GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)
COIMBATORE-641 013

DEPARTMENT OF INDUSTRIAL BIOTECHNOLOGY

VISION AND MISSION

VISION

To achieve the highest caliber in Biotechnology research and innovation to develop intellectual leaders to meet out the societal, environmental, and industrial needs.

MISSION

To provide quality education with global competence and molding the students as technologically sound and ethically motivated technocrats through advanced skill based learning.

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PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1 : Demonstrate competence in Biological sciences and technology courses to pursue higher education.

PSO 2 : Demonstrate an ability to acquire technical skills and work ethics to meet the industry needs and to become an entrepreneur.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013
B.Tech. INDUSTRIAL BIOTECHNOLOGY (FULL TIME)

THIRD SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22BBS307	Transform Calculus and Partial Differential Equations (*Common to Civil & IBT*)	BS	40	60	100	3	1	0	4
2	22BBS308	Cell Biology	BS	40	60	100	3	0	0	3
3	22BES306	Process Calculations and Heat transfer	ES	40	60	100	3	1	0	4
4	22BPC302	Industrial Microbiology	PC	40	60	100	3	0	0	3
5	22BPC303	Biochemistry	PC	40	60	100	3	0	0	3
6	22BPC304	Genetics	PC	40	60	100	3	0	0	3
PRACTICAL										
7	22BBS309	Cell biology Laboratory	BS	60	40	100	0	0	3	1.5
8	22BPC305	Microbiology Laboratory	PC	60	40	100	0	0	3	1.5
9	22BPC306	Biochemistry Laboratory	PC	60	40	100	0	0	3	1.5
		TOTAL		**420**	**480**	**900**	**18**	**2**	**9**	**24.5**

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22BES407	Fluid Mechanics	ES	40	60	100	3	0	0	3
2	22BPC407	Molecular Biology	PC	40	60	100	3	0	0	3
3	22BPC408	Biochemical Thermodynamics	PC	40	60	100	3	0	0	3
4	22BPC409	Enzyme Engineering and Technology	PC	40	60	100	3	0	0	3
THEORY COURSE WITH PRACTICAL COMPONENT										
5	22BPC410	Analytical Techniques in Biotechnology	PC	50	50	100	3	0	2	4
PRACTICAL										
6	22BES408	Engineering Exploration For Industrial Biotechnology	ES	100	-	100	0	0	3	1.5
7	22BES409	Chemical Engineering Laboratory	ES	60	40	100	0	0	3	1.5
8	22BPC411	Molecular Biology Laboratory	PC	60	40	100	0	0	3	1.5
		TOTAL		**430**	**370**	**800**	**15**	**0**	**11**	**20.5**

22BBS307	TRANSFORM CALCULUS AND PARTIAL DIFFERENTIAL EQUATIONS *(Common to Civil and IBT Branches)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	To be familiar with Fourier Series. To gain the knowledge of solving Boundary value problems. To be familiar with Laplace and Inverse Laplace transforms to solve ordinary differential equations. To acquire knowledge on Fourier transforms. To be familiar with Z-transform to solve difference equations.	
UNIT – I	**FOURIER SERIES**	**9 Periods**
Dirichlet's Conditions – General Fourier series – Odd and even functions- Half range Sine and Cosine series –Root Mean Square Value- Parseval's Identity on Fourier series–Harmonic Analysis		
UNIT – II	**BOUNDARY VALUE PROBLEMS**	**9 Periods**
Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Infinite Stripes in cartesian coordinates only).		
UNIT – III	**LAPLACE TRANSFORMS**	**9 Periods**
Laplace transform –Sufficient condition for existence –Transform of elementary functions –Basic properties –Transforms of derivatives and integrals of functions -Derivatives and integrals of transforms -Transforms of unit step function and impulse functions –Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem –Initial and final value theorems– Solution of linear ordinary differential equation of second order with constant coefficients using Laplace transformation techniques.		
UNIT – IV	**FOURIER TRANSFORMS**	**9 Periods**
StatementofFourierintegralTheorem–Fouriertransformpair–FourierSineandCosineTransforms– properties – Transforms of Simple functions – Convolution Theorem – Parseval's Identity.		
UNIT – V	**Z TRANSFORMS**	**9 Periods**
Z-transforms - Elementary properties –Convergence of Z-transforms - Initial and Final value theorems - Inverse Z-transform using partial fraction and convolution theorem– Formation of difference equations - Solution to difference equations of second order with constant coefficients using Z-transform.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*Veerarajan. T.* ***"Transforms and partial Differential equations"****, Tata Mc GrawHill Publishing Co., New Delhi. 2015.*
2	*B.S.Grewal.,****"HigherEngineeringMathematics"****,KhannaPublishers,NewDelhi,44th Edition,2018.*

REFERENCES

1	*Kandasamy,ThilagavathyandGunavathy.,****"EngineeringMathematics"****forIIISemester,S.Chand &Co, Ramnagar, New Delhi.*
2	*N.P.Bali andManish Goyal ,****"Transformsand partial Differentialequations"****,University Science Press, New Delhi, 2010.*
3	*VeerarajanT.,****"EngineeringMathematics"****forSemesterI&II,TataMcGrawHillEducation (India) Pvt Ltd., New Delhi, Third Edition 2012.*
4	*Erwinkreyszig,****"AdvancedEngineeringMathematics"****,9thEdition,JohnWiley&Sons,2006.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Express the periodic functions arising in the study of engineering problems as sine and cosine series.	K3
CO2	Solve the Partial Differential Equations arising in engineering problems like Wave, Heat flow and Laplace equation in steady state (Cartesian coordinates) using Fourier series.	K3
CO3	Apply Laplace transform technique to solve the given integral equations and ordinary differential equations.	K3
CO4	Find Fourier Transforms, infinite Fourier Sine &Cosine transforms.	K3
CO5	Apply Z - transform technique to solve difference equations	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-
22BBS307	3	2	-	-	-	-	-	-	-	-	-	-	1	1
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2,1.3.1,1.4.1,2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.1
CO2	1.1.1, 1.1.2,1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	50	-	-	-	100
ESE	20	30	50	-	-	-	100

22BBS308	CELL BIOLOGY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
BIOMOLECULES	BS	3	0	0	3

Course Objectives	To Gain the insights of cell structure and cell division ,understand the composition of extracellular matrix, cell junction and cell adhesion.Get familiarized with the various transport mechanisms and understand the different types of receptor and signal transduction and familiarized with the techniques to study cell line	
UNIT – I	**CELL STRUCTURE AND FUNCTION OF THE ORGANELLES**	**9 Periods**
Structure of Prokaryotic and Eukaryotic cells their organelles, principles of membrane organization, membrane proteins, types of cell division, mitosis & meiosis, cell cycle and molecules that control cell cycle. Cell cycle check points.		
UNIT – II	**EXTRACELLULAR MATRIX AND CELL JUNCTIONS**	**9 Periods**
Extra cellular matrix- composition, cytoskeletal proteins-Microfilaments, Microtubules, Intermediate filaments, actin-myosin interaction and its role. types of cell junctions and cell adhesion molecules(CAMs)		
UNIT – III	**TRANSPORT ACROSS BIOMEMBRANES**	**9 Periods**
Passive & active transport, permeases, Co- transport - symport, antiport, .types of ATPase pumps-Na K pump, V type, P type pumps, voltage and ligand gated channels, endocytosis and exocytosis. Mode of entry of virus and toxins into cells.		
UNIT – IV	**RECEPTORS AND SIGNAL TRANSDUCTION**	**9 Periods**
Cytosolic, nuclear and membrane bound receptors with examples, autocrine, paracrine and endocrine modes of action Signal amplification, role of secondary messengers- cyclic AMP, inositol tri phosphates and cyclic GMP; G proteins - role in signal transduction, calcium ion flux and its role in cell signaling, Tyrosine kinases and Serine Threonine kinases –examples and mechanism.		
UNIT – V	**TECHNIQUES USED TO STUDY CELLS AND CELL LINES**	**9 Periods**
Cell fractionation - Preparation of Nuclear, Mitochondrial & cytoplasmic fractions, Cell viability,flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM, Confocal Microscopy. Localization of proteins in cells – Immunostaining.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, Keith; Walter, P., (eds) c2002: *"**Molecular Biology of the Cell**",* Garland Science, New York and London.
2	Darnell J, Lodish H, Baltimore D, *"**Molecular Cell Biology**",* W.H.Freeman; 8th edition,2016
3	Brai De Robertis& De Robertis, *"**Cell Biology**",* Fourth edition,2007
4	Geoffrey M. Cooper and Robert E. Hausman,***"The Cell: A Molecular Approach"***, ASM Press and Sinauer Associates, Fifth Edition, 2009.

REFERENCES:

1	James D.Watson,***"Molecular Biology of the Cell"***,Third edition,2004.
2	Channarayappa,***"Cell biology"***,Universities Press,2010
3	Rastogi.S.C, *"**Cell biology**",* New Age International publishers, 2005
4	https://www.ncbi.nlm.nih.gov/books
5	http://www.di.uq.edu.au/sparqglossary#b
6	https://cellbiology.med.unsw.edu.au
7	https://micro.magnet.fsu.edu

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the structural organization of the cell and cell division.	K2
CO2	Familiarize with extracellular matrix, cell junction, cell adhesion.	K1
CO3	Understand the various transport mechanism in the cell.	K2
CO4	Get familiarized with the type of receptors and signal transduction pathways.	K2
CO5	Familiarize with the techniques for cytometry analysis.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO3	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO4	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO5	1	1	-	1	1	1	-	-	-	-	-	-	1	1
22BBS308	1	1	-	1	1	1	-	-	-	-	-	-	1	1
1 – Slight, 2 – Moderate, 3 – Substantial														
b) CO and Key Performance Indicators Mapping														
CO1	1.2.1,2.2.2													
CO2	1.2.1,2.2.2													
CO3	1.2.1,2.2.2													
CO4	1.2.1,2.2.2													
CO5	1.2.1,4.1.2,4.1.3,5.1.2													

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	70	30	-	-	-	-	100
CAT2	60	40					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	60	-	-	-	-	100
ESE	50	50	-	-	-	-	100

22BES306	PROCESS CALCULATIONS AND HEAT TRANSFER	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	1	0	4

Course Objectives	The primary aim of this course is to train the students in the fundamental principles of material balance, energy balances and various heat transfer methods to develop solutions for the problems encountered in chemical engineering.	
UNIT – I	**BASICS OF BIOCHEMICAL CALCULATIONS**	**9+3 periods**
Dimensions and Units: Dimensions and Systems of units - fundamental and derived quantities, Dimensional equation. Different ways of expression of units of quantities and unit conversion. Composition conversion- atomic weight, molecular weight, equivalent weight, molar concept, mole percent, weight percent, volume percent, molarity, molality, normality, etc., Basics of unit operations and unit processes involved in biotechnology industries and its applications.		
UNIT – II	**MATERIAL BALANCE**	**9+3 periods**
Process flow sheet, degrees of freedom, Overall and component balances; material balances without and with chemical reactions; recycle, by pass and purge streams; Unsteady state material balance.		
UNIT – III	**ENERGY BALANCE**	**9+3 periods**
Fundamentals of energy balance calculations–Concepts of heat capacity, latent heat, sensible heat, enthalpy change, Standard heat of reaction, the heat of mixing and dissolution of solids, Hess's law, and Humidity calculations. Energy balance with and without chemical reactions.		
UNIT – IV	**CONDUCTION AND CONVECTION**	**9+3 periods**
Introduction – Mode of heat transfer; Conduction – Basic concepts of conduction in solids, liquids and gases – One dimensional heat conduction – Critical and optimum insulation thickness. Principles of convection – Equations of forced and free convection. Combined heat transfer coefficients by convection and conduction. Unsteady state heat transfer fundamentals.		
UNIT – V	**RADIATION AND HEAT EXCHANGERS**	**9+3 periods**
Basic laws of heat transfer by radiation – black body and gray body concepts – solar radiations – combined heat transfer coefficients by convection and radiation. Principle and working of Heat Transfer equipment – Double pipe, Shell & tube and Plate type heat exchanger, Overall & Individual heat transfer co-efficient, LMTD.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60Periods**		

TEXT BOOK

1	K.V. Narayanan, B.Lakshmikutty, ***"Stoichiometry and Process calculations",*** Prentice hall of India, 2nd edition. 2017.
2	YunusCengel, "***Heat and Mass Transfer – Fundamentals & Applications***", McGraw-Hill, 2019.

REFERENCES

1	Bhatt B.I and VoraS.M.***"Stoichiometry"****, Tata McGraw-Hill, New Delhi, 4th Edition.2010.*
2	O.A.Hougen, K.M.Watson, R.A.Ragatz, "***Chemical Process Principles Part-I: Material andEnergy Balances***", CBS Publishers, 2018
3	C. J. Geankoplis, "***Transport Processes and separation process principles (includes unitOperations)***", Pearson Education Limited, 2013.
4	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt***"Principle of Heat and Mass Transfer",*** John Wiley,2019.

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Develop a fundamental understanding of the engineering unit conversions and Stoichiometry for doing balance calculations.	K1
CO2	Have a comprehensive understanding and be able to perform engineering calculations based on material balances.	K2
CO3	Establish mathematical methodologies for the computation of energy balances.	K2
CO4	Understand the basic laws of heat transfer & to develop solutions for the problem involving steady state & transient heat conduction in simple geometries.	K1
CO5	Calculate heat transfer by conduction, convection & thermal radiation realistic cases.	K2

COURSE ARTICULATION MATRIX

a)CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	-	-	3	1
CO2	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO4	2	1	1	-	-	-	-	-	-	-	-	-	3	1
CO5	3	1	1	-	-	-	-	-	-	-	-	-	3	1
22BES306	3	1	1	-	-	-	-	-	-	-	-	-	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.2.1, 1.4.1, 2.1.2, 2.1.3, 3.2.1
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 3.2.1
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 3.2.1
CO4	1.1.1, 1.2.1, 1.4.1, 2.1.2, 2.1.3, 3.2.1
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 3.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	70	-	-	-	-	100
CAT2	30	70	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	30	70	-	-	-	-	100

22BPC302	INDUSTRIAL MICROBIOLOGY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To Understand the classification, microscopic examination, staining methods of microorganisms, nutritional media types, growth, control of micro organisms and to developknowledge about the industrial fermentation process and production of modern biotechnology products.	
UNIT – I	**BASIC MICROBIOLOGY**	**9 Periods**
History of microbiology, Classification and nomenclature of microorganism, microscopic examination of microorganisms- light and electron microscopy; Staining techniques – simple, differential & special staining; Colony morphology and arrangement of bacterial cells.		
UNIT – II	**GROWTH AND CONTROL OF MICROORGANISMS**	**9 Periods**
Nutritional requirements of bacteria and different media used for bacterial culture; Isolation of pure culture (Spread Plate, Streak Plate, Pour Plate); Growth curve and different methods to quantify the bacterial growth; Physical control of microorganisms (dry and moist heat sterilization,filtration, radiation)-Chemical control of microorganisms (Phenolics, alcohol, aldehydes, halogens,heavy metals, quaternary ammonium salts, sterilizing gases)-evaluation of antimicrobial agent effectiveness; Host-microbe interactions, anti-bacterial, anti-fungal and anti-viral agents, mode of action of antibiotics and its resistance.		
UNIT – III	**INDUSTRIAL FERMENTATION PROCESS**	**9 Periods**
Historical overview of industrial fermentation process -traditional and modern Biotechnology. Commercial potential of Biotechnology products in India. Industrial Fermentation- microorganisms, mode of operation, fermentation processes-pictorial representation.		
UNIT – IV	**PRODUCTION OF PRIMARY & SECONDARY METABOLITES**	**9 Periods**
Production of primary metabolites- Organic acids (citric acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol &butanol), Production of secondary metabolites- antibiotics: (penicillin & streptomycin), vitamins (Vit B_{12} and Vit B_2), enzymes (proteases & amylases).		
UNIT – V	**PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS**	**9 Periods**
Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Prescott LM, Harley JP, Klein DA, **"Microbiology",** 4th Edition, Wm. C. Brown Publishers, 2010.*
2	*Waites, M.J., Morgan,N.L.,Rockey,J.S.,Higton, G.,"**Industrial Microbiology: An Introduction**", Blackwell, 2001.*

REFERENCES:

1	*Pelczar MJ, Chan ECS and Krein NR, **"Microbiology",** McGraw Hill Education, 5th Edition, 2001.*
2	*Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "**Industrial Biotechnology: Products and Processes**", John Wiley & Sons, 2016.*
3	*Cruger, W.,Cruger, A ., "**A Textbook of Industrial Microbiology**", Panima Publishing Corporation, 2nd Edition, 2005.*
4	*Pandey, A., Negi, S.,Soccol, C.R., "**Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products**". Elsevier, 2016.*
5	*Okafor, N., "**Modern Industrial Microbiology and Biotechnology**", CRC Press, 2007.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the classification, microscopic examination and staining methods of microorganisms	K1
CO2	Differentiate the types of nutritional media, growth pattern and control of micro organisms	K2
CO3	Develop knowledge about the industrial fermentation process.	K2
CO4	Identify the importance of microbes and their role in production of primary and secondary metabolites.	K3
CO5	Explore the microbial process for production of modern biotechnology products.	K3

COURSE ARTICULATION MATRIX

a)CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
CO1	1	2	-	-	-	-	-	-	-	-	-	-	2	1
CO2	1	2	-	-	-	-	-	-	-	-	-	-	2	1
CO3	1	2	-	-	-	-	-	-	-	-	-	-	2	1
CO4	1	2	-	-	-	-	-	-	-	-	-	-	2	1
CO5	1	2	-	-	-	-	-	-	-	-	-	-	2	1
22BPC302	1	2	-	-	-	-	-	-	-	-	-	-	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,2.2.2
CO2	1.2.1,2.2.2
CO3	1.2.1,2.2.2, 2.2.3,2.2.4
CO4	1.2.1,2.2.2, 2.2.3,2.2.4
CO5	1.2.1,2.2.2, 2.2.3,2.2.4

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50	-	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	30	30	-	-	-	100

22BPC303	BIOCHEMISTRY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
Chemistry for Biotechnology Biomolecules	PC	3	0	0	3

Course Objectives	To provide an insight into catabolic and anabolic metabolism of biomolecules and the mechanisms of protein folding and transportation	
UNIT – I	**CARBOHYDRATE METABOLISM**	**9 Periods**
Metabolism concepts-Glycolysis, TCA cycle, pentose phosphate &glyoxalate shunt, Respiratory chain- Oxidative Phosphorylation and Photophosphorylation. Metabolic disorders associated with carbohydrates.		
UNIT – II	**LIPID METABOLISM**	**9 Periods**
Fatty acid synthesis and oxidative degradation, Triacylglycerol, phospholipid biosynthesis and degradation; Cholesterol biosynthesis. Metabolic disorders associated with lipids.		
UNIT – III	**NUCLEIC ACID METABOLISM**	**9 Periods**
Biosynthesis of nucleotides, denovo and salvage pathways for purines, denovo and salvage pathways for pyrimidines, Regulation of purine and pyrimidine synthesis, Degradation of nucleotides, Metabolic disorders associated with nucleic acids.		
UNIT – IV	**AMINO ACID METABOLISM**	**9 Periods**
Nitrogen metabolism, Biosynthesis of six essential amino acids (Met, Thr, Lys, Ile, Val, Leu) and aromatic amino acids. Urea cycle, Metabolic disorders associated with chain and aromatic amino acid degradation.		
UNIT – V	**PROTEIN FOLDING & TARGETING**	**9 Periods**
Protein folding: Levinthal paradox, Anfinsen's experiment, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, Protein targeting, signal sequence, secretion; targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.		
Contact Periods: **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS

1	APA. Nelson, D. L., & Cox, M. M., "***Lehninger's —Principles of Biochemistry***", 7h Edition, Macmillan, 2017.
2	Voet, Donald, Judith G. Voet, and Charlotte W. Pratt, "***Fundamentals of Biochemistry: Life at the Molecular Level***", 5th Edition, Wiley., 2016.

REFERENCES:

1	Shawn O. Farrell and Mary K. Campbell, "***Biochemistry*"**, 8th Edition, Brooks/Cole, 2013
2	Satyanarayana, U. and U. Chakerapani, "***Biochemistry***" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3	Victor W. Rodwell; David Bender; Kathleen M. Botham; Peter J. Kennelly; P. Anthony Weil., "***Harper's Illustrated Biochemistry***", 31st Edition, McGraw-Hill Education, 2018.
4	Berg, J.M., Tymoczko, J.L., Stryer, L., "***Biochemistry***", 9th Edition, WH Freeman, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the metabolic pathways of Carbohydrates, amino acids, nucleic acids and lipids.	K1
CO2	Fathom the complex relationship between biochemical pathways within living cells	K1
CO3	Know the metabolic disorders associated with biochemical metabolisms	K2
CO4	Understand the mechanism of protein targeting and transport	K2
CO5	Grasp the protein folding mechanism	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO2	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO3	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO4	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO5	1	1	-	-	-	-	-	-	-	-	-	-	3	1
22BPC303	1	1	-	-	-	-	-	-	-	-	-	-	3	1
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.4.1, 2.1.3
CO2	1.4.1, 2.1.3
CO3	1.4.1, 2.1.3,
CO4	1.4.1, 2.1.3
CO5	1.4.1, 2.1.3,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	70	30	-	-	-	-	100
CAT2	40	60	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	60	40	-	-	-	-	100

22BPC304	GENETICS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To give an understanding on the fundamentals of conventional genetics and its relevance in disease and therapy. To describe various genetic laws, learn the chromosome structure function and understand methodologies for cytogenetic applications. To apply the Hardy-Weinberg Law in analyzing population genetics for gene frequency, sex linkage, equilibrium, and heterozygote frequency.	
UNIT – I	**BACTERIAL GENETICS**	**9 Periods**
Fine structure in merozygotes- plasmids and episomes, Recombination in bacteria, Transformation, Transduction, Conjugation – mapping.		
UNIT – II	**CLASSICAL GENETICS**	**9 Periods**
Mendel's Principles and experiments, segregation, multiple alleles – independent assortments, genotypic interactions, epistasis and sex chromosomes, sex determination, dosage compensation, sex linkage and pedigree analysis.		
UNIT – III	**APPLIED GENETICS**	**9 Periods**
Chromosome organization, structure and variation in prokaryotes and eukaryotes, Giant chromosomes – polytene and lampbrush, deletion, inversion, translocation, duplication. variation in chromosomal numbers – aneuploidy, euploidy, polyploidy, Ames test, karyotyping, Linkage-complete and incomplete, Crossing over – cytological basis of crossing over, chromosome mapping – two and three factor cross – interference, somatic cell hybridization.		
UNIT – IV	**POPULATION GENETICS**	**9 Periods**
Hardy-Weinberg equilibrium, Extensions of Hardy- Weinberg equilibrium, Random mating and non-random mating, Population analysis, Models for population genetics. Mutation and Migration size, Genetic variation and Sociobiology, Eugenics.		
UNIT – V	**GENETIC DISEASES**	**9 Periods**
Inborn errors of metabolism, Sickle cell anemia, Hemochromatosis, Cystic fibrosis, Hypogonadotropic hypogonadism, Gaucher's disease, Achondroplasia, Phenylketonuria, Huntington's Disease, Cystic fibrosis, Hemoglobinopathies, Age-related macular degeneration, Obesity, Type 2 diabetes,Psychiatric disease, Including missing heritability, Autism.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	Gardner, E.J, Simmons, M.J, and Snustad, D.P.,***"Principles of Genetics"***, 8 Edition, JohnWiley& Sons, Singapore,2015.
2	Strickberger, M.W.,***"Genetics"***, 3rd Edition, Prentice Hall of India, New Delhi,2015.
3	Klug, W.S. and Cummings, M.R.,***"Concepts of Genetics"***, Pearson Education, New Delhi, 2019

REFERENCES

1	Tamarin, R.H.,***"Principles of Genetics"***, Tata McGraw Hill, New Delhi,2002.
2	De Robertis, E. D. P. and De Robertis, E. M. F.,***"Cell and Molecular Biology"***, 8th Edition, Lippincott Williams & Wilkins, New York, USA,2010.

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of bacterial genetics.	K1
CO2	Understand classical mendelian genetics in inheritance of genes.	K1
CO3	Apply concepts of genetics in chromosomal mapping	K2
CO4	Know population based on concepts of population genetics.	K2
CO5	Understand various genetic disorders and their genetic basis.	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO2	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO3	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO4	1	1	-	-	-	-	-	-	-	-	-	-	3	1
CO5	1	1	-	-	-	-	-	-	-	-	-	-	3	1
22BPC304	1	1	-	-	-	-	-	-	-	-	-	-	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.4.1, 2.1.3
CO2	1.4.1, 2.1.3
CO3	1.4.1, 2.1.3
CO4	1.4.1, 2.1.3
CO5	1.4.1, 2.1.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50	-	-	-	-	100
CAT2	40	60	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	60	40	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	50	50	-	-	-	-	100

22BBS309	CELL BIOLOGY LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	0	0	3	1.5

Course Objectives	Students are able to handle and operate light microscope and familiarize with slide preparation and staining techniques. Students are able to study the different cell division stages.

LIST OF EXPERIMENTS

1.	Principles of microscopy, phase contrast and fluorescent microscopy
2.	Identification of given plant, animal and bacterial cells and their components by microscopy
3.	Identification of cells in a blood smear using Leishman stain.
4.	Identification of cells in a blood smear using Giemsa staining.
5.	Identification of cells in a blood smear Haemotoxylin Eosin Staining.
6.	Counting of RBCs and WBCs using Haemocytometer
7.	Study of Osmosis and Tonicity of blood cells.
8.	Study of Cell viability using Tryphan Blue Assay
9.	Separation and identification of peripheral blood mononuclear cells from blood.
10.	Identification of meiosis cell division in grasshopper testis.
11.	Staining of different stages of mitosis in *Alliumcepa*(Onion) root tip.
12.	Immunostaining of cells

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCES:

1	De Robertis& De Robertis,***Cell biology***, W B Saunders Co publications, 4th edition, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Operate and identify the parts and function of microscope.	**K3**
CO2	Prepare the slides for microscopic examinations.	**K3**
CO3	Perform different staining techniques to identify blood cells	**K3**
CO4	Interpret the different stages of cell division using microscope.	**K3**
CO5	Work as a team to interpret practical data.	**K3**

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
CO1	-	-	-	2	-	-	-	-	-	-	-	-	3	1
CO2	-	-	-	1	-	-	-	-	-	-	-	-	3	1
CO3	-	-	-	3	-	-	-	-	-	-	-	-	3	1
CO4	-	-	-	2	-	-	-	-	-	-	-	-	3	1
CO5	-	-	-	-	-	-	-	-	2	-	-	-	3	1
22BBS309	-	-	-	2	-	-	-	-	2	-	-	-	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	4.1.1, 4.1.2,4.2.1
CO2	4.2.1
CO3	4.1.1, 4.1.2, 4.2.1, 4.3.1
CO4	4.2.1, 4.3.1
CO5	9.2.1,9,2.2,9.2.3

22BPC305	MICROBIOLOGY LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To demonstrate the proper safety procedures, parts & functions of microscope, staining techniques for microorganism identification, culture media preparation and growth pattern of bacteria.
LISTOF EXPERIMENTS	
1.	Laboratory safety and sterilization techniques.
2.	Microscopic Methods-Identification of Microorganisms.
3.	Staining techniques–simple and differential staining (Gram staining), lacto phenol and acid fast staining
4.	Identification of fungal morphology by lactophenol cotton blue staining
5.	Preparation of culture media–nutrient broth, nutrient agar-slant preparation
6.	Culturing of microorganisms in broth and in plates (pour plates, streak plates and spread plate techniques)
7.	Preparation of selective media using MacConkey agar.
8.	Serial Dilution method
9.	Biochemical Tests for bacterial identification
10.	Motility Test-Hanging drop technique
11.	Antibiotic sensitivity assay-Disc Diffusion method
12.	Preservation of bacterial cultures-lyophilization & glycerol stock
13.	Study of bacterial growth curve.
Contact Periods: **Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 45Periods** **Total: 45 Periods**	

TEXT BOOK:

1	*James G. Cappuccino & Natalie, "**Microbiology, A Laboratory manual**", Pearson Education Publishers, 6th edition, 2004.*
2	*Waites, M.J., Morgan,N.L.,Rockey,J.S.,Higton, G.,"**Industrial Microbiology: An Introduction**", Blackwell, 2001.*

REFERENCES:

1	*Harsha S,* **"Biotechnology Procedures andExperiments Handbook",** *Infinity Science Press, 2007.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify and demonstrate the proper safety procedures concerning lab safety.	K3
CO2	Identify the parts & functions of microscope.	K3
CO3	Perform different staining techniques to identify microorganisms.	K3
CO4	Identify the purpose & principle associated with different media types used in lab.	K3
CO5	Demonstrate the preservation methods and growth pattern of bacteria.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO2	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO3	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO4	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO5	1	-	-	2	-	-	-	-	-	-	-	-	2	1
22BPC305	1	-	-	2	-	-	-	-	-	-	-	-	2	1
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 4.1.1,4.1.2
CO2	1.2.1, 4.1.1,4.1.2,4.2.1
CO3	1.2.1, 4.1.1,4.1.2,4.2.1,4.3.1
CO4	1.2.1, 4.1.1,4.1.2, 4.2.1,4.3.1
CO5	1.2.1, 4.1.1,4.1.2, 4.2.1,4.3.1

22BPC306	BIOCHEMISTY LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
Chemistry for Biotechnology **Chemistry Laboratory**	**PC**	**0**	**0**	**3**	**1.5**

Course Objectives	Train the students on qualitative and quantitative analysis of basic biomolecules.
Experiment No.	**EXPERIMENTS**
1.	Units, Volume/Weight measurements, concentrations, Sensitivity, Specificity, Precision and Accuracy.
2.	Preparation of buffers and Titration curves of amino acids.
3.	Qualitative tests for carbohydrates.
4.	Quantitative tests for reducing sugars.
5.	Qualitative tests for Amino Acids.
6.	Quantitative tests for Protein.
7.	Estimation of Nucleic acids : Test for ribose and deoxyribose.
8.	Estimation of glucose by GOD-POD method.
9.	Quantitative tests for Cholesterol.
10.	Determination of isoelectric point of casein.
Contact Periods: **Lecture:0 Periods** **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**	

REFERENCES

1	David. T. Plummer, "***An Introduction to Practical Biochemistry***", McGraw – Hill, 3rd edition., 2017
2	Benjamin F. Lasseter, "***Biochemistry in the Lab A Manual for Undergraduates***", 1st Edition, CRC Press, 2019.
3	Andreas Hofmann, Samuel Clokie, "***Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology***", 8th Edition, Wiley, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Prepare reagents accurately and reproducibly for experiments	K3
CO2	Operate pH meter, weighing balance, colorimeter and spectrophotometer	K3
CO3	Do the experiments for isolation and extraction of any bioactive compounds	K3
CO4	Identify and quantify the bio molecules (Carbohydrate, Protein, Nucleic acid, Lipids) in any	K3
CO5	Understand the practical accession behind preparation and separation of various biomolecules	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO1 1**	**PO 12**	**PSO 1**	**PSO 2**
CO1	-	-	-	2	-	-	-	-	-	-	-	-	3	1
CO2	-	-	-	1	-	-	-	-	-	-	-	-	3	1
CO3	-	-	-	4	-	-	-	-	-	-	-	-	3	1
CO4	-	-	-	2	-	-	-	-	-	-	-	-	3	1
CO5	-	-	-	1	-	-	-	-	-	-	-	-	3	1
22BPC306	-	-	-	2	-	-	-	-	-	-	-	-	3	1
1 – Slight, 2 – Moderate, 3 – Substantial														
b) CO and Key Performance Indicators Mapping														
CO1	4.2.1, 4.3.1													
CO2	4.2.1													
CO3	4.1.1, 4.1.2, 4.2.1, 4.3.1													
CO4	4.2.1, 4.3.1													
CO5	4.1.4,													

22BES407	FLUID MECHANICS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Differential Equations and Numerical Methods	ES	3	0	0	3

Course Objectives	Understand dynamics and properties of fluid flow, learn strong foundation of fluid mechanics (flow measurements) and develop dynamic characteristics of fluid flow through pipes and porous medium.	
UNIT – I	**INTRODUCTION**	**9 periods**
Properties of fluids, fluid statics, concept of shear stress, Newton's law of viscosity – Fluid behavior under shear, Newtonian and non-Newtonian fluids, Types of flow – laminar, turbulent, steady,unsteady, non uniform and uniform flows – compressible and incompressible fluids, Similitude -relationship between dimensional analysis and similitude		
UNIT – II	**FLUID DYNAMICS**	**9 periods**
Continuity equation, Bernoulli's equation, boundary layer condition, form drag, skin drag, drag coefficient – laminar and turbulent flow through closed conduit velocity profiles, pipes, tubes, fittings, valves, friction factor for smooth and rough pipes, head losses due to friction in pipes and fittings.		
UNIT – III	**FLUID FLOW MEASURMENT AND PUMPING EQUIPMENTS**	**9 periods**
Orifice meter, Venturimeter, Pitot tube, Rota meter, weirs and notches, hot wire anemometer, displacement meter, current meter, magnetic flow meter, pressure measurement bymanometers, U-tube, differential and inclined manometers. Pumps – types, selection and specifications, positive displacement pumps, reciprocating pump, rotary pumps, centrifugal pumps - characteristics curve of pumps – fans and compressors		
UNIT – IV	**FLUIDIZATION AND PACKED BEDS**	**9 periods**
Mechanisms, types – fluidized beds, properties of fluidized beds, continuous fluidization and application, packed beds – pressure drop, flooding and loading. Mixing & agitation		
UNIT – V	**MECHANICAL OPERATIONS**	**9 periods**
Size reduction equipments – operations and their classification, Energy and power requirements, Laws of crushing, open and closed circuit operations - techniques of size analysis – different methods for storage of solids, conveyors and elevators.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*McCabe Smith and Harriott, **"Unit Operations of Chemical Engineering"**, 7th Edition, Tata McGraw-Hill company, 2022.*
2	*Geankoplis C.J, **"Transport Processes and Unit Operations"**, 3rd Edition, Prentice Hall of India, 2003.*

REFERENCES :

1	*Frank M. White, **"Fluid Mechanics"**, 8th Edition, Tata McGraw-Hill company, 2017.*
2	*J. M. Coulson, J. F. Richardson and R. K. Sinnott, **"Chemical Engineering. Vol I & II"**, 6th Edition, Butterworth-Heinemann Ltd, 1999.*
3	*Bansal R K, **"Fluid mechanics and Hydraulic machines"**, 10th Edition, Lakshmi publications (P) Ltd, New Delhi, 2019.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand stress – strain relationship in fluids and analyse fluid flow problems.	K1
CO2	To apply Bernoulli principle and measure pressure drop in flow systems	K3
CO3	Describe the function and performance of flow metering devices.	K5
CO4	Determine minimum fluidization velocity in fluidized bed.	K4
CO5	Present characteristics of particulate solids, Principles of size reduction and screening, crushing and grinding equipment.	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	-	1	1	1	1	-	-	-	-	-	-	1	3	2
CO2	1	1	-	1	-	2	1	-	1	-	1	1	3	2
CO3	-	1	1	-	1	2	-	-	-	-	-	-	2	3
CO4	1	1	1	1	-	-	-	-	1	-	-	1	3	2
CO5	-	1	1	1	-	-	1	-	-	1	1	1	3	2
22BES407	1	1	1	1	1	1	1	-	1	1	1	1	3	2
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	2.2.3, 2.2.4,2.3.2,3.1.6, 4.1.4, 5.1.1,
CO2	1.2.1, 2.1.3, 4.3.1, 6.2.1, 7.2.2,
CO3	2.2.2, 2.4.1, 3.1.1, 3.2.2, 5.3.2, 6.2.1
CO4	1.2.1, 2.1.3, 2.3.2, 3.2.3, 4.3.3
CO5	2.1.2, 2.4.2, 3.2.1, 4.2.2, 7.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	20	-	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	20	-	20	-	100
ESE	40	30	20	-	10	-	100

22BPC407	MOLECULAR BIOLOGY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Microbiology **Cell Biology**	**PC**	**3**	**0**	**0**	**3**

Course Objectives	To learn the fundamental aspects of nucleic acids, the principle and process of DNA replication, transcription and translation and to study the basics of regulation of gene expression, mutation and DNA repair.	
UNIT – I	**CHEMISTRY OF NUCLEIC ACIDS**	**9 Periods**
Nucleic acids as genetic material;Structure and physico chemical properties of elements in DNA and RNA, Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X–ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling, Conformation of DNA and RNA; classes of RNA; Organization of eukaryotic chromosome – c0t value**.**		
UNIT – II	**DNA REPLICATION**	**9 Periods**
- Overview of differences in prokaryotic and eukaryotic DNA replication, Rules of replication in all nucleic acid; enzymology; DNA replication: Meselson& Stahl experiment, bi–directional DNA replication, Okazaki fragments; Replication in prokaryotes - D-loop and rolling circle mode of replication; replication of linear viral DNA. Replication of telomeres in eukaryotes. Inhibitors of DNA replication.		
UNIT – III	**TRANSCRIPTION**	**9 Periods**
RNA polymerase- RNA replicase (Virus), Transcription in prokaryotes and eukaryotes; Inhibitors; features of promoters and enhancers; transcription factors; nuclear RNA splicing mechanisms – tRNA- rRNA- mRNA; ribozymes; RNA - editing.		
UNIT – IV	**TRANSLATION**	**9 Periods**
Elucidation of genetic code; Salient features of genetic code - Wobble hypothesis; ribosomes – prokaryotic & eukaryotic; protein synthesis; post translational processing; Protein targeting.		
UNIT – V	**MUTATION – REPAIR AND REGULATION OF GENE EXPRESSION**	**9 Periods**
Regulation of genes – replication- transcription & translation factors; Lac and trp operon; Mutation– transition- transversion- artificial & natural mutation; suppressor mutation; Repair of DNA.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	David Friefelder, ***"Molecular Biology"***, Narosa Publ. House.2nd edition, 1999.
2.	Harvey Lodish, Arnold Berk, S.L Zipursky, Paul Matsudaira, David Baltimore and James Danell ***"Molecular Cell Biology",***4 th Edition, New York: W.H Freeman and company, 2016.

REFERENCES

1	Malacinski, G.M., Freifelder's ***"Essentials of Molecular Biology",*** 4 th edition, Nasora Publishing House, New Delhi, 2015.
2	Watson J.D., Hopkins W.H., Roberts J.W., Steitz J.A., Weiner A.M., ***"Molecular Biology of the Gene",*** McGraw Hill,2 nd Edition, 1986.
3	Waston, B.B, & Gann, L.L, ***"Watson Molecular Biology of the Gene"***, 7 th Edition, Pearson Education, 2014.
4	Weaver, R.., ***"Molecular Biology",*** 3 rd Edition, McGraw Hill, 2011
5.	Benjamin L., ***"Genes IX"***, 9th Edition, Jones & Bartlett Publishers Inc. 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basic structure and biochemistry of nucleic acids	K1
CO2	Comprehend the principle of DNA replication	K1
CO3	Get familiarize with the process of transcription and RNA processing.	K2
CO4	Become aware of the process of protein synthesis.	K2
CO5	Understand the regulatory mechanism of molecular biology.	K1

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO3	1	2	3	-	-	-	-	-	-	-	-	-	3	2
CO4	-	3	2	-	2	-	-	-	-	-	-	-	2	3
CO5	-	1	3	-	2	-	-	-	-	-	-	2	2	3
22BPC407	3	3	3	-	2	-	-	-	-	-	-	2	3	3

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 2.4.3
CO2	3.1.5
CO3	3.1.4,3.1.5,
CO4	5.1.2.
CO5	12.1.1,12.1.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	70	30	-	-	-	-	100
CAT2	40	60	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	60	40	-	-	-	-	100

22BPC408	BIOCHEMICAL THERMODYNAMICS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To expound theory and fundamentals behind the thermodynamics implications in the biological processes. The students will be able to design & solve physical and chemical problems encountered in chemical and biochemical industries by applying fundamental thermodynamics laws.	
UNIT – I	**THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS**	**9 Periods**
First Law of thermodynamics; a generalized balance equation and conserved quantities; Volumetric properties of fluids exhibiting non ideal behavior; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.		
UNIT – II	**SOLUTION THERMODYNAMICS**	**9 Periods**
Partial molar properties; Chemical potential, Fugacity and fugacity coefficient in solutions; Henrys law and dilute solutions; Activity in solutions and activity coefficient;Gibbs-Duhem equation ; Excess properties and residual properties of mixtures.		
UNIT – III	**PHASE EQUILIBRIA**	**9 Periods**
Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.		
UNIT – IV	**CHEMICAL REACTION EQUILIBRIA**	**9 Periods**
Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.		
UNIT – V	**THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION**	**9 Periods**
Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	Smith J.M., Van Ness H.C., Abbott M.M.,***'Introduction to Chemical Engineering Thermodynamics'***, McGraw-Hill, 8th edition, 2018.
2	Narayanan K.V,***'A Text Book of Chemical Engineering Thermodynamics'***, Prentice Hall of India, 2nd edition, 2013.
3	Christiana D Smolke,***'The Metabolic Pathway Engineering Handbook Fundamentals'***, CRC Press Taylor & Francis, 1st edition, 2010.

REFERENCES:

1	Hougen O.A., Watson K.M., and Ragatz R.A., ***'Chemical Process Principles Part II'***, John Wiley & Sons, 2ndedition. 2004.
2	Stanley I. Sandler***'Chemical, Biochemical, and Engineering Thermodynamics'***, John Wiley Sons, 5thedition, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the application of thermodynamics in design & operation of process industries.	**K1**
CO2	Design & solve problem in realistic cases by applying thermodynamics concepts.	**K1**
CO3	Estimate thermodynamic properties of substances in gas and liquid states	**K2**
CO4	Interpret the phase equilibria concepts in multi-component systems	**K2**
CO5	Understand about biochemical equilibrium and able to calculate the kinetics of biological systems.	**K2**

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2	2	-	2	-	-	-	-	-	-	-	-	1	1
CO2	2	1	-	2	-	-	-	-	-	-	-	-	1	1
CO3	2	2	-	2	1	2	-	-	-	-	-	-	1	1
CO4	2	2	-	2	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	2	-	2	-	-	-	-	-	-	1	1
22BPC 408	2	2	-	2	1	2	-	-	-	-	-	-	1	1
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 1.3.1,1.4.1,2.1.2,2.1.3, 2.1.3,2.2.2,2.3.2,2.4.4,4.1.1,4.1.4,4.3.3
CO2	1.2.1, 1.3.1,1.4.1,2.1.2,2.1.3, 2.1.3,2.2.2,2.2.3,4.1.1,4.1.2,4.3.2
CO3	1.2.1, 1.3.1,1.4.1,2.1.2,2.1.3, 2.1.3,2.2.2,2.3.2,2.4.4,4.1.1,4.1.2,4.1.4,4.2.1,4.3.1,5.3.1,6.1.1
CO4	1.2.1, 1.3.1,1.4.1,2.1.2,2.1.3, 2.1.3,2.2.2,2.3.2,2.4.4,4.1.1,4.1.2,4.1.4,4.2.1,4.3.1.
CO5	1.2.1, 1.3.1,1.4.1,2.1.2,2.1.3, 2.1.3,2.2.2,2.3.2,2.4.4,4.1.1,4.1.2,4.1.4,4.2.1,4.3.1,6.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
Unit test - 1	20	20	-	20	40	-	100
Unit test - 2	20	20	-	20	40	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	20	20	-	30	30	-	100

22BPC409	ENZYME ENGINEERING AND TECHNOLOGY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
BIOMOLECULES BIOCHEMISTRY	PC	3	0	0	3

Course Objectives	Students are able to understand the basic enzyme catalysis and kinetics. Get to know about different immobilization methods. Students able to familiarize with different enzyme assay and also about enzyme applications	
UNIT – I	**INTRODUCTION TO ENZYMES**	**9 Periods**
Enzymes-Introduction-active site, concept of active site, co factors, co enzymes-examples, Lock and Key Hypothesis, Induced fit hypothesis, Classification of enzymes, Mechanism of catalysis-acid base catalysis, electrostatic catalysis, covalent catalysis, Enzyme catalysis, Theory of catalysis-collision state theory, transition state theory, Enzyme activity and specific activity, role of entropy in catalysis		
UNIT – II	**ENZYME KINETICS**	**9 Periods**
Kinetics of enzyme catalyzed reaction-MichaelisMenten equation, Briggs Haldane modification, Significance of Km kcat,Vmax. Linear plots-Line weaver burk plot, Eadiehofstee plot. Mechanism of Bimolecular reaction, Inhibition-types of enzyme inhibition-competitive, uncompetitive, non-competitive, mixed, allosteric inhibition. Allosteric enzymes-Monod Wyman Changeux Model		
UNIT – III	**ENZYME IMMOBILISATION**	**9 Periods**
Enzyme immobilization- Physical and Chemical methods Physical methods-Adsorption, entrapment, encapsulation. Chemical methods-covalent bonding, cross linking. Application of immobilized enzymes in industries. case studies		
UNIT – IV	**ENZYME CHARACTERIZATION AND PURIFICATION**	**9 Periods**
Extraction and purification of enzymes from microbial, plant and animal sources, methods of precipitation, dialysis, filtration, chromatography – methods-ion-exchange, size exclusion, hydrophobic interaction, Affinity chromatography, HPLC, Molecular weight determination-SDS PAGE, Native PAGE		
UNIT – V	**ENZYME ASSAYS AND APPLICATIONS**	**9 Periods**
Types of Enzyme assays- End point methods, kinetic methods, coupled kinetic assay, Immuno assay methods, artificial enzymes.Application of enzymes as Biosensors, Application in food industries,textileindustries,foodindustries,Biopharmaceutical industries, tanning industries		

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOK

1	Trevor Palmer, *"**Enzymes**",* Affiliated East West Press Pvt Ltd, New Delhi, 2004.
2	Harvey W. Blanch, Douglas S. Clark, "***Biochemical Engineering***", Marcel Dekker Inc, 2002
3	B. Sivasankar, ***"Bioseparations: Principles and Technique"***, Prentice-Hall of India Pvt.Ltd, 2007

REFERENCES

1	James M Lee, ***Biochemical Engineering***, Prentice Hall of India, USA, 2009.
2	James. E. David F. Bailey & Ollis,***Biochemical Engineering Fundamentals***, McGraw Hill, 2011.
3	Rufus O. Okotore,***Essentials of Enzymology***,Xlibris Corporation,2015

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of enzymes and mechanism of enzyme catalysis	K1
CO2	Familiarize with the enzyme kinetics and apply to solve problems in enzyme kinetics	K3
CO3	Familiarize with the different types of enzyme immobilisation and its applications	K1
CO4	Analyze the different methods for enzyme extraction and purification.	K4
CO5	Understand the different assay procedures for enzymes and get familiarize with the different enzyme applications	K1

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	1	-	-	1	-	1	-	-	-	1	-
CO2	1	-	2	-	2	-	1	1	1	-	2	-	-	2
CO3	1	-	1	2	-	-	-	3	1	-	1	-	-	3
CO4	1	2	2	-	-	1	-	2	-	-	-	-	1	-
CO5	1	-	-	-	-	-	-	2	1	1	2	-	-	3
22BPC409	1	1	2	2	2	1	1	2	1	1	2	-	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance indicators mapping

CO1	1.2.1, 1.3.1, 2.3.1, 4.1.1
CO2	1.1.1, 3.1.1, 5.1.1
CO3	1.2.1, 4.2.1, 1.1.2
CO4	1.2.1, 2.2.1, 3.1.1, 5.1.2
CO5	1.3.1, 2.1.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	60	30	10	-	-	-	100
CAT2	40	30	30	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30	-	-	-	100
ESE	40	30	30	-	-	-	100

22BPC410	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Engineering Physics **Chemistry for Biotechnology**	**PC**	**3**	**0**	**2**	**4**

Course objectives	To enable the students to understand and to get familiarized with principles of analytical instruments to solve research problems and to enable them to interpret the analytical data and research findings based on the knowledge obtained from this course.

UNIT – I	**BASICS OF MEASUREMENT**	**9+6 Periods**

Classification of analytical methods – calibration of instrumental methods – electrical components and circuits -signal to noise ratio; Properties of electromagnetic radiations and their interaction with matter.

UNIT – II	**MOLECULAR SPECTROSCOPY**	**9+6 Periods**

UV and visible light spectroscopy-Qualitative and Quantitative absorption Measurement, Beer- Lambert law, IR spectroscopy, Raman spectroscopy, NMR spectroscopy, X- ray crystallography– principle, instrumentation and applications; Atomic Absorption spectroscopy, Mass Spectroscopy.

UNIT – III	**ELECTROPHORESIS**	**9+6 Periods**

General principle of electrophoresis, support media (Agarose and Polyacrylamide gels, Electrophoresis of proteins by SDS-PAGE gradient gels, Isoelectric Focusing, Two Dimensional PAGE, Electrophoresis of nucleic acids using agarose gel, PFGE, Capillary Electrophoresis.

UNIT – IV	**CHROMATOGRAPHY**	**9+6 Periods**

Basic Principles of chromatography, TLC and Column chromatography, matrix materials, HPLC, Affinity chromatography, Ion Exchange Chromatography, Gel Exclusion Chromatography and Gas chromatography.

UNIT – V	**THERMAL METHODS**	**9+6 Periods**

Differential Thermal Analysis techniques - instrumentation & application, DTA curve. Differential Scanning Calorimetry - Instrumentation & Application, Instrumentation, Thermogravimetry – Instrumentation & Application, TGcurve. Biosensors – Components, Types

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods

LIST OF EXPERIMENTS

- Precision and Validity in an instrument.
- Validation of Lambert-Beer's law using $KMnO_4$.
- Determination of concentration of the Iron content present in the tablet using atomic absorption spectrometry.
- Raman spectroscopy – Identification of functional groups
- Data interpretation of FTIR spectra
- Demonstration on the working of XRD
- Determination of the concentration of Na and Ca using flame photometer.
- Separation of amino acids by TLC.
- Column chromatographic analysis of chlorophyll
- Separation of compounds using High Performance Liquid chromatography
- Gel filtration – Size based separation of proteins

TEXT BOOK:

1	Willard H.W., Merritt L.L., Dean J.A. & Settle F.A***"Instrumental Methods of Analysis"***, East West Publishers, 7th Edition.2004
2	Skoog, D.A., F. James Holler and Stanky, R. Crouch***"Instrumental Methods of Analysis"***. Cengage Learning India Pvt. Ltd., 7th edition, 2020.

REFERENCES:

1	Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B.***"Bioseparations: Science and Engineering"***, Oxford University Press,2015.
2	Wilson K. and Walker J.***"Principles and Techniques of Biochemistry and Molecular Biology"***, Cambridge University Press,8th Edition, 2018.
3	J. Jayaraman.***"Laboratory Manaual in Biochemistry",***1st Edition., New Age International Publications, 2007
4	R. F. Boye,***Modern experimentl Biochemistry***, Pearson India, 2002

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To understand the basic principles of measurement and calibration in analytical methods.	K2
CO2	To impart knowledge on the working principles of spectroscopic instruments.	K1
CO3	To instill knowledge on the separation of biomolecules such as nucleic acids and proteins by electrophoresis and chromatography methods.	K3
CO4	To describe the thermal behavior of thebioproducts and components of a biosensor.	K3
CO5	To develop a protocol to identify and determine the concentration of a analyze by analytical instruments.	K6

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**
CO 1	2	1	1	1	-	-	-	-	-	-	2	1	1	1
CO 2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 3	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO 4	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	1	2	-	-	-	-	-	-	-	-
22BPC410	2	1	1	1	1	2	-	-	-	-	2	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial														
b) CO and Key Performance Indicators Mapping														
CO1	1.1,1.2,1.3,1.4,2.1,2.2,2.3,2.4,3.1, 3.2,4.1,4.2,11.2,11.3,12.3													
CO2	1.1,1.2,1.3,1.4,2.1,2.2, 2.3,2.4, 3.2,4.1,4.2,12.2,12.3													
CO3	1.1,1.3,1.4,2.1, 2.2,2.4,4.1													
CO4	1.1													
CO5	1.2													

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	14	10	2	10	12	2	100
CAT2	10	12	4	10	10	4	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	5	5	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	5	5	-	-	-	100
ESE	40	30	30	-	-	-	100

22BES408	ENGINEERING EXPLORATION FOR INDUSTRIAL BIOTECHNOLOGY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

COURSE OBJECTIVE	The objective of the course is to provide an introduction to the engineering field. It is designed to help the student to learn about engineering and how it is useful in our everyday life.	
UNIT-1	**INTRODUCTION**	**15 Periods**
Introduction to Engineering and Engineering study: Difference between science and engineering, scientist and engineer needs and wants, various disciplines of engineering, some misconceptions of engineering, expectation for the 21st century engineer and Graduate Attributes.		
UNIT-II	**ENGINEERING DESIGN**	**15 Periods**
Engineering Requirement, Knowledge within Engineering disciplines, Engineering advancements, Problem definition, Idea generation through brain storming and researching, solution creation through evaluating and communicating, text/analysis, final solution and design improvement.		
UNIT-III	**ENGINEERING DISCIPLINES**	**15 Periods**

INDUSTRIAL BIOTECHNOLOGY:

Defining the problem, Data gathering through literature, Specify requirements, Brainstorm, Evaluate, Choose solution, Design, Implementation of the design, Develop Prototype/Model.

GUIDELINES

- Practical based learning carrying credits.
- Multi-disciplinary/ Multi-focus group of 3-4 students.
- Groups can select to work on specific tasks, or projects related to real world problems.
- Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
- The students have to display their project/model/product at the end of the semester.
- The progress of the course is evaluated based on class performance and final demonstration.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCES:

1	*Ryan A Brown, Joshua W. Brown and Michael Berkihiser: "**Engineering Fundamentals: Design, Principles, and Careers**", Goodheart-Willcox Publisher, Second edition, 2014.*
2	*Saeed Moaveni, "**Engineering Fundamentals: An Introduction to Engineering**", Cengage learning, Fourth Edition, 2011.*

COURSE OUTCOMES On Completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Explain technological and engineering development, change and impacts of engineering	K2
CO2	Complete initial steps (Define a problem list criteria and constraints, Brainstorm potential solutions and document ideas) in engineering designs	K3
CO3	Communicate possible solutions through drawings and prepare project reports.	K3
CO4	Draw sketches to a Design problem.	K3
CO5	Apply the concept of engineering fundamentals in Industrial Biotechnology	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	1	1	1	2	2	2	3	3	1	2	1	3
CO2	3	3	1	2	1	2	2	2	3	3	1	2	1	3
CO3	3	3	3	3	1	2	2	2	3	3	1	2	1	3
CO4	3	2	3	3	1	2	2	2	3	3	1	2	1	3
CO5	3	2	3	3	1	2	2	2	3	3	1	2	1	3
22BES408	3	3	3	3	1	2	2	2	3	3	1	2	1	3

b) CO and Key Performance Indicators mapping	
CO1	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.4, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.4, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.4, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.4, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.4, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1

22BES409	CHEMICAL ENGINEERING LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Fluid Mechanics **Process calculations and Heat transfer**	**ES**	**0**	**0**	**3**	**1.5**

Course Objectives	To learn chemical engineering principles and their practical applications in the areas of fluid mechanics, Heat transfer, mass transfer and particle mechanics.
LISTOF EXPERIMENTS	
1.	Flow measurement using Venturimeter, Orificemeter for liquids
2.	Studies on flow behavior and friction loss in Fluidized bed.
3.	Product size distribution analysis using Roll Crusher
4.	Product size distribution analysis using Ball Mill
5.	Studies on Simple Distillation.
6.	Calculations of filter and medium resistances in Leaf filter apparatus
7.	Adsorption Equilibria
8.	Leaching
9.	Liquid-Liquid Equilibria
10	Batch drying
11	Batch sedimentation
12	Double Pipe Heat exchanger
13	Determination of effect of temperature on reaction rate content
Contact Periods **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**	

TEXT BOOKS

1	*YunusCengel*, "***Heat and Mass Transfer – Fundamentals & Applications***", *McGraw-Hill, 5th edition. 2015.*
2	*Geankoplis C.J*, "**Transport Processes and Unit Operations**", *Prentice Hall of India, 4th edition. 2003.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Able to calculate pressure and flow rate of liquid	K3
CO2	Find out the efficiencies of filtration and distillation range.	K3
CO3	Calculate the heat exchange limitation.	K3
CO4	Separate soluble components by using liquid equilibria.	K3
CO5	Knowledge on the basic principles of chemical engineering.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO2	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO3	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO4	1	-	-	2	-	-	-	-	-	-	-	-	2	1
CO5	1	-	-	2	-	-	-	-	-	-	-	-	2	1
22BES409	1	-	-	2	-	-	-	-	-	-	-	-	2	1
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 4.1.1,4.1.2
CO2	1.2.1, 4.1.1,4.1.2,4.2.1
CO3	1.2.1, 4.1.1,4.1.2,4.2.1,4.3.1
CO4	1.2.1, 4.1.1,4.1.2, 4.2.1,4.3.1
CO5	1.2.1, 4.1.1,4.1.2, 4.2.1,4.3.1

22BPC411	MOLECULAR BIOLOGY LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Microbiology Lab **Cell biology Lab**	**PC**	**0**	**0**	**3**	**1.5**

Course Objectives	To provide hands on experience in performing basic and advanced molecular biology techniques and to introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research.

LIST OF EXPERIMENTS

1. DNA Extraction from plant cells.
2. DNA Extraction from animal cells.
3. DNA Extraction from Human blood.
4. DNA Extraction from bacterial cell.
5. Qualitative Analysis of Genomic DNA
6. Quantitative Analysis of DNA.
7. Isolation of total RNA from bacteria.
8. Qualitative analysis of RNA.
9. Quantitative analysis of RNA.
10. Plasmid Extraction from bacterial cell.
11. Elution of DNA from Agarose gel.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCE BOOK

1	Sambrook J and Russell DM, ***"Molecular Cloning: A Laboratory Manual",***2014.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the principles underlying in the techniques of molecular biology .	K3
CO2	Analyze the applications of these techniques.	K3
CO3	Carry out lab experiments and interpret the results.	K3
CO4	Take safety precautions on usage of hazardous chemicals in case of emergency.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO3	1	3	2	-	2	-	-	-	-	-	-	-	3	2
CO4	-	3	3	-	3	-	-	-	-	-	-	3	2	3
22BPC411	3	3	3	-	3	-	-	-	-	-	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.4.1,
CO2	2.4.3,3.1.5
CO3	3.1.4,3.1.5,4.3.2
CO4	5.1.2,8.2.1,8.2.2