HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

B. TECH. BIOTECHNOLOGY

(Duration: 4 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2021-22)

DEPARTMENT OF CHEMICAL ENGINEERNG

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

Motto:

To Make Every Man *a* Success *and* No Man *a* Failure

Vision:

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

Mission:

- *To create an ecosystem that promotes learning and world class research.*
- *To nurture creativity and innovation.*
- *To instil highest ethical standards and values.*
- *To pursue activities for the development of the Society.*
- *To develop national and international collaborations with institutes and industries of eminence.*
- *To enable graduates to become future leaders and innovators.*

Value Statement:

Integrity, Innovation, Internationalization.

DEPARTMENT OF CHEMICAL ENGINEERING

Vision:

To achieve the pinnacle of success through quality education, research and entrepreneurship in emerging areas of Chemical Engineering and Biotechnology.

Mission:

- *To provide innovative education empowered with excellent technical and leadership skills*
- *To create state-of-the-art infrastructure for research and training, promote scientific discovery and development by fostering relationship with research organizations and industries.*

PROGRAMME'S EDUCATIONAL OBJECTIVES (PEO'S):

***PEO1**. Apply the knowledge in the field of engineering biotechnology to pursue higher studies and careers in industries, consultancies and research institutions.*

***PEO2**. Design, develop and provide solutions for product/processes/technology development*

***PEO3.** Apply modern computational, analytical tools and techniques in biotechnology to address environmental challenges.*

PROGRAMME'S OUTCOMES (PO'S):

PO-1: *Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.*

PO-2: *Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*

PO-3: *Design processes for complex biotechnological problems that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.*

PO-4: *Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.*

PO-5: *Create, select, 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.*

PO-6: *Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the biotechnological practice.*

PO-7: *Understand the impact of biotechnology in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.*

PO-8: *Apply ethical principles and commit to professional ethics and responsibilities and norms of the biotechnological practice.*

PO-9: *Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.*

PO-10: *Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.*

PO-11: *Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.*

PO-12: *Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.*

PROGRAMME'S SPECIFIC OUTCOMES (PSO'S):

***PSO-1**:* *Understand the mechanism and functions of cellular metabolism using biotechnological methods.*

***PSO-2**:* *Optimizing the performance and tools in genetic engineering for synthesizing plant and animal products.*

***PSO-3**:* *Designing a bioreactor using bioprocess engineering methods.*

B.TECH – BIOTECHNOLOGY									
SEMESTER- I									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MEA4101/ ELA4101	Engineering Graphics and Computer Aided Design /Professional English and soft skills	1	1	2	3	1	4
2	BS	MAA4101	Matrices and Calculus	3	0	2	4	1	5
3	BS	PHA4101/ CYA4101	Engineering Physics /Engineering Materials	3	0	0	3	1	3
4	PC	CSA4101/ GEA4102	Problem Solving Using C* /Sustainable Engineering Systems	2	0	2*	3/2	1	4/3
5	BS	EEB4101/ CHB4101	Introduction to Digital Systems /Engineering and Design	3	0	0	3	1	3
6	BS	ATA4131	Engineering Immersion Lab	0	0	2	1	2	2
7	BS	PHA4131/ CYA4131	Engineering Physics Lab/Materials Chemistry Lab	0	0	2	1	0	2
			Total	12	1	10	17/ 18	7	22/23
*** Project based learning; L – Lecture; T – Tutorial; P – Practical; C – Credit; S – Self Study; TCH – Total Contact Hours**									

SEMESTER- II									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4117	Analytical Mathematics	3	0	2	4	0	5
2	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
3	BS	MEA4101/ ELA4101	Engineering Graphics and Computer Aided Design / Professional English and soft skills	1	1	2	3	1	4

4	PC	EEB4101/ BTB4101	Introduction to Digital Systems / Engineering and Design	3	0	0	3	1	3
5	BS	GEA4102 / CSA4101	Sustainable Engineering Systems / Problem Solving Using C*	2	0	2*	2/2	1	3/4
6.	PC	CHB4116	Instrumental Analysis for Engineers	3	1	0	4	1	4
7.	PC	BTB4116	Cell Biology	3	0	0	3	1	3
8.	PC	BTB 4141	Cell Biology Lab	0	0	2	1	0	2
9.	BS	GEA4131	Engineering Immersion Lab	0	0	2	1	2	2
10.	BS	PHA4131/ CYA4131	Engineering Physics Lab/ Materials Chemistry Lab	0	0	2	1	0	2
			Total	**17**	**2**	**14**	**25/ 26**	**8**	**32/ 33**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

SEMESTER- III									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4201	Partial Differential Equations and Transforms	3	1	0	4	0	4
2	PC	BTB4201	Biochemistry	3	1	0	4	1	4
3	PC	BTB4202	Microbiology	3	1	0	4	1	4
4	BS	GEA4216	Professional Ethics and Life Skills	2	0	0	2	1	2
5	DE	*******	Department Elective-I	3	0	0	3	1	3
6	NE	*******	Non Department Elective- I	2	0	0	2	1	2
7	PC	BTB4231	Biochemistry Lab	0	0	2	1	1	2
8	PC	BTB4232	Microbiology Lab	0	0	2	1	1	2
9	PC	BTB4233	Design Project I	0	0	2	1	0	2
			Total	**16**	**3**	**6**	**22**	**8**	**25**

L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours

******* Separate table for department and non-department electives given below

SEMESTER- IV									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4217	Numerical Methods	3	1	0	4	0	4
2	PC	BTB4216	Molecular biology	3	1	0	4	1	4
3	PC	CHB4216	Heat Transfer	3	1	0	4	1	4
4	PC	BTB4217	Enzyme Engineering and Technology	3	0	0	3	1	3
5	DE	*******	Department Elective-II	3	0	0	3	1	3
6	NE	*******	Non Department Elective–II	2	0	0	2	1	2
7	PC	BTB4241	Molecular Biology Lab	0	0	2	1	1	2
8	PC	CHB 4241	Heat Transfer Lab	0	0	2	1	1	2
9	PC	BTB4242	Design Project II	0	0	2	1	0	2
			Total	**17**	**3**	**6**	**23**	**7**	**26**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

******* Separate table for department and non-department electives given below

SEMESTER- V									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4301	Optimization Techniques	3	1	0	4	0	4
2	PC	BTB4301	Recombinant DNA Technology	3	1	0	4	1	4
3	PC	CHB4301	Chemical Reaction Engineering	3	1	0	4	1	4
4	PC	CHB4303	Mass Transfer	3	1	0	4	1	4
5	DE	*******	Department Elective –III	3	0	0	3	1	3

6	NE	*******	Non Department Elective–III	2	0	0	2	1	2
7	PC	BTB4331	Recombinant DNA Technology Lab	0	0	2	1	1	2
8	PC	CHB4331	Chemical Reaction Engineering Lab	0	0	2	1	1	2
9	PC	BTB4332	Design Project III	0	0	2	1	0	2
			Total	**17**	**4**	**6**	**24**	**8**	**27**
HONOURS COURSES IN GENETICS									
10	*HONOURS*	*BTH4364*	*Classical Papers in Molecular Genetics*	*3*	*0*	*0*	*3*	*0*	*3*
11	*HONOURS*	*BTH4365*	*Basics of Genetics*	*2*	*0*	*1*	*3*	*0*	*3*
			Total	**5**	**0**	**1**	**6**	**0**	**6**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

******* Separate table for department and non-department electives given below

SEMESTER- VI									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	BTB4316	Metabolic Engineering	3	1	0	4	2	4
2	PC	BTB4318	Plant Biotechnology	3	1	0	4	1	4
3	PC	BTB4319	Animal Biotechnology	3	0	2	4	2	5
4	BS	GEA4304	Business Economics	2	0	0	2	1	2
5	DE	*******	Department Elective-IV	3	0	0	3	1	3
6	NE	*******	Non-Department Elective–IV	2	0	0	2	1	2
7	PC	BTB4341	Plant Biotechnology Lab	0	0	2	1	1	2
8	PC	BTB4342	Design Project IV	0	0	2	1	0	2
9	PC	BTB4343	Comprehension	0	0	2	1	0	2
			Total	**16**	**2**	**8**	**22**	**9**	**26**

HONOURS COURSES IN GENETICS									
10	*HONOURS*	*BTH4379*	*Genomics for Law*	*3*	*0*	*0*	*3*	*0*	*3*
11	*HONOURS*	*BTH4380*	*Human Molecular Genetics*	*3*	*0*	*0*	*3*	*0*	*3*
			Total	**6**	**0**	**0**	**6**	**0**	**6**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

******* Separate table for department and non-department electives given below

SEMESTER- VII									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	BTB4401	Bioprocess Engineering	3	1	0	4	1	4
2	PC	BTB4402	Bioinformatics	3	1	0	4	1	4
3	PC	BTB4403	Industrial Biotechnology	3	1	0	4	1	4
4	PC	BTB4404	Immunology	3	0	2	4	0	5
5	DE	*******	Department Elective-V	3	0	0	3	1	3
6	NE	*******	Non Department Elective–V	2	0	0	2	1	2
7	PC	BTB4431	Bioinformatics Lab	0	0	2	1	1	2
8	PC	BTB4432	Bioprocess Engineering Lab	0	0	2	1	1	2
9	PC	BTB4433	Design Project V/ Internship	0	0	2	1	0	2
			Total	**17**	**3**	**8**	**24**	**7**	**28**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

******* Separate table for department and non-department electives given below

SEMESTER- VIII									
SL. NO	**COURSE**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	BTB4441	Project & Viva – voce	0	0	24	8	0	24
			Total	**0**	**0**	**24**	**8**	**0**	**24**
L – Lecture ; T – Tutorial ; P – Practical ; C – Credit; S- Self Study; TCH- Total Contact Hours									

TOTAL CREDITS: 165

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE

SEM	COURSE	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
Elective I									
3	DE	BTC4251	Unit Operations	3	0	0	3	1	3
3	DE	BTC4252	Proteomics	3	0	0	3	1	3
3	DE	BTC4253	Clinical Research	3	0	0	3	1	3
3	DE	BTC4254	Bioinstrumentation	3	0	0	3	1	3
Elective II									
4	DE	BTC4266	Bio-nanotechnology	3	0	0	3	1	3
4	DE	BTC4267	Human Genomics	3	0	0	3	1	3
4	DE	BTC4268	Chemical Process Calculations	3	0	0	3	1	3
4	DE	BTC4269	Vaccine Biotechnology	3	0	0	3	1	3
Elective III									
5	DE	BTC4351	Bioethics, IPR and Patents	3	0	0	3	1	3
5	DE	BTC4352	Occupational Safety and Health in Bioengineering	3	0	0	3	1	3
5	DE	BTC4353	Chemical Engineering Thermodynamics	3	0	0	3	1	3
5	DE	BTC4354	Animal Therapeutics	3	0	0	3	1	3
Elective IV									
6	DE	BTC4366	Biopharmaceutical Technology	3	0	0	3	1	3
6	DE	BTC4367	Stem Cells in Health Care	3	0	0	3	1	3
6	DE	BTC4368	Environmental Biotechnology	3	0	0	3	1	3
6	DE	BTC4369	Protein Engineering	3	0	0	3	1	3
Elective V									
7	DE	BTC4451	Food Processing and Preservation Technology	3	0	0	3	1	3
7	DE	BTC4452	Cancer Biology	3	0	0	3	1	3
7	DE	BTC4453	Marine Biotechnology	3	0	0	3	1	3

7	DE	BTC4454	Regenerative Medicine	3	0	0	3	1	3

LIST OF NON DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE

SEM	COURSE	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
Elective I									
3	NE	BTD4281	Biomaterials and their Applications	2	0	0	2	0	2
3	NE	BTD4283	Food Processing	2	0	0	2	0	2
Elective II									
4	NE	BTD4291	Genetic Engineering	2	0	0	2	0	2
4	NE	BTD4292	Biopolymers	2	0	0	2	0	2
Elective III									
5	NE	BTD4381	Biotechnology in Defence	2	0	0	2	0	2
5	NE	BTD4382	Phytoremediation	2	0	0	2	0	2
Elective IV									
6	NE	BTD4391	Biotechnology in Alternate energy Resources	2	0	0	2	0	2
6	NE	BTD4392	Targeted Drug Delivery	2	0	0	2	0	2
Elective V									
7	NE	BTD4481	Bio entrepreneurship	2	0	0	2	0	2
7	NE	BTD4482	Agro biotechnology	2	0	0	2	0	2

SEMESTER I

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEB4101	COURSE CATEGORY	BS	L-T-P-S	1-1-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME				
	First Periodical Assessment	Second Periodical Assessment	Practical Assessment	ESE
	15%	15%	20%	50%

Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of free hand sketching. It prepares the students to learn the basic concepts involved in technical drawing skills and computer graphics. It also emphasis on the principles and basic understanding of projections and visualizations aspects of component designing.
Course Objective	1. To understand the basics of Engineering graphics and plane curvatures using AutoCAD tool 2. To visualize the free hand sketch and orthographic projections and to solve simple problems 3. To comprehend the various geometrical models and its developments 4. To understand the transformation of 2D drafting to 3D models using CAD tools 5. To generate associated views of 3D models and related geometric dimensioning and tolerencing.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the AutoCAD commands to generate simple drawings and understand drafting techniques. 2. State the acquired knowledge to solve simple problems involving straight planes and solids. 3. Relate solid objects and apply AutoCAD commands to generate the models. 4. Understand and use 3D model commands in AutoCAD tool to generate solid objects. 5. Apply various views of the geometrical solid model manually and using AutoCAD as well.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-	2	1	-	-	-	-	-	-	1	-	-	-	2	-	-

1															
CO-2	**-**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-3	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-4	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**
CO-5	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF ENGINEERING GRAPHICS AND PLANE CURVES	**(12L)**
Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer. **Practical component:** AutoCAD – Solid modelling tool - Basics. **Suggested Readings:** Basics of drafting and dimensioning	**CO-1** **BTL-2**
MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING	**(12L)**
Visualization concepts and Free Hand sketching: Visualization principles — Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views. **Practical component:** 2D drafting, Orthographic projections **Suggested Readings:** AutoCAD tool – Commands for sketching, Projections.	**CO-2** **BTL-2**
MODULE 3: GEOMETRICAL MODELLING, ISOMETRIC AND DEVELOPMENT OF SURFACES	**(12L)**
Principles of isometric projection and solid modelling. Isometric drawing – IsoPlanes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modeling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces **Practical component:** 3D modelling and surface development **Suggested Readings:**	**CO-3** **BTL-3**

Surface modelling and solid modelling	
MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING	**(12L)**
Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc. using appropriate modelling software. 2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer. **Practical component:** 2D to 3D transformation, plotting of drawings **Suggested Readings:** 3D modelling – view generations and commands	**CO-4** **BTL-2**
MODULE 5: SIMPLE DESIGN PROJECTS – COMPUTER AIDED DESIGN	**(12L)**
Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerencing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying color coding according to drawing practice. **Practical component:** 3D solid meshed topology, geometrical dimensioning, simple components **Suggested Readings:** AutoCAD dimensioning, assembly of solid components	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jeyapoovan, T. (2016). *Engineering Drawing and Graphics Using AutoCAD*, Vikas Publishing House Pvt. Ltd., 7th Edition, New Delhi.
REFERENCE BOOKS	
1.	Luzadder, w.L., Duff, J.M. (2016). *Fundamentals of Engineering Drawing*, Prentice Hall of India Pvt. Ltd., 11th Edition.
2.	Jensen, C., Helsel, J.D., Short, D.R. (2012). *Engineering Drawing and Design*, McGraw-Hill, 6th Edition.
E BOOKS	
1.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-freeebook-pdf-download.html
2.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1.	http://nptel.ac.in/courses/112103019/

2.	http://nptel.ac.in/courses/105104148/

COURSE TITLE	MATRICES AND CALCULUS			CREDITS	4
COURSE CODE	MAA 4101	COURSE CATEGORY	BS	L-T-P-S	3-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-1-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of matrices and calculus using MATLAB
Course Objective	1. To Know how to perform some simple operations on matrices 2. To understand effectively the basic concepts of differentiation and partial differentiation and their applications. 3. To perform integration and other operations for certain types of functions and carry out the computation fluently. 4. To classify ordinary differential equations. 5. To understand efficiently the minimum requirement of differential equations.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the concept of matrices and Eigen Values. 2. Demonstrate the concept of features in Differential Calculus 3. Apply the concept of Integral Calculus 4. Analyse the concept of ordinary differential equation 5. Assess the principles of matrices and Eigen Values
Prerequisites:	

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	-	-	-	-	2	-	-	-	-	-	2	-	-	2	-
CO-3	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-

CO-4	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:MATRICES	**(13L+2P=15)**
Characteristic equation – Eigen values and Eigenvectors – Properties – Cayley Hamilton theorem (Statement only) – Verification and inverse of the matrix using Cayley Hamilton theorem- Diagonalization of matrices using similarity transformation **Suggested Reading**: Basics of Matrices **Practical Component:** Eigen values and Eigenvectors, Verification and inverse using Cayley Hamilton theorem- Diagonalization	**CO-1** **BTL-1,2,3,4**
MODULE 2: DIFFERENTIAL CALCULUS	**(13L+2P=15)**
Methods of differentiation of functions – Product and Quotient rules – Inverse trigonometric functions – Implicit function – parametric form. Partial differentiation – Total differentiation- Taylor's series – Maxima and minima of functions of two variables **Suggested Reading**: Basics of Differentiation **Practical component:** Taylor's series – Maxima and minima of functions of two variables	**CO-2** **BTL-1,2,3,4**
MODULE 3:INTEGRAL CALCULUS	**(13L+2P=15)**
Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. Applications of Integral Calculus: Area, Surface and Volume. **Suggested Reading**: Basics of Integrations **Practical component:** Applications of Integral Calculus: Area, Surface area and Volume.	**CO-3** **BTL-1,2,3**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS	**(13L+2P=15)**
Second order differential equations with constant coefficients – Particular integrals – e^{ax}, $Sinax, Cosax, x^m$, e ^{ax} Cos bx, e^{ax} Sin bx. Solutions of homogeneous differential equations with variable coefficients – Variation of parameters. **Suggested Reading**: Basics of Differential Equations. **Practical component**: Solution of Second order differential equations.	**CO-4** **BTL-1,2,3**

TEXT BOOKS

1.	Grewal B.S. (2014). *Higher Engineering Mathematics*. Khanna Publishers, 43rd Edition., New

	Delhi.
2.	Bali N. P., Goyal, M. (2011). *A Text book of Engineering Mathematics*, Laxmi Publications Pvt Ltd., 8th Edition.
3.	Chandrasekaran, A. (2010). *A Text book of Engineering Mathematics* I, Dhanam Publications, Chennai.
REFERENCE BOOKS	
1.	Srimantha, P., Bhunia, S.C. (2015). *Engineering Mathematics,* Oxford University Press.
2.	Weir, M.D., Thomas, J.H. (2016). *Calculus*, 12th Edition, Pearson India.
3.	Duffy, D.G. (2015). *Advanced Engineering Mathematics With Matlab,* CRC Press, 3rd Edition. P. 1105.
E BOOKS	
1.	http://nptel.ac.in/courses/111105035/ https://www.edx.org/.../introduction-engineering-mathematics-utarlingtonx-engr3
MOOC	
1.	https://www.mooc-list.com/tags/engineering-mathematics

COURSE TITLE	ENGINEERING PHYSICS (Common to ECE,EEE,CSE & IT)			CREDITS	3
COURSE CODE	PHA4102	COURSE CATEGORY	BS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course will familiarize the student with properties of matter, heat, acoustics, ultrasonics, quantum physics, semiconducting materials and photonics. Application of the concepts to solve engineering problems				
Course Objective	1. To impart knowledge on types of stress and elastic moduli and to explain the concept of heat conduction and determination of thermal conductivity of different materials. 2. To appraise knowledge on acoustics and ultrasonics and to apply it as an engineering tool in material processing. 3. To Illustrate theoretically and experimentally particle nature of radiation. 4. To distinguish materials based on band theory and expose the students to functioning of basic electronic devices 5. To expose students to principles of lasers and fibre optics and their applications				
Course Outcome	Upon completion of this course, the students will be able to 1. Differentiate between the types of stress and elastic moduli and apply the concepts to solve basic problems and explain the concept of heat conduction and determination of thermal conductivity of different materials. 2. Explain the concept of reverberation and compute Sabine's formula for reverberation time and outline the principles of generation and properties of ultrasonics and employ it as an engineering tool in material processing. 3. Describe theoretically and experimentally particle nature of radiation and Compute Schrödinger's equation to solve infinite potential well problem. 4. Distinguish materials based on band gap. Illustrate the functioning of discrete devices.				

	5. Apply the principle, working and application of lasers and optical fibres.

Prerequisites: XII standard Physics

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3
CO-2	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	2	-	-	-	1	-	-	-	-	1	-
CO-4	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 –PROPERTIES OF MATTER& HEAT	**(9L)**
Elasticity - Hooke's law– Elastic Moduli – Young's modulus of elasticity - Rigidity modulus - Bulk modulus - Twisting couple on a wire - Torsional pendulum - determination of rigidity modulus of a wire - Depression of a cantilever - Young's modulus by cantilever - uniform and non-uniform bending, Thermal conductivity – experimental determination of thermal conductivities of good and bad conductors – Forbe's method – theory and experiment – Lee's disc method for bad conductors.	**CO-1 BTL-3**
MODULE 2 – ACOUSTICS AND ULTRASONICS	**(9L)**
Classification of sound - Characteristics of musical sound – intensity - loudness - Weber Fechner law - Decibel - Reverberation - Reverberation time, derivation of Sabine's formula for reverberation time(Jaeger's method) - absorption coefficient and its determination - factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies Ultrasonics- Production – Magnetostriction and Piezoelectric methods – properties – applications.	**CO-2 BTL-3**
MODULE 3 –QUANTUM PHYSICS (9L)	
Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory - Compton effect – Theory and experimental	**CO-3 BTL-3**

verification, Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Extension to 3 dimension (no derivation).	
MODULE 4 –SEMICONDUCTING MATERIALS	**(9L)**
Band theory of solids - Classification of metals, semiconductors & insulators – Intrinsic & Extrinsic Semiconductors (Qualitative Treatment) – Direct & Indirect band gap – semiconductor Hall Effect – Determination of Hall Coefficient. PN junction diode – Construction, working & VI characteristics, Zener diode - Construction, working & VI characteristics – Zener diode as voltage regulator – Transistors - Construction & working – CE & CB Configuration characteristics curves.	**CO-4** **BTL-3**
MODULE 5 – PHOTONICS AND FIBRE OPTICS	**(9L)**
Principle of lasers - Stimulated absorption - Spontaneous emission, stimulated emission - population inversion - pumping action - active medium - laser characteristics – Nd-Yag laser - CO_2 laser - Semiconductor laser - applications - optical fiber - principle and propagation of light in optical fibers - Numerical aperture and acceptance angle - types of optical fibers - single and multimode, step index and graded index fibers - fiber optic communication system.	**CO-5** **BTL-3**
TEXT BOOKS	
1.	Man, P. (2016). *Engineering Physics,* Vol-I & II, Dhanam Publications, Chennai.
2.	Gaur, R.K., Gupta, S.L. (2015). *Engineering Physic,* Dhanpat Rai publications (P) Ltd., 8th edition, New Delhi.
REFERENCE BOOKS	
1.	Poople, C.P., Owens, F.J. (2017). *Introduction to Nanotechnology,* Wiley India.
2.	Beiser, A. (2007). *Concepts of Modern Physics*, Tata Mc Graw – Hill Publications.
3.	Rajendran, V., Marikani, A. (2013). *Applied Physics for Engineers*, Tata Mc Graw –Hill publishing company Ltd., 3rd edition, New Delhi.
MOOC	
1.	http://nptel.ac.in/courses/115106061/
2.	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	PROBLEM SOLVING USING C			CREDITS	4
COURSE CODE	CSA4101	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME			
First Periodical Assessment	Second Periodical Assessment	Practical Component	ESE
15%	15%	20%	50%

Course Description	To introduce computers and programming in C and also explore the power of computational techniques that are currently used by engineers and scientists and to develop programming skills with reasonable complexity.
Course Objective	1. To acquire the basic knowledge in computer hardware, programming languages and Problem-solving techniques. 2. To learn the fundamentals of C programming. 3. To gain knowledge in Functions, arrays and strings in C programming. 4. To understand the pointers, Structures and Union in C programming 5. To gain Knowledge on Embedded Programming
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of digital computer and programming languages. 2. Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem. 3. Design and Implement C program using Control Statements and Functions. 4. Apply and Implement C program using Pointers and File operations. 5. Recognize the need for embedded C in real-time applications.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO	PO-	PO-	PO-	PO-	PO-	PO-	PO-	PO-	PO	PO-	PO-	PSO-	PSO-	PSO-

	-1	2	3	4	5	6	7	8	9	-10	11	12	1	2	3
CO-1	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-2	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**
CO-4	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
CO-5	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO CYBER SECURITY	**(6L+6L=12)**
Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code. **Practical Component:** Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems (i) Greatest of three numbers (ii) Sum of N numbers (iii) Computation of nCr	**CO-1** **BTL-1**
MODULE 2: SECURITY ATTACKS, PRINCIPLES AND MANAGEMENT	**(6L+6L=12)**
Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements. **Practical Component:** (i) Program to illustrate arithmetic and logical operators (ii) Program to read and print data of different types (iii) Program to calculate area and volume of various geometrical shapes (iv) Program to compute biggest of three numbers (v) Program to print multiplication table (vi) Program to convert days to years, months and days (vii) Program to find sum of the digits of an integer	**CO-2** **BTL-3**
MODULE 3: SECURITY PLANS, POLICIES AND PROCEDURES	**(6L+6L=12)**
Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements. **Practical Component:** (i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion (ii) Program to compute sum and average of N Numbers stored in an array (iii) Program to sort the given n numbers stored in an array	**CO-3** **BTL-4**

(iv) Program to search for the given element in an array (v) Program to do word count (vi) Program to insert a substring in a string (vii) Program to concatenate and compare two strings (viii) Program using pre-processor statements	
MODULE 4: OVERVIEW OF SECURITY COUNTERMEASURE TOOLS	**(6L+6L=12)**
Pointers – Dynamic Memory allocation – Structure and Union – Files. **Practical Component:** (i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation (ii) Program to read and print records of a student/payroll database using structures (iii) Program to simulate file copy (iv) Program to illustrate sequential access file (v) Program to illustrate random access file	**CO-4** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY	**(6L+6L=12)**
Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler. **Practical component:** Simple programs using embedded C	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Jeyapoovan, T. (2015). *Fundamentals of Computing and Programming in C*, Vikas Publishing house.
2.	Siegesmund, M. (2015). *Embedded C Programming,* Elsevier publications, 1st edition.
REFERENCE BOOKS	
1.	Kamthane, (2017). *Computer Programming,* Pearson Education, 7th Edition, Inc.
2.	Kanetkar, Y. (2016). *Let us C*. BPP publication, 15th edition.
3.	Sathyalakshmi, S., Dinakar, S. (2015). *Computer Programming Practical – Computer Lab Manual*. Dhanam Publication, 1st Edition.
E BOOKS	
1.	https://en.wikibooks.org/wiki/C_Programming
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	INTRODUCTION TO DIGITAL SYSTEMS			CREDITS	3
COURSE CODE	EEB4101	COURSE CATEGORY	DE	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides an introduction to digital system using microprocessors, sensors and actuators. Within this context it introduces the fundamentals of Boolean algebra, digital arithmetic, Sensors and Displays, Signal Conditioning Circuits, microprocessor architecture and I/O, and Consumer Electronics and Communication System.
Course Objective	1. To gain knowledge on basic operation in digital systems 2. To study about sensors and display units 3. To have knowledge on the concepts of signal processing and converting elements 4. To study about microcontroller and its interfacing 5. To gain knowledge about different types of communication
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the basic operation in digital systems and instruments 2. Analyse knowledge on basic functioning of sensors and display units. 3. Develop the concepts of signal processing and converting elements. 4. Defend the industrial controllers, microcontrollers Illustrate the principles 5. Determine the operation of satellite communication.

Prerequisites: Physics and Mathematics

CO, PO AND PSO MAPPING

CO	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
CO-1	2	-	-	1	-	-	-	-	-	-	-	1	-	-

CO-2	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-
CO-3	-	**1**	-	-	**2**	-	-	-	-	**3**	-	-	-	**3**
CO-4	-	-	-	-	-	-	-	-	-	-	-	-	**2**	-
CO-5	-	**2**	-	-	**1**	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Introduction to Digital Systems	**(9L)**
Analog & Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF). **Suggested Readings:** Basics of number systems	**CO-1** **BTL-3**
MODULE 2: Sensors and Displays	**(9L)**
Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays. **Suggested Readings:** Primary sensing elements, introduction to displays	**CO-2** **BTL-3**
MODULE 3: Signal Conditioning Circuits	**(9L)**
D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor **Suggested Readings:** Basic network theorems	**CO-3** **BTL-3**
MODULE 4: Introduction to Micro controllers	**(9L)**
Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller **Suggested Readings:** Electronics with Microcontroller interface	**CO-4** **BTL-3**
MODULE 5: Consumer Electronics and Communication System	**(9L)**
Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.)	**CO-5** **BTL-2**

Communication System: - Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.) **Suggested Reading:** Consumer Electronics User Manuals	
TEXT BOOKS	
1.	Floyd, T.I. (2015). *Digital Fundamentals*, Pearson India, 11th edition.
2.	Gayakwad, R.A. (2015). *Op-amps and Linear Integrated Circuits*, Prentice Hall, 4th edition.
3.	Bell, D.A. (2015). *Electronic Instrumentation and Measurements*, Oxford University Press, London.
4.	Naimi, S., Mazid, M.A. (2017). *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd edition.
5.	Petruzella, F.D. (2016). *Programmable Logic Controllers*, McGraw-Hill Education.
REFERENCE BOOKS	
1.	Mano, M.M. (2016). *Digital Logic and Computer Design*, Prentice-Hall, 2016
2.	Choudhury, R. (2011). *Linear Integrated Circuits,* New Age International Publishers, 4th edition.
3.	Naimi, S., Mazid, M.A. (2017). *The 8051 Microcontroller and Embedded Systems Using Assembly and C,* 2nd edition.
4.	Bali, S.P. (2008). *Consumer Electronics*, 1st Edition, Pearson Education Asia Pvt., Ltd.
5.	Ilcev, S.D. (2018). *Global Mobile Satellite Communications Applications (For Maritime, Land and Aeronautical Applications Volume 2)*, Springer, 2nd edition.
E BOOKS	
1.	http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf
2.	https://electronics.howstuffworks.com/home-audio-video-channel.htm
MOOC	
1.	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2.	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
3.	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
4.	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/ Course_home2_5.html

COURSE TITLE	ENGINEERING IMMERSION LAB			CREDITS	1
COURSE CODE	GEA4131	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	Engineering Immersion Lab helps the students to understand and familiarize the basic knowledge on Computer, Electrical, Electronic and Mechanical Engineering domains
Course Objective	To make students trained on basic engineering experiments in Computer, Electrical, Electronic and Mechanical Engineering fields.
Course Outcome	1. Identify and use of tools, accessories, trouble shooting, software installations, Assembling and fabrication techniques in basic Engineering domains. 2. Have hands on experience on designing circuits for various applications.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	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	PSO 3
CO-1	2	-	-	1	-	-	-	-	-	-	-	1	-	-	-
CO-2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO-3	-	1	-	-	2	-	-	-	-	3	-	-	-	3	-
CO-4	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS

I. ELECTRICAL ENGINEERING

1. Study of tools and accessories
2. Study of cables.
3. Staircase wiring, Tube light and Fan connection
4. Measurement of energy using single phase energy meter.

II. ELECTRONICS ENGINEERING

1. Study of Active and Passive Components.
2. Study of Logic Circuits.
3. Making simple circuit using Electronic Components.
4. Measuring of parameters for signal using CRO.

III. COMPUTER SCIENCE

1. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
2. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
3. Installation of commonly used software like MS Office
4. Assembling digital computer.

IV. MECHATRONICS ENGINEERING

1. Study of Key Elements of Mechatronics Systems
2. Sensors – Load Cell, Thermocouple
3. Actuators – Linear & Rotary Actuators
4. Interfacing & Measurements – Virtual Instrumentation

REFERENCE BOOKS

1.	Jeyapoovan, T., Saravanapandian M. (2015). *Engineering practices lab manual*, Vikas Publishing House, 4th Edition, New Delhi.
2.	Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K. (2010). *Elements of Workshop Technology*. Vol. I (2008) and Vol. II (2010), Media promoters and publishers private limited. Mumbai.
3.	Zeid, I.. (2011). *CAD/CAM Theory and Practice*, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4.	Quesada, R., Jeyapoovan T. (2006). *Computer Numerical Control Machining and Turning Centers*, Pearson Education, New Delhi.

SEMESTER II

COURSE TITLE	ANALYTICAL MATHEMATICS			CREDITS	4
COURSE CODE	MAA 4117	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To make the student understand the basic analytical mathematical skills that is imperative for effective understanding of engineering subject using MATLAB.				
Course Objective	1. To demonstrate the fundamental understanding and history of AI 2. To apply problem solving skills using the problem solving methods of AI 3. To demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems. 4. To understand the applications of AI. 5. To demonstrate the fundamental understanding and history of AI				
Course Outcome	Upon completion of this course, the students will be able to 1. Evaluate surface and volume integrals. 2. Perform vector operations and interpret the results geometrically 3. Solve the system of ordinary differential equations using Laplace Transform 4. Analyse the periodic function satisfying Dirichlet's conditions. 5. Understand complex variable theory and applications of analytic function				
Prerequisites:					

CO, PO AND PSO MAPPING															
CO	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	PSO-3
CO-1	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-

CO-2	-	-	-	-	-	**1**	-	-	-	-	-	-	-	**2**	-
CO-3	-	-	**2**	-	-	-	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	**1**	-	-	-	-	-	**2**	-	-	**1**	-	-
CO-5	-	**1**	-	-	-	-	**2**	-	-	-	-	-	-	-	**2**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:MULTIPLE INTEGRALS	**(10L+2P)**
Double integration – Cartesian and polar co-ordinates – Change of order of integration. Area as a double integral – Triple integration in Cartesian coordinates – Volume as a triple integral – Change of variables between Cartesian and polar coordinates. **Suggested Reading**: Line Integrals **Practical Component**: Area and Volume using double and triple integration.	**CO-1** **BTL-1,2,3**
MODULE 2:VECTOR CALCULUS	**(10L+2P)**
Gradient, Divergence and Curl – Unit normal vector, Directional derivative – angle between surfaces–Solenoidal and Irrotational vector fields, Green's theorem - Gauss divergence theorem and Stoke's theorem (without proof) – Verification and evaluation of the above theorems - Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds. **Suggested Reading**: Basics of Vectors **Practical Component**: Area using Green's theorem and Volume using Gauss divergence theorem.	**CO-2** **BTL-1,2,3**
MODULE 3:LAPLACE TRANSFORMS	**(10L+2P)**
Laplace transform – Conditions of existence – Transform of elementary functions – properties– Transforms of derivatives– Initial and final value theorems – Transform of periodic functions. Inverse Laplace transforms using partial fraction and convolution theorem. Solution of linear ODE of second order with constant coefficients. **Suggested Reading**: Basics of Transform **Practical Component**: Finding Laplace and Inverse Laplace Transform of Elementary Functions, Solutions of Ordinary differential equations using Laplace transform.	**CO-3** **BTL-1,2,3**
MODULE 4: FOURIER SERIES	**(10L+2P)**

Dirichlet's Conditions – General Fourier Series – Odd and even functions – Half range sine and cosine series –Harmonic Analysis. **Suggested Reading**: Basics of series **Practical Component**: Fourier series Expansion of simple functions, Harmonic Analysis	**CO-3** **BTL-1,2,3**
MODULE 5: COMPLEX VARIABLES	**(10L+2P)**
Functions of a complex variable – Analytic function – Cauchy - Riemann equations (Statement only) – Properties of analytic function (Statement only) – Construction of Analytic functions by Milne – Thomson method. **Suggested Reading**: Complex Numbers **Practical Component**: Complex Numbers	**CO-4** **BTL-1, 2, 3**

TEXT BOOKS	
1.	Erwin, K. (2016). *Advanced Engineering Mathematics,* John Wiley and Sons, 10th Edition, New Delhi.
2.	Santhakumaran, A. P., Titus, P. (2012). *Engineering Mathematics - II*, Numeric Publications, Nagercoil.
3.	Chandrasekaran, A. (2014). *Engineering Mathematics- II*, Dhanam Publication.
4.	Bansal, R.J., Goel, A.K., Sharma, M.K. (2016). *MATLAB and its Applications in Engineering*, Pearson Publication, 2nd Edition.
REFERENCE BOOKS	
1.	Sastry, S.S. (2014). *Engineering Mathematics*, Vol. I & II, PHI Learning Pvt. Ltd, 4thEdition, New Delhi.
2.	Wylie, R.C., Barrett, L.C. (2012). *Advanced Engineering Mathematics*, Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi.
3.	Duffy, D.G. (2013). *Advanced Engineering Mathematics with MATLAB*, CRC Press, Third Edition.
E BOOKS	

1.	http.// nptel.ac.in/courses/122104017/28 https://www.khanacademy.org/.../double-integrals.../double-integral. nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-1.pdf nptel.ac.in/syllabus/122104017/ nptel.ac.in/courses/111105035/22 nptel.ac.in/syllabus/111103070/
MOOC	
1.	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	**ENGINEERING MATERIALS (Common to ALL Branches of Engineering)**			**CREDITS**	**3**
COURSE CODE	**CYA4101**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	To make the students understand the basic concepts of Engineering Materials and their applications.				
Course Objective	1. To make the students understand the basics of crystal structure and phase rule. 2. To provide an exposure on the fundamentals of powder metallurgy and applications of inorganic materials and composites. 3. To give a strong foundation on the basic concepts of nanomaterials, the general synthetic methods with emphasis on their applications. 4. To illustrate the applications of conducting polymers and liquid- crystals, with a good exposure on their basic terminologies. 5. To provide a knowledge on the theoretical basis of the chemical composition, properties and applications of lubricants, adhesives and explosives.				
Course Outcome	Upon completion of this course, the students will be able to 1. Understand and justify suitable metals/materials for alloying.				

	2. Distinguish suitable high-temperature material for industrial applications. 3. Apply appropriate technique for nanomaterial synthesis and also select a property-guided molecular material for a given application. 4. Analyse the materials which can be employed as organic conductors and liquid- crystals in electronic devices. 5. Understand and select a suitable organic / inorganic material as lubricant / adhesive / explosive based on its applications.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	-	-	-	-	-	1	-	-	-	-	1	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	1	-	-	2	-	-	-	-	-	-	-	-	-	-	1
CO 4	1	-	-	-	2	-	-	-	-	-	-	-	1	-	-
CO 5	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CRYSTAL STRUCTURE AND PHASE RULE	**(9L)**
Basic crystal systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure. Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.	**CO-1** **BTL-1, 2,3**
MODULE 2: POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES	**(9L)**
Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses. Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites –Types and Applications. Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.	**CO-2** **BTL-1,2**
MODULE 3: NANOMATERIALS AND MOLECULAR SIEVES	**(9L)**

Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only). Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.	**CO-3** **BTL-2, 3**
MODULE 4: MATERIALS FOR ELECTRONIC APPLICATONS	**(9L)**
Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermochroic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications. Conducting and Super conducting Organic electronic materials - Applications. Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.	**CO-3** **BTL-1, 2**
MODULE 5: LUBRICANTS, ADHESIVES AND EXPLOSIVES	**(9L)**
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	**CO-4** **BTL-1, 2**

TEXT BOOKS	
1.	Jain, P.C., Jain, M. (2012). *Engineering Chemistry,* Dhanpat Raj Publishing Company (P) Ltd, New Delhi.
2.	Sharma, P., Pathania. (2004). *Principles of Physical Chemistry*, Vishal Publishing Co. Jalandar.
REFERENCE BOOKS	
1.	Chawala, K.K. (2012). *Composite materials*, Springer-Verlag, 3rd ed., New York.
2.	Ajayan, P.M., Schadler, L.S., Braun, P.V. (2003). *Nanocomposite Science and Technology*, Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
3.	Vasiliev, V.V., Morozov, E.V. (2001). Mechanics and Analysis of Composite Materials, Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2.	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf`
MOOC	
1.	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2.	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	PROFESSIONAL ENGLISH AND SOFT SKILLS			CREDITS	3
COURSE CODE	ELA4101	COURSE CATEGORY	HS	L-T-P-S	2-0-2-1
Version	1.0	Approval Details	24 ACM 30th May 2018	LEARNING LEVEL	BTL- 3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course has been designed to meet students' current and future language and communication needs. It attempts to develop their proficiency in the four language skills and knowledge of grammar and vocabulary. This course teaches students how to communicate accurately, appropriately and fluently in professional and social situations.				

Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing and report writing. 5. To equip the learners in analysing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the ability to construct sentences with accuracy with focus on syntax. 2. Define vocabulary, use of phrases, expressions, idioms, and proverbs. Derive the contextual meaning through reading and listening from general and academic situations, identify specific details and general ideas. Learn to give instructions and make suggestions. 3. Analyse and transcode data, construct different types of written essays, read complex passages and summarize ideas, create personal profiles in the form of a resume. 4. State and articulate ideas, concepts, and perceptions in a comprehensive manner in written business correspondence, and speaking in formal and informal situations. 5. Apply critical thinking skills and participate in brainstorming sessions on general topics, and transact information with an audience. Prepare students for interview questions, presentation skills. Produce complex written documents such as reports, business/scientific documents, and project proposals.
Prerequisites: Plus Two English-Intermediate Level	

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO-2	1	-	-	-	-	-	-	2		-	-	-	-	1	-
CO-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	-	2	-	-	-	2	-	1	-	-
CO-5	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNCTIONAL GRAMMAR AND VOCABULARY	(6L + 6P=12)
Introduction to communication skills –Self Introduction - Basic grammar (tenses, subject verb agreement) - Basic vocabulary (prefixes , suffixes, synonyms & antonyms, phrasal verbs and idioms)- Topic sentences , paragraph writing **Suggested Activities:** Short conversations-Situational Communication-Dialogue Writing - Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences**.** **Suggested Reading:** 1. Dr. Bikram K. Das et al.(2009) *An Introduction to Professional English and Soft Skills* with audio CD, Cambridge University Press. 2. John, Dolly (2014), *English for Life and the Workplace Through LSRW&T Skills*, Pearson Publications.	**CO-1** **BTL-2**
MODULE 2 – LISTENING AND SPEAKING SKILLS	**(6L + 6P=12)**
Academic listening (listening to lectures different topics, audio excerpts and answering question) - General listening (conversations, speeches: formal and informal) - Giving instructions and suggestions- Active and Passive Voice **Suggested activities:** Listen and repeat, Listening to audio excerpts- Listening to native speakers - TED Talks, short prepared speeches, Table topics – Speaking in different situations- MCQ's - Cloze exercises- Complete the Dialogue **Suggested sources:** 1. Bommelje, R. (2011). *LISTEN, LISTEN, LISTEN. In The top 10 ways to strengthen your self- leadership.* International Listening Leadership Institute. Retrieved from http://www.listening leaders.com/Articles.html 2. Hoppe, M. H. (2006). *Active listening: Improve your ability to listen and lead* [ebook]. Greensboro, NC: Center for Creative Leadership. 3. Barnes, D. (2008) *Exploratory talk for learning in Mercer*, N. and Hodgkinson, S. (eds) Exploring Talk in School. London: Sage Publications	**CO-2** **BTL-3**
MODULE – 3 : FUNCTIONAL READING AND WRITING	**(6L+ 6P=12)**

Reading comprehension (academic texts and general texts)-Reading and Interpreting visual data, charts, tables and graphs-- Report writing- accident, industrial, survey, general reports –Direct and Indirect speech **Suggested Activities:** Identify the errors in sentences, grammar exercise, reading passage for identifying the contextual meaning, interpreting charts, tables and graphs, choose the right meaning of the word given Assignment on suggested reading activity – Book review **Suggested sources:** 1. Murphy, Raymond (2016) *Essential English Grammar,* Cambridge University Press.	**CO-3** **BTL-3**
MODULE – 4 : BUSINESS CORRESPONDENCE	**(6L + 6P=12)**
Memo-Notice - Agenda – Minutes of the Meeting-Action Taken report- Report Writing-Connectives - Cause and effect **Suggested activities:** Drafting agenda, notice, memo, minutes of the meeting- ATR- Cause and effect exercises - Presentation in the language lab (Technical or Non-technical topic) **Suggested sources:** 1. Bailey, E. (2008). Writing and speaking. New York, NY: McGraw-Hill. 2. Maynard-Smith, Julian. (2021), *Ultimate Guide to Business Writing, All the Secrets of Creating and Managing Business Documents,* Routledge.	**CO-4** **BTL-4**
MODULE 5 – PRESENTATION SKILLS AND INTERVIEW SKILLS	**(6L + 6P=12)**
Presentation Skills - Reading and Interpreting Advertisements—Job Application-Covering Letter -Curriculum Vitae –E-mail - Project proposal –Interview skills (HR questions) – Group Discussion **Suggested Activities:** Presentation in the language lab (Technical or Non-technical topic) Group Discussion (Technical or Non-technical topic) **Suggested Sources:** 1. Manoharan. K. (2016), *Education and Personality Development,* APH Publishing Home.	**CO-5** **BTL-4**
TEXT BOOKS	
1.	*Professional Skills and Soft Skills* (2020), Study Material, Hindustan Institute of Technology and Science.
REFERENCE BOOKS	
1.	Sabina, P., Agna, F. (2018). *Soft Skills & Employability Skills,* Cambridge University Press.

2.	Hart, S. (2016) *Embark, English for Undergraduates*, Cambridge University Press.
3.	Jeff, B. (2010) *Soft Skills for Everyone*, Cengage Learning.
4.	Aruna, K. (2015) *Professional Speaking Skills,* Oxford University Publishers.
E BOOKS	
1	https://www.britishcouncil.in/english/courses-business
2	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3	http://www.bbc.co.uk/learningenglish/english/
4	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	**SUSTAINABLE ENGINEERING SYSTEMS**			**CREDITS**	**2**
COURSE CODE	**GEA4102**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/**	**Surprise Test / Quiz**	**Attendance**	**ESE**

		Project			
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	Sustainable Engineering systems is designed with an overview of sustainability, including changing attitudes and values toward technology and the environment throughout the twentieth century. This course discussed about the green engineering principles, waste management, water pollution, life cycle assessment test and design of sustainable systems.
Course Objective	1. To learn the principles of sustainability with case studies …. 2. To understand assessing technologies and their impact on environment 3. To learn green engineering concepts with examples 4. To learn about the management of natural resources and waste management 5. To understand different types of water protection and treatment technologies
Course Outcome	Upon completion of this course, the students will be able to 1. Familiarize the principles of sustainability and the sustainable engineering goals 2. Explain the life cycle assessment methodologies and technical merits 3. Understand the principles of green engineering 4. Explain the waste recycling and waste management systems. 5. Recognize the features of water conservation, protection and treatment technologies.

Prerequisites: GEA4102 - Sustainable Engineering systems

CO, PO AND PSO MAPPING

CO	**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**	**PSO-3**
CO-1	-	-	-	**2**	-	-	-	-	-	-	-	-	-	**1**	-
CO-2	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-	-
CO-3	-	-	**2**	-	-	-	-	-	-	-	-	-	**2**	-	-
CO-4	-	**1**	-	-	-	-	-	-	-	-	-	-	-	-	**2**
CO-5	-	-	-	-	-	**3**	-	-	-	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRINCIPLES OF SUSTAINABLE SYSTEMS (6L+6L=12)

Sustainability Definitions – Principles of Sustainable Design, Sustainable Engineering – Frame work for applying sustainability Principles – Summary & Activities. **Practical component:** Frame work for applying sustainability Principles. **Suggested Readings:** Principles of Sustainable Engineering	**CO-1** **BTL-2**

MODULE 2: TECHNOLOGY DEVELOPMENT AND LIFE CYCLE ASSESSMENT (6L+6L=12)	
Technology as a part of anthropogenic environment – Technology readiness levels (TRL) – Technical metrics- Emerging, converging, disruptive technologies – Life Cycle Assessment (LCA) methodology – Summary & Activities **Practical component:** Emerging, converging, disruptive technologies. **Suggested Readings:** Life Cycle Assessment (LCA) methodology	**CO-2** **BTL-2**
MODULE 3: GREEN ENGINEERING (6L+6L=12)	
Principles of green Engineering – Frameworks for assessment of alternatives – Green Engineering examples – Multifunctional materials and their impact on sustainability - Summary & Activities. **Practical component:** Multifunctional materials and their impact on sustainability. **Suggested Readings:** Green Engineering principles	**CO-3** **BTL-3**
MODULE 4: RESOURCE MANAGEMENT TECHNOLOGIES (6L+6L=12)	
Waste management purpose and strategies – Recycling: Open loop versus closed loop thinking, Recycling efficiency- management of food waste and composting technologies – E-waste stream management – Reuse and redistribution programs – LCA approach to waste management systems - Summary & Activities **Practical component:** LCA approach to waste management systems **Suggested Readings:** Waste management systems	**CO-4** **BTL-3**
MODULE 5: SUSTAINABLE WATER AND WASTE WATER SYSTEMS (6L+6L=12)	
Water cycle – Water conservation and protection technologies – Water treatment systems metrics for assessment of water management technologies - Summary & Activities **Practical component:** Water conservation and protection technologies **Suggested Readings:** Water treatment systems metrics	**CO-5** **BTL-3**
TEXT BOOKS	
1.	Vanak, F.M., Albright, L.D. (2008). *Energy system Engineering: Evaluation and implementation*, McGraw Hill.
REFERENCE BOOKS	

1.	Anastas, P. T., Zimmermen, J.B. (2013). *Innovation in green chemistry and green engineering*, Springer.
2.	Christensen, T. (2015). *Solid waste technology and management*. Vol 1 & 2, Wiley & sons.
E BOOKS	
1.	Allen, D.T., Shonnard, D.R. (2011). *Sustainable Engineering Concepts, Design & Case studies*, Pearson Education Dec.
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.coursera.org/learn/ecosystem-services
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview

COURSE TITLE	**INTRODUCTION TO DIGITAL SYSTEMS**			**CREDITS**	**3**
COURSE CODE	**EEB4101**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides an introduction to digital system using microprocessors, sensors and actuators. Within this context it introduces the fundamentals of Boolean algebra, digital arithmetic, Sensors and Displays, Signal Conditioning Circuits, microprocessor architecture and I/O, and Consumer Electronics and Communication System.
Course Objective	1. To gain knowledge on basic operation in digital systems 2. To study about sensors and display units 3. To have knowledge on the concepts of signal processing and converting elements 4. To study about microcontroller and its interfacing 5. To gain knowledge about different types of communication
Course Outcome	Upon completion of this course, the students will be able to 1. Understand basic operation in digital systems and instruments 2. Analyze the basic functioning of sensors and display units. 3. Determine the concepts of signal processing and converting elements 4. Compare the industrial controllers and microcontrollers with interfacing for specific applications 5. Explain the principles and operation of satellite communication.

Prerequisites: Physics and Mathematics

CO, PO AND PSO MAPPING

CO	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
CO-1	-	-	-	**2**	-	-	-	-	-	-	-	-	-	**1**
CO-2	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-
CO-3	-	-	**2**	-	-	-	-	-	-	-	-	-	**2**	-
CO-4	-	**1**	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	-	-	-	-	-	**3**	-	-	-	-	-	-	-	**1**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Introduction to Digital Systems **(9L)**

Analog & Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF). **Suggested Readings:** Basics of number systems	**CO-1** **BTL-3**

MODULE 2: Sensors and Displays	**(9L)**
Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays. **Suggested Readings:** Primary sensing elements, introduction to displays	**CO-2** **BTL-3**
MODULE 3: Signal Conditioning Circuits	**(9L)**
D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor **Suggested Readings:** Basic network theorems	**CO-3** **BTL-3**
MODULE 4: Introduction to Micro controllers	**(9L)**
Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller **Suggested Readings:** Electronics with Microcontroller interface	**CO-4** **BTL-3**
MODULE 5: Consumer Electronics and Communication System	**(9L)**
Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.) Communication System: - Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.) **Suggested Reading:** Consumer Electronics User Manuals	**CO-5** **BTL-2**
TEXT BOOKS	

1.	Floyd, T.I. (2014). *Digital Fundamentals*, Pearson, 11th edition.
2.	Ramakant, A., Gayakwad. (2013). *Op-amps and Linear Integrated Circuits*, Prentice Hall, 4th edition.
3.	Bell, D.A. (2013). *Electronic Instrumentation and Measurements*, Oxford University Press.
4.	Naimi, S., Naimi, S., Mazidi, M.A. (2017). *The 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd edition.
5.	Petruzella, F.D. (2016). *Programmable Logic Controllers*, McGraw-Hill Education.
REFERENCE BOOKS	
1.	Mano, M.M. (2016). *Digital Logic and Computer Design*, Prentice-Hall.
2.	Choudhury, R. (2011). *Linear Integrated Circuits*, New Age International Publishers, 4th edition.
3.	Schultz, T.W., Thomas, W.C. (2008). *8051 and C*, Schultz Publishers, 4th edition,2008
4.	Bali, S.B. (2008). *Consumer Electronics*, , Pearson Education Asia Pvt., Ltd.
5.	Global Mobile Satellite Communications Applications (For Maritime, Land and Aeronautical Applications Volume 2). (2018). 2nd edition, Springer.
E BOOKS	
1.	http://www.ee.iitm.ac.in/giri/pdfs/EE4140/textbook.pdf
2.	https://electronics.howstuffworks.com/home-audio-video-channel.htm
MOOC	
1.	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2.	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
3.	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
4.	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/ Course_home2_5.html

COURSE TITLE	INSTRUMENTAL ANALYSIS FOR ENGINEERS			CREDITS	4
COURSE CODE	CHB4116	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides a descriptive account on various types of instrumentation techniques and illustrate with examples, the interpretation of analytical data.
Course Objective	To make the students acquire knowledge on 1. The different types of instrumental methods, Beer Lambert law and colorimetry 2. Principles, instrumentation and applications of molecular spectroscopy 3. Principles, instrumentation and applications of atomic spectroscopy, surface characterization techniques and principles of NMR, polarimetry and refractometry 4. The various types of chromatographic techniques and their applications 5. Principles and applications of electrochemical and thermo analytical methods
Course Outcome	Upon completion of this course, the students will be able to 1. Identify the suitable instrumental method of analysis based on the physical 2. Analyse and gain basics of spectroscopic methods of analysis 3. Relate the data from vibrational, rotational characteristics of molecules 4. Apply the spectroscopy at atomic level and gain knowledge on surface morphology. 5. Solve suitable chromatography techniques based on the nature of the substances present in a mixture and to make qualitative and quantitative assessment.

Prerequisites: Basic knowledge of chemistry at higher secondary level

CO, PO AND PSO MAPPING

CO	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	PSO 3
CO-1	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-
CO-2	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-
CO-3	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4	-	-	1	-	-	-	2	-	-	-	-	-	-	-	1
CO-5	-	-	-	-	-	-	1	-	-	-	-	2	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO SPECTROSCOPY	(9L+3L=12)
Classification of instrumental methods based on physical properties - Electromagnetic Spectrum - Interaction of photons with matter – Beer-Lambert's Law: Absorbance, Transmittance and their relationship, Applications, Limitations, Deviations (Real, Chemical, Instrumental) – Photometric titrations (Experimental setup and various types of titrations) - Various electronic transitions in organic and inorganic compounds effected by UV & Visible radiations, charge-transfer transitions-Nesslerimetry, Duboscq colorimetry, Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer-Lambert's Law. **Suggested Reading:** Properties of light	**CO-1** **BTL-2**
MODULE 2: MOLECULAR SPECTROSCOPY	**(9L+3L=12)**
Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Chromophores, auxochromes, Bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect - Auxochromes and conjugation: Effects on the absorption maxima, Woodward-Fischer rules: calculation of absorption maxima (dienes and carbonyl compounds). UV, Visible and IR spectrophotometer: Instrumentation (Block diagram and various components) - Applications of UV & Visible and IR Spectroscopy: General, Quantitative determinations and in structural elucidations of simple organic and inorganic molecules. **Suggested Reading:** Basics of carbon compounds and Transition metal complexes	**CO-2** **BTL-4**
MODULE 3: ATOMIC SPECTROSCOPY AND SURFACE CHARACTERIZATION	**(9L+3L=12)**
Principle and functioning of Atomic Absorption Spectrophotometer (AAS), Atomic Emission Spectrophotometer (AES), Atomic Fluorescence (AFS) - Instrumentation (Block diagram and various components): Atomic Absorption and Atomic Emission Spectrometry - Applications of AAS, AES, AFS – Principles and simple applications of Polarimetry, Refractometry, Nuclear Magnetic Resonance Spectroscopy, mass spectrometry, SEM, TEM and XRD. **Suggested Reading:** Crystal structures and Optical activity.	**CO-3** **BTL-3**
MODULE 4: CHROMATOGRAPHIC TECHNIQUES	**(9L+3L=12)**
Chromatography: Classification –Principles, mode of separation, block diagram and Technique behind Column, Thin layer, Paper, Gas, High Performance Liquid Chromatography - Separation of organic compounds: By column and Thin layer chromatography –Paper chromatography: Separation of amino acids and separation of Cu, Co and Ni in a mixture – Quantitative and qualitative estimation of organic compounds by GC and HPLC – Applications of Ion Exchange Chromatography and Size Exclusion chromatography. **Suggested Reading:**	**CO-4** **BTL-2**

Principles of Surface Chemistry	
MODULE 5: ELECTRODICS AND THERMOANALYTICAL METHODS	**(9L+3L=12)**
Basics of Ionic Conductance, Electrode Potential and pH - Principles behind Potentiometry, Conductometry and pH metry - Thermogravimetry: Instrumentation, factors affecting the shapes of thermograms, applications, thermograms of some important compounds (CuSO4, 5H2O, CaC2O4.2H2O etc). Differential thermal analysis: Principle, Instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples). **Suggested Reading:** Electrochemistry and Ionic equilibrium	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Willard, H.H., Merritt. I.I., Dean J.A., and Settle, F.A. (2000). *Instrumental methods of analysis*. CBS publishers, Sixth edition.
2.	Skoog, D.A., West, D.M. (2002). *Fundamentals of Analytical Chemistry*. Saunders-college Publishing, 4th edition.
REFERENCE BOOKS	
1.	Vogel A.I. (2007). *Quantitative Inorganic analysis*. Goel publishing House, 5th Edition.
2.	Sharma, B.K. (2005). *Instrumental Methods of Analysis*. Goel publishing House, third edition.
E BOOKS	
1.	https://pdfgoal.com/downloads/books_instrumental_methods_of_chemical_analysis_by_chatwal_pdf_pdf
2.	https://www.amazon.in/Instrumental-Method-Chemical-Analysis-Sharma/dp/8182836735
MOOC	
1.	http://riceonline.tendenciapp.com/mooc/course/analytical-chemistry- instrumental analysis/

COURSE TITLE	**CELL BIOLOGY**			**CREDITS**	**3**
COURSE CODE	**BTB4116**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**2018**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**

15%	15%	10%	5%	5%	50%

Course Description	Cell Biology course deals with the biology of cells of higher organisms: The structure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; chromatin structure and RNA synthesis.
Course Objective	1. To gain basic knowledge about different types of cells and organelles found therein 2. To understand about different transport mechanisms across the cell membranes 3. To have extensive knowledge about cell signalling pathways 4. To distinguish different cell culture techniques 5. To understand the process of differentiation of stem cells and familiar with the molecular and cellular basis of occurrence of cancer cells
Course Outcome	Upon completion of this course, the students will be able to 1. Describe about different types of cells and organelles found therein 2. Understand about different transport mechanisms across the cell membranes 3. Apply extensive knowledge about cell signalling pathways 4. Distinguish different cell culture techniques 5. Understand the process of differentiation of stem cells and familiar with the molecular and cellular basis of occurrence of cancer cells

Prerequisites: Basics of biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO-2	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-
CO-3	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-4	1	-	-	-	2	-	-	-	-	-	-	-	-	1	-
CO-5	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Overview of the Cells	**(9L)**
Introduction to Cells, types, structure; Eukaryotic cells - organelles and other cellular components principles of membrane organization; Membrane proteins, cytoskeletal proteins; Types of cell division - mitosis & meiosis; Extra cellular matrix, cell cycle and molecules that control cell cycle	**CO-1** **BTL-2**
MODULE 2: Transport across Cell Membranes	**(9L)**

Membrane transporter proteins and types. Passive & active transport, Passive-permeases, Active-sodium potassium pump, Ca^{2+} ATPase pumps, lysosomal and vacuolar membrane ATP dependent proton pumps, co transport symport, antiport, transport into prokaryotic cells, endocytosis and exocytosis. Entry of viruses and toxins into cells	**CO-2 BTL-2**
MODULE 3: Cell Receptors and Signal Transduction	**(9L)**
Cell surface receptors – structure, domains and signal transduction. Cytosolic, nuclear and membrane bound receptors; Cell signalling – intracrine, autocrine, paracrine and endocrine, juxtacrine models of action; Signalling molecules and their receptors-Intracellular and extracellular receptors, Second messengers; Cell Death and Cell Renewal-Programmed Cell Death	**CO-3 BTL-4**
MODULE 4: Cell culture	**(9L)**
Techniques for the propagation of eukaryotic and prokaryotic cells. Cell line, generation of cell lines, maintenance of stock cells, characterization of cells, immunochemistry, morphological analysis techniques, in cell culture, ex-plant cultures primary cultures, contamination, differentiation, three dimensional cultures, role of matrix in cell growth	**CO-4 BTL-2**
MODULE 5: Stem cells and Cancer cells	**(9L)**
Stem cells – embryonic stem cells and adult stem cells. Cancer cell development, causes of Cancer, markers, prevention and treatment	**CO-5 BTL-3**

TEXT BOOKS	
1.	Darnell, J., Lodish, H., Baltimore, D. (2016). *Molecular Cell Biology*, Macmillan Learning, 4th Edition.
2.	Kimball, T.W. (2007). *Cell Biology*, Wesley Publishers, 5th Edition.
REFERENCE BOOKS	
1.	De Robertis & De Robertis. (2017). *Cell and Molecular Biology*, Lipppincott Williams and Wilkims, 8th Edition.
2.	Alberts, B. (2017). *Molecular Biology of the Cell*, Garland Science, 4th Edition.
E BOOKS	
1.	https://books.google.co.in/books?isbn=1284047628
2.	https://books.google.co.in/books?isbn=0323400027
MOOC	
1.	https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/

COURSE TITLE	**CELL BIOLOGY LAB**			**CREDITS**	**1**
COURSE CODE	**BTB4141**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-1**

Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30	10	10	20	10	20%

Course Description	Cell Biology laboratory course is designed to familiarize you with techniques used in cell biology. By the end of the course you should be familiar with: cell identification, cell culture, cell and organelle staining and visualizing the cells through microscopy.
Course Objective	1. To familiar with the use of microscope and the identification of different kinds of cells 2. To calculate the cell concentration using cell disruption techniques.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the use of microscope and the identification of different kinds of cells 2. Analyse the cell concentration using cell disruption techniques

Prerequisites: Physics practical at higher secondary level

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(15L)
1. To learn the parts of Microscope 2. To differentiate the stages of mitosis using onion root tip 3. To visualize the polytene chromosome of the chironomous larva 4. Identification of blood group and Rh factor	**CO-1 BTL-3**
MODULE 2	**(15L)**
1. Isolation and visualization of buccal cavity cells 2. Differentiation of white blood cells using Leishman's stain 3. Isolation of monocytes from blood 4. Identification of t cells by T-cell rossetting using sheep RBC	**CO-2 BTL-4**

COURSE TITLE	MATERIALS CHEMISTRY LABORATORY (Common to ALL branches of Engineering)	CREDITS	1

COURSE CODE	CYA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	Learn and apply basic techniques used in materials chemistry laboratory for analyses of lubricants, refractories, & other engineering materials and utilize the fundamental laboratory techniques for instrumental analyses of metal ions.
Course Objective	1. To train students to characterize lubricants. 2. To develop skill of developing phase diagram between partially miscible liquids. 3. To train students to prepare polymers. 4. To develop skill of characterizing refractories. 5. To train students in estimation of metal ions using instruments.
Course Outcome	Upon completion of this course, the students will be able to 1. Determine properties of lubricants 2. Analyze phase diagram in liquid system. 3. Understand about the preparation of polymer resin. 4. Analyze basic properties of refractories. 5. Estimate metal ion contents in the sample.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-
CO-2	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3	-	-	-	-	-	-	1	-	2	-	-	1	-	-	-
CO-4	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF LUBRICANTS	(6L)
1. Determination of viscosity of polymer using Ostwald Viscometer. 2. Determination of Viscosity Index of lubricants. 3. Determination of viscosity of oil using Red-Wood Viscometer.	CO-1 BTL-3

MODULE 2: PHASE DIAGRAM IN LIQUID SYSTEM (6L)

4. Construction of phenol-water phase diagram. 5. Determination of adsorption isotherm for acetic acid on activated charcoal.	**CO-2** **BTL-3**
MODULE 3: PREPARATION POLYMER RESIN.	**(6L)**
6. Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: BASIC PROPERTIES OF REFRACTORIES	**(6L)**
7. Determination of porosity of a refractory. 8. Determination of apparent density of porous solids.	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6L)**
9. Estimation of dye content in the effluent by UV-Visible spectrophotometry. 10. Determination of copper / iron content in the alloy by colorimetry. 11. Estimation of sodium and potassium ions by flame photometry. 12. Verification of Beer-Lambert's law using gold nanoparticles.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Raghavan, P.S. (2018). *Materials Chemicals Laboratory Manual*, Dhanam Publications.
REFERENCE BOOKS	
1.	Mendham, J., Denney, R.C., Barnes, J.D., Thomas, N.J.K. (2009). *Vogel's Textbook of Quantitative Chemical Analysis*, Pearson Education, 6th Edition.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

SEMESTER III

COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS			CREDITS	4
COURSE CODE	MAA 4201	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-1-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of partial differential equations and transforms and its applications
Course Objective	1. To present the main results in the context of partial differential equations and to study numerical methods for the approximation of their solution 2. To introduce the wave equation including time and position dependence 3. to mathematically model the way thermal energy moves through the plate 4. To understand the concept of Fourier transform 5. To understand the concept of Z-transform and its properties.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand and solve some of the physical problems involving partial differential equations 2. Classify and solve the Wave and Heat equations 3. Apply and solve two dimensional heat equations 4. Determine problems related to engineering applications by using Fourier Transform techniques 5. Understand the discrete transform applied to engineering problems.

Prerequisites:

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	1	-	-	-	-	-	2
CO-2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3	-	-	-	3	-	-	-	2	-	-	-	-	-	1	-
CO-4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	1	-	-	2	-	-	-	-	-	2	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: PARTIAL DIFFERENTIALEQUATIONS	**(9L+3T=12)**
Formation of partial differential equations by elimination of arbitrary constants, arbitrary functions - Solution of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients. **Suggested Reading**: Partial Differentiation	**CO-1** **BTL-1,2,3,4**
MODULE 2: ONE DIMENSIONAL WAVE AND HEAT FLOW EQUATION	**(9L+3T=12)**
Classification of second order linear partial differential equations - Solutions of one dimensional wave equation (without proof) - One dimensional heat flow equation (without proof) and application in string and rod problems. **Suggested Reading**: Partial Differential Equations, Half range sine series.	**CO-2** **BTL-2,3,4**
MODULE 3: TWO DIMENSIONAL HEAT FLOW EQUATION	**(9L+3T=12)**
Steady state solution of two dimensional heat equations and applications in finite plates and infinite plates problems. **Suggested Reading**: Partial Differential Equations, Half range sine series.	**CO-3** **BTL-1,2,3,4**
MODULE 4: FOURIERTRANSFORM	**(9L+3T=12)**
Fourier Integral Theorem (without proof) - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of Simple functions - Convolution theorem - Parseval's identity. **Suggested Reading**: Basic integration.	**CO-3** **BTL-1,2,3**
MODULE 5: Z-TRANSFORM AND DIFFERENCE EQUATIONS	**(9L+3T=12)**
Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution theorem - Formation of Difference equations - Solution of difference equations using Z-Transform **Suggested Reading**: Basic calculus	**CO-4** **BTL-1,2,3,4**
TEXT BOOKS	
1.	Sivarama Krishna Das, P., Vijayakumar, C. (2015). *Transforms and partial differential equations*, 1 Pearson Publication.
2.	Grewal, B.S. (2012). *Higher Engineering Mathematics*, Khanna Publishers, 42nd Edition, Delhi.
3.	Chandrasekaran, A., (2015). *A Text Book of Transforms and Partial Differential Equations*, Dhanam Publication.

REFERENCE BOOKS	
1.	Bail, N.P., Goyal, M., (2007). *Textbook of Engineering Mathematics*, Laxmi Publications Pvt Ltd., 7th Edition.
2.	Datta, K.B. (2013). *Mathematical Methods of Science and Engineering,* Cengage Learning India Pvt Ltd, Delhi.
3.	Veerarajan, T. (2012). *Transforms and Partial Differential Equations*, Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint.
E BOOKS	
1.	nptel.ac.in/courses/122107037/
2.	nptel.ac.in/courses/122107037/22
MOOC	
1.	https:f/www.mooc-list.com/tags/laplace-transforms
2.	https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1

COURSE TITLE	BIOCHEMISTRY			CREDITS	4
COURSE CODE	BTB4201	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course framed for the first-year students, provides a good exposure on the fundamentals of Biochemistry and also gives a detailed account on the significance of water in biological processes, various biomolecules, metabolism and bioenergetics
Course Objective	1. To give a good exposure on the significance of water in biological processes 2. To make the students understand about the chemistry of carbohydrates and proteins 3. To make the students understand about the chemistry of lipids and nucleic acids 4. To give an exposure on the role of biomolecules in various metabolic processes 5. To explain the bioenergetics and the associated metabolism
Course Outcome	Upon completion of this course, the students will be able to 1. Exhibit their basic knowledge about Carbohydrates. 2. Analyze the significance of various proteins and amino acids in biosynthesis. 3. Relate the knowledge gained about nucleic acids. 4. Differentiate fats, lipids and enzymes. 5. Apply the knowledge gained in metabolism and bioenergetics regulation for further studies at advanced level.

Prerequisites: BTB4201 – Biochemistry

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	1	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3	-	-	-	3	-	-	-	2	-	-	-	-	-	1	-
CO-4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	1	-	-	2	-	-	-	-	-	2	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO BIOMOLECULES	(9L+3L=12)
Overview of Biomolecules- Types, Structure and Biological Functions, Organic Chemistry of Biomolecules with its Chemical bond, Metabolic Pathways and Role of ATP in Metabolism, Biological Buffers, Water and its importance in Biochemistry. **Suggested Readings:** Importance of Biomolecules	**CO-1,2,3,4** **BTL-2**
MODULE 2: STRUCTURES & PROPERTIES OF CARBOHYDRATES, PROTEINS	**(9L+3L=12)**
Carbohydrates: Monosaccharide with examples- Structure, Optical isomerism of sugars, Occurrence and biological importance, Disaccharides – Glycosidic linkage, Polysaccharides - Starch- glycogen- Cellulose and their derivatives- Chitin- Agar, Qualitative and Quantitative analysis of Carbohydrates Proteins: Structure and classification of Amino acids, Essential and Non-Essential amino acids, Peptides, Peptide bond, Structure of Proteins- Primary-Secondary- Tertiary and Quaternary - Myoglobin & Hemoglobin, Protein Quantification Techniques. **Suggested Readings:** Role of carbohydrate and proteins	**CO-1,2** **BTL-2**
MODULE 3: STRUCTURES & PROPERTIES OF LIPIDS, NUCLEIC ACIDS	**(9L+3L=12)**
Lipid - Classification and structure of lipids (Fatty acids, Glycerolipids, Phospholipids, Glycolipids, Sphingolipids, Steroids) - Physiological importance, Significance of Cholesterol, biological membranes. Nucleic Acids - Structure of – base - Nucleosides - Nucleotides - Ribonucleic acids – Deoxyribonucleic acids - Nucleoprotein complexes, Functions of Nucleotides. **Suggested Readings:** Lipids and Nucleic acids	**CO-3,4** **BTL-3**
MODULE 4: INTERMEDIATE METABOLISM	**(9L+3L=12)**
Glycolysis - TCA cycle - Gluconeogenesis - Pentose phosphate shunt – Deamination, Transamination and Decarboxylation reactions, Urea Cycle - Interconnection Of Pathways - Metabolic Regulations. **Suggested Readings:** Metabolic pathways	**CO-5** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY	**(6L+6L=12)**
High energy compounds - Electronegative Potential of compounds, Respiratory Chains-ATP cycle-Calculation of ATP production during Glycolysis and TCA cycle, Regulation of levels of High energy compounds and reducing equivalents inside the cell. **Suggested Readings:** Energy production in metabolic pathways	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Nelson, D.L., Cox, M.M. (2012). *Lehninger's Principles of Biochemistry*, Macmillan Learninger, 6th Edition.
2.	Berg, M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2015). *Biochemistry*, W.H. Freeman, 8th Edition.
REFERENCE BOOKS	
1.	Voet, D., Voet, J., Pratt, C.W. (2016). *Fundamentals of Biochemistry*, Wiley Publisher, 5th Edition,.

2.	Murray, R.K. (2012). *Harper's Illustrated Biochemistry* McGraw Hill Professional, 29th Edition.
E BOOKS	
1.	https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/videolectures/lecture-2-biochemistry-1/
2.	https://books.google.co.in/books?isbn=0763757365
MOOC	
1.	https://nptel.ac.in/courses/102/105/102105034/

COURSE TITLE	MICROBIOLOGY			CREDITS	4
COURSE CODE	BTB4202	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Microbiology is a subject that comprises microorganisms such as bacteria, viruses, fungi, protozoa, etc. The course is structured to provide education regarding the properties of microorganisms and their impact on the human body. The programme also covers the diseases caused by different types of bacteria and viruses.
Course Objective	1. To become familiar with the foundation concepts of history of Microbiology 2. To understand the structure and functions of a typical prokaryotic cell 3. To gain the knowledge of microscopy and staining concepts 4. To understand and implement disposal and safety measures. 5. To Understand the disease causing pathogenic microbes
Course Outcome	Upon completion of this course, the students will be able to 1. Distinguish various microorganisms and know their nomenclature 2. Understand the mechanism of replication in microorganisms. 3. Design various culture media for microbial culture 4. Distinguish microorganisms using agents like Heat, antibiotics and chemical. 5. Employ microorganisms for pollution abatement and other purposes.

Prerequisites: Basics of Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-
CO-3	2	-	-	-	-	1	-	-	-	-	-	-	-	-	1
CO-4	2	-	-	-	1	-	-	-	-	-	-	1	-	-	-

CO-5	**-**	**-**	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(6L+6L=12)**
Basics of microbial existence; Classification and nomenclature of microorganism, Microscopic examination of microorganisms, Types of microscopy; Principles of different staining techniques like gram staining, Acid fast, Capsular staining, Flagellar staining. **Suggested Readings:** Biochemistry of peptidoglycan, Types of Electron microscope.	**CO-1** **BTL-2**
MODULE 2: MICROBES-STRUCTURAL ORGANIZATION	**(6L+6L=12)**
Structural organization of bacteria, and fungi – Structure and composition of bacterial cell wall, Cellular appendages, Genetic materials. Structure of Virus, Classification of viruses, Life cycle of Phages. **Suggested Readings:** Viral Titrations, Membrane Proteins.	**CO-2** **BTL-2**
MODULE 3: MICROBIAL NUTRITION AND GROWTH	**(6L+6L=12)**
Nutritional requirements for bacterial growth, Different types of Nutritional media and their composition; Growth curve Different methods to quantitate bacterial growth, Determination of viable count, Different types of Plating techniques. **Suggested Readings:** McFarland's standards, Analysis of Optical Properties.	**CO-3** **BTL-3**
MODULE 4: CONTROL OF MICROORGANISMS	**(6L+6L=12)**
Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents, mode of action and resistance to antibiotics; clinically important microorganisms Case studies (Dengue, Flu, TB). **Suggested Readings:** Plants effective against Dengue.	**CO-4** **BTL-2**
MODULE 5: INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY	**(6L+6L=12)**

Primary metabolites; Secondary metabolites and their applications; Preservation of food; Production of penicillin, alcohol, Vitamins(B2,C & E only); Bioremediation of oil spills (Case study); Leaching of ores by microorganisms; Bio-fertilizers and bio-pesticides; Microorganisms and pollution control; Biosensors. **Suggested Readings:** Chemical process industries- organic materials.	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Pelczar, M.J., Chan, E.C.S., Krein, N.R. (2001). *Microbiology*, Tata McGraw-Hill Edition, 5th edition, New Delhi, India.
2.	Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M. (2008). *Microbiology,* McGraw-Hill Higher Education, 6th Edition, New York.
REFERENCE BOOKS	
1.	Talaron, K., Talaron, A., Casita, Pelzer. Reid. (2003). *Foundations in Microbiology*, W.C. Brown Publishers, 4th Edition,
2.	Money. N.P. (2014), *Microbiology: A Very Short Introduction*, 4th Edition, Oxford University Press.
E BOOKS	
1.	https://www.coursera.org/learn/bacterial-infections.
2.	https://books.google.co.in/books?isbn=0781782155.
MOOC	
1.	https://learn.saylor.org/course/bio307.

COURSE TITLE	PROFESSIONAL ETHICS AND LIFE SKILLS			CREDITS	2
COURSE CODE	CSA401	COURSE CATEGORY	DE	L-T-P-S	2-0-2-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	A study of ethical principles and of ethical problems in the professional world. The course is intended to provide students with the ability to analyze ethical situations within a specific profession such as health care, business, and public administration. The course includes lectures, discussions, case analyses, the study of codes of ethics, and individual projects.
Course Objective	1. To uunderstand the core values required in a human being 2. To uunderstand the core values that shape the ethical behaviour of an engineer 3. To uunderstand social responsibility of an engineer 4. To uunderstand ethical dilemma while discharging duties in professional life 5. To get ffamiliar with the legal requirements, ethical issues, and professional issues in the engineering profession.
Course Outcome	Upon completion of this course, the students will be able to 1. Uunderstand the core values required in a human being 2. Distinguish the core values that shape the ethical behaviour of an engineer 3. Determine social responsibility of an engineer 4. Apply ethical dilemma while discharging duties in professional life 5. Understand with the legal requirements, ethical issues, and professional.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	1	-	-	-	-	2	-	-	1	-	-
CO-2	1	-	-	-	-	-	-	-	-	2	-	-	-	1	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
CO-4	2	-	-	-	-	-	1	-	-	-	-	-	-	2	-
CO-5	-	-	3	-	-	-	-	-	2	-	-	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

Module 1: HUMAN VALUES	**(6L)**
Definition of ethics-Morals values and ethics – integrity-Work ethics- Service learning-Civic virtue-Respect for others-Caring-Sharing-Honesty-Courage-Valuing time-Cooperation-Commitment-Empathy-Self-confidence-Character-Spirituality-Introduction to Yoga and meditation for professional excellence and stress management. **Self-Study**: Case study of Discovery failure.	**CO-1** **BTL-2**
Module 2: ENGINEERING ETHICS	**(6L)**
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories. **Self-study**: Study the Bhopal gas tragedy.	**CO-2** **BTL-2**
Module 3: SAFETY, RESPONSIBILITIES AND RIGHTS	**(6L)**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination. **Self-study**: Chernobyl explosion, Nuclear and thermal power plant issues.	**CO-3** **BTL-3**
Module 4: LIFE SKILLS	**(6L)**

Definition, Relevance, Types of values, changing concepts of values-aims and values of value education- basic etiquette-morals and values in life-dealing with people. Personal values – Self – Strengths (self-confidence, self-assessment, self-reliance, self-discipline, determination, self-restraint, contentment, humility, sympathy and compassion, gratitude, forgiveness) Weaknesses. **Self-study:** Influences - Peer pressure, familial and societal expectations, media.	**CO-4** **BTL-2**
Module 5: SOCIETIES IN PROGRESS	**(6L)**
Definition of society; Units of society; Communities – ancient and modern – Agents of change – Sense of survival, security, desire for comfort and ease sense of belonging, social consciousness and responsibility. **Self-study**: Personal value and professional value of Engineers on societies perception.	**CO-5** **BTL-2**
EXT BOOKS	
1.	Lawrence, C. (2016). *Cyber security for Dummies*, John Wiley & Sons Inc., 2nd Edition, pp.213--432.
REFERENCE BOOKS	
1.	Raef, Meeuwisse. (2017). *Cyber security for Beginners*, Cyber Simplicity Ltd. Publications, 2nd Edition, pp.410-440.
2.	William, Stallings. (2018). *Effective Cyber security: A Guide to Using Best Practices and Standards*, Addison - Wesley Professional Publishers, 1st Edition.
E BOOKS	
1.	http://www.uou.ac.in/sites/default/files/slm/Introduction-cyber-security.pdf
MOOC	
1.	https://www.edx.org/course/cybersecurity-fundamentals
2.	https://www.coursera.org/specializations/cyber-security

COURSE TITLE	PROTEOMICS			CREDITS	3
COURSE CODE	BTC4252	COURSE CATEGORY	DE	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	Proteomics course introduces to the basic biology of proteins and the new advanced science called as proteomics which aims to look into the protein properties from a global perspective, i.e., not undertaking one protein at a time, but an entire set of proteins in the account. The course covers in detail the major aspects of proteomics i.e., Gel-based proteomics, Gel free-based proteomics and Mass spectrometry.				
Course Objective	1. To clearly understand the term Proteomics 2. To distinguish between gel based and gel free proteomics 3. To analyse the role of Mass spectrometry in Proteomics 4. To understand quantitative proteomics through use of various techniques 5. To distinguish between functional and quantitative proteomics				

Course Outcome	Upon completion of this course, the students will be able to 1. Understand the term Proteomics 2. Distinguish between gel based and gel free proteomics 3. Analyze the role of Mass spectrometry in Proteomics 4. Understand Quantitative proteomics through use of various techniques 5. Differentiate between functional and quantitative proteomics

Prerequisites: Cell Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-
CO-2	-	-	-	-	1	-	-	-	-		-	-	-	-	-
CO-3	-	1	-	-	-	-	-	-	-	-	-	1	-	-	2
CO-4	1	-	-	-	-	-	2	-	-	-	-	2	-	1	-
CO-5	-	-	3	1	-	-	-	-	-	-	-	1	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: AN INTRODUCTION TO PROTEOMICS	**(9L)**
An overview of systems biology, evolution from protein chemistry to proteomics: Proteomics methods, applications; Bioinformatics role in proteomics **Suggested Reading:** Protein structure and function, protein chemistry	**CO-1** **BTL-2**
MODULE 2: ABUNDANCE BASED PROTEOMICS	**(9L)**
Sample preparation and pre-fractionation steps, Gel- based proteomics, Gel-free proteomics **Suggested Reading:** Proteomics using gel, without using gel	**CO-2** **BTL-2**
MODULE 3: CENTRAL ROLE OF MASS SPECTROMETRY	**(9L)**
Mass spectrometry, Mass spectrometry mass analysis-computational tools; Types-Tandem Mass spectrometry; MALDI-TOF, ESI. TOFMS; Bottom up, top down and short gun proteomics **Suggested Reading:** Mass Spectrometry	**CO-3** **BTL-3**
MODULE 4: QUANTITATIVE PROTEOMICS	**(9L)**

Gel based quantitative proteomics- Fluorescence; 2D Difference Gel electrophoresis (DIGE), Gel free mass spectrometry based quantitative proteomics-Stable isotope labelling by amino acids in Cell culture (SILAC), Isotope coded Affinity Tag (ICAT), Isobaric Tagging for Relative and Absolute Quantification (iTRAQ), Proteolytic Labelling with [ISO]-water, Application of quantitative Proteomics, Merits and demerits of gel free quantitative techniques **Suggested Reading**: Gel based quantitative techniques	**CO-4** **BTL-2**
MODULE 5: FUNCTIONAL PROTEOMICS	**(9L)**
Interactomics: techniques to study protein-protein interactions; Cross linking Mass spectrometry - protein structure studies; Nano proteomics **Suggested Reading:** Functional Proteomics	**CO-5** **BTL-2**
TEXT BOOKS	
1.	Liebler, D. (2008). *Introduction to proteomics*, Humana Press, 4th Edtion.
2.	Walke. (2005). *Proteomics Protocols Handbook,* Humana Press, 3rd Edition.
REFERENCE BOOKS	
1.	Reinders, J. (2015). *Proteomics in system biology- Methods and Protocols*, Humana Press, 4th Edition.
2.	Kill, T.P. (2007). *Proteomics*, Springer Science & Business Media, 2nd Edition.
E BOOKS	
1.	https://www.elsevier.com/books/concepts-and-techniques-in-genomics-and-proteomics/saraswathy/978-1-907568-10-7
2.	https://books.google.co.in/books?isbn=159745432X
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc16_bt07/preview

COURSE TITLE	FOOD PROCESSING			CREDITS	3
COURSE CODE	BTD4283	COURSE CATEGORY	NE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	Creating a new food product to sell to the public can take a food company months, or even years, to complete! This class will focus on the entire process involved in the movement of food from the farm to the grocery store. Students will work to create a unique product in class that they can produce and market within the school.				
Course Objective	1. To illustrate students on various aspects of food engineering. 2. To develop understanding of students about unit operations and its applications in food engineering. 3. To understand mechanism of heat transfer in food processing 4. To explain students on the emerging technologies in food processing 5. To make students to understand about the food preservation and storage.				

Course Outcome	Upon completion of this course, the students will be able to 1. Summarize the fundamentals of food processing 2. Describe basics of food processing with food additives 3. Estimate the recent advances in food processing 4. Classify the emerging technologies of food processing 5. Demonstrate the industrial applications of food processing.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2	-	1	2	-	-	-	-	-	-	2	-	-	-	-	-
CO-3	1	1	-	1	-	-	-	-	1	-	-	-	-	1	-
CO-4	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-5	2	1	-	1	-	-	3	-	-	-	-	-	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: : History and Overview of Food Processing	**(9L)**
Introduction to Food Processing - History - Classification of food constituents – carbohydrates, lipids, proteins, water, vitamins and minerals - dietary sources, contribution to organoleptic and textural characteristics.	**CO-1 BTL-1**
MODULE 2: Basics in Food processing	**(9L)**
Types of food processing operations – Food Additives – Food colorants and flavors	**CO-2 BTL-2**
MODULE 3: Recent Advances in Food Preservation and Storage	**(9L)**
Food preservation techniques - Types – sterilization, pasteurization and blanching, Irradiation – Refrigeration – Canning	**CO-3 BTL-3**
MODULE 4: Emerging Technologies in Food Processing	**(9L)**
Preparation of Bread, yogurt, Cheese, Beer and wine – Single Cell Protein, Mushroom	**CO-4 BTL-4**
MODULE 5: Industries & Case Studies	**(9L)**
Meat Processing - Dairy Industries – Beer Production and packaging – Fermentation – Sugar Industries – Case studies	**CO-5 BTL-4**

TEXT BOOKS	
1.	Coultate, T.P. (2015). *Food - The Chemistry of Its Components*, Royal Society of chemistry, 6th Edn., London.
2.	Sivasanker, B. (2002). *Food Processing and Preservation*, Prentice-Hall of India Pvt. Ltd., New Delhi.
REFERENCE BOOKS	
1.	Roslyn, M.A. (2018). *Food Processing Operations: Management, Machines, Materials & Methods*.
2.	Clark, S., Jung, S., Lamsal, B. (2014). *Food Processing: Principles and Applications, 2nd edition*, Wiley.
E BOOKS	
1.	FOOD-PROCESSING-PRESERVATION-B-Sivasankar-ebook/dp/B00K7YG2J2
2.	extbook-Science-Technology-Avantina-Sharma-ebook/dp/B07F8P8QW1
MOOC	
1.	https://www.mooc-list.com/tags/food-processing
2.	https://www.coursera.org/courses?query=food

COURSE TITLE	BIOCHEMISTRY LAB			CREDITS	1
COURSE CODE	BTB4231	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
Experimental	Calculation	Result	Viva	Record	ESE
30	10	10	20	10	20%

Course Description	The course, which spans two thirds of a semester, provides students with a research-inspired laboratory experience that introduces standard biochemical techniques in the context of investigating a current and exciting research topics like test for amino acids, carbohydrates, qualitative, quantitative estimation of sugars and etc.,
Course Objective	1. To learn fundamental approaches for experimentally investigating biochemical problems, 2. To learn the theoretical foundations for the methods used 3. To understand the applicability of the biochemical methods to realistic situations. 4. To make the students to gain hands on training in various estimation methods 5. To impart students to acquire skills on different qualitative and quantative

	methods of analysis of macro molecules.
Course Outcome	Upon completion of this course, the students will be able to 1. Familiar with the qualitative and quantitative methods for the estimation of Carbohydrate and protein. 2. Understand techniques of extraction and estimation of lipid and Cholesterol. 3. Comprehend the method for the isolation and estimation of cholesterol 4. Apply knowledge on various macromolecules such as proteins, amino acids, lipids like cholesterol by following specific protocols. 5. Analyse their own research work with the knowledge gained from the course.

Prerequisites: Basics of biochemistry

CO, PO AND PSO MAPPING

CO	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	PSO -3
CO-1	**1**	-	-	-	-	-	-	-	-	-	-	-	**1**	-	-
CO-2	-	-	**2**	-	-	-	-	-	-	-	-	-	-	-	**1**
CO-3	-	-	-	-	**1**	-	-	-	-	-	-	-	**2**	-	-
CO-4	**2**	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-
CO-5	-	-	**3**	-	-	-	-	-	**1**	-	-	-	-	-	**3**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 (15L)	
1. General guidelines for working in biochemistry lab (theory) 2. Preparation of buffer – titration of a weak acid and a weak base. 3. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars. 4. Quantitative method for carbohydrate estimation-Benedict's and Anthrone method 5. Quantitative method for amino acid estimation using ninhydrin –distinguishing amino from imino acid.	**CO-1 BTL-3**
MODULE 2 (15L)	
6. Quantitative method for protein estimation by Biuret and Lowry's method 7. Quantitative method for cholesterol estimation 8. Extraction of lipids and analysis by paper chromatography and TLC. 9. Estimation of nucleic acids by absorbance at 260 nm and its hyperchromic effect. 10. Isolation and estimation of chlorophyll	**CO-2 BTL-4**

COURSE TITLE	MICROIOLOGY LAB			CREDITS	1
COURSE CODE	BTB4232	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
Experimental	Calculation	Result	Viva	Record	ESE
30	10	10	20	10	20%
Course Description	This laboratory course introduced students to procedures for handling microbes, methods of identification of microorganisms (microscopic and by diagnostic media), preparation of stained slides and wet mounts, aseptic techniques, isolation of a single colony, preparation of a pure culture, inoculation and interpretation of select diagnostic tests.				
Course Objective	1. To demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures 2. To understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes				

	3. To know various Culture media and their applications and also understand various physical and chemical means of sterilization 4. To know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi. 5. To master aseptic techniques and be able to perform routine culture handling tasks safely and effectively
Course Outcome	Upon completion of this course, the students will be able to 1. Understand with the culturing and microscopic staining techniques 2. Define the method for the isolation and identification of microbes 3. Distinguish the different growth pattern of microbes 4. Categorize between different bacteria 5. Apply the concept of growth curve of bacteria for their research related activities.

Prerequisites: Basics of microbiology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-
CO-2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO-3	-	-	-	1	-	-	2	-	-	-	-	-	2	-	-
CO-4	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-
CO-5	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1	**(15L)**
1. Laboratory safety and sterilization techniques 2. Microscopic methods in the identification of microorganisms 3. Preparation of culture media – nutrient broth and nutrient agar 4. Culturing of microorganisms – in broth and in plates (pour plates, streak plates, isolation and preservation of bacterial cultures). 5. Staining techniques – grams' and differential.	**CO-1** **BTL-3**
MODULE 2	**(15L)**
6. Quantification of microorganisms 7. Effect of disinfectants on microbial flora 8. Isolation and identification of microorganisms from different sources – soil, water and milk 9. Antibiotic sensitivity assay 10. Growth curve – observation and growth characteristics of bacteria and yeast. 11. Effect of different parameters on bacterial growth (pH, temperature & UV irradiation).	**CO-2** **BTL-4**

SEMESTER IV

COURSE TITLE	NUMERICAL METHODS			CREDITS	4
COURSE CODE	MAA 4217	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-1-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	To make the student understand the basic concepts and techniques of numerical solution of algebraic equation, numerical solution of differentiation, integration and their application to engineering and science.				

Course Objective	1. To solve system of linear equations by substitution and elimination 2. To define interpolation and prove the order of the polynomial is unique. 3. To develop own numerical differentiation and experience computational limitation 4. To identify the suitable methods to solve ordinary differential equations 5. To identify suitable method to solve partial differential equations
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the techniques for solving the algebraic and transcendental equations. 2. Construct an approximate polynomial to represent the given data. 3. Demonstrate the differentiation and integration when the functions are in analytical form. 4. Measure ordinary differential equation using an appropriate numerical method. 5. Analyze partial differential equation using an appropriate numerical method.

Prerequisites:

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	-	2	-	-	-	-	-	-	1	-	1	-	-	2	-
CO-3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	**(9L+3T=12)**
Solution of algebraic and transcendental equations: Method of false position – Newton's method –Fixed point iteration method – Solution of linear system of Gaussian elimination and Gauss-Jordan methods – Iterative methods: Gauss Jacobi and Gauss – Seidel methods-Inverse of a matrix by Gauss-Jordan method. Eigenvalue of a matrix by power method. Suggested Reading: System of equations	**CO-1** **BTL-1,2,3,4**
MODULE 2: INTERPOLATION AND APPROXIMATION	**(9L+3T=12)**
Lagrangian Polynomials – Divided difference – Newton forward and backward difference method – Cubic Spline interpolation. Suggested Reading: Relations and functions	**CO-2** **BTL-1,2,3,4**
MODULE 3: NUMERICAL DIFFERENTIATION AND INTEGRATION	**(9L+3T=12)**

Derivatives from difference table – Divided difference and finite difference – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two and three point Gaussian quadrature formula – Double integrals using trapezoidal and Simpson's rules. Suggested Reading: Basic differentiation and integration	**CO-3** **BTL-1,2,3,4**
MODULE 4: NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS	**(9L+3T=12)**
Single step Methods: Taylor Series method –Euler and Modified Euler method – Fourth order Runge-Kutta method for solving first and second order differential equations - Multistep method: Milne's and Adam's predictor and corrector methods. Suggested Reading: Ordinary Differential Equations	**CO-4** **BTL-1,2,3,4**
MODULE 5: BOUNDARY VALUE PROBLEMS	**(9L+3T=12)**
Finite difference solution for the second order ordinary differential equations. Finite difference solution for one dimensional heat equation by implicit and explicit methods – one dimensional wave equation and two dimensional Laplace and Poisson equations. Suggested Reading: Partial Differential Equations	**CO-5** **BTL-1, 2, 3, 4**

TEXT BOOKS	
1.	Gunavathi, K., Kandasamy, P., Thilagavathy, K. (2006). *Numerical Methods*, 3rd Edition.
2.	Gerald, C.F, Wheatley, P.O. (2002). *Applied Numerical Analysis*, Pearson Education Asia, Sixth Edition, New Delhi.
3.	Grewal. B.S., Grewal. J.S. (2007). *Numerical methods in Engineering and Science*, Khanna Publishers, 9th Edition, New Delhi.
4.	Bansal, R.J., Goel, A.K., Sharma, M.K. (2016). *MATLAB and its Applications in Engineering*, Pearson Publication, 2nd Edition.
REFERENCE BOOKS	
1.	Chapra, S.C., Canale, R.P (2007). *Numerical Methods for Engineers*, Tata McGraw Hill, 5th Edition, New Delhi.
2.	Gerald, C.F., and Wheatley, P.O. (2006). *Applied Numerical Analysis*, Pearson Education, Asia, New Delhi, 2006.
3.	Jaankiusalaas, (2013). *Numerical methods with engineering with Python*, Cambridge Press, 3, 2nd Edition.
	Duffy, D.G. (2013). *Advanced Engineering Mathematics with MATLAB*, CRC Press, 3rd Edition.
E BOOKS	

1.	http://nptel.ac.in/courses/112106061/Module_2/Lecture_2.2.pdf
2.	http://www.nptel.ac.in/courses/122104018/node109.html
3.	http://nptel.ac.in/courses/122107036/35
MOOC	
1.	https://www.mooc-list.com/course/numerical-methods-engineers-saylororg

COURSE TITLE	**MOLECULAR BIOLOGY**			**CREDITS**	**4**
COURSE CODE	**BTB4216**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-1-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-4**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Molecular Biology course focuses on the structure and function of biologically important molecules. Students will learn about DNA, RNA and proteins and the molecular events that govern cell function while exploring the relevant aspects of biochemistry, genetics and cell biology.				

Course Objective	1. To appreciate the genetic machinery at play in life 2. To identify the importance of DNA, RNA and how they replicate 3. To evaluate how transcription and translation occurs in the cell 4. To assess the regulation of gene expression its relevance in Biotechnology 5. To ascertain genetic code and repair mechanism in both prokaryotes and eukaryotes
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the genetic machinery at play in life 2. Distinguish the importance of DNA, RNA and how they replicate 3. Evaluate how transcription and translation occurs in the cell 4. Assess the regulation of gene expression its relevance in Biotechnology 5. Determine genetic code and repair mechanism in both prokaryotes and eukaryotes

Prerequisites: BTB4116 – Cell Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2	-	2	-	-	-	-	-	-	1	-	1	-	-	2	-
CO-3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF MOLECULAR BIOLOGY AND NUCLEIC ACIDS (12L + 3T = 15)

Molecular Biology – Introduction – Scope – Applications – Central dogma. Nucleotides-Structure. Structure of DNA-DNA Double Helix-Conformations of DNA-Organization of DNA in the Cell. Classical Experiments – Griffith Experiment, Hershey and Chase; Avery, Mcleod& McCarty. Structure of RNA-Types-Ribozymes **Suggested Reading:** DNA as the genetic material	**CO-1** **BTL-2**

MODULE 2: DNA REPLICATION AND RECOMBINATION (12L + 3T =15)

DNA Replication – Types – Experiments of Messelson and Stahl – Okazaki fragments- D-loop and Rolling Circle Model of Replication, Replication of Linear Viral DNA. Replication of Telomeres in Eukaryotes. Prokaryotic and Eukaryotic Replication. Enzymes of Replication. Recombination-Homologous and Non-Homologous **Suggested Reading:** DNA replication and recombination.	**CO-2** **BTL-2**

MODULE 3: TRANSCRIPTION AND TRANSLATION (7L + 3T =10)	
Transcription and Translation in Prokaryotes and Eukaryotes, features of promoters and enhancers, transcription factors, Post transcriptional and Post translational mechanism. Reverse Transcription; Mitochondrial Transcription and translation. **Suggested Reading:** Transcription and Translation.	**CO-3** **BTL-3**
MODULE 4: REGULATION OF GENE EXPRESSION (7L + 3T =10)	
Positive and negative control – Operon concept – Trp operon – Lac operon – Ara operon - Control. Catabolite repression. Methods to study gene regulation-PCR-RACE-Northern and Southern blotting. Methods to study protein-Phage display and yeast two hybrid system. **Suggested Reading:** Gene expression.	**CO-4** **BTL-4**
MODULE 5: GENETIC CODE AND DNA REPAIR (7L + 3T =10)	
Genetic code – Characteristic features – Mutagens – Wobble hypothesis – Mutation in genetic code. DNA repair mechanism-Defects in DNA repair and cancer **Suggested Reading:** Genetic code and DNA Repair.	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Friefelder, D. (2004). *Molecular Biology*, Narosa Publ. House, 6th Edition.
2.	Lewin, B. (2007). *Gene VIII*, Oxford University Press, 5th Edition.
REFERENCE BOOKS	
1.	Clark, D.P. Pazdernik, N.J. (2013). *Molecular Biology*, Elsevier, 4th Edition.
2.	Alberts, B. (2017). *Molecular Biology of the Cell*, Garland Science, 5th Edition.
E BOOKS	
1.	https://archive.org/details/FundamentalsOfGenetics
MOOC	
1.	https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-11-molecular-biology-2/
2.	https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/exam-2/

COURSE TITLE	HEAT TRANSFER			CREDITS	4
COURSE CODE	CHB4216	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	The course covers the basic modes of heat transfer, principle and working of heat transfer equipment and design calculations.				

Course Objective	1. To acquire basic understanding of the modes of heat transfer and rate of heat transfer by conduction 2. To understand the basis for selecting different vessel supports. 3. To familiarize with the design procedures for pressure vessels 4. To acquire knowledge of different types of heat exchangers and heat transfer calculations 5. To familiarize with the principle and laws governing radiation
Course Outcome	Upon completion of this course, the students will be able to 1. Categorize the different modes of heat transfer and carry out the conduction calculations in various geometries. 2. Estimate the rate of heat transfer by combined conduction and convection process design requirements of heat transfer in co-current and counter-current heat exchanger operations 3. Analyze the design calculations for condensers and evaporators for carrying physical transformations 4. Apply the overall heat transfer area requirement for evaporators 5. Analyze the systems involving radiation and to solve problems pertaining to them

Prerequisites: Fluid Mechanics and Unit Operations

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO-2	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-3	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**
CO-4	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO-5	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CONDUCTION (9L+3T = 12)

Importance of heat transfer in Chemical Engineering operations, Modes of heat transfer, Concept of heat conduction, Fourier's law of heat conduction, One dimensional steady state heat conduction equation for flat plate, Hollow cylinder, Hollow sphere, Heat conduction through a series of resistances, Analogy between flow of heat and flow of electricity, Thermal Conductivity measurement, Effect of temperature on thermal conductivity, Critical thickness of insulation. **Suggested Reading:** Heat transfer by conduction	**CO-1** **BTL-2**

MODULE 2: CONVECTION (9L+3T = 12)

Concept of heat transfer by convection, Natural and forced convection, Application of dimensional analysis for convection, Equations for forced convection under laminar, Transition and turbulent conditions, Equations for natural convection, Individual and overall heat transfer coefficients and the relationship between them, Film wise and Drop wise Condensation, Boiling heat transfer, Regimes of boiling, Nucleate Boiling, Film Boiling, Heat transfer from condensing vapors, Heat transfer to boiling liquids, Influence of boundary layer on heat transfer. **Suggested Reading:** Heat transfer by Convection	**CO-2** **BTL-2**
MODULE 3: HEAT EXCHANGERS	**(9L+3T = 12)**
Heat exchanger: Classification, Overall heat transfer coefficient, Fouling factor, LMTD & Effectiveness, NTU method of heat exchanger analysis for parallel, Counter flow & cross flow arrangement, Use of correction factor charts, Wilson's plot, Design aspect of heat exchangers, Introduction to compact heat exchangers, Types of condensers, Types of Reboilers. **Suggested Reading:** Heat transfer coefficient	**CO-3** **BTL-4**
MODULE 4: EVAPORATORS	**(9L+3T = 12)**
Introduction, Single- and multiple- effect operation, Types of Evaporators, BPE and Duhring's rule, Enthalpy balances for single effect evaporator, Design calculation for single effect evaporation, Multiple effect evaporators, Methods of feeding, Capacity and economy of single and multiple effect evaporators. **Suggested Reading:** Various types of Evaporators	**CO-4** **BTL-3**
MODULE 5: RADIATION	**(9L+3T = 12)**
Thermal radiation, Blackbody radiation, Basic laws of radiation (Planck's law, Kirchoff's law, Stefan-Boltzman law, Wien's displacement law, Lambert's cosine law), Emissivity, Absorptivity, Transmissivity, Reflectivity, Radiation exchange between black surfaces, Shape factor, Radiation exchange between gray surfaces, Radiation shield and Radiation effect **Suggested Reading:** Heat transfer by Radiation	**CO-5** **BTL-2**
TEXT BOOKS	
1.	Mccabe, W.L., Smith, J.C. (2005). *Unit Operations in Chemical Engineering*, McGraw-Hill, Higher Education, 7th Edition.
2.	Dutta, B.K., (2001). *Heat Transfer Principles and Applications*, Prentice Hall of India, 3rd edition.
REFERENCE BOOKS	

1.	Kern, D. (2008). *Process Heat Transfer*, Tata McGraw Hill Book Co., New Delhi, 4th edition.
2.	Coulson, J.M., Richardson, J.F., Backhurst, J.R., Harker J.H. (2009). *Coulson & Richardson's Chemical Engineering*, Butterworth Heinemann, Vol. I, 6th Edition, Oxford.
3.	Holman. J.P. (2008). *Heat Transfer*, Tata McGraw Hill Book Co., 9th Edition, New Delhi.
E BOOKS	
1.	http://sv.20file.org/up1/423_0.pdf
2.	http://www.learncheme.com/screencasts/heat-transfer
MOOC	
1.	http://nptel.ac.in/courses/103103032/

COURSE TITLE	**ENZYME ENGINEERING & TECHNOLOGY**			**CREDITS**	**3**
COURSE CODE	**BTB4217**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	Enzyme Engineering and Technology gives an in-depth insight into methodologies and approaches regarding enzymatic engineering and the use of enzymes in industrial processes. An overview of industrial scale protein production will be presented.
Course Objective	1. To Understand the different types of enzymes and their applications 2. To know about enzyme catalysis, Apo enzymes and metallo-enzymes. 3. To learn the concepts of free and immobilized enzyme kinetics 4. To understand various methods of production, extraction and purification of enzymes 5. To impart technical knowledge about instrumental techniques employed.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the different types of enzymes and their applications 2. Have fundamental knowledge about enzyme catalysis, apo enzymes and metallo-enzymes 3. Distinguish between free and immobilised enzyme kinetics 4. Understand various methods of production, Extraction and purification of enzymes 5. Have technical knowledge about instrumental techniques employed in enzymatic analysis.

Prerequisites: Basics of Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-
CO-2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3	-	1	-	-	-	-	2	-	-	-	-	-	1	-	-
CO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO ENZYMES (8L)

Classification of enzymes, specificity of enzyme action –monomeric and oligomeric enzymes,-Factors modifying enzyme activity, biotechnological applications of enzymes and applications of enzymes in various industries **Suggested Reading:** Enzymes	**CO-1** **BTL-1**

MODULE 2: CHEMICAL NATURE OF ENZYME CATALYSTS (9L)

Structural Components of Enzymes –Structure, apoenzymes, prosthetic group, cofactors, Mechanisms of reactions catalyzed by enzymes – Metal activated enzymes – metallo enzymes –involvement of co enzymes. **Suggested Reading:** Classification of enzymes based on their catalysis	**CO-2** **BTL-2**
MODULE 3: FREE AND IMMOBILISED ENZYME KINETICS	**(10L)**
Kinetics of single substrate reactions, turnover number, Enzyme Inhibition, presteady state kinetics, Kinetics of multi-substrate reactions, Allosteric enzymes –The Monad – Changeux –Wyman model (MCW) and The Koshland –Nemethy –Filmer (KNF) model, Temperature and pH effects on enzyme activity. Methods of immobilization of enzymes, Kinetics of immobilized enzymes –Effects of external mass transfer and intra – particle diffusion. **Suggested Reading**: Kinetics of enzymes to substrates and ligands	**CO-3** **BTL-2**
MODULE 4: EXTRACTION AND PURIFICATION OF ENZYMES	**(9L)**
Methods of production of enzymes, Extraction of Enzymes –soluble enzymes – membrane bound enzymes –Nature of extraction medium –purification of enzyme – criteria of purity–Determination of molecular weight of enzymes. **Suggested Reading:** Production of Enzymes	**CO-4** **BTL-3**
MODULE 5: INSTRUMENTAL TECHNIQUES IN ENZYMATIC ANALYSIS	**(9L)**
Principles –Manometry –Spectrophotometry –Spectrofluorometric –Electrochemical methods –Enthalpimetry –Radio chemical methods –Automation in enzymatic analysis **Suggested Reading:** Enzymatic Analysis.	**CO-5** **BTL-3**
TEXT BOOKS	
1.	Blanch, H.V., Clark, D.S. (2005). *Biochemical Engineering*, Marcel Dekker Inc., 4th Edition.
2.	Palmer, T. (2001). *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*, Horwood Pub, 3rd Edition.
REFERENCE BOOKS	
1.	Bailey, J.E., Ollis, D.F. (2009). *Biochemical Engineering Fundamentals*, McGraw-Hill, 6th Edition.
2.	Khan, M. Y., Khan, Farha. (2015). *Principles of Enzyme Technology*, PHI Learning Pvt. Ltd.
E BOOKS	

1.	https://ebookcentral.proquest.com/lib/hindustanuniv/detail.action?docID=588366
2.	https://books.google.co.in/books?isbn=9402410260
MOOC	
1.	http://nptel.ac.in/courses/102102033/1

COURSE TITLE	**VACCINE BIOTECHNOLOGY**			**CREDITS**	**3**
COURSE CODE	**BTC4269**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-1-0-1**
Version	**1.0**	**Approval Details**	**24th ACM - 30.5.2018**	**LEARNING**	**BTL-4**

				LEVEL	
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Recent advances in medical and microbial molecular biotechnology, have led to great strides in the understanding and treatment of human diseases. This course develops key concepts in molecular bacteriology and virology, identifying key targets for rational vaccine design, use of animal models to determine immune responses to vaccines.				
Course Objective	1. To describe the historical development of vaccines 2. To describe the better production of vaccines 3. To learn the types, methods and application of vaccines 4. To understand the delivery methods of vaccines 5. To understand the regulatory issues of vaccines				
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the concepts of vaccine development 2. Apply the knowledge on conventional to recent technology of vaccine production 3. Integrate types of vaccine, immunological effects and regulatory guidelines. 4. Analyze the delivery methods of vaccines 5. Understand the regulatory issues of vaccines				
Prerequisites: Microbiology					

CO, PO AND PSO MAPPING

CO	**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**	**PSO-3**
CO-1	-	-	-	-	-	-	-	-	-	-	-	-	**1**	-	-
CO-2	-	-	-	-	-	-	**2**	-	**2**	-	-	-	**1**	-	-
CO-3	-	-	-	**1**	-	-	-	-	-	-	**1**	-	-	**2**	-
CO-4	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**
CO-5	-	-	**2**	-	-	-	-	-	-	-	**3**	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: - HISTORICAL DEVELOPMENTS OF VACCINE	**(9L)**
History of vaccine development-Conventional strategies for vaccine improvement, live attenuated and killed vaccines, types of adjuvant, quality control, preservation and monitoring of microorganisms in seed lot systems.	**CO-1** **BTL-2**
MODULE II BETTER PRODUCTION	**(9L)**
Technology related to monitoring - temperature, sterilization, environment, quality assurance and related areas. Production techniques- growing the microorganisms in maximum titre, preservation techniques, freeze drying.	**CO-2** **BTL-2**
MODULE III: TYPES, METHODS AND APPLICATIONS	**(10L)**
Types of vaccines- subunit vaccine, synthetic vaccines, DNA vaccines, virus like particles, recombinant vaccines and edible vaccines. Uses of nanoparticles in vaccine application.	**CO-3** **BTL-3**
MODULE IV DELIVERY METHODS	**(8L)**
Immuno-modulators-Innovative methods of delivery of immunogens through liposome, microspheres, ISCOMS.	**CO-4** **BTL-2**
MODULE V GUIDELINES FOR THE MANAGEMENT	**(9L)**
Regulatory issues- Environmental concerns with the use of recombinant vaccines- Disease security and biosecurity principles and OIE guidelines such as seed management- Method of manufacture- in process control, batch control, test on final products.	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Ellis, R.W. (2001). *New Vaccine Technologies*, Landes Bioscience.
REFERENCE BOOKS	
1.	Kindt, T.J., Goldsby, R.A., Osborne, B.A., Kuby, J. (2007). *Immunology*, W.H. Freeman and company, 6 th edition.
2.	Ramadass, P. (2008). *Animal Biotechnology – Recent concepts and Developments*, MJP Publications, India.
E BOOKS	
1.	https://books.google.co.in/books?isbn=012039233X
MOOC	
1.	https://www.mooc-list.com/tags/vaccines

2.	https://www.mooc-list.com/course/vaccines-coursera

COURSE TITLE	MOLECULAR BIOLOGY LAB			CREDITS	1
COURSE CODE	BTB4241	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1

Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4
ASSESSMENT SCHEME					
Experimental	**Calculation**	**Result**	**Viva**	**Record**	**ESE**
30%	**10%**	**10%**	**20%**	**10%**	**20%**
Course Description	This course will provide students with a thorough review of common techniques and concepts that are used in the molecular biology Laboratory.				
Course Objective	1. To train the students in isolation of bacterial genomic DNA 2. To give a practical exposure for the separation and amplification of DNA 3. To impart hands-on training in Southern and western blotting 4. To equip the students with practical skill in protein extraction. 5. To study the protein separation.				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the DNA isolation and amplification techniques 2. Apply the basic techniques of proteomics 3. Develop knowledge on protein extraction 4. Analyze the different blotting techniques. 5. Understand with protein separation methods				
Prerequisites: Basics of biology					

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2	-	-	-	-	-	-	2	-	2	-	-	-	1	-	-
CO-3	-	-	-	1	-	-	-	-	-	-	1	-	-	2	-
CO-4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5	-	-	2	-	-	-	-	-	-	-	3	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:ISOLATION OF GENOMIC DNA (6L)

1. To isolate the bacterial genomic DNA by phenol chloroform extraction method 2. Isolation of plant and animal cell genomic DNA.	**CO-1** **BTL-3**
MODULE 2: SEPARATION AND AMPLIFICATION OF DNA	**(6L)**
3. To separate the DNA by Agarose gel electrophoresis. 4. Amplification of isolated DNA by PCR Thermal cycler.	**CO-2** **BTL-3**
MODULE 3: PROTEIN EXTRACTION	**(6L)**
5. Protein Extraction from plant and animal cells	**CO-3** **BTL-3**
MODULE 4: PROTEIN SEPARATION	**(6L)**
6. Separation of protein by SDS-PAGE 7. Separation of protein by 2D-Electrophoresis and Silver staining	**CO-4** **BTL-3**
MODULE5:DNAandPROTEINCONFIRMATION	**(6L)**
8. Confirmation of target gene in the genome by using Southern Blotting 9. Reconfirmation of protein by Western blotting.	**CO-5** **BTL-3**
TEXT BOOKS	
1.	Oelkers, P. (2016). *Molecular Biology Laboratory Manual*.
REFERENCE BOOKS	
1.	Wolf, J.B. (2015). Molecular Biology Lab Manual**,** Department of Biological Sciences, UMBC.
E BOOKS	
1.	https://www.researchgate.net/publication/320508474_Molecular_Biology_Laboratory_manual
MOOC	
1.	https://www.coursera.org/learn/methods-of-molecular-biology

COURSE TITLE	HEAT TRANSFER LAB	CREDITS	1

COURSE CODE	CHB4201	COURSE CATEGORY	BS	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	To determine heat transfer coefficients, thermal conductivity and other parameters using heat transfer equipment.
Course Objective	The course should enable the students to 1. Understand the various forms of heat transfer and their applications in real life problems 2. Recognize the practical significance of various parameters those are involved 3. Apply the knowledge of heat transfer in an effective manner for different applications. 4. Analyze the theoretical knowledge and apply it in conducting experiments 5. To provide the students practical knowledge in operating of various size reduction equipment.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the design requirements of heat transfer in co-current and counter-current heat exchanger operations 2. Analyze design calculations and piping diagrams 3. Perform steady state conduction experiments to estimate thermal conductivity of different materials. 4. Estimate heat transfer coefficients in natural convection 5. Determine surface emissivity of a test plane and Stefan-Boltzmann's constant

Prerequisites: Knowledge in fundamentals of characteristics of solids, liquids and gaseous molecule.

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	-	-	-	-	-	-	-	-	-	1	-	-	-	1
CO-2	-	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-
CO-4	1	-	-	-	-	-	-	1	-	-	-	1	-	-	-
CO-5	-	-	-	4	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: SCREENING	(6L)
1. To measure thermal conductivity of given materials 2. Determination of heat transfer coefficient measurement using natural convection apparatus	**CO-1** **BTL-3**
MODULE 2: SIZE REDUCTION	**(6L)**
3. Determination of heat transfer rate in counter flow heat exchanger. 4. Determination of heat transfer rate in parallel flow heat exchanger.	**CO-2** **BTL-3**
MODULE 3: SEPARATIONS	**(6L)**
5. Heat transfer coefficient measurement using forced convection apparatus 6. Emissivity measurement.	**CO-3** **BTL-3**
MODULE 4: FILTRATIONS	**(6L)**
7. Determination of temperature profile in a rod 8. To study transient heat conduction in a rod	**CO-4** **BTL-4**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE	**(6L)**
9. Determination of heat transfer coefficient for a jacket vessel.	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Cengel, Y.A. (2012). *Heat Transfer a Practical Approach*. Tata McGraw-Hill Education, 4th Edition.
REFERENCE BOOKS	
1.	Sachdeva, R. C. (2012). *Fundamentals of Engineering, Heat and Mass Transfer*. New Age publication, 3rd Edition.
E BOOKS	
1.	https://www.skkatariaandsons.com/view_book.aspx?productid=7838
MOOC	
1.	https://nptel.ac.in/courses/112/101/112101097/

SEMESTER V

COURSE TITLE	OPTIMIZATION TECHNIQUES			CREDITS	4
COURSE CODE	MAA 4301	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-1-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student develop a knowledge in the field of optimization techniques their basic concepts, principles of linear and integer programming, assignment and transportation problems.
Course Objective	1. To understand the concept of optimization 2. To formulate linear programming model 3. To understand the concept of integer programming 4. To understand the assignment and transportation problem 5. To understand the concept of network analysis
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate mathematical model 2. Determine engineering maxima/minima problems into optimization framework. 3. Solve the integer programming problems 4. Apply the assignment and transportation problems 5. Analyze the designs of networks
Prerequisites:	

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	2	-	-	-	-	-	2	-	-	-	-	1	-	-
CO-2	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-
CO-3	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
CO-4	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:INTRODUCTION TO OPTIMIZATION (9L+3T=12)	
Introduction to operations research – objective – scope of OR – Limitations of OR – Introduction and formulation of linear programming – Solving LPP using Graphical method. Suggested Reading: Basics of inequalities.	**CO-1** **BTL-1,2**
MODULE 2:LINEAR PROGRAMMMING PROBLEM (9L+3T=12)	
Solving LPP using simple method – Big-M method – Two phase method – conversion of primal to dual. Suggested Reading: System of equations.	**CO-2** **BTL-1,2,3**
MODULE 3:INTEGER PROGRAMMING (9L+3T=12)	
Integer programming – Cutting plane method – Gomory's Mixed integer method – Branch and Bound method Suggested Reading: System of equations	**CO-3** **BTL-1,2,3,4**
MODULE 4:ASSIGNMENT AND TRANSPORTATION PROBLEM (9L+3T=12)	
Hungarian Method – Maximization and unbalanced assignment problem – Basic feasible solution of transportation problem – Modi method – Degeneracy – Unbalanced Transportation problem. Suggested Reading: Arithmetic Calculation	**CO-3** **BTL-1,2,3,4**
MODULE 5:PERT AND CPM (9L+3T=12)	
Network diagram – Representation – Labeling – CPM – PERT probabilities of CPM – PERT probabilities of project duration. Suggested Reading: Basics of graphs	**CO-4** **BTL-1,2,3,4**

TEXT BOOKS	
1.	Chandrasekaran, A. (2017). *A Text book of Operation Research*, Dhanam Publications, Chennai.
2.	Sundaresan, V., Subramanian, G. K. S., Ganesan, K. (2004). *Resource Management Techniques*, A. R. Publications, Chennai.
3.	Sharma, S. D. (2002). *Operation Research*, Kedarnath Ramnath & Co.
REFERENCE BOOKS	
1.	Taha, H.A. (2010). *Operations Research: An Introduction*, Prentice Hall, 9th Edition.
2.	Hira, H.D., Gupta, P.M. (2012). *Introduction to Operations Research*, Chand Publishing.
E BOOKS	
1.	http://nptel.ac.in/courses/112106134/1
2.	https://onlinecourses.nptel.ac.in/noc17_mg10/preview
MOOC	
1.	https://www.edx.org/course/operations-management-iimbx-om101-1x

COURSE TITLE	RECOMBINANT DNA TECHNOLOGY			CREDITS	4
COURSE CODE	BTB4301	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course will cover some basic recombinant DNA technologies, why they were developed, and how they are used today in many different scientific arenas. Starts with introduction of the restriction enzymes, function of DNA ligase, understand how vectors are used, and learn how to construct a recombinant genomic DNA library.
Course Objective	1. To gain basic knowledge about recombinant DNA Technology 2. To understand the methods of gene transfer 3. To have extensive knowledge about genomic libraries 4. To distinguish the basic techniques in genetic engineering 5. To get exposure on metabolism and bioenergetics regulation
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate basic knowledge about recombinant DNA Technology 2. Understand the methods of gene transfer 3. Analyze extensive knowledge about genomic libraries 4. Distinguish the basic techniques in genetic engineering 5. Acquire exposure on metabolism and bioenergetics regulation

Prerequisites: BTB4216 – Molecular Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	2	-	-	-	-	-	2	-	-	-	-	1	-	-
CO-2	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-
CO-3	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
CO-4	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF RECOMBINANT DNA TECHNOLOGY	(9L + 3T =12)
History of recombinant DNA technology, Molecular Tools of Genetic Engineering- Restriction Endonuclease, DNA ligase, Alkaline Phosphatase, DNA polymerase. Outline of r-DNA technology, Vectors - Plasmid, Bacteriophages, Cosmids, Artificial vectors, Shuttle vectors, Insect, Yeast and Mammalian vectors. Safety guidelines of recombinant DNA research **Suggested Readings:** Recombinant DNA Technology	**CO-1** **BTL-2**
MODULE 2: METHODS OF GENE TRANSFER	**(9L + 3T =12)**
Transformation, Conjugation, Electroporation, Liposome-Mediated Gene Transfer, Transduction, Microinjection **Suggested Reading:** Gene Transfer Methods	**CO-2** **BTL-2**
MODULE 3: CONSTRUCTION OF LIBRARIES	**(9L + 3T =12)**
Construction of cDNA and genomic libraries. Screening of libraries -DNA probes, Colony hybridization, PCR, Immunological Assay and Protein Functions. **Suggested Readings:** Genomic Libraries	**CO-3** **BTL-4**
MODULE 4: BASIC TECHNIQUES IN GENETIC ENGINEERING	**(9L + 3T =12)**
Agarose Gel Electrophoresis, Isolation of nucleic acids, PCR-Technique –Types-Inverse PCR, Nested PCR, RACE PCR, RAPD, AFLP, Application of PCR. site directed mutagenesis, methods of nucleic acid sequencing- Maxam and Gilbert technique, Sangers method, Automated DNA Sequencing, Pyrosequencing, Micro array **Suggested Readings:** PCR and Sequencing	**CO-4** **BTL-2**
MODULE 5: APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY	**(9L + 3T =12)**
Transgenic plants, Transgenic Animals, knockout and knockdown animals, Recombinant Vaccines, Bioremediation-Superbug **Suggested Readings:** Transgenesis	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Old, R.W., Primrose, S.B. (2009). *Principles of Gene Manipulation, An Introduction To Genetic Engineering,* Blackwell Science Publications, 3rd Edition.
2.	Ansubel, F.M., Brent, R., Kingston, R.E., Moore, D.D. (2008). C*urrent Protocols In Molecular Biology*, Green Publishing Associates, 4th Edition,.
REFERENCE BOOKS	
1.	Berger, S.l., Kimmer, A.R. (2007). *Methods In Enzymology*, Academic Press, 4th Edition,.

2.	Setlow, J.K. (2006). *Genetic Engineering: Principles and Methods*, Springer Science & Business Media.
E BOOKS	
1.	Old, R.W. (2009). *Principles of Gene Manipulation, An Introduction To Genetic Engineering*, Blackwell Science Publications, 3rd Edition.
MOOC	
1.	https://www.coursera.org/learn/methods-of-molecular-biology#syllabus

COURSE TITLE	CHEMICAL REACTION ENGINEERING			CREDITS	4
COURSE CODE	CHB4301	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make students apply the principles of reaction kinetics, rate equations and solve problems based on the same.
Course Objective	1. Enable students to solve problems involving conversion and space time. 2. Understand types of reactors and find rate constants for different reactions. 3. Enable students to calculate selectivity, reactivity, and yield for mixed reactions 4. Understand principles of reaction kinetics and rate equations. 5. Examine how far real reactors deviate from ideal.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the principles of reaction kinetics, formulate rate equations and analyse the batch reactor data 2. Solve problems involving conversion and space time for different types of reactors 3. Analyze the experimental kinetic data 4. Evaluate selectivity, reactivity and yield for parallel and mixed reactions 5. Examine how far real reactors deviate from the ideal

Prerequisites: Heat Transfer, Thermodynamics

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	-	-	-	1	-	-	1
CO-2	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-4	-	-	1	-	-	-	-	-	-	2	-	-	1	-	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF REACTOR DESIGN	(9L+3T=12)
Kinetics of homogeneous reactions: Concentration-dependent term of a rate equation, Temperature-dependent term of a rate equation, Predictability of reaction rate from theory. Interpretation of batch reactor data: Constant volume batch reactor, Varying-volume batch reactor, Temperature and reaction rate, Search for a rate equation. **Suggested Reading:** Kinetics	**CO-1** **BTL-3**
Module 2: IDEAL REACTORS	**(9L+3T=12)**
Introduction to reactor design. Ideal reactors for a single reaction: Ideal batch reactors, Steady-state mixed flow reactors, Steady-state plug flow reactors. **Suggested Reading:** Design of reactors	**CO-2** **BTL-3**
Module 3: SINGLE REACTIONS	**(9L+3T=12)**
Design for single reactions: Size comparison of single reactors, Multiple-reactor systems, Recycle reactor. **Suggested Reading:** Rate equation	**CO-3** **BTL-3**
Module 4: MULTIPLE REACTIONS	**(9L+3T=12)**
Design for parallel reactions. Irreversible first-order reactions in series. **Suggested Reading:** Series and Parallel reactions	**CO-4** **BTL-4**
Module 5: TEMPERATURE AND PRESSURE EFFECTS	**(9L+3T=12)**
Single reactions: Heats of reaction from thermodynamics, Equilibrium constants from thermodynamics, Optimum temperature progression, Heat effects, Adiabatic operations, Non-batic operations. **Suggested Reading:** Thermodynamics	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Fogler, S.K. (2006). *Elements of Chemical Reaction Engineering*, Prentice Hall of India Pvt. Ltd., 4th Edition.
2.	Levenspiel, O. (2006). *Chemical Reaction Engineering*, John Wiley, 3rd Edition.
REFERENCE BOOKS	
1.	Smith J. M. (2014). *Chemical Engineering Kinetics*, 3rd Edition, McGraw Hill.
2.	Froment and Bischoff. (2010). *Chemical Reactor Analysis and Design*, John Wiley & Sons, 3rd Edition.
E BOOKS	
1.	https://authors.library.caltech.edu/25070/1/FundChemReaxEng.pdf.
MOOC	
1.	https://www.youtube.com/watch?v=ANjzlZ_Zsak&list=PLbMVogVj5nJRrrhcrAIIJs1W0qgH5axqO
2.	https://ocw.mit.edu/courses/chemistry/5-68j-kinetics-of-chemical-reactions-spring-2003/

COURSE TITLE	MASS TRANSFER			CREDITS	4
COURSE CODE	CHB4303	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course provides a basic knowledge of mass transfer by applying principles of diffusion, mass transfer coefficients and interphase mass transfer.
Course Objective	1. Understand the concept of molecular diffusion in gases and liquids 2. Familiarize with the analogies and theories in mass transfer 3. To acquire basic understanding of humidification principles and cooling towers 4. To understand the working of various drying equipment 5. 5. To have an overview of the mechanism of crystallization
Course Outcome	Upon completion of this course, the students will be able 1. Determine mass transfer flux using Ficks Law 2. Use correlations in calculating mass transfer coefficients 3. Analyse the thermodynamic properties of air using psychrometric chart 4. Calculate drying rate for batch and continuous drying equipment 5. Analyse the process parameters in crystallization equipment

Prerequisites: Fluid Mechanics and Unit Operations

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	-	-	-	1	-	-	1
CO-2	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-4	-	-	1	-	-	-	-	-	-	2	-	-	1	-	-
CO-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MOLECULAR DIFFUSION	(9L+3T = 12)
Fick's Law; Steady state molecular diffusion in binary gas mixture; Measurement and prediction of gas phase diffusion coefficient; molecular diffusion in liquids; Diffusion through variable area; Knudsen diffusion **Suggested Reading :** Multi-component diffusion	**CO-1** **BTL-2**
MODULE 2: CONVECTIVE MASS TRANSFER	**(9L+3T = 12)**
Mass transfer coefficient Dimensionless groups in mass transfer; Correlations for mass transfer coefficient; Eddy diffusion; Theories of mass transfer; Momentum, heat and mass transfer analogies; Interface mass transfer and overall mass transfer coefficient **Suggested Reading :** Wetted wall column	**CO-2** **BTL-2**
MODULE 3: HUMIDIFICATION	**(9L+3T = 12)**
Terminologies and definitions; Adiabatic saturation temperature; Wet bulb temperature; Psychometric chart; Classification, construction and operation of cooling towers. **Suggested Reading :** Non-adiabatic operations	**CO-3** **BTL-3**
MODULE 4: DRYING	**(9L+3T = 12)**
Physical mechanism of drying; Drying equilibria and important definitions; Drying rate curve and calculation of drying time; Mechanism of batch and continuous drying; Drying equipment. **Suggested Reading :** Drying calculations	**CO-4** **BTL-4**
MODULE 5: CRYSTALLIZATION	**(9L+3T = 12)**
Solid Liquid phase equilibria; Nucleation and crystal growth; Crystallization equipment **Suggested Reading:** Design of crystallizers.	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Treybal R.E. (2005). *Mass Transfer Operations*, McGraw Hill International**,** 3rd Edition, International Student Edition.
2.	Dutta B.K. (2009). *Principles of Mass Transfer and Separation Processes*, PHI Learning Pvt. Ltd., 1st Edition.
REFERENCE BOOKS	
1.	Geankoplis, C.J. (2009). *Transport Processes and Separation Process Principles*, Prentice Hall Inc., 4th Edition.
2.	McCabe, W.L., Jullian, S.C., Harriott, H. (2005). Unit operations of Chemical Engineering, McGraw-Hill international edition, 7th Edition.
E BOOKS	
1.	http://sv.20file.org/up1/423_0.pdf
MOOC	
1.	http https//ocw.mit.edu/courses/mechanical-engineering/2-51-intermediate-heat-and-mass-transfer-fall-2008/

COURSE TITLE	BIOETHICS, IPR AND PATENTS			CREDITS	3
COURSE CODE	BTC4351	COURSE CATEGORY	DE	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course helps to adhere to the ethical practices appropriate to the discipline at all times and to adopt safe working practices relevant to the biotechnology industry and research.
Course Objective	1. To impart students awareness on Intellectual Property Rights (IPRs) and to take measure for the protecting their ideas 2. To devise business strategies by taking account of IPRs 3. To assists students in technology upgradation and enhancing competitiveness. 4. To acquire adequate knowledge in the use of genetically modified organisms and its effect on human health 5. To gain more insights into the regulatory affairs
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the concepts of bioethics and its relevance in biotechnology 2. Analyze the safety levels required for the biotechnological Experiments 3. Create an awareness about the intellectual property rights 4. Apply the knowledge on importance of Patent filing 5. Acquire knowledge on bioethics principles behind the GMOs.

Prerequisites: Basics of Biotechnology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-2	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	-	-	-	-	-	-	-	3	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BIOETHICS	(10L)
Concepts and principles relevance to Biotechnology; Ethics and the Law Issues: Genetic Engineering, Stem Cells, Cloning, Medical techniques, Bioweapons; Research concerns - Animal Rights, Ethics of Human Cloning, Reproduction and Stem Cell Research; Emerging issues: Biotechnology's Impact on Society.	**CO-1** **BTL-1**
MODULE 2: BIOSAFETY	**(9L)**
Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines.	**CO-2** **BTL-2**
MODULE 3: INTELLECTUAL PROPERTY	**(8L)**
Types of IP: Patents, Trademarks, Copyright & Related Rights; Protection of New GMOs; International framework for the protection of IP, IPs of relevance to Biotechnology	**CO-3** **BTL-3**
MODULE 4: CONCEPT OF PATENT FILING	**(9L)**
Patent databases; Searching International Databases; Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting disclosure/non-disclosure.	**CO-4** **BTL-4**
MODULE 5: GENETICALLY MODIFIED ORGANISMS (GMO)	**(9L)**
Definition of GMOs; GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.	**CO-5** **BTL-4**

TEXT BOOKS	
1.	BAREACT. (2007). *Indian Patent Act 1970 Acts & Rules*, Universal Law, Publishing Co. Pvt. Ltd., 2nd Edition.
REFERENCE BOOKS	
1.	Kankanala, C. (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.
2.	Jecker, N.S., Jonsen, A.R., Pearlman, R.A. (2015). Bioethics, Jones & Bartlett Publishers.
E BOOKS	
1.	http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
2.	http://www.wipo.int/portal/index.html.en
MOOC	
1.	http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
2.	https://practicalbioethics.org/what-is-bioethics

COURSE TITLE	RECOMBINANT DNA TECHNOLOGY LAB			CREDITS	1
COURSE CODE	BTB4331	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30	10	10	20	10	20%

Course Description	Recombinant DNA laboratory course is about the fundamentals of recombinant DNA techniques that are used in molecular cloning. Procedures that are useful for constructing recombinant plasmid for protein expression are discussed, and experiments are included to learn the fundamentals of recombinant DNA technology
Course Objective	1. To understand the basic techniques of recombinant DNA technology 2. To familiar with the optimization techniques for the recombinant protein expression
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the basic techniques of recombinant DNA technology 2. Apply the optimization techniques for the recombinant protein expression

Prerequisites: Molecular Biology Lab

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	2	-	-	-	1	-	-	-	-	-	-	-	-	2
CO-2	3	-	-	-	-	-	-	2	-	-	-	-	1	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	**(15L)**
1. Isolation of plasmid DNA from bacterial cells 2. Elution of DNA from agarose gels 3. Restriction enzyme digestion 4. Ligation of DNA into expression vectors 5. Competent cells preparation	**CO-1** **BTL-3**
MODULE 2	**(15L)**
6. Transformation and screening of recombinants 7. Blue and white screening for recombinant colonies 8. Optimization of inducer concentration for recombinant protein expression 9. Optimization of time of inducer for recombinant protein expression 10. Hybridization with anti-sera	**CO-2** **BTL-4**

COURSE TITLE	CHEMICAL REACTION ENGINEERING LAB			CREDITS	1
COURSE CODE	CHB4331	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	To make students perform experiments and calculate, interpret, and analyze rate constants for multiple reactor systems.
Course Objective	1. To train students to calculate rate constants for different 2. To educate students to interpret and analyze data from reaction systems 3. To be able to identify reactor arrangements
Course Outcome	Upon completion of this course, the students will be able to 1. Determine the rate constants for multitude of reactor systems 2. Interpret and analyze the data from reaction systems. 3. Identify the best possible arrangement of reactors vis-à-vis series/parallel/ or mixed types reactor systems.

Prerequisites: -

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-3	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	(15L)
1. To determine the reaction rate constant of saponification reaction using batch reactor 2. To determine the reaction rate constant of saponification reaction using PFR 3. To determine the reaction rate constant of saponification reaction using CSTR 4. To analyze residence time distribution of plug flow reactor using step tracer input 5. To analyze residence time distribution of plug flow reactor using pulse tracer input 6. To analyze residence time distribution of packed bed reactor using pulse tracer input 7. To analyze residence time distribution of CSTR using step tracer input	**CO-1,2,3** **BTL-4**

SEMESTER VI

COURSE TITLE	METABOLIC ENGINEERING			CREDITS	4
COURSE CODE	BTB4316	COURSE CATEGORY	PC	L-T-P-S	3-1-0-2
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Metabolic engineering is an emerging field of biotechnology/bioprocess engineering which aims towards purposeful modification of cellular (metabolic, gene regulatory, and signaling) processes/networks to achieve desirable goals such as enhanced production of metabolites including pharmaceuticals, biofuels and biochemical and other biotechnology products. This course aims to provide fundamental and advanced knowledge in the development of microbial strain for bio production through metabolic engineering.
Course Objective	1. To identify the appropriate host and/or metabolic pathways to produce a desired product or remediate a toxin 2. To make the students to compare potential metabolic engineering strategies using quantitative metabolic modelling 3. To make the students to design 13C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway utilization 4. To construct genome-scale metabolic flux models using available tools and software and perform simulations 5. To devise effective strategies to implement genetic manipulations
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the metabolic pathway of amino acids 2. Analyze protein transport and its degradation 3. Describe the metabolism of nucleic acids, polysaccharides and lipids 4. Apply fundamental knowledge about structural proteins and cytoskeleton 5. Explain the importance of vitamins and coenzymes
Prerequisites: Biochemistry	

CO, PO AND PSO MAPPING															
CO	**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**	**PSO-3**
CO-1	-	-	**2**	-	-	-	-	**1**	-	-	-	-	**1**	-	-
CO-2	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	-	**1**	-	-	-	-	**2**	-	-	-	-	**1**	-
CO-4	**1**	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-
CO-5	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-	**2**
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1: METABOLISM OF AMINO ACIDS	**(12L)**
Biosynthesis of Gly, Ser and Cys amino acid, Biosynthesis of Six Essential amino-acids (Met, Thr, Lys, Ile, Val, Leu) and its Regulation, Biosynthesis of aromatic acids-Important molecules derived from amino-acids (auxins, serotonin and polyamines). **Suggested Reading**: Amino acid synthesis	**CO-1** **BTL-1**
MODULE 2: PROTEIN TRANSPORT AND DEGRADATION	**(12L)**
Protein targeting- Signal sequence, Secretion, Organelle proteins, Protein Folding-Chaperons, Protein degradation, Receptor-mediated Endocytosis, Turnover. **Suggested Reading**: Protein targeting	**CO-2** **BTL-2**
MODULE 3: METABOLISM OF NUCLEIC ACIDS, POLYSACCHARIDES AND LIPIDS	**(12L)**
Biosynthesis of nucleotides and its regulation- Degradation of nucleic acid by nucleases-Biosynthesis and degradation of starch - Biosynthesis and degradation of Lipids(phospholipids)-Cholesterol biosynthesis and regulation-Growth hormones. **Suggested Reading:** Lipids and Nucleic acids synthesis	**CO-3** **BTL-3**
MODULE 4: STRUCTURAL PROTEINS AND CYTOSKELETON	**(12L)**
Contractile proteins, Mechanism of myosin ATPase activity, Excitation - contraction coupling and relaxation, Microtubules, Microfilaments and their role in organelle movements **Suggested Reading**: Muscle contraction	**CO-4** **BTL-3**

MODULE 5: VITAMINS AND COENZYMES	(12L)
Fat Soluble Vitamins, Pro vitamins - Structure, Physiological significance. Water soluble vitamins, structure, and coenzyme role with its deficiency symptoms. Thiamine, Riboflavin, Pyridoxine, Niacin, Folic Acid, Biotin And Vitamin B12. Recommended dietary intake. Coenzymes: Their role in metabolic pathways. NAD, FAD, TPP, PLP, Carboxy biotin **Suggested Reading**: Importance of Vitamins	**CO-5** **BTL-4**

TEXT BOOKS	
1.	David L.Nelson and Michael M. Cox. (2012). *Lehninger's Principles of Biochemistry*, Macmillan Learninger, 6th Edition.
2.	Jeremy M. Berg, John L. Tymoczko, Gregory J.Gatto, Jr., Lubert Stryer. (2015). *Biochemistry*. W.H. Freeman, 8th Edition.
REFERENCE BOOKS	
1.	Voet, D., Voet, J., Pratt, C.W. (2016). *Fundamentals of Biochemistry*. Wiley Publisher, 5th Edition.
2.	Satyanarayana, U., Chakrapani, U. (2013). *Biochemistry*, Elsevier, 4th Edition.
3.	Murray, R.K. (2012). *Harper's Illustrted Biochemistry*, McGraw Hill Professional, 29th Edition.
E BOOKS	
1.	https://biology.mit.edu/graduate/course/topics_metabolic_biochemistry
2.	https://books.google.co.in/books?isbn=3540453008
MOOC	
1.	http://www.nptelvideos.in/2012/11/biochemistry-i.html

COURSE TITLE	PLANT BIOTECHNOLOGY			CREDITS	4
COURSE CODE	BTB4318	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course focuses on the biotechnology of plants. The course is designed to give a brief understanding of the fundamentals of plant biochemistry with a view to provide the learners with an understanding of plant growth and requirements of plants. Studying of biochemical processes including photosynthesis, respiration, nitrogen cycle, growth hormones and secondary metabolism will provide a unique insight into how plant cells can be used and manipulated in in vitro cultures.
Course Objective	1. To recall the basic concepts of Biotechnology 2. To make the students to understand fundamental cellular events during the process of plant cell culture development 3. To express the concerns over modern plant biotechnology 4. To analyze them according to the regulatory frame works 5. Determine the factors influencing plant cell differentiation and thereby execute proper techniques/procedures for the maintenance of sterile condition and proper plant growth
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the basics of plant tissue culture 2. Analyze the different types of plant tissue culture. 3. Describe the process of nitrogen Fixation and what benefit it has to the N cycle 4. Perform experimental on Agrobacterium and other Viral Vectors for the production of transgenic plants 5. Explain about raising transgenic plants to the need of the environment

Prerequisites: Recombinant DNA Technology

CO, PO AND PSO MAPPING

CO	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	PSO-3

CO-1	-	-	**2**	-	-	-	-	**1**	-	-	-	-	**1**	-	-
CO-2	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	-	-	-	-	-	-	**2**	-	-	-	-	**1**	-
CO-4	**1**	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-
CO-5	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-	**2**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF PLANT TISSUE CULTURE	**(12L)**
Historical Perspectives, Laboratory Organization, Sterilization Methods, Plant Tissue Culture Media - Composition and Preparation - Plant Growth Regulators and Functions, Basic Technique of Plant Tissue Culture **Suggested Reading**: Techniques of plant tissue culture	**CO-1** **BTL-1**
MODULE 2: TYPES OF PLANT TISSUE CULTURE	**(12L)**
Cell Culture, Callus Culture, Protoplast Culture and Somatic Hybridization, Production of Haploid Plants-Androgenesis, Gynogenesis, Somaclonal Variation, Micropropagation, Germplasm Conservation and Cryopreservation **Suggested Reading**: Different culture types	**CO-2** **BTL-2**
MODULE 3: GROWTH PROMOTING BACTERIA IN PLANTS	**(12L)**
Biological Nitrogen Fixation-Nitrogen Fixing Bacteria - Nitrogenase activity, nod genes, nif genes, Biocontrol of phyto-pathogens, Bio-fertilizers **Suggested Reading**: Growth promoting bacteria in plants	**CO-3** **BTL-3**
MODULE 4: TRANSGENESIS IN PLANTS	**(12L)**
Agrobacterium Mediated Gene Transfer technique- crown gall disease and Ti plasmid –t-DNA, Ti Plasmid Derived Vectors, Viral Vectors: Gemini virus, Cauliflower mosaic virus, Direct or Vectorless DNA transfer. **Suggested Reading**: Transgenic technique	**CO-4** **BTL-4**

MODULE 5: : APPLICATION OF TRANSGENIC PLANTS	(12L)
Transgenic Plants Resistance to Biotic stresses- Insect, Virus, Fungal and Bacterial, Transgenic Plants Resistance to Abiotic stresses-Herbicide, Drought, Salt and Flood, Transgenic plants as Bioreactors- Metabolic engineering of carbohydrate, protein and lipids, Molecular Pharming. **Suggested Reading**: Genetically modified plants	**CO-5** **BTL-4**

TEXT BOOKS	
1.	Gamburg OL, Philips GC, (2015). *Plant Tissue & Organ Culture fundamental Methods*, Narosa Publications, 4th Edition.
2.	Singh BD. (2008). *Text Book of Biotechnology*, Kalyani Publishers, 3rd Edition.
REFERENCE BOOKS	
1.	Manoj Kumar Singh, (2017). *Plant Tissue Culture and Applied Plant Biotechnology*, Wiley Publishers, 7th Edition.
2.	Malik Zainul Abdin, Usha Kiran, Kamaluddin, Athar Ali. (2017). *Plant Biotechnology: Principles and Applications*, Springer.
E BOOKS	
1.	https://archive.org/details/FundamentalsOfGenetics
2.	https://books.google.co.in/books?isbn=8189866141
MOOC	
1.	https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-11-molecular-biology-2/
2.	https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular- biology/exam-2/

COURSE TITLE	ANIAMAL BIOTECHNOLOGY			CREDITS	4
COURSE CODE	BTB4319	COURSE CATEGORY	PC	L-T-P-S	3-0-1-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer (i.e. modify the genome of) animals in order to improve their suitability for pharmaceutical, agricultural or industrial applications. This course imparts techniques for genetic modification of animals that synthesize therapeutic proteins, have improved growth rates or are resistant to disease.
Course Objective	1. To learn the basic animal tissue culture techniques 2. To know about the various bacterial and viral diseases that affect animal's organs and cells of immune system. 3. To Design therapeutic approaches for treating animal diseases 4. To understand the micromanipulation technology and breeding of farm animals. 5. To impart knowledge on various strategies towards making transgenic animals.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand knowledge about basic animal tissue culture techniques 2. Analyse various Bacterial and viral diseases that affect animals 3. Design therapeutic approaches for treating animal diseases 4. Measure how to undertake micromanipulation technology. 5. Apply DNA manipulative techniques effectively to modify the genome of organism.

Prerequisites: Recombinant DNA Technology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	-	-	-	2	-	-	-	-	-	2	-	-	1	-
CO-2	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-
CO-3	1	-	-	-	-	1	-	-	-	-	1	-	-	1	-
CO-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5	2	-	-	-	-	1	-	-	-	-	2	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: INTRODUCTION TO ANIMAL CELL CULTURE MEDIA	**(9L+ 6P)**
Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures Lab1 : Preparation of media and maintenance of cell lines **Suggested Readings:** Basic animal tissue culture	**CO-1** **BTL-1**
MODULE 2: RECOMBINANT VACCINES FOR ANIMAL HEALTH AND THEIR DIAGNOSIS OF DISEASES	**(9L+ 9P)**
Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, RAPD, RFLP, Blotting Techniques Lab2: Isolation of DNA animal cells, Amplification by PCR and Analysis by RAPD, RFLP and Blotting Techniques **Suggested Readings:** Molecular diagnostic techniques	**CO-2** **BTL-2**
MODULE 3: VACCINES AND GENE THERAPY FOR ANIMAL DISEASES	**(6L)**
Vaccines and their applications in animal infections; gene therapy for animal diseases. **Suggested Readings:** Gene therapy and vaccine	**CO-3** **BTL-4**
MODULE 4: MICROMANIPULATION	**(9L+3P)**
What is micromanipulation technology; Equipment's used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation, Lab 4:Isolation of chicken embryo fibroblasts **Suggested Readings:** Micromanipulation strategies.	**CO-4** **BTL-3**
MODULE 5: TRANSGENIC ANIMALS	**(9L)**
Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals **Suggested Readings:** Stem cell culture	**CO-5** **BTL-4**
TEXT BOOKS	

1.	Ranga, M.M. (2002). *Animal Biotechnology,* Agrobios India Limited, 4th Edtion.
2.	Ramadass, P., Meera Rani, S. (2007). *Text Book of Animal Biotechnology*, Akshara Printers, 3rd Edition.
REFERENCE BOOKS	
1.	Masters J.R.W. (2005). *Animal Cell Culture: Practical Approach*, Oxford University Press, 2nd Edition.
2.	Verma, A., Singh, A. (2013). *Animal Biotechnology: Models in Discovery and Translation*, Academic Press.
E BOOKS	
1.	https://books.google.co.in/books?isbn=817993327X
2.	https://books.google.co.in/books?isbn=0123914345
MOOC	
1.	https https://www.mooc-list.com/course/industrial-biotechnology-edx
2.	https://www.mooc-list.com/tags/biotechnology

COURSE TITLE	BUSINESS ECONOMICS			CREDITS	2
COURSE CODE	GEA4304	COURSE CATEGORY	BS	L-T-P-S	2-0-0-2
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-2

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course introduces economic concepts and principles which are useful in understanding the general economic environment within which businesses and other organizations operate. Microeconomics examines how consumers and firms make decisions and how they interact with each other in markets.
Course Objective	1. To understand the importance of economics 2. To acquire knowledge on cost analysis 3. To know about consumer's and producer's behaviour 4. To know about the budget 5. To know about financial services.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding the introduction of economics 2. Validate about cost analysis 3. Acquire knowledge about consumer's and producer's behaviour 4. Perform the budget analysis 5. Analyze about financial services.

Prerequisites: CSB231 - Cryptography and Network Security

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2	-	-	-	-	2	-	-	-	-	-	-	1	-	-	1
CO-3	-	-	1	-	-	-	-	1	-	-	-	-	2	-	-
CO-4	-	-	1	-	-	-	-	-	-	2	-	-	-	1	-
CO-5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO ECONOMICS	(9L)
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics	**CO1** **BTL1**
MODULE 2: COST ANALYSIS	**(9L)**
Types of Cost, Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Economies of Scale Cost Classification	**CO2** **BTL2**
MODULE 3: CONSUMER'S AND PRODUCER'S BEHAVIOUR	**(9L)**
Consumer Behavior: Law of Diminishing Marginal utility – Equi marginal Utility – Consumer's Equilibrium - Indifference Curve – Production: Law of Variable Proportion – Laws of Returns to Scale – Producer's equilibrium – Economies of Scale Cost Classification	**CO3** **BTL1**
MODULE 4: BUDGET	**(9L)**
Process of budgeting in India –classification of budgets trends – evaluation systems – types of deficits – fiscal policy – indicators –– taxation – centre, state and local – public debt and management.	**CO4** **BTL1**
MODULE 5: FINANCE	**(9L)**
Basics of finance and financial environment – instruments of financial markets – financial intermediation – investment banking and brokerage services – securities – types of securities – market for securities – how and where traded – initial public offering (IPO) – secondary markets – trading on exchanges and trading with margins.	**CO5** **BTL2**

TEXT BOOKS	
1	Shankaran, S. (2012). *Business Economics*, Margham Publications.
2	Ahuja, H.L. (2016). *Business Economics – Micro & Macro*, Sultan Chand & Sons, New Delhi.
REFERENCE BOOKS	
1	Ross, S.A., Westerfield, R.W., Jaffe, J., Roberts. (2015). *Corporate Finance*, McGraw-Hill.
2	Stiglitz, J.A. (2018). *Economics of the Public Sector.*
E BOOKS	
1	https://sites.google.com/site/readbookpdf7734/pdf-download-business-economics-by---mark-taylor-read-online
2	https://bookboon.com/en/economics-ebooks

COURSE TITLE	PROTEIN ENGINEERING			CREDITS	3
COURSE CODE	BTC4369	COURSE CATEGORY	DE	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Protein engineering is the process of modifying the structures of proteins and assigns them new and/or desirable properties in terms of activity, solubility, affinity, stability, specificity, resistance, etc. The most commonly applied approaches for protein engineering include *de novo* design, rational design, and directed evolution. Creative Biostructure offers protein evolution and engineering services covering the full cycle of protein engineering to satisfy customers' requirements.
Course Objective	1. To identify the importance of protein biomolecules. 2. To realize the structure-function relationships in protein. 3. To apply the approached for *de novo* design, rational design, and directed evolution. 4. To Create the biostructure for protein evaluation 5. To get knowledge on protein engineering for the application towards proteomics.
Course Outcome	Upon completion of this course, the students will be able to 1. Determine the characteristics of individual amino acids and their effect on the solubility, structure and function of proteins 2. Analyze and compare the amino acid sequence and structure of proteins, and relate this information to the function of proteins 3. Describe the structure and classification of proteins 4. Apply factors significant for protein folding processes and stability 5. Acquire the fundamental elements at molecular level concerning protein structure-function relationships.

Prerequisites: Biochemistry

CO, PO AND PSO MAPPING

CO	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	PSO-3

CO-1	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**2**
CO-2	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-3	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
CO-4	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**
CO-5	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BONDS, ENERGIES INVOLVEMENT IN PROTEIN AND PROTEIN STRUCTURE ELUCIDATION (5L)	
Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, Xray). Elucidation of protein structure using - X-ray crystallography, NMR, Cryo-Electron Microscopy, SAXS. **Suggested Readings:** Structural Biology tools	**CO-1** **BTL-2**
MODULE 2: AMINO ACIDS, POST TRANSLATIONAL MODIFICATION IN PROTEINS, PEPTIDE SYNTHESIS (5L)	
Amino acids (the students should be thorough with three and single letter codes) and their role in solubility, Protein post-translational modification, Peptide synthesis, peptide mapping, peptide sequencing - automated Edman method & mass-spec. High-throughput protein sequencing **Suggested Readings:** Protein sequencing	**CO-2** **BTL-2**
MODULE 3: PROTEIN ARCHITECTURE AND BIOINFORMATICS TOOL TO VIEW PROTEIN STRUCTURE (12L)	
Primary structure of protein. Introduction to bioinformatic tools - PyMOL. Secondary structure: Alpha, beta and loop structures and methods to determine, Super-secondary structure: Alpha-turnalpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites. Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures, Quaternary	**CO-3** **BTL-3**

structure: Modular nature, formation of complexes. **Suggested Reading**: PyMOL, Domains and Protein folding	
MODULE 4: STRUCTURE-FUNCTION RELATIONSHIP	**(15L)**
DNA-binding proteins: prokaryotic transcription factors, Eukaryotic transcription factors; Domains - Zn fingers, helix-turn helix motifs, Leucine zippers; Ribosomes, Chaperones and Heat shock proteins. Membrane proteins: General characteristics, Trans-membrane segments, bacteriorhodopsin and Photosynthetic reaction center; Immunoglobulins: IgG Light chain and heavy chain architecture; Enzymes: Serine protease, DNA polymerase. **Suggested Reading**: Protein complexes	**CO-4** **BTL-2**
MODULE 5: PROTEIN ENGINEERING	**(8L)**
Advantages and purpose, overview of methods used to engineer proteins - recombinant technology, chromatographic techniques; Need to engineer protein: thermal stability T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, de novo protein design. **Suggested Reading**: Recombinant technology, Protein purification	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Anders Liljas. (2009). *Textbook of Structural Biology*, World Scientific.
2.	Voet, D., Voet, G. (2001). *Biochemistry ||*, John Wiley and Sons, 3rd Edn.
REFERENCE BOOKS	
1.	Höhne, M., Bornscheuer, U.I. (2018). *Protein Engineering: Methods and Protocols*, Springer New York.
2.	Samish, I. (2016). *Computational Protein Design Springer*, New York.
E BOOKS	
1.	https://www.buecher.de/shop/biochemie/protein-engineering-handbook-ebookpdf/ebook-pdf/products_products/detail/prod_id/37349486/
MOOC	
1.	https://nptel.ac.in/syllabus/102102011/

COURSE TITLE	PLANT BIOTECHNOLOGY LAB			CREDITS	1
COURSE CODE	BTB4341	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30	10	10	20	10	20%

Course Description	Plant Biotechnology aims to impart understanding of the basic principles of the plant sciences and molecular biology, as well as the integration of these disciplines, to provide healthy plants in a safe environment for food, non-food, feed and health applications. This course is designed to provide students with theoretical knowledge through lectures as well as critical discussion through the seminar abut current technological developments in research with trends in the aims and needs of today's biotechnology industries.
Course Objective	1. To describe methods for obtaining and application of genetically modified plants 2. To define regulatory issues for genetically modified plant production 3. To explain the application of plants as bioreactors for the production of vaccines and therapeutic proteins 4. To demonstrate critical knowledge in problem solving within an interdisciplinary context of biotechnological production of secondary metabolites. 5. To exploit the recombinant proteins using plant cell technology
Course Outcome	The students will be able to 1. Understand the basic techniques of plant tissue culture 2. Comprehend different types of plant tissue culture 3. Apply methods for the isolation and fusion of protoplasts 4. Determine the culture medium composition 5. Analyze the plant tissue culture techniques

Prerequisites: Basics of microbiology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-
CO-2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO-3	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CO-5	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1	**(15L)**
1. Preparation of Media for plant tissue culture 2. Sterilization of media and plant growth regulators 3. Selection and sterilization of explants 4. Inoculation of explant into the prepared media 5. Development of Callus from the explants	**CO-1** **BTL-3**
MODULE 2	**(15L)**
6. Regeneration of plantlets from the callus 7. Growth of plantlets from different parts of the plants 8. Isolation of protoplast from the plant cells 9. Fusion of protoplast to produce hybrid plants	**CO-2** **BTL-4**

SEMESTER VII

COURSE TITLE	BIOPROCESS ENGINEERING			CREDITS	4
COURSE CODE	BTB4401	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Study of the engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Emphasis is placed on enzyme kinetics and technology, bio reaction kinetics, design, analysis, and control of bioreactors and fermenters, and downstream processing of bio reaction products.
Course Objective	1. To impart knowledge on design and operation of fermenter with all its prerequisites 2. To study about design concepts in Bioreactor processes 3. To endow the students with the basics of microbial kinetics and modelling 4. To comprehend the concepts of bioreactor scale up 5. To understand various kinetic models of enzyme bioreactors
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the fundamental design concept and operation of fermenter. 2. Acquire with design concepts in Bioreactor processes 3. Formulate design kinetics of microbial growth and model the biochemical reaction. 4. Design concept and tools for scale up of bioreactors. 5. Determine the features of enzymes and its application and apply in reactors.

Prerequisites: Microbiology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO-2	-	-	-	2	-	-	-	-	2	-	-	-	1	-	-
CO-3	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	3	-	-	-	2	-	-	-	-	1	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1: BIOREACTORS AND MEDIUM OPTIMIZATION	**(9L+3T)**
Overview of Bioprocesses- General requirements of fermentation processes, Basic configuration of fermenter and ancillaries. Criteria for good medium, Medium requirements for fermentation processes and optimization techniques **Suggested Readings:** Introduction to fermentation process	**CO-1** **BTL-2**
MODULE 2: ANALYSIS OF BIOREACTOR CONFIGURATIONS	**(9L+3T)**
Stirred Tank Reactor, Packed bed reactor, Air Lift reactor, Fluidized bed reactor, bubble column reactor -non-ideality, RTD and Stability, Design of sterilization equipment-batch and continuous. **Suggested Readings:** Overview of reactor types	**CO-2** **BTL-3**
MODULE 3: MODELLING OF BIOPROCESSES	**(9L+3T)**
Modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, Study of structured models for analysis of various bioprocesses – Compartmental models, models of cellular energetics and metabolism, single cell models **Suggested Readings:** Models for bioreactors	**CO-3** **BTL-4**
MODULE 4: BIOREACTOR SCALE-UP	**(9L+3T)**
Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors. **Suggested Readings:** Oxygen Requirement and scale up	**CO-4** **BTL-4**
MODULE 5: BIOREACTOR CONSIDERATION IN ENZYME SYSTEM	**(9L+3T)**
Design of immobilized enzyme reactors –packed bed, fluidized bed and membrane reactors. Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions, formulation of dimensionless groups and calculation of effectiveness factors. **Suggested Readings:** Immobilized bioreactors	**CO-5** **BTL-3**
TEXT BOOKS	

1.	Shuler, M.L., Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts*, Pearson Education.2nd Edition,
	Bailey, J.E., Ollis, D.F. (2010). *Biochemical Engineering Fundamentals*, McGraw-Hill Education, Second Edition.
REFERENCE BOOKS	
1.	Doran, P.M. (2013). *Bioprocess Engineering Principles*, Elseiver, 2nd Edition.
2.	Blanch, H.W., Clark, D.S. (2005). *Biochemical Engineering*, Marcel Decker Inc., Anton Moser, —Bioprocess Technology, Kinetics and Reactors, Springer Verlag, 4th Edition.
E BOOKS	
1.	https://ocw.mit.edu/courses/chemical-engineering/10-442-biochemical-engineering-spring-2005/index.htm
	https://books.google.co.in/books?isbn=012220851X
MOOC	
1.	http://nptel.ac.in/courses/103105054/
2.	https://www.coursera.org/learn/industrial-biotech

<table>
<tr><td>COURSE TITLE</td><td colspan="3">BIOINFORMATICS</td><td>CREDITS</td><td>4</td></tr>
<tr><td>COURSE CODE</td><td>BTB4402</td><td>COURSE CATEGORY</td><td>PC</td><td>L-T-P-S</td><td>3-1-0-2</td></tr>
<tr><td>Version</td><td>1.0</td><td>Approval Details</td><td>24th ACM - 30.5.2018</td><td>LEARNING LEVEL</td><td>BTL-4</td></tr>
<tr><td colspan="6">ASSESSMENT SCHEME</td></tr>
<tr><td>First Periodical Assessment</td><td>Second Periodical Assessment</td><td colspan="2">Seminar/ Assignments/ Project</td><td>Surprise Test / Quiz</td><td>Attendance</td><td>ESE</td></tr>
<tr><td>15%</td><td>15%</td><td colspan="2">10%</td><td>5%</td><td>5%</td><td>50%</td></tr>
<tr><td>Course Description</td><td colspan="5">This course is an introduction to the application of computational methods to biological data analysis and for discovery. The focus will be on computational methods in Genomics and Proteomics. In Genomics, computational methods will include DNA sequencing and fragment assembly, identification of genes in DNA, gene regulation, expression, large data arrays, and methods to study genetic diversity.</td></tr>
<tr><td>Course Objective</td><td colspan="5">1. To provide an introduction to what bioinformatics is and why it is important
2. To provide an overview of the application areas of bioinformatics, with a focus on the topics that will be taught in the course
3. To explain what type of knowledge will be gained from the course
4. To describe how bioinformatics data is stored and organized
5. To describe the different types of data found at the NCBI and EBI resources</td></tr>
<tr><td>Course Outcome</td><td colspan="5">Upon completion of this course, the students will be able to
1. Understand the fundamental knowledge on Bioinformatics and its various applications
2. Apply how to use biological databases.
3. Analyze and use different tools and programs to analyze the sequences
4. Evaluate phylogenetic tree analysis
5. Explain the advanced techniques in bioinformatics.</td></tr>
<tr><td colspan="6">Prerequisites: : Molecular Biology, Biochemistry</td></tr>
<tr><td colspan="6">CO, PO AND PSO MAPPING</td></tr>
</table>

CO	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	PSO-3
CO-1	1	-	-	-	-	-	-	1	-	-	-	-	1	-	1
CO-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	1	-	-	-	-	-	-	-	-	1
CO-4	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-
CO-5	1	-	-	3	-	-	-	-	-	-	-	-	2	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(6L+6L=12)**
Bioinformatics- Introduction-Birth of Bioinformatics-Human genome project-Current status. Sub disciplines of Bioinformatics, Components of Bioinformatics, and Applications of Bioinformatics. **Suggested Readings:** Introduction about Bioinformatics	**CO-1** **BTL-2**
MODULE 2: DATABASES	**(6L+6L=12)**
Data management —biological databases - Nucleotide databases - Genbank, Protein databases, Protein structural databases, Alternative databases. Data Submission system, Information Retrieval Systems, Data mining, Pubmed. **Suggested Readings:** Databases	**CO-2** **BTL-2**
MODULE 3: SEQUENCE ANALYSIS	**(6L+6L=12)**
Sequence Alignment-Pairwise sequence alignment-dot matrix analysis –substitution matrices – dynamic programming —local vs. global alignment. Tools for sequence analysis- BLAST and FASTA. Multiple sequence alignment – Algorithms and Tools, Sequence file formats, Translation of sequences by Expasy, Primer Designing. **Suggested Readings:** Genetics and sequences	**CO-3** **BTL-3**
MODULE 4: PHYLOGENETIC ANALYSIS	**(6L+6L=12)**

Phylogenetic tree-Process for phylogenetic analysis- Tools for phylogenetic analysis, Mutations; Irrelevant mutations; Mutations as a measure of time; Distances between species. **Suggested Readings:** Evolution	**CO-4** **BTL-2**
MODULE 5: ADVANCED TECHNIQUES IN BIOINFORMATICS	**(6L+6L=12)**
Biomolecular and cellular computing –micro array analysis –systems biology–Next Generation Sequencing-Transcriptomic Analysis-Data analysis-Gene identification by ORF finder **Suggested Readings:** Next Generation Sequencing	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Bergeron, B. (2002). *Bioinformatics Computing*, PHI, 2nd Edtion.
2.	Baby Joseph and Nair, V.M. (2014). *Bioinformatics an elementary and practical approaches*, Elite Publishing House Pvt. Ltd, 1st Edition.
REFERENCE BOOKS	
1.	Westhead, D.R., Parish, J.H., Twyman, R.M. (2000). *Instant Notes In Bioinformatics*, BIOS Scientific Publishers, 3rd Edtion.
2.	Xiong, J. (2006). *Essential Bioinformatics*, Cambridge University Press.
E BOOKS	
1.	https://books.google.co.in/books?id=SFu7UMSmr_gC&printsec=frontcover&dq=subject:%22Animal+biotechnology%22&hl=en&sa=X&ved=0ahUKEwiTj4zihJjXAhUDPo8KHUpZAzAQ6AEIMDAC#v=onepage&q&f=false
2.	https://books.google.co.in/books/about/Animal_Biotechnology.html?id=DKM_k7M8dAUC&redir_esc=y
MOOC	
1.	C 1. http://nptel.ac.in/syllabus/syllabus.php?subjectId=102999902

COURSE TITLE	INDUSTRIAL BIOTECHNOLOGY			CREDITS	4
COURSE CODE	BTB4403	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Study of the overall industrial bioprocesses and process requirements of the industrial needs. Emphasis is placed on fermenter system, bulk production of primary and secondary metabolites, commercially important modern bio products, industrial enzymes, products of plant and animal cell cultures
Course Objective	1. To impart knowledge on various industrial bioprocess. 2. To study about fermentative production of primary metabolites. 3. To endow the students with the fermentative concept of secondary metabolite production. 4. To comprehend the methods of producing enzymes and other biological products. 5. Understand the application of modern biotechnology products.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the various industrial bioprocesses 2. Identify commercially important primary metabolites and their usage 3. Evaluate thoroughly the manufacturing processes of various secondary metabolites 4. Assess the various methods for producing industrially relevant enzymes 5. Identify the recombinant proteins used for therapeutic and diagnostic application

Prerequisites: Microbiology

CO, PO AND PSO MAPPING

CO	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	PSO-3

CO-1	-	-	**1**	-	-	-	-	-	-	-	-	-	**1**	-	-
CO-2	-	-	-	-	-	-	**1**	-	-	-	**1**	-	-	-	**2**
CO-3	-	-	-	-	-	-	**2**	-	-	-	-	-	-	**1**	-
CO-4	**1**	-	**1**	-	-	-	-	-	-	-	-	-	-	-	**1**
CO-5	-	-	**3**	-	-	-	-	-	-	-	-	-	-	**2**	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO INDUSTRIAL BIOPROCESS	**(9L+3T)**
Historical overview of industrial fermentation process – Fermenters system, Types of fermenters, Process flow sheeting –Block Diagrams, Pictorial Representation. **Suggested Readings:** Bioreactors	**CO-1** **BTL-2**
MODULE 2: PRODUCTION OF PRIMARY METABOLITES	**(9L+3T)**
A brief outline of processes for the production of some commercially important organic acids (e.g. Citric acid, Lactic acid, Acetic acid); Amino acids (Glutamic acid, Phenylalanine, Aspartic acid etc.,) and alcohols (Ethanol, Butanol etc.,). **Suggested Readings:** Commercial production of primary metabolites	**CO-2** **BTL-2**
MODULE 3: PRODUCTION OF SECONDARY METABOLITES	**(9L+3T)**
Study of production processes for various classes of secondary metabolites: Antibiotics: Beta-lactams (Penicillin, Cephalosporin etc.), Aminoglycosides (Streptomycin) **Suggested Readings:** Commercial production of secondary metabolites	**CO-3** **BTL-2**
MODULE 4: PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS	**(9L+3T)**
Production of industrial enzymes such as Proteases, Amylases, Lipases, Cellulases etc., Production of Biopesticides, Biofertilisers, Bio preservatives (nisin), Cheese, Biopolymers (Xanthan gum, PHB), Single cell protein. **Suggested Readings:** Enzyme large scale production	**CO-4** **BTL-3**
MODULE 5: PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS	**(9L+3T)**
Production of recombinant proteins having therapeutic and diagnostic applications, Production of vaccines. Production of monoclonal antibodies. Products of plant and animal cell culture. **Suggested Readings:** Biotechnology products for medical applications	**CO-5** **BTL-4**
TEXT BOOKS	

1.	Cruger, W., Crueger, A. (2005). *Biotechnology: A Textbook of Industrial Microbiology*, Panima Publishing Corporation, Second Edition.
2.	CasidaJr, L.E. (2015). *Industrial Microbiology*, New Age International (P) Ltd., 4th Edition, New Delhi.
REFERENCE BOOKS	
1.	Jogdand, S.N. (2006). *Industrial Biotechnology: Approach to Clean Technology*, Himalaya Publishing House, 2nd Edition, Mumbai.
2.	Murrey Moo & Young. (2011). *Comprehensive Biotechnology*, Elseiver Publication, 2nd Edition.
E BOOKS	
1.	https://ebookcentral.proquest.com/lib/hindustanuniv/detail.action?docID=588366
2.	https://books.google.co.in/books?isbn=3527630244
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc17_bt23/preview
2.	https://www.coursera.org/learn/industrial-biotech

COURSE TITLE	IMMUNOLOGY			CREDITS	4
COURSE CODE	BTB4404	COURSE CATEGORY	PC	L-T-P-S	3-0-1-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The immune system governs defense against pathogens and is of importance for development of autoimmune diseases, allergy and cancer. The course discusses basic immunology including cellular and molecular processes that represents the human immune system. Subjects to be presented include cells and organs of the immune system, antigen, immunoglobulins, molecular mechanisms of innate and adaptive immunity, the complement system, antigen presentation, and select lectures on the immune system in health and disease.
Course Objective	1. To learn the fundamentals of immunity 2. To know about the organs and cells of immune system. 3. To study about immune responses to infections. 4. To ascertain the autoimmunity and genetics of transplantation. 5. To understand the fundamental techniques of immunology.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the fundamentals of immunity 2. Acquire knowledge on the organs and cells of immune system 3. Determine immune responses to infections 4. Describe the autoimmunity and genetics of transplantation 5. Apply the fundamental techniques of immunology

Prerequisites: Basics of biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	1	-	2	-	-	-	-	-	-	-	-	-	1

CO-2	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO-3	**-**	**-**	**-**	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO-4	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-5	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**2**
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1: OVERVIEW OF IMMUNITY	**(9L)**
Introduction and Historic perspectives of Immunology: Types of Immunity – Innate and acquired immunity; Cells of Immune system; Types of immune response, Primary and Secondary Lymphoid organs, Antigens – nature of antigens, Haptens, Adjuvants **Suggested Readings:** Basics of immunology	**CO-1** **BTL-1**
MODULE 2: CELLULAR RESPONSES	**(9L)**
Development, maturation, Activation and differentiation of T cells and B cells. TCR and BCR. Regulation of T cell and B cell responses. Antibodies- Structure, types and Functions, Genes and generation of Diversity, Types and significance of MHC molecules; mechanism of antigen processing and presentation **Suggested Readings:** Immune cells and antibodies	**CO-2** **BTL-2**
MODULE 3: INFECTION AND IMMUNITY	**(9L+6P)**
Injury and Infection, Immune responses to infections: immunogenicity, antigenicity, cytokines, complement; immunosuppression, allergy and hypersensitivity; AIDS and Immuno-deficiencies; Tolerance, resistance and immunization, Vaccines **Suggested Readings:** Infection, immunogenicity and vaccine Lab 1: Agglutination reaction – Active (WIDAL Test) and Passive (Latex agglutination test)	**CO-3** **BTL-2**
MODULE 4: AUTOIMMUNITY AND TRANSPLANTATION	**(9L+3P)**
Autoimmunity, Autoimmune disorders and diagnosis; Transplantation: genetics of transplantation; laws of transplantation, tumor immunology **Suggested Readings:** Autoimmunity and rejection Lab 2: Isolation of antigen from microbes by SDS-PAGE	**CO-4** **BTL-3**
MODULE 5: IMMUNOTECHNOLOGY	**(9L+6P)**
Hybridoma Technology and Monoclonal antibodies, Polyclonal antibodies Production, ELISA RIA, Immunoprecipitation, Immunodiagnosis, Flow cytometry, Immunoblotting	**CO-5** **BTL-4**

techniques **Suggested Readings:** Biotechnology products for medical applications Lab 3: Detection of specific antigens by Indirect ELISA technique ; Identification of specific antigens by Immunoblotting technique	
TEXT BOOKS	
1.	Roitt I, Male, Brostoff. (2002). *Immunology*, Mosby Publ., 2nd Edition.
2.	Kindt, T.J., Goldsby, R.A., Osborne, B.A., Kuby, J., Kuby. (2007). *Immunology*, W.H. Freeman, 4th Edition.
REFERENCE BOOKS	
1.	Chakravarthy, A. (2008). *Immunology*, Tata McGraw-Hill, 3rd Edition.
2.	Punt, J., Stranford, S., Jones, P., Owen, J.A., Kuby. (2018). *Immunology*, Macmillan Learning publisher, 8th Edition.
E BOOKS	
1.	https://books.google.co.in/books?isbn=1118451643
2.	https://books.google.co.in/books?id=rhRrAAAAMAAJ
MOOC	
1.	https://www.mooc-list.com/tags/immunology
2.	https://www.mooc-list.com/tags/immune-system

COURSE TITLE	FOOD PROCESSING AND PRESERVATION TECHNOLOGY			CREDITS	3
COURSE CODE	BTC4451	COURSE CATEGORY	DE	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	Food Processing and Preservation Technology course, gives an explanation of food constituents and energy levels. The course also discusses use of additives in food processing industry for preservation and to prevent the spoilage of food-by-food products manufacture. Finally, explaining the methods employed for shelf-life extension of perishable foods.				
Course Objective	1. To figure out the relationship between the food constituents and their energy levels 2. To determine the pros and cons of various food additives 3. To analyse the process of food processing and preservation using appropriate microorganism 4. To suggest steps to prevent food spoilage 5. To employ the correct method of food preservation to improve the shelf life of food products.				
Course Outcome	Upon completion of this course, the students will be able to 1. Understand relationship between the food constituents and their energy levels. 2. Determine the pros and cons of various food additives 3. Analyze the process of food processing and preservation using appropriate microorganism 4. Apply steps to prevent food spoilage 5. Employ the correct method of food preservation to improve the shelf life of food products.				
Prerequisites: BTB4202 – Microbiology					

CO, PO AND PSO MAPPING															
CO	**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**	**PSO-3**
CO-1	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-2	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**-**
CO-3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO-4	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**
CO-5	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FOOD AND ENERGY	**(9L)**
Constituents of food - carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics. **Suggested Reading:** All the structural components present in food.	**CO-1** **BTL-2**
MODULE 2: FOOD ADDITIVES	**(9L)**
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants - natural and artificial; food flavors; enzymes as food processing aids **Suggested Reading:** Food Additives	**CO-2** **BTL-2**
MODULE 3: MICROORGANISMS ASSOCIATED WITH FOOD	**(9L)**
Bacteria, yeasts and molds - sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein **Suggested Reading:** Microbiology	**CO-3** **BTL-3**
MODULE 4: FOOD BORNE DISEASES	**(9L)**
Classification - food infections - bacterial and other types; food intoxications and poisonings - bacterial and non-bacterial; food spoilage - factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products **Suggested Reading:** Diseases caused by Microbes in food	**CO-4** **BTL-2**
MODULE 5: FOOD PRESERVATION	**(9L)**

Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods. **Suggested Reading:** Methodology of Food Preservation	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Coultate, T.P. (2002). *Food - The Chemistry of Its Components*, Royal Society, 2nd Edition, London.
2.	Sivasanker, B. (2002). *Food Processing and Preservation*, Prentice-Hall of India Pvt. Ltd., 3rd Edition, New Delhi.
REFERENCE BOOKS	
1.	Frazier, W.C., Westhoff, D.C. (2008). *Food Microbiology*, McGraw-Hill Book Co, 4th Ed., New York.
2.	Jay, J.M. (2007). *Modern Food Microbiology*, CBS Pub., 3rd Edition, New Delhi.
E BOOKS	
1.	https://books.google.co.in/books?isbn=0081005237
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc18_ar08/preview

COURSE TITLE	BIOINFORMATICS LAB			CREDITS	1
COURSE CODE	BTB4431	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	This course will provide students with a thorough review of common techniques and concepts that are used in the Bioinformatics Laboratory.
Course Objective	1. To retrieve of information from different databases 2. To compare the different genome 3. To impart training in primer designing 4. To equip the students with how to construct phylogenetic tree 5. To study the next generation sequencing.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the retrieval of information from different databases 2. Apply the genomic comparison and its analysis 3. Analyze with primer designing 4. Describe the phylogenetic tree construction 5. Explain about the next generation sequencing.

Prerequisites: Basics of molecular biology and genetics

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	-	3	2	-	-	-	-	-	2	-	2	-	-

CO-2	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**
CO-3	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO-4	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO-5	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**1**

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:RETRIEVAL OF INFORMATION FROM DIFFERENT DATABASES	**(6L)**
1. Searching biological databases using NCBI 2. Retrieval of information from Pubmed database 3. Recovery of gene sequences from GenBank database 4. Retrieval of protein structure from protein data bank	**CO-1** **BTL-3**
MODULE 2: GENOME COMPARISON	**(6L)**
5. Genome comparison- BLAST, FASTA 6. Translation of the sequences by Expasy Server	**CO-2** **BTL-3**
MODULE 3:PRIMER DESIGNING	**(6L)**
7. Primer designing	**CO-3** **BTL-3**
MODULE 4: MULTIPLE SEQUENCE ALIGNMENT	**(6L)**
8. Phylogenetic Reconstruction/Multiple sequence alignment	**CO-4** **BTL-3**
MODULE5:NEXT GENERATION SEQUENCING	**(6L)**
9. Gene Identification by ORF finder 10. Next Generation Sequence Analysis	**CO-5** **BTL-3**

TEXT BOOKS

1. Iftekhar, M., Iftekhar, M., Ghalib, M.R. (2016). *Bioinformatics Laboratory*.

REFERENCE BOOKS

1. Samal, K.C., Raut, G.C. (2014). *Bioinformatics Lab Manual***.**

E BOOKS

1. http://teodorolab.mcgill.ca/300D/bioinfo_manual.biochem.pdf

MOOC

1.	https://www.coursera.org/lecture/bioinformatics-methods-1/lab-discussion-3b0C0

COURSE TITLE	BIOPROCESS ENGINEERING LAB			CREDITS	1
COURSE CODE	BTB 4432	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	24th ACM - 30.5.2018	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	This course imparts practical exposure on basic techniques employed for the culture growth, medium optimization, reaction kinetics, immobilization, mass transfer and reactor operation.
Course Objective	1. To provide the students practical knowledge on the medium optimization in different kinds of reactors 2. To impart hands-on training in operating reactor and to Estimate the mass transfer coefficient using bioreactor.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the medium optimization in different kinds of reactors 2. Estimate the mass transfer coefficient using bioreactor

Prerequisites: Bioprocess Engineering and Industrial Biotechnology.

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	3	2	2	-	-	-	-	-	1	-	-	-	-
CO-2	-	-	2	3	3	-	-	-	-	-	2	-	-	-	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1	(15L)
1. Growth of yeast –Estimation of biomass, calculation of specific growth rate, yield coefficient 2. Medium optimization by Plackett Burman design	CO-1 BTL-3

3. Medium optimization by Response surface methodology 4. Enzyme kinetics – Evaluation of Michelis Menton parameters 5. Effect of temperature and pH on Enzyme activity	
MODULE 2	**(15L)**
6. To perform the Enzyme immobilization by cross linking 7. Estimation of mass transfer coefficient by dynamic gassing out method 8. Estimation of mass transfer coefficient by Sulphite oxidation method 9. Estimation of RTD in bioreactor 10. Bioreactor Operations and cultivation or product formation	**CO-2** **BTL-4**

HONOURS COURSES - GENETICS

COURSE TITLE	CLASSICAL PAPERS IN MOLECULAR GENETICS			CREDITS	3
COURSE CODE	BTH4364	COURSE CATEGORY	HONORS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course discusses a selection of classical papers, and to put these landmarks in their historical context. The role of DNA manipulation and its application. Further, the use of modern sequencing techniques to study the disease outbreak.
Course Objective	1. To understand evolution of living systems and the role of genetic mutation and selection in the evolution of the human species. 2. To explain DNA replication in bacteria, plasmids, transposable elements, as well as eukaryotic organelles and the nucleus. 3. To describe molecular events involved in DNA repair and recombination. 4. To illustrate the role of molecular mechanisms related to gene expression. 5. To demonstrate the synthesis and manipulation of DNA.
Course Outcome	Upon completion of this course, the students will be able to 1. Summarize the evolution of living systems and the role of genetic mutation and selection in the evolution of the human species. 2. Explain DNA replication in bacteria, plasmids, transposable elements, as well as eukaryotic organelles and the nucleus. 3. Describe the molecular events involved in DNA repair and recombination. 4. Illustrate the molecular mechanisms related to gene expression. 5. Demonstrate the synthesis and manipulation of DNA.

Prerequisites: Molecular Biology

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	2	-	-	1	-	1	-	1	2	-	-	1	-
CO-2	-	1	-	-	1	-	-	-	2	-	1	-	-	-	1
CO-3	-	-	-	2	-	2	-	-	-	3	-	1	-	1	-
CO-4	2	-	1	-	-	-	1	3	-	-	1	-	2	-	-
CO-5	-	2	-	1	3	-	-	-	1	-	-	3	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 CRACKING THE GENETIC CODE AND CENTRAL DOGMA	**(9L)**
Introduction to DNA - Molecular structure of DNA solved by James Watson and Francis Crick, Packing of DNA into Chromosomes. Central dogma - Replication, Transcription and Translation; Molecular biology techniques - PCR, Gel Electrophoresis. DNA fingerprinting - Forensic studies	**CO-1** **BTL-2**
MODULE 2 GENE A TRANSFORMATION MATERIAL	**(9L)**
Mendels Principles, Relationship between gene and enzyme - Garrod, Cuénot. Beadle and Tatum - Discovery of Biochemical Genetics, formation of “one gene one enzyme” hypothesis; multigene enzymes, structural and enzymatic RNAs. Avery experiment on pneumococcus and bacterial pneumonia. Griffith’s experiment on transformation. Hershey and chase confirmation on genes	**CO-2** **BTL-2**
MODULE 3 UNDERSTANDING THE ROLE OF MUTATIONS	**(9L)**
Origin of mutation - Darwinism Vs Lamarckism; Mutations – genetic error, pros and cons of mutation; Random mutation and specific mutation by mutagen, Mutation to immunity vs acquired immunity; Bacterial resistance link with mutation; Quantitative approaches to understand genes; Mutation rates; Newcombe experiment - resistant bacteria.	**CO-3** **BTL-2**
MODULE 4 DNA MANIPULATION AND ITS APPLICATIONS	**(9L)**

DNA manipulation: applications of genetic engineered DNA, construction of plasmid DNA using molecular biology techniques; Genetically modified organism – ethics and safety. Human genome project, pharmacogenomics; Genetic genealogy tests.	**CO-4** **BTL-3**
MODULE 5 ASSEMBLY OF GENOME USING MODERN SEQUENCING	**(9L)**
European *E. coli* Outbreak – Role of computational biologist in finding out the genome sequence of *E.coli* X; Genome assembly programming language; Sequencing viral genome, algorithmic challenge of DNA sequencing, Bridges of Konigsberg; Assembling Genomes using de Bruijn Graphs; Challenges faces in modern sequencing technologies- assembling the smallest bacterial genome of leafhoppers, assemble the *E. coli* X genome.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Janitz, M. (Ed.). (2011). *Next-generation genome sequencing: towards personalized medicine*. John Wiley & Sons, New York, USA, pp.1-282.
2.	Glover, D. M. (2013). *Gene cloning: the mechanics of DNA manipulation. Springer, Germany*. pp.1-221.
REFRENCE BOOKS	
1.	Alberts, B. (2015). *Molecular Biology of the Cell*. United Kingdom: Garland Science, Taylor and Francis Group, UK, pp.1-1464.
MOOC	
1.	https://www.coursera.org/learn/papers-molecular-genetics
2.	https://www.coursera.org/learn/dna-decoded
3.	https://www.coursera.org/learn/assembling-genomes

COURSE TITLE	**BASICS OF GENETICS**			**CREDITS**	**3**
COURSE CODE	**BTH4365**	**COURSE CATEGORY**	**HONORS**	**L-T-P-S**	**2-0-1-0**

Version	1.0	Approval Details		LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course deals with genetics at cellular and organismal levels, population genetics and micro evolutionary processes. It provides the basic knowledge for the beginners in Genetics on the structure and function of the DNA molecule and the flow of genetic information from gene to products, chromosome structure and organization. Processes and pathways are introduced progressively, from DNA to RNA to protein to whole cell systems. Various genetic engineering tools and their various applications are included in this course.				
Course Objective	1. To acquire knowledge on basic aspects of the flow of genetic information from DNA to proteins. 2. To familiarize the fundamental genetic concepts and basic processes in population genetics, mutation, genetic drift and describe how they affect the genetic diversity within a species. 3. To provide knowledge about transcription, translation and the genetic code to demonstrate an understanding of the various genetic engineering tools. 4. To expose students to application of recombinant DNA technology in biotechnological research. 5. To train students in strategizing research methodologies employing genetic engineering techniques.				
Course Outcome	Upon completion of this course, the students will be able to 1. Explain the basic aspects of the flow of genetic information from DNA to proteins. 2. Describe the processes in population genetics, mutation, genetic drift and its effect on genetic diversity. 3. Demonstrate about genetic engineering techniques and their role in diagnosis and healthcare. 4. Organize and design different vectors for gene cloning and expression. 5. Analyze the recent genetic developments and concerns in medical technology and regulatory environment.				
Prerequisites: Molecular Biology					
CO, PO AND PSO MAPPING					

CO	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	PSO-3
CO-1	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-
CO-2	-	-	-	-	1	-	-	-	-	2	-	-	-	1	-
CO-3	-	-	-	-	-	1	2	-	-	-	-	-	-	1	-
CO-4	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: EVOLUTION AND BASICS OF GENETICS	**(9L)**
Classical ecological genetics, Population size and Natural selection, Human Evolution and patterns of Evolution, Genes and inheritance, Basics of Biological System, DNA- the hereditary material, DNA structure and Function.	**CO-1 BTL-2**
MODULE 2: GENETIC LIBRARIES	**(7L+2P)**
cDNA & genomic DNA library construction and screening, Preparation of DNA, RNA probes immunoscreening, Artificial chromosomes – BACs and YACs, Chromosomal walking, Screening of DNA libraries using nucleic acid probes and antisera. Lab1: To isolate the bacterial genomic DNA by phenol chloroform extraction method	**CO-2 BTL-3**
MODULE 3: GENETIC INFORMATION CODING AND EXPRESSION	**(7L+2P)**
DNA Replication and Repair, Organization of prokaryotic and eukaryotic chromosomes, Structure and function of mRNA, rRNA and tRNA, Transcription-RNA synthesis: Initiation, elongation and termination of RNA synthesis, Translation- Introduction and elucidation of Genetic code: Codon degeneracy, Wobble hypothesis and its importance. Lab 2: To separate the DNA by Agarose gel electrophoresis	**CO-3 BTL-3**
MODULE 4: GENETIC ENGINEERING TOOLS AND TECHNIQUES	**(7L+2P)**
Restriction Enzymes - Exonucleases and Endonucleases, DNA ligase, Methyl transferases, DNA Polymerases, Alkaline Phosphatase, Reverse Transcriptase and Plasmids. Techniques – DNA and RNA extraction methods, PCR and types, Gel Electrophoresis and variations, Blotting techniques. Lab 3: Amplification of isolated DNA by PCR Thermal cycler.	**CO-4 BTL-3**
MODULE 5: GENETICS AND APPLICATIONS	**(7L+2P)**
Recombinant DNA technology, Basics and creation of recombinant molecules, Immunotechnology, Role in human welfare, Transgenic plants and animal knock out,	**CO-5 BTL-3**

Gene therapy, Basics of cloning, Cloning vectors and types, Concerns and limitations of genetic applications. Lab 4: Confirmation of target gene in the genome by using Southern Blotting	
TEXTBOOKS	
1.	Allison, L. A. (2021). *Fundamental molecular biology*, John Wiley & Sons, USA. Pp.1-816.
2.	Glick, B. R. and Patten, C. L. (2017). *Molecular biotechnology: principles and applications of recombinant DNA*, American Society for Microbiology, Washington DC, US, pp.1-708.
REFERENCE BOOKS	
1.	Chandar, N., & Viselli, S. (2012). *Cell and molecular biology*, Lippincott Williams & Wilkins. New York, pp.1-236.
2.	Lewis, R. (2016). *Human Genetics: The Basics*, Taylor and Francis, London, UK, pp.1-206.
MOOC	
1.	https://alison.com/course/biology-evolution-and-genetics.

COURSE TITLE	**GENOMICS FOR LAW**			**CREDITS**	**3**
COURSE CODE	**BTH4379**	**COURSE CATEGORY**	**HONORS**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	Genomics for law provides a unique framework to review the history and basics of genomics research as well as explore how genomics has, and will continue to, interact with the law. Throughout this course you will explore the implications of genomics research on law as it pertains to the topics such as Forensic, IPR and genome sequencing				
Course Objective	1. To explain the genomics and criminal laws 2. To interpret the concept of forensic genomics ad ethical considerations 3. To illustrate intellectual property in genomic law 4. To identify the methods in whole genome sequencing 5. To demonstrate a strong foundation on genetic testing and sequencing technologies				
Course Outcome	Upon completion of this course, the students will be able to 1. Explain genomic and criminal laws 2. Interpret the concept of forensic genomics ad ethical considerations 3. Illustrate intellectual property in genomic law 4. Identify the methods in whole genome sequencing 5. Demonstrate the techniques of sequencing and genetic testing				
Prerequisites: Molecular Biology					

CO, PO AND PSO MAPPING															
CO	**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**	**PSO-3**
CO-1	-	-	-	-	1	-	-	2	-	-	-	2	1	-	-
CO-2	1	-	1	2	-	-	1	1	-	1	3	-	-	1	-
CO-3	-	2	-	-	-	3	-	-	3	-	2	-	-	2	1
CO-4	2	-	-	1	-	-	1	-	1	2	-	-	1	-	-
CO-5	-	1	2	-	3	1	-	-	-	-	-	2	-	-	2
1: Weakly related, 2: Moderately related and 3: Strongly related															

MODULE 1 GENOMICS AND CRIMINAL- LAWS AND PROCEDURES	(9L)

Introduction to genomics for law: Structure and function of the genome; Central dogma; Evolution of gene sequencing - genomics and criminal law - essential elements - Short Tandem Repeats (STR) – basics of Combined DNA Indexing System STRs (CODIS).	**CO-1** **BTL-2**
MODULE 2 FORENSIC GENOMICS	**(9L)**
Introduction to forensic genomics- DNA in investigative leads - Ancestry estimations; Introduction to race and ancestry - ancestry and physical appearance - ancestry and investigations - ethical and legal considerations.	**CO-2** **BTL-2**
MODULE 3 INTELLECTUAL PROPERTY	**(9L)**
Origins of patent law - Trade secret alternative - Utility patents - Introduction to CRISPR technology - Plant patents - Patenting practicalities - the "art" of claims drafting- Blocking patents - First sales doctrine - literal infringement - doctrine of equivalency - Infringement defenses and remedies.	**CO-3** **BTL-3**
MODULE 4 WHOLE GENOME SEQUENCING	**(9L)**
General principles of typing of bacteria- surveillance of antimicrobial resistance using whole genome sequencing- Introduction to Next Generation Sequencing- whole genome sequencing tools: Species identification, multi-locus sequence typing and finding resistance genes - Serotyping of *Salmonella* and *Escherichia coli* strains, and finding plasmid replicons.	**CO-3** **BTL-2**
MODULE 5 GENETIC PRIVACY	**(9L)**
Genetic privacy - personal genome project initiated by George Church - Genetic testing and sequencing technologies - Sequencing approaches: polymerase chain reaction, sanger sequencing, sequencing by synthesis, non-coding variants, DNA methylation testing.	**CO-3** **BTL-3**
TEXT BOOKS	
1.	Cohen, I. G., Hoffman, A. K., & Sage, W. M. (Eds.). (2017). *The Oxford handbook of US health law*, Oxford University Press, Oxford, UK, pp.1-1232.
2.	Janitz, M. (Ed.). (2011). *Next-generation genome sequencing: towards personalized medicine*, John Wiley & Sons, New Jersey, USA, pp.1-282.
REFERENCE BOOKS	
1.	Kaan, T. S. H., & Ho, C. W. L. (Eds.). (2013). *Genetic Privacy: An Evaluation of the Ethical and Legal Landscape*, World Scientific, Singapore, pp.1-412.
MOOCS	
1.	https://www.coursera.org/learn/genomics-for-law
2.	https://www.coursera.org/learn/wgs-bacteria
3.	https://www.coursera.org/learn/mind-of-the-universe-genetic-privacy

COURSE TITLE	HUMAN MOLECULAR GENETICS			CREDITS	3
COURSE CODE	BTH4380	COURSE CATEGORY	HONORS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course aims to provide knowledge on the principles and technologies of storing and coding genetic information. The integration of biology, chemistry and engineering will be stressed. Emphasis is also laid upon incorporating the understanding on DNA Sequencing technology, Methods for annotating genomes, characterizing functional genes, Gene Expression with special attention to genetic interactions in immune therapeutics. It also aims to provide background for generating genomic information for ecological, biomedical and biotechnological applications.
Course Objective	1. To understand the concepts and basic processes in genomics. 2. To learn and relate concepts of Mendelian Pedigree Patterns and inheritance. 3. To emphasize the role of genetic information, cloning and expression of genes. 4. To understand the concepts of pedigree and phylogeny. 5. To train students on molecular techniques, mutation and human genome project.
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze and integrate knowledge and information within the context of Genetics. 2. Discuss role of gene sequencing in diagnosis and disease treatment. 3. Apply molecular techniques such as sequencing, fingerprinting and hybridization in forensic and real-time research studies. 4. Analyze and compare sequences of genes using various molecular tools. 5. Appraise the molecular techniques in transgenesis, monogeneic and polygeneic disorders, HGP etc.

Prerequisites: Molecular Biology, Genetic Engineering.

CO, PO AND PSO MAPPING

CO	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	PSO-3
CO-1	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-2	-	-	-	-	1	-	-	-	-	2	-	-	-	1	-
CO-3	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
CO-4	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-5	-	-	3	-	-	-	-	-	-	-	-	-	-	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF GENOMICS AND ORGANIZATION	(9L)
Central Dogma, DNA structure, Gene information and expression, Organization and structure of genomes, Genetic mapping, Gene regulation and function. The Genetic code – Mutations in the Coding Region. Types of Mutations. Chromosome structure and function – Organization; structure –function relationship; chromosome abnormalities, Cell division.	**CO-1** **BTL-2**
MODULE 2: PEDIGREE AND GENETICS	**(9L)**
Concept and mode of inheritance, Pedigree analysis, Mitochondrial Genome and Mitochondrial Inheritance, Complications in Mendelian Pedigree Patterns.	**CO-2** **BTL-3**
MODULE 3: GENETIC INFORMATION, CLONING AND EXPRESSION OF GENES	**(9L)**
Genomics DNA library, DNA Cloning, Cloning vehicles, Restriction enzymes, DNA Sequencing, DNA Hybridization Techniques, DNA Fingerprinting.	**CO-3** **BTL-3**
MODULE 4: PEDIGREE ANALYSIS	**(9L)**
Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.	**CO-4** **BTL-3**
MODULE 5: MUTATIONS AND HUMAN DNA	**(9L)**
Mutations and instability of human DNA, Animal models for Human Diseases – Popular Model Systems, DNA constructs for the transgenics, Genetics in human health, Monogenic and Polygenic Disorders: Identifying Disease Genes, Positional Cloning of Genes for Monogenic Disorders, Human Genome Project and HapMap project.	**CO-5** **BTL-3**

TEXTBOOKS	
1.	Strachan, T., & Read, A.P. (2018). Human Molecular Genetics (5th ed.), Garland Science., Manchester, UK, pp.1-784.
REFERENCE BOOKS	
1.	Primrose, S. B., & Twyman, R. (2013). *Principles of gene manipulation and genomics*, John Wiley & Sons, 7th Ed., USA, pp.1-1593.
2.	Green MR and Sambrook J. (2012). *Molecular Cloning: A Laboratory Manual,* SHL press, 4th Edition, New York, US, pp.1-2028.
MOOCS	
1.	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-bt06/

Program Structure

PSO1			PSO2	PSO3			
Understand the mechanism and functions of cellular metabolism using biotechnological methods.			Optimizing the performance and tools in genetic engineering for synthesizing plant and animal products.	Designing a bioreactor using bioprocess engineering methods.			
1	2	3	4	5	6	7	8
Basic Science Courses	**Cellular Metabolism**	**Applications of Biotechnology**	**Molecular Biology/Genetic Engineering**	**Interdisciplinary domain**	**Management domain**	**NTCC (non-teaching credit courses)**	**Ethics/ Env. & social issues**
Engineering Graphics and Computer Aided Design	Cell Biology	Animal Biotechnology	Molecular biology	Heat Transfer	Operations Research	Summer Internship Evaluation-I	Bioethics, IPR and Patents
Sustainable Engineering Systems	Biochemistry	Industrial Biotechnology	Recombinant DNA Technology	Chemical Reaction Engineering	Employability Skills	Summer Internship Evaluation-II	Professional Ethics and Life Skills
Engineering Physics	Microbiology	Plant Biotechnology	Immunology	Mass Transfer	Relationship Management	Project (Dissertation)	
Analytical Mathematics	Enzyme Engineering and Technology	Bioinformatics	Proteomics		Project Management		
Numerical Methods	Metabolic Engineering		Protein Engineering				
Optimization Techniques			Bioprocess Engineering				
Engineering Graphics Lab							
Problem Solving Using C*							