATMENT AND ENGINEERING – 16CHBC2EBW

Subject Code	:	16CHBC2EBW	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Cognize the different regulatory standards with design criteria for environmental parameters
CO 2. Learn the wastewater treatment criteria based on the regional requirement.
CO 3. Comprehend the reaction kinetics, reactor selection and its process analysis.
CO 4. Design the treatment plant based on the fundamentals studies, bench scale and pilot plant studies.

Module 1	
INTRODUCTION: Objectives of wastewater treatment. Flow measurements and Composition. Characterization -Properties and analysis of wastewater, Problems on wastewater characterizations. Waste-water treatability studies-a bench scale and pilot scale. Effluent standards for discharge to water bodies and land applications- state and central	08
Module 2	
Physical and Chemical treatment of wastewater: Screens, Comminutes, Grit chambers, Flow equalizations, Sedimentation, Flotation, Granular medium filtration Chemical treatment: chemical precipitation, Adsorption, Disinfection with chlorine, ozone, Ultraviolet light etc. Treatment disposal of sludge – Sludge characteristics, concentration. Aerobic/Anaerobic sludge digestion, sludge conditioning, Dewatering and drying. Incineration and wet oxidation.	09
Module 3	
Microbiology of waste treatment – Growth and inhibition of bacteria. Kinetic of Biological growth, Batch culture substrate limited growth, Cell growth and substrate utilization, Effects of endogenous metabolism. Monods and Michaels Menton kinetics and their applications. Determination of kinetic coefficients. Fundamentals of process analysis, Mass balance analysis, Reactors and their hydraulic characteristics, Reaction kinetics and Reactor selection. (Batch, Plug flow, Completely stirred tank reactor and packed and fluidized bed reactor).	09
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. Aerators/diffusers. With applicable numerical	06
Module 5	
Biological Nutrient Removal: Nitrogen removal with and without phosphorous removal, Nitrogen and Phosphorous removal, Phosphorous removal with or without nitrifications, Removal of ammonia by biological nitrifications, Removal of Nitrogen by biological nitrification/denitrifications. Combined removal of Nitrogen and Phosphorus by Biological, Physical and Chemical methods.	07

TEXT BOOKS:

1.Eckenfelder and O'Conner, Biological Waste Treatment, 2001
2.Metcalf and Eddy, Wastewater Engineering -Treatment, Disposal & Reuse, Tata McGraw Hill, 1991

REFERENCE BOOKS:

1. H.E. Babbilt and R.Baumann, Sewage and Sewage Treatment, 1986.
2. Webber WJ, Physicochemical processes for water quality
3. Fasir GM , Geyer JG and Okun- Waste water engineering
4. RonandDroste, Theory and practice of water and wastewater treatment, John Wiley and sons, Canada, 2005.
5. George Tchobanoglous and Franlin L. Burton, *Wastewater Engineering- Treatment, Disposal and Reuse*, Tata McGraw Hill Publishing Co. Ltd, 1990.

BIOPROCESS MODELINGAND SIMULATION - 16CHBC2EBM

Subject Code	:	16CHBC2EBW	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Understand the modeling concepts and illustrate examples of a model
CO 2. Apply and model Heat and mass transfer problems
CO 3. Understand chemical-biochemical reaction kinetics and model reactors.
CO 4. Understand the kinetic modeling for biosensor applications.
CO 5. Implement nonlinear dynamic concept in bioprocess modeling.

Module 1	Hours
INTRODUCTION TO PROCESS MODELING: Models and model building, model formulation principles. Fundamental laws used in modeling: Continuity Equation, Energy Equation, Equation of motion and transport Equations-equations of state &equilibrium states. Classification of mathematical models: linear & non-linear models, static & dynamic models and lumped & distributed parameter models, with examples for all the models.	07

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.	08
Module- -3	
MODELS IN REACTION ENGINEERING: Unstructured growth model with bottle-neck kinetics, Adiabatic batch reactor: Assumptions, model development, continuous stirred tank bioreactor, fed batch bioreactor, **pH-dependent bioprocess**- Enzymatic conversions; state and parameter estimation in bioreactors, Numericals.	09
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.	09
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.	08

TEXT BOOK

1. William. L Luyben, Process Modeling Simulation and Control for Chemical Engineering 2nd Edition, McGraw Hill, 1990
2. B.V.Babu, Process plant simulation, OXFORD university publication press, 2012.
3. Wayne Bequette.B, Process dynamics modeling and analysis and simulation,. Prentice Hall Inc, 2004

REFRENCE BOOKS

1. Turner A.P.F, Karube.I and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press, 1990.
2. John H. Seinfeld and Leon Lapidus., Mathematical Methods in Chemical Engg., (Vol. 3), Process Modeling, Estimations and Identification. Prentice Hall, 1974.
3. Shyam S. Sablani., Handbook of Food and Bioprocess Modeling Techniques. C R C

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

MEMBRANE SEPARATION TECHNOLOGY- 16CHBC2EMS

Subject Code	:	16CHBC2EMS	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

COURSE OUTCOMES:

CO 1: Classify and characterizer the membranes for bioseparation.
CO 2: Understand the preparation of membranes
CO 3: Analyze and select the appropriate method of membrane and membrane process.
CO 4: Evaluate the flux of solvent and solute through membrane.

Module 1	Time (hrs)
INTRODUCTION: Membrane separation process, Definition of Membrane, Membrane types, Advantages and limitations of membrane technology compared to other separation processes, Membrane materials and properties. Membrane Modules	07
Module 2	
CHARACTERIZATION OF MEMBRANES Preparation of synthetic membranes: Phase inversion membranes, Preparation techniques for immersion precipitation, Synthesis of asymmetric and composite membranes and Synthesis of inorganic membranes.	09
Module 3	
TRANSPORT IN MEMBRANES: Introduction, Driving forces, Non-equilibrium thermodynamics, Transport through porous membranes, transport through non-porous membranes, Transport through ion-exchange membranes. Pressure driven membrane processes, Concentration as driving force, Electrically driven membrane processes, Numericals on transport of solute/solvent in membrane Separations	07
Module 4	
MEMBRANE PROCESSES: Reverse osmosis, electro dialysis, gas permeation; pervaporation, concentration, pressure, electrically and thermally driven membrane processes; membrane bioreactors, liquid membranes **MAJOR AREAS OF APPLICATIONS:** Chemical industry, pharmaceutical industry, Food Industry, and Biotechnology industries	09
Module 5	
LIMITATIONS OF MEMBRANES: Polarisation phenomena and fouling: Concentration polarization, Pressure drop, Membrane fouling, methods to reduce fouling. Factors affecting retentivity, concentration polarization, gel polarization, fouling, cleaning and regeneration of membranes.	07

TEXT BOOK

1. Nath K., Membrane Separation Processes, Prentice-Hall Publications, New Delhi, 2008.

REFERENCE BOOKS

1. Marcel Mulder, *Basic principles of Membrane Technology*, Kluwer Academic Publishers,

Boston/London.

2. W S Ho, K K Sirkar, *Membrane Handbook* Kluwer.
3. Baker R. W., Membrane Technology and Research, Inc.(MTR), Newark, California, USA, 2004.
4. J.D.Seader, Ernest J. Henley, D. Keith Roper, *"Separation Process Principles:Chemical and Biochemical Operations"*, Third edition, Wiley 2010.
5. Geankoplis C. J., *"Transport Processes And Separation Process principles"* 4th Edition Prentice-Hall of India Private Ltd , New Delhi

ANIMAL & TISSUE CULTURE ENGINEERING 16CHBC2EAT

Subject Code	:	16CHBC2EAT	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Understand the characteristics of animal cells hybridoma technology in scale up and large scale operation

CO 2. Prepare, sterilize and harvest the tissue, organ and organotypic culture media using advanced techniques

CO 3. Know on tissues like skin, bone, tendon and national and international regulations of pharmaceutical and medical tissue products

Module 1	Time (hrs)
Characteristics of animal cell, metabolism, regulation and nutritional requirement. Effects of shear force and kinetics of cell growth and product formation. Product and substrate transportation	07
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.	07
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	09
Module 4	
Culture media (Preparation and sterilization), Harvesting, selection and expansion. Differentiation, Change of phenotype. Cryopreservation. Tissue, organ and organotypic cultures. Mass transport and nutrition gradients in tissue engineering (O_2) as model. Cryopreservation of organs and ECM-Freezing and vitrification. Most common Bioreactors in Tissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, Design Considerations, Challenges in Bioreactor Technologies.	09

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.	07

TEXT BOOKS

1. Ruiereis, Introduction to tissue engineering, 2006
2. Tissue Engineering by Clemens Van Blitterswijk
3. Tissue Engineering by John P. Fisher, A G Mikos & Joseph D. Bronzino, CRC Press, 2007.

REFERENCE BOOKS

1. Methods of Tissue Engineering by Anthony Atala & P Lanza, Academic Press Elsevier 2006.
2. Biocatalytic Membrane Reactor by Drioli, Taylor & Francis, 2005
3. Translational approaches in Tissue Engineering and regenerative medicine.

NANOTECHNOLOGY IN BIOPROCESS INDUSTRIES – 16CHBC2ENT

Subject Code	:	16CHBC2ENT	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO1. Learn basic knowledge in the interface between chemistry, physics and biology on the nano structural level with a focus on bioprocess industries use
CO2. Understand Basic concepts of BioMEMS and their use in drug delivery
CO3. Know the available nanomaterials in biological system

Module 1	Time (hrs)
METHODS OF MEASURING PROPERTIES: Atomic size, crystallography, Particle size determination, Surface structure, Microscopy- Transmission Electron Microscopy, Field Ion Microscopy, Scanning Microscopy; Spectroscopy- Infrared and Raman Spectroscopy, Photoemission and X-ray Spectroscopy, Magnetic resonance.	07
Module 2	
PROPERTIES OF INDIVIDUAL NANOPARTICLES: Metal nanoclusters, Semiconducting nanoparticles, Rare gas and molecular clusters, methods of synthesis- RF Plasma, Chemical Methods, Thermolysis, Pulsed Laser methods. Carbon nanostructures: Carbon molecule, Clusters, Carbon nanotubes, Applications. Bulk nanostructured materials: Solid disordered nanostructures, nanostructure crystals	07
Module 3	

NANOSTRUCTURED FERROMAGNETISM: Basics of ferromagnetism, Effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets. nanostrucures in zeolite cage. Quantum wells, wires and dots: Preparation of quantum nanostructures, Single electron tunneling, Applications. Catalysis: Nature of catalysis, Surface area of nanoparticles, porous materials, pillered clays, Colloids.	09
Module 4	
BIOMEMS: Introduction and Overview, BioMEMS Applications: Case Studies in Biomagnetic Sensors, Applications of optical and chemical transducers. Ultimate Limits of Fabrication and Measurement, Recent Developments in BioMEMS. Drug Delivery using Nanobiosensors, Drug Delivery Applications, Bioavailability, Suistained and targeted release, Drug Delivery, Health Risks, and Challenges**.**	09
Module 5	
BIOLOGICAL NANOMATERIALS: Biological building blocks, biological nanostructures. Nanomachines and nanodevices: Microelectromechanical systems (MEMSs), Nanoelectromechanical Systems (NEMSs) - Fabrication, Devices. Molecular and Supramolecular Switches. Nanodiagnostics: Diagnostics and Sensors, Rapid *Ex-Vivo* Diagnostics, Nanosensors as Diagnostics, Nanotherapeutics. Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices.	07

TEXT BOOK:

1. Charles P. Poole, Jr., Frank J. Owens, Introduction to Nanotechnology, John Wiley and Sons, 2009.
2. Handbook of Nanostructured Materials and Nanotechnology, Vol. 1-5, Academic Press, Boston, 2000.

REFERENCE BOOK

1. CNR Rao, Nanoworld- An introduction to science and technology, JNCASR, Bangalore, 2010.

BIOSENSORS - 16CHBC2EBS

Subject Code	:	16CHBC2EBS	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO1. Acquaint with definition need of biosensor types of sensors viz., optical sensors, electrochemical sensors, thermal sensors and mass sensors and their parameters.
CO2. Learn role of transducers in chemical analytics during the work with biosensors.
CO3. Practice the kinetic modeling of biosensors and learn the applications in industrial online monitoring

Module 1	Hours
INTRODUCTION: A historical perspective; Definition and Expanding Needs of Biosensors; Advantages and limitations; Biosensor Economics; various components of biosensors	07

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	07
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	09
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	09
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.	07

TEXT BOOKS:

1. Rajmohan Joshi, Biosensors (1e), Gyan Books, 2006
2. Cooper J.M. and Anthony E.G, Biosensors (2e), Oxford University Press, 2004.
3. Turner A.P.F, Karube.I and Wilson,G.S, Biosensors Fundamentals and applications, Oxford Univ. Press, 1990
4. Sadana.A, Biosensors: Kinetics of Binding and Dissociation Using Fractals (1e), Elsevier B.V, 1995

REFERENCE BOOKS

1. Ashok M and Kim Rogers, Enzyme & Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998.
2. Ashok M and Kim Rogers, Affinity Biosensors: Techniques and Protocols (Methods in Biotechnology) (1e), Humana Press, 1998.
3. Damia Barcelo, Biosensors for the Environmental Monitoring of Aquatic Systems: Bioanalytical and Chemical Methods for Endocrine Disruptors (1e), Springer, 2009.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

SAFETY MANAGEMENT IN BIOPROCESS INDUSTRIES - 16CHBC2ESM

Subject Code	:	16CHBC2ESM	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Understand the biohazard and its abatement in a safe way.
CO 2. Risk analysis, assessment and abatement of hazards for the safe operation of processes in biochemical industries.
CO 3. Apprehend process safety in Biotechnological based products in order to comply with industrial & regulatory standards

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, Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.	07
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	07
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.	09
Module 4	
REGULATIONS Good manufacturing practice and Good lab practices (GMP and GLP). GMOs: Concerns and Challenges, Regulatory mechanism for GMO, Case studies in IPR (Turmeric and Neem Patent Case) and Biosafety (Bt Bringal and Bt cotton, Golden Rice)	07
Module 5	
FOOD SAFETY The GM-food debate and biosafety assessment procedures for biotech foods & related products, case studies of relevance. Environmental aspects of biotech applications. **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.	09

TEXT BOOK

1. Deepa Goel & Shomini Prasar, IPR, Biosafety, and Bioethics, Pearson Press, New Delhi 2013.

2. Thomas JA and Fuch RI (2002) Biotechnology and safety assessment, Academic press 2002.

REFERENCE

1. Fleming DA and Hunt DL., Biological Safety principles and practices, ASM Press 2000.
2. Lees F.P, Loss Prevention in Process Industries, 2nd Edition, Butterworth Heinemann, 1996.
3. Patterson D, Techniques of safety managements, McGraw Hill, 1978.
4. Handley W., Industrial Safety hand book, 2nd Edition, McGraw Hill, 1977.
5. Levine S.P and Martin, Protecting personnel at hazardous waste sites, Butterworth, 1985

BIOPHARMACEUTICALS- 16CHBC2EBP

Subject Code	:	16CHBC2EBP	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO 1. Reinforce the knowledge on biopharmaceuticals, distinguish it from chemical drugs and identify the pharmaceuticals of plant, animal and microbial origin.
CO 2. Analyze the sources of biopharmaceuticals and to identity the products of biopharmaceuticals for various applications.
CO 3. Design the biopharmaceutical manufacturing process with consideration of clean room, maintaining records and study the products using appropriate characterization technique.
CO 4. To design a suitable drug delivery process and inculcate critical thinking to perform clinical trials in order to meet the required regulations.
CO 5. To develop research skills for identification structure activity relationship of drugs, and hence to design advanced drug delivery systems.

Module 1	Time (hrs)
Biopharmaceuticals: An Overview History of biopharmaceutical industry, Birth and age of biopharmaceuticals, Biopharmaceuticals: current status and future prospects, Distinctions between Chemical Drugs Versus Biopharmaceuticals ,Traditional pharmaceuticals of biological origin, Pharmaceuticals of animal, plant and microbial origin	07
Module 2	
Sources of Biopharmaceuticals: E. coli as a source of recombinant, therapeutic proteins, Expression of recombinant proteins in animal cell culture systems, Additional production systems: yeasts, Fungal production systems, Transgenic animals, Transgenic plants, Insect cell-based systems **Products of Biopharmaceuticals:** Cytokines, enzymes, hormones, clotting factors, vaccines, monoclonal antibodies, cell therapies, antisense drugs, and peptide therapeutics.	07
Module 3	

Biopharmaceutical Manufacturing: Clean rooms, Water for biopharmaceutical processing, Generation of purified water and water for injections (WFI), Documentation and Specifications, Manufacturing formulae, processing and packaging instructions, Generation of manufacturing records **Production and Analysis of Final Product**: Cell banking systems, Upstream processing, Microbial cell fermentation, Mammalian cell culture systems, Downstream processing, Final product formulation. Product potency, Determination of protein concentration, Detection of protein-based product impurities, Capillary electrophoresis, High-pressure liquid chromatography (HPLC), Mass spectrometry, Immunological approaches to detection of contaminants.	09
Module 4	
Delivery of Biopharmaceuticals: Oral delivery systems, Pulmonary delivery, Nasal, Transmucosal and transdermal delivery systems. **Clinical Trials**: Pharmacokinetics and pharmacodynamics, Toxicity studies, Reproductive toxicity, teratogenicity, Mutagenicity, carcinogenicity and other tests, Clinical trial design, Trial size and study population, the role and remit of regulatory authorities for The Food and Drug Administration and new drug application	09
Module 5	
Advanced Drug Delivery and design Introduction, Drug Therapeutic Index and Clinical Impact, Routes of Therapeutic Protein Administration, Approaches Using Devices, Physiological and Mechanistic Approaches, Molecular Approaches to design - Computer-Aided Drug Design, ligand structure based drug design, Quantitative Structure Activity Relationship (QSAR)	07

BOOKS:

1. Gary Walsh, *Biopharmaceuticals Biochemistry and Biotechnology*, Second Edition, (Editor)., John Wiley & Sons, Ltd, 2003.
2. Susanna Wu-Pong ,Yon Rojanasakul, *Biopharmaceutical Drug Design and Development*, Humana Press, 2008.

REFERENCE BOOKS

1. Gary Walsh and Brendan Murphy, *Biopharmaceuticals, An Industrial Perspective*, Kluwer Academic Publishers, 1999.
2. Shargel, L. and Yu, A.B.C., *Applied Bio pharmaceutics and Pharmacokinetics*, McGrawHill, New York, 5th ed., 2005.
3. Jörg Knäblein, *Modern Biopharmaceuticals, Recent success stories*, (Editor), Wiley-VCH Verlag GmbH & Co, Weinheim, Germany, 2013.
4. Gary Walsh, *Pharmaceutical Biotechnology Concepts and Applications*, John Wiley & Sons Ltd, 2007.
5. O. Kayser and R.H. Muller, *Pharmaceutical Biotechnology, Drug Discovery and Clinical Applications*, Wiley-VCH Verlag GmbH & Co. 2004.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

INSTITUTIONAL ELECTIVE
TOTAL QUALITY MANAGEMENT – 16CHBC2ITQ

Subject Code	:	16CHBC2ITQ	LTPS	:	3-0-0-0
No of Lecture Hrs/Week	:	03	Exam hours	:	03
Total No.of Lecture Hours	:	39	CIE +SEE Exam Marks	:	50+50=100
Credits	:	03			

Course Outcomes:

CO1. Understand the main principles of business and social excellence.
CO2. Use models and quality management methodology for the implementation of total quality management at all scope of business and public sector.
CO3. Develop an understanding of total quality management principles, frameworks, tools and techniques for effective real life applications in both manufacturing and services.

Module 1	Time (hrs)
CONCEPTS OF TQM:Basics of total quality, Guru's of TQM, Philosophy of TQM, customer focus, organization, quality philosophies of Deming, Crossby.	07
Module 2	
TQM PROCESS: QC tools, problem solving methodologies, cost of quality, quality circles, bench marking, strategic quality planning.	09
Module 3	
TQM SYSTEMS: Quality policy deployment, quality function deployment, standardization, designing for quality, manufacturing for quality.	09
Module 4	
QUALITY SYSTEM: Need for ISO 9000 system, advantages, clauses of ISO 9000, Implementation of ISO 9000, quality auditing, case studies.	07
Module 5	
IMPLEMENTATION OF TQM: KAIZEN, 5s, JIT, POKAYOKE, Taguchi methods, case studies.	07

TEXT BOOK

1. Dale H. Besterfield, Total Quality Management, PHI, India.
2. Rose, J.E, Total Quality Management, Kogan Page Ltd. 1993.

REFERENCE BOOKS

1. John Bank., The essence of total quality management, PHI, 1993.
2. Greg Bonds *et al*, Beyond Total Quality Management, McGraw-Hill, 1994.

BMS COLLEGE OF ENGINEERING, BENGALURU-19

CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2016-2017

MTECH IN BIOCHEMICAL ENGINEERING

PROJECT ENGINEERING MANAGEMENT - 16CHBC2IPM

Subject Code	:	16CHBC2IPM	LTPS	:	4-0-0-0
No of Lecture Hrs/Week	:	04	Exam hours	:	03
Total No.of Lecture Hours	:	52	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

Course Outcomes:

CO 1. Understand the concept of a project with relevance to industry and biochemical engineering industry in particular

CO 2. Understand the various stages and procedures involved in conducting industrial projects

CO 3. Comprehend the ideas like project selection, planning , implementation, success and review

Modules	Time (hrs)
Module 1	
PROJECT PLANNING: Overview of project planning, resource allocation strategies, generation and screening of project ideas and plans	09
Module 2	
PROJECT ANALYSIS: Analysis, market and demand analysis, technical anlaysis, financial requirements and estimation	11
Module 3	
PROJECT SELECTION: Time value of money, investment criteria, cash flow, cost of capital, risk factor and analysis and analysis of rate of return	12
Module 4	
FINANCING OF PROJECTS: Raising capital methods and means, venture capital, credit risk rating, case studies and corporate examples in brief	10
Module 5	
IMPLEMENTATION AND REVIEW OF PROJECT: Time and cost control tools, project quality control, Importance of environmental and safety aspects, Project termination: Commissioning; Start UP: Stabilization, Close out **PROJECT SCHEDULING AND EXECUTION:** CPM AND PERT,(Critical Path, Float, total float, AON, AOA diagram), GANTT Charts, LOB, resource allocation, ABC Analysis, EOQ, CAT, & RAT. Numerical problems	12

TEXT BOOKS:

1. Prassanna Chandra, *Projects*, Tata McGraw Hill , 7th Edition, New Delhi, 2016
2. Sadhan Choudhury, Project Management, Tata McGraw Hill Education , New Delhi, 1988.

REFERENCE BOOKS

1. S. D. Sharma, Operation Research – 8th edition, Kedarnath & Co, 2003.
2. Kanti Swaroop, P. K. Gupta and Manmohan, Operation Research – 9th Edition, S Chand & Co. 1999.

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

FERMENTATION TECHNOLOGY - 16CHBC2IFT

Subject Code	:	16CHBC2IFT	LTPS	:	4-0-0-0
No of Lecture Hrs/Week	:	04	Exam hours	:	03
Total No.of Lecture Hours	:	52	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

Course Outcomes:
CO1. To devise the isolation and improvement methods base on metabolic pathway of the product
CO2. Design, formulate and sterilize the media for different inocula on large scale
CO3. To understand design and operation of basic control loops with respect to fermentation process

Module 1	Time (hrs)
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.	09
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.	12
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	09
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.	12
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;	10

TEXT BOOK

1. Peter F. Stanbury, Alan Whitaker and Hope, Principles of Fermentation Technology, Pergamon Press, 2nd Edition, Reprint 2010

REFERENCE BOOKS:

1. Shuler M. L. and Kargi F, Bioprocess Engineering, 2nd Edition, Prentice Hall, 2002.
2. Mitchell DA. Krieger N, Berovic, "Solid State Fermentation Bioreactors", Springer Press, Germany, 2005.

BIOMATERIALS- 16BCHBC2IBM

Subject Code	:	16BCHBC2IBM	LTPS	:	4-0-0-0
No of Lecture Hrs/Week	:	04	Exam hours	:	03
Total No.of Lecture Hours	:	52	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

COURSE OUTCOMES:

CO 1: Classify and understand the properties of biomaterials
CO 2: Understand the concept of biocompatibility
CO 3: Ability to characterize the biomaterials using modern tools & techniques
CO 4: Assess biocompatibility of materials using in vivo and in vitro techniques
CO 5: Understand the concepts for developing new biomaterials for its applications.

Module 1	Time (hrs)
INTRODUCTION: Overview of Biomaterials, Impact of Biomaterials, Safety and efficacy Testing, Biocompatibility. Structure and properties of materials, Mechanical Properties of materials, thermal treatments	09
Module 2	
INTERACTIONS OF MATERIALS AND ITS CHARACTERIZATION: Interactions of materials with human body, bio-compatibility of materials, metals, alloys, ceramics, polymers and composites as biomaterials. *Characterization of Biomaterials:* Contact Angle, Infrared Spectroscopy, XRay Photoelectron Spectroscopy, Atomic Force Microscopy, X-Ray Diffraction,.	12
Module 3	
BIOPOLYMERS: Biopolymers, Collagen, Elastin, Silk, Chitosan, Cellulose, Alginate, material for drug delivery: biodegradable polymers. Applications of Biomaterial. **Hydrogels:** Synthesis and Properties of Hydrogels, Aplications of Hydrogels	09
Module 4	

APPLICATIONS OF BIOMATERIALS: Materials for hard tissue replacement: orthopaedic implants, dental implants. Materials for soft tissue replacement: dermal and facial prosthesis, cardiovascular implants, ophthalmology, materials for artificial organs transplant and extracorporeal device.	12
Module 5	
NEW TRENDS IN BIOMATERIALS: Recent developments in biomaterials, legal issues related to development of biomaterials, Role of Nano-biomaterials and its various application	10

TEXT BOOK

1. Sujatha V. Bhat, *Biomaterials*, 2nd Edition, Narosa Publishing House, Mumbai, 2010.
2. Joon Park, R. S. Lakes, *Biomaterials: An Introduction,* 3rd Edition, Springer Press, 2009. (ISBN-13: 978-1441922816)

REFERENCES

1. Buddy D. Ratner, *Biomaterials Science: An Introduction to Materials in Medicine* 2nd Edition, Academic Press, 2004.
2. H. Reza Rezaie, L. Bakhtiari, A. Öchsner, *Biomaterials and their Applications*, Springer 2015.
3. C. Mauli Agrawal, Joo L. Ong, *Introduction to Biomaterials: Basic Theory with Engineering Applications*, Cambridge Texts in Biomedical Engineering Cambridge University Press, (ISBN-13: 978-0521116909) 2016.

TECHNICAL SEMINAR - 16CHBC2TS1

Subject Code	:	16CHBC2TS1	LTPS	:	0-0-0-0
No of Lecture Hrs/Week	:	00	Exam hours	:	03
Total No.of Lecture Hours	:	00	CIE +SEE Exam Marks	:	100+0=100
Credits	:	2			

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

INTERNSHIP/INDUSTRIAL TRAINING, REPORT AND VIVA-VOCE- 16CHBC3CIN

Subject Code	:	**16CHBC3CIN**	LTPS	:	0-0-0-0
No of Lecture Hrs/Week	:	00	Exam hours	:	03
Total No.of Lecture Hours	:	00	CIE +SEE Exam Marks	:	50+50=100
Credits	:	21			

The student shall make a 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**.**
- The students are required to give a presentation on any INTERNSHIP in the form of seminar. The seminar shall be evaluated.

PROJECT PHASE I - 16CHBC3CIP

Subject Code	:	16CHBC3CIP	LTPS	:	0-0-0-0
No of Lecture Hrs/Week	:	00	Exam hours	:	03
Total No.of Lecture Hours	:	00	CIE +SEE Exam Marks	:	50+50=100
Credits	:	04			

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 HOD.

FOURTH SEMESTER M.TECH – BIOCHEMICAL ENGINEERING

PROJECT PHASE II, III AND FINAL EVALUATION - 16CHBC4CPR

Subject Code	:	16CHBC4CPR	LTPS	:	0-0-0-0
No of Lecture Hrs/Week	:	00	Exam hours	:	03
Total No.of Lecture Hours	:	00	CIE +SEE Exam Marks	:	100+100=200
Credits	:	23			

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 HOD.

TECHNICAL SEMINAR - 16CHBC4TS2

Subject Code	:	16CHBC4TS2	LTPS	:	0-0-0-0
No of Lecture Hrs/Week	:	00	Exam hours	:	03
Total No.of Lecture Hours	:	00	CIE +SEE Exam Marks	:	100+0=100
Credits	:	2			

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

BMS COLLEGE OF ENGINEERING, BENGALURU-19
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2016-2017
MTECH IN BIOCHEMICAL ENGINEERING

RUBRICS FOR INTERNSHIP

		Poor	Average	Admirable	Outstanding
	Marks	**5**	**7**	**9**	**10**
A	**Organization (10 marks)**	Audience cannot understand presentation because there is no sequence of information	Audience has difficulty following presentation because student jumps around	Student presents information in logical sequence which audience can follow	Student presents information in logical, interesting sequence which the audience can follow
B	**Subject Knowledge (10 marks)**	Student does not have grasp of information; student cannot answer questions about subject	Student is uncomfortable with information and is able to answer only rudimentary questions	Student is at ease with expected answers to all questions, but fails to elaborate	Student demonstrate full knowledge (more than required) by answering all class questions with explanations and elaboration
C	**Mechanics (5 Marks)**	Presentation has four or more spelling errors and/or grammatical errors	Presentation has three misspellings and/or grammatical errors	Presentation has no more than two misspellings and/ or grammatical errors	Presentation has no misspellings or grammatical errors
D	**Graphics (10 Marks)**	Student uses superfluous graphics or no graphics	Student occasionally uses graphics that rarely support text and presentation	Student's graphics relate to text and presentation	Student's graphics explain and reinforce screen text and presentation
E	**Elocution (5 Marks)**	Student mumbles, incorrectly pronounces terms, and speaks to quietly for students in the back of class to hear	Student's voice is low. Student incorrectly pronounces some terms. Audience members have difficulty hearing	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear
F	**Eye Contact (10 marks)**	Student reads all of report with no eye contact	Student occasionally uses eye contact, but still reads most of report	Student maintains eye contact most of the time but frequently returns to notes	Student maintains eye contact with audience , seldom returning to notes

BMS COLLEGE OF ENGINEERING, BENGALURU-19

CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2016-2017

MTECH IN BIOCHEMICAL ENGINEERING

RUBRICS FOR PROJECT WORK

		Inadequate	Average	Admirable	Outstanding
	Marks	**5**	**7**	**9**	**10**
A	**Organization of presentation (10 marks)**	Hard to follow sequence of information jumpy	Most of the information presented in sequence	Information presented in logical sequence and easy to follow	Information presented as interesting story in logical and easy to follow
B	**Background content (10 marks)**	Material not clearly related to topic or seminar	Material sufficient for clear understanding	Material sufficient for clear understanding and effectively presented	Material sufficient for clear understanding and exceptionally presented
C	**Results (Figures, table and graphs) (10 marks)**	Methods are too brief, figure are hard to read, some explanation missing	Majority of figures are clear, and reasonably explained	Most of the figures are clear, well explained	All figures are clear and exceptionally explained
D	**Contribution of work (5 Marks)**	Significance not mentioned just hinted	Significance mentioned	Significance explained	Significance exceptionally well explained
E	**Knowledge of subject (5 Marks)**	Don't have grasps of information, answered only rudimentary questions	At ease with information answered most questions	At ease, answered all questions, but failed to elaborate	Demonstrated full knowledge, answered all questions with elaboration
F	**Presentation skills (10 marks)**	• Uses graphics that did not match the text • Reads most of the slides, no eye contact • 10 Spelling mistake in the slide • Incorrect pronounces of all term • Voice is low	• Uses graphics that relate to the text • Refer to slides, occasional eye contcact • 5 Spelling mistake in the slide • Incorrect pronounces of some term • Voice is low-clear	• Uses graphics that explain the text and presentation • Refer to slides to make points, with eye contact • 3 Spelling mistake in the slide • Incorrect pronounces of some term • Voice is clear with few fluctuations	• Uses graphics that explain, reinforce text and presentation • Refer to slides to make points, with good eye contact • 2 Spelling mistake in the slide • Refer to the slides and make points Engaged with audience • Voice is clear and steady