Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.2	Percentage of Programmes where syllabus revision was carried out during academic year 2022-23

DEPARTMENT OF BIOTECHNOLOGY

Sl. No.	Programme Code	Programme name	Year of Introduction	Year of revision	Percentage of Syllabus content added or replaced
01.	101	Bachelor of Biotechnology	2002-03	2022	16.9 %

S.No	Contents
1.	Minutes of Board of Studies
2.	Extracts of minutes of the Academic Council Meeting
3.	Curiculum and Syllabus of the programme – Before Revision
4.	Curiculum and Syllabus of the programme – After Revision

Legend : Highlighted Color - Red – Indicates courses which are removed from syllabus before revision

Highlighted Color - Green – Indicates courses which are removed from syllabus after revision

1. **A. Minutes of the Board of Studiesof Bachelor of Technology – Biotechnology conducted on16.07.2022**

Department of Biotechnology
Faculty of Engineering and Technology
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PERIYAR
MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY

ANNEXURE-II

BOARD OF STUDIES MEETING

For B.Tech. Biotechnology (FULL TIME) PROGRAMME

Minutes of Meeting

Date: 16.07.2022 Time: 10. 00 AM   Venue: Marie curie Hall

Mode of Meeting: off line and online (Google meet)

Meeting Link: meet.google.com/iat-afjs-cxb

The Board of Studies (BOS) meeting was held in both offline and online mode on 16.07.2022 for framing the B.Tech. Biotechnology Honors course and its Curriculum with syllabi of Regulation 2021 Revision -I.

Agenda:

1. Implementation of B.Tech. Biotechnology Honors course and suggestions from board studies members for Regulation 2021 Revision -I.

2. Presentation of increased six course outcomes on biotechnology syllabus for B.Tech. Biotechnology degree programme for Regulation 2021 Revision -I.

3. Presentation of Split on XBT602 process biotechnology into two courses as XBT602 Process biotechnology - Upstream and XBT603 Process biotechnology - Downstream respectively.

4. Presentations of modified Programme Educational Outcomes (PEOs) for involve BOS and DAC members in framing.

Members present

Table.1. Members of the BoS

Sl.No.	Name	Designation	Membership
1.	Dr. A.Ashokkumar	Assistant Professor & Head, Dept. of Biotechnology, PMIST	Chairperson
2.	Dr.S.Meenakshisundaram	Professor and Dean, Centre for Biotechnology, Alagappa College of Technology, Anna University Chennai	External Member (Academic Expert for BOS)
3.	Dr.N.Shivakumar	Associate Director Enterprise Technology Services AstraZeneca India Pvt Ltd Chennai	External Member (Member from Industry for BOS)
4.	Mr.M.Jagadeesh M.Tech	Research Scholar IIT Hydrabad	Member from Alumni For BOS
5.	Mrs.G.Sharmila Gulabdeen	No.200 NGO Nagar NK Road Thanjavur – 6 Sharmilagulab2002@gmail.com	Parent Invite
6.	Dr.S.Kumaran	Associate Professor, Dept. of Biotechnology Dean Research PMIST	Member
7.	Dr.K.Anbarasu	Assistant Professor, Dept. of Biotechnology, PMIST	Member
8.	Dr.B.Nazeema Banu	Assistant Professor, Dept. of Biotechnology, PMIST	Member
9.	Ms.P.Mala	Assistant Professor, Dept. of Biotechnology, PMIST	Member
10.	Ms.R.Ramya	Assistant Professor, Dept. of Biotechnology, PMIST	Member
11.	Ms.S.Keerthana	Assistant Professor, Dept. of Biotechnology, PMIST	Member
12.	Priyanka. K	Final year students, Dept. of Biotechnology, PMIST	
13.	Joseph Antony. A		
14.	J.S.Kavya	Third year students, Dept. of Biotechnology, PMIST	Student Members
15.	M.Sivakarthikeyan		
16.	G. Riswana Affrin	Second year students, Dept. of Biotechnology, PMIST	
17.	R. Chandhru		

MINUTES

BOS Minutes for 16.07.2022

- Dr. A. Ashokkumar, Associate Professor and Head of the Department welcomed all the stake holders and expert members, and introduced the invited experts and students. B.Tech (Honors) Biotechnology specialization in computer science and biology and the curriculum and syllabus for B. Tech Biotechnology for Regulation 2021 Revision-I, was discussed and finalized.
- The difference between regulation 2021 and regulation 2021 revision –I was highlighted.

External Suggestions:

- BOS member Dr.S.Meenakshisundram raised a query on Honors degree which should be given to advanced learners other hand it could be given as minor degree only. In this regard BOS chairman Dr.A.Ashokumar showed the AICTE recommendation and convinced.
- Dr.A.Ashokkumar presented the curriculum and syllabus of Honors degree and also discussed over the increased six course outcomes from syllabus of Biotechnology courses, split of XBT602 Process Biotechnology of Regulation 2021 and discussed over the modified PEOs. BOS members accepted, and suggestions are given below.
- In the Honors degree of computer science and biology the application part of biology computer science interpretation should be conducted through appropriate experts from the respective pioneer Institutes / Industries.
- The students may take the courses like JAVA, R programme, Python as a crash course during their holidays and also the earned certificates can be considered for IPT.
- In house biotechnology faculty members must be equipped themselves in above programme languages to train the students instead of depending on computer faculty for the effective way of communication with biotechnology application.

Table.2. List of the subject topics and syllabus Revised

Regulation 2021	Regulation 2021 Rev.1
XBT 602-Process biotechnology	XBT 602 Process biotechnology - Upstream XBT603 Process biotechnology- Down Stream
-	C and JAVA
-	Python
-	BIOSTATISTICS
-	R Programme and R Studio
-	MATLAB
-	Mini Project

A. LIST OF NEWLY INTRODUCED COURSES IN REGULATION 2021 –Revision –I

Computer Science and Biology

S.No	Course Code	Semester	Course Title	Credits Detail				
				L	T	P	C	H
1.	XBTHC1	III	C and JAVA	1	0	2	3	5
2.	XBTHC2	IV	Python	1	0	2	3	5
3.	XBTHC3	IV	Biostatistics	2	1	0	3	5
4.	XBTHC4	V	R Program and R Studio	1	0	2	3	5
5.	XBTHC5	VI	MAT Lab	1	0	2	3	5
6.	XBTHC6	VII	Mini Project	0	0	5	5	10
			Total	6	1	13	20	35

B. LIST OF COURSES REMOVED

Table .3 Table of courses removed with remarks

S.No	Course Code and Name	Remarks
	XBT602-Process Biotechnology	Replaced by XBT602 Process biotechnology - Upstream XBT603 Process Biotechnology-Down Stream

C. PERCENTAGE CHANGE IN THE SYLLABUS

Number of new courses added = 6 = 20 credits
Credits revised in average with and Regulation 2021 and Regulation 2021 –Revision -I
% change = 100%

COURSES ON EMPLOYABILITY/ENTREPRENEURSHIP/SKILL DEVELOPMENT

The courses are given below

Table .4 Categorization of courses

Semester	Course Code	Courses	Category
III	XBTHC1	C and JAVA	Employability
IV	XBTHC2	Python	Employability
IV	XBTHC3	Biostatistics	Employability
V	XBTHC4	R Program and R Studio	Employability
VI	XBTHC5	MAT Lab	Employability
VII	XBTHC6	Mini Project	Employability

D. DISCUSSION ON PROGRAMME ARTICULATION MATRIX (PO COVERAGE BY ALL COS)

The existing POs and PSO were presented. The members agreed that there need not be any changes in the PSO and POs.
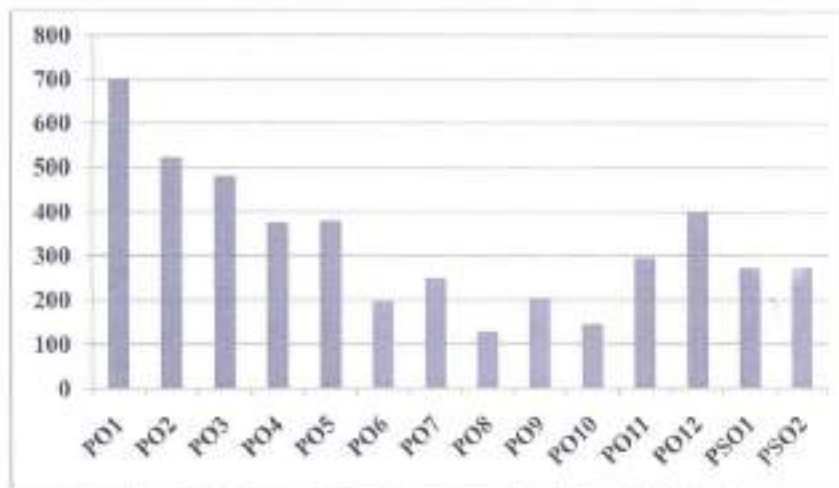

Figure I PO coverage by various courses (Regulation 2018 Rev-1)

It is found that the curriculum covers all POs with small deviations. PO1 is strongly supported than the other POs.
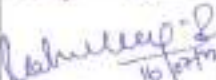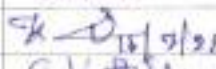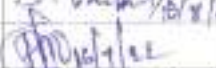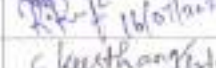
HoD/Biotechnology
(Dr.A.Ashokkumar)

Dean (FET)
(Dr.S.Senthamil Kumar)

Dean (Academic)
(Dr. A.George)

Members of the Board of Studies and Department Advisory Committee
Venue: Biotechnology Department Office: Google Meet
BOS DAC (16Jul2022): meet.google.com/fyh-gitr-yms

SLNo.	Name	Designation	Membership	Signature
1.	Dr. A.Ashokkumar	Associate Professor & Head, Dept. of Biotechnology, PMIST	Chairperson	
2.	Dr.S.Meenakshisundaram	Professor and Dean, Centre for Biotechnology, Alagappa College of Technology, Anna University Chennai	External Member (Academic Expert for BOS)	16/7/
3.	Dr.R.Mahendran	Associate Professor & Head Centre of Excellence in Non-Thermal Processing (CENTP), IIFPT Thanjavur	External Member (Academic Expert for DAC)	16
4.	Dr.N.Shivakumar	Associate Director Enterprise Technology Services AstraZeneca India Pvt Ltd Chennai	External Member (Member from Industry for BOS)	ONLINE
5.	Mr.H.Saravanan	Project Delivery Head DFE Pharma SIPCOT, Cuddalore	External Member (Member from Industry for DAC)	ONLINE
6.	Dr.M.Shamila Begum	Associate Professor & Head, Dept. of CSE, PMIST	Special Member	
7.	Mr.M.Jagadeesh	Research Scholar IIT Hyderabad	Member from Alumni For BOS	ONLINE
8.	Mrs.G.Shamila Gulabdeen	No.200 NGO Nagar NK Road Thanjavur – 6 Sharmilagulab2002@gmail.com	Parent Invite	
9.	Dr.S.Kumaran	Associate Professor, Dept. of Biotechnology Dean Research PMIST	Member	
10.	Dr.K.Anbarasu	Assistant Professor, Dept. of Biotechnology, PMIST	Member	ONLINE
11.	Dr.K.Geetha	Assistant Professor, Dept. of Biotechnology, PMIST	Member	15/7/22
12.	Dr.S.Vasanthavel	Assistant Professor, Dept. of Biotechnology, PMIST	Member	8/8/4
13.	Ms.P.Mala	Assistant Professor, Dept. of Biotechnology, PMIST	Member	16/7/22
14.	Ms.R.Ramya	Assistant Professor, Dept. of Biotechnology, PMIST	Member	16/07/2022
15.	Ms.S.Keerthana	Assistant Professor, Dept. of Biotechnology, PMIST	Member	S.Keerthana
16.	M.Theepan	Final year student, Dept. of Biotechnology, PMIST	Student Members	
17.	S. Shankar			
18.	G. Riswana Affrin	Third year student, Dept. of Biotechnology, PMIST		
19.	R. Pavithran			
20.	A. Sangeetha	Assistant professor, Dept of Biotechnology, PMIST	Member	

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2. Extracts of Minutes of the 40thAcademic Council Meeting conducted on 27.08.2022

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PERIYAR MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY
Deemed to be University
Established Under Sec. 3 of UGC Act 1956 - NAAC Accredited
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MINUTES OF FORTIETH MEETING OF THE ACADEMIC COUNCIL

Date   : 27.08.2022   Venue: Richard Dawkins Hall
Time : 10.30 A.M   Place : PMIST, Vallam – Thanjavur

The Fortieth Meeting of the Academic Council of the Periyar Maniammai Institute of Science & Technology (PMIST), Vallam, Thanjavur held on 27.08.2022 at 10.30 a.m.

Prof.S.Velusami, Hon'ble Vice-Chancellor, chaired the meeting.

The following Academic Council Members were present

1.	Dr.D.Aarthi Saravanan	Member
2.	Dr.A.Anand Jerard Sebastine	Member
3.	Dr.S.Arumugam	Member
4.	Dr.P.Aruna	Member
5.	Dr.S.Asokan	Member
6.	Dr.S.Buvaneswari	Member
7.	Dr.A.George	Member
8.	Dr.S.Gomathi	Member
9.	Dr.P.Guru	Member
10.	Dr.V.Hamsadhwani	Member
11.	Dr.R.Jayanthi	Member
12.	Dr.N.Jayanthi	Member
13.	Dr.J.Jeyachidra	Member
14.	Mr.I.Karthic Subramaniayan	Member
15.	Dr.T.Kavitha	Member
16.	Dr.K.Kesavan	Member
17.	Dr.R.Krishnamurthi	Member
18.	Dr.S.P.Kulanthaivel Babu	Member

1

8th BOS/BIOTECH/Date: 19.08.2021

19.	Dr.D.Kumar	Member
20.	Dr.S.Kumaran	Member
21.	Dr.D.Maghesh Kumar	Member
22.	Dr.B.Mahendra Mohan	Member
23.	Dr.C.Narmadha	Member
24.	Dr.T.Narmadha	Member
25.	Mr.A.Pugazhenthi	Member
26.	Dr.KVR.Rajandran	Member
27.	Mr.R.Rakesh	Member
28.	Dr.D.Ramesh	Member
29.	Ar.N.Ramesh Babu	Member
30.	Dr.D.Ruby	Member
31.	Dr.V.Sangeetha	External Member
32.	Dr.J.Santhosh	Member
33.	Dr.J.Sathyapriya	Member
34.	Dr.K.Selvakumar	Member
35.	Dr.K.Selvam	Member
36.	Dr. S.Senthamil Kumar	Member
37.	Dr.V.A.Shanmugavelu	Member
38.	Dr.M.Sharmila Begum	Member
39.	Dr.M.A.Sikandar	External Member
40.	Dr.C.V.Subramanian	Member
41.	Dr.G.Thamilvanan	Member
42.	Dr.K.Thirumaran	External Member
43.	Dr.P.Vijayalakshmi	Member
44.	Dr.S.Suppiah	Special Invitee

ADDRESS BY THE VICE-CHANCELLOR

The Chairperson welcomed all the Academic Council External and Internal members. He also presented the academic activities, organized by various Departments and Centers, held after the previous Academic Council Meeting.

2

the courses in B.Tech.– Aerospace Engineering curriculum and syllabi, Regulation 2021).

DEPARTMENT OF BIOTECHNOLOGY

FET B.Tech Bio 40.3.2

TO CONSIDER AND APPROVE the Curriculum and Syllabi for B.Tech (Hons).- Biotechnology with specialization in Computer Science and Biology in the existing regulation 2021 under Full Time (Regulation 2021, Revision 1; Full time mode). The courses pertaining to the specialization and their credits (In addition to the courses in B.Tech.– Biotechnology curriculum and syllabi, Regulation 2021) are given below:

Computer Science and Biology

S.No.	Course Code	Semester	Course Title	Credits Detail				
				L	T	P	C	H
1.	XBTHC1	III	C and JAVA	1	0	2	3	5
2.	XBTHC2	IV	Python	1	0	2	3	5
3.	XBTHC3	IV	Biostatistics	2	1	0	3	5
4.	XBTHC4	V	R Program and R Studio	1	0	2	3	5
5	XBTHC5	VI	MATLAB	1	0	2	3	5
6	XBTHC6	VII	Mini Project	0	0	5	5	10
			Total	6	1	13	20	35

Notes:

1) The Board of Studies of the Department of Biotechnology recommended the Curriculum and Syllabus for B.Tech Biotechnology Honors programme with specialization in "Computer Science and Biology" under Full Time in existing Regulation 2021).

2) Based on the National Biotechnology Strategy (2021-2025) released from Department of Biotechnology, Government of India, the existing Programme Educational Objectives (PEO) are modified.

The matter is placed before the Academic Council for approval.

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DEPARTMENT OF CIVIL ENGINEERING

**FET
B.Tech-
Civil
40.3.3**

TO CONSIDER AND APPROVE the Curriculum and Syllabi for B.Tech (Hons).- Civil Engineering with specialization in GIS and Remote Sensing programme (Regulation 2021, Revision 1: Full time mode). The courses pertaining to the specialization and their credits (In addition to the courses in B.Tech – Civil Engineering Curriculum and Syllabi, Regulation 2021) are given below:

New Courses:

Course code	Semester	Course Title	L	T	P	C	H
XCEHR1	III	Photogrammetry	3	0	0	3	3
XCEHR2	IV	Image processing	3	0	1	4	5
XCEHR3	V	Remote sensing	3	0	1	4	5
XCEHR4	VI	Geographic information system	3	0	1	4	5
XCEHR5	VII	Mini Project	0	0	5	5	10
		Total	12	0	8	20	28

Notes:

The Board of Studies of the Department of Civil Engineering recommended Curriculum and Syllabi for B.Tech.-(Hons) Civil Engineering with specialization in GIS and Remote Sensing programme under Full-Time (Regulation 2021, Revision 1).

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the Curriculum and Syllabi for B.Tech (Hons).-

15

3. Curriculum and Syllabus of the Programme – Before Revision

Semester I

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	BSC	XMA101	Calculus and Linear Algebra	3	1	0	4	3	1	0	4
2.	ESC	XCP102	Programming for Problem Solving	3	0	0	3	3	0	0	3
3.	BSC	XAP103	Applied Physics for Engineers	3	1	0	4	3	1	0	4
4.	ESC	XBT104	Biology for Engineers	3	0	0	3	3	0	0	3
5	HSMC	XGS105	Speech Communication	0	0	3	3	0	0	3	3
6	MC	XUM106	Constitution of India *#	0	0	0	0	2	0	0	2
7	ESC	XCP107	Programming for Problem Solving Laboratory	0	0	1	1	0	0	3	3
8	BSC	XAP108	Applied Physics for Engineers Laboratory	0	0	2	2	0	0	3	3
			Total	**12**	**2**	**6**	**20**	**14**	**2**	**9**	**25**

Semester II

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	BSC	XMA201	Calculus, Ordinary Differential Equations and Complex Variable	3	1	0	4	3	1	0	4
2.	ESC	XBE202	Electrical and Electronic Engineering Systems	3	1	0	4	3	1	0	4
3.	BSC	XAC203	Applied Chemistry for Engineers	3	1	0	4	3	1	0	4
4	HSMC	XGS204	Technical Communication	2	0	0	2	2	0	0	2
5	ESC	XWP205	Workshop Practices	1	0	2	3	1	0	3	4
6	ESC	XBT206	Chemical Engineering Thermodynamics	2	1	0	3	2	1	0	3
7	ESC	XBE207	Electrical and Electronic Engineering Systems Laboratory	0	0	1	1	0	0	3	3
8	BSC	XAC208	Applied Chemistry for Engineers Laboratory	0	0	1	1	0	0	3	3
			Total	**14**	**4**	**4**	**22**	**14**	**4**	**9**	**27**

Semester III

S.No.	AICTE Code	Course Code	Courses	Credits				Hour			
				L	T	P	C	L	T	P	Total
1.	BSC	XPS301	Probability and statistics	3	0	0	3	3	0	0	3
2.	PCC	XBT302	Biochemistry	2	1	0	3	3	1	0	4
3.	PCC	XBT303	Microbiology	3	0	0	3	3	0	0	3
4.	PCC	XBT304	Material and Energy Balances	2	1	0	3	2	1	0	3
5.	PCC	XBT305	Genetics and Evolutionary Biology	3	0	0	3	3	0	0	3
6.	HSMC	XUM306	Entrepreneurship Development	2	0	0	2	2	0	0	2
7	MC (HSMC)	XUM307	Universal Human Values 2: Understanding Harmony	2	1	0	3	2	1	0	3
8	PCC	XBT308	Biochemistry Laboratory	0	0	2	2	0	0	6	6
9	PCC	XBT309	Microbiology Laboratory	0	0	2	2	0	0	6	6
10	PROJ	XBT310	In-plant Training - I	-	-	1	1	-	-	2	2
			Total	17	3	5	25	18	3	14	35

Semester IV

S.No.	AICTE Code	Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	PCC	XBT401	Basic Transport Processes	2	1	0	3	2	1	0	3
2.	PCC	XBT402	Bioenergetics and Metabolism	2	1	0	3	2	1	0	3
3.	PCC	XBT403	Cell Biology	3	0	0	3	3	0	0	3
4.	PCC	XBT404	Immunology	3	0	0	3	3	0	0	3
5.	HSMC	XUM405	Economics for Engineers	3	0	0	3	3	0	0	3
6	MC	XUM406	Disaster Management[*#]	0	0	0	0	2	0	0	2
7	PCC	XBT407	Basic Transport Processes Laboratory	0	0	1	1	0	0	4	4
8	PCC	XBT408	Cell Biology Laboratory	0	0	2	2	0	0	8	8
9	PCC	XBT409	Immunology Laboratory	0	0	1	1	0	0	4	4
			Total	13	2	4	19	15	2	16	33

Semester V

S.No.	AICTE Code	Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT501	Bioanalytical Tools	3	0	0	3	3	0	0	3
2	PCC	XBT502	Molecular Biology	3	0	0	3	3	0	0	3
3	PCC	XBT503	Bio reaction Engineering	2	1	0	3	3	1	0	4
4	PCC	XBT504	Plant Biotechnology	3	0	0	3	3	0	0	3
5	PEC	XBT505A	A. Food Biotechnology	3	0	0	3	3	0	0	3
		XBT505B	B.Agricultural Biotechnology	3	0	0	3	3	0	0	3
		XBT505C	Pharmaceutical Biotechnology	3	0	0	3	3	0	0	3
6	OE	XOE1	Open Elective Courses	3	0	0	3	3	0	0	3
7	PCC	XBT507	Bioanalytical Tools Laboratory	0	0	1	1	0	0	6	6
8	PCC	XBT508	Bio reaction Engineering Laboratory	0	0	2	2	0	0	8	8
9	PROJ	XBT509	In-plant Training - II	-	-	1	1	-	-	2	2
10	PMC	XBTMO1	Minor Course I[*#]	0	0	0	0	0	0	2	2
			Total	17	1	4	22	18	1	18	37

Semester VI

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT601	Animal Biotechnology	3	0	0	3	3	0	0	3
2	PCC	XBT602	Process Biotechnology	3	1	0	4	3	2	0	5
3	PEC	XBT603A	Mass Transfer Fundamentals	3	0	0	3	3	0	0	3
		XBT603B	Fermentation Technology	3	0	0	3	3	0	0	3
		XBT603C	Nanobiotechnology	3	0	0	3	3	0	0	3
4	OE	XOE2	Open Elective Courses	3	0	0	3	3	0	0	3
5	HSMC	XGS605	Professional Skills	1	0	2	3	1	0	4	5
6	MC	XUM606	Cyber Security*#	0	0	0	0	3	0	0	3
7	PCC	XBT607	Process Biotechnology Laboratory	0	0	4	4	0	0	8	8
8	PMC	XBTMO2	Minor Course II*#	0	0	0	0	0	0	2	2
			Total	**13**	**1**	**6**	**20**	**16**	**2**	**14**	**32**

Semester VII

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT701	Microbial Biotechnology	3	0	0	3	3	0	0	3
2	PCC	XBT702	Recombinant DNA Technology	3	0	0	3	3	0	0	3
3	PEC	XBT703A	A. Stem Cell Biotechnology	2	1	0	3	2	1	0	3
		XBT703B	B. Cancer Biology	2	1	0	3	2	1	0	3
		XBT703C	C. Design of Bioprocess Equipments	2	1	0	3	2	1	0	3
4	OE	XOE3	Open Elective Courses	3	0	0	3	3	0	0	3
5	MC	XES705	Environmental studies*#	0	0	0	0	3	0	0	3
6	PCC	XBT706	Recombinant DNA Technology Laboratory	0	0	2	2	0	0	6	6
7	PCC	XBT707	Bioinformatics	1	0	1	2	1	0	5	6
8	PROJ	XBT708	Project Work (Phase-I)	0	0	2	2	0	0	6	6
9	PROJ	XBT709	In-plant Training – III	-	-	2	2	-	-	2	2
10	PMC	XBTMO3	Minor Course III*#	0	0	0	0	0	0	2	2
			Total	**12**	**1**	**7**	**20**	**15**	**1**	**21**	**37**

Semester VIII

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PEC	XBT801A	A. Introduction to Quantum Biology, AI and Data Science	2	1	0	3	2	1	0	3
		XBT801B	B. Enzyme Engineering	2	1	0	3	2	1	0	3
		XBT801C	C. Bio waste and Bio products Utilization	2	1	0	3	2	1	0	3
2	OE	XOE4	Open Elective Courses	3	0	0	3	3	0	0	3
3	OE	XOE5	Open Elective Courses	3	0	0	3	3	0	0	3
4	PROJ	XBT804	Project Work (Phase-II)	0	0	9	9	0	0	18	18
5	PMC	XBTMO4	Minor Course IV*#	0	0	0	0	0	0	2	2
			Total	**8**	**1**	**9**	**18**	**8**	**1**	**20**	**29**

Grant Total Credits: 166

LIST OF SKILL ORIENTED MINOR COURSES

Sl no	Category	Name of the Course	Credit
1.	PMC	Training on GC-MS, HPLC	0
2.	PMC	Training on AFM, SEM	0
3.	PMC	Training on PCR and Electrophoresis	0
4.	PMC	MATLAB Basics for Biotechnology researchers	0
5.	PMC	Training on Lab Scale Fermentor	0

LIST OF OPEN ELECTIVE COURSES OFFERED FROM BIOTECHNOLOGY

Sl no	Category	Name of the Course	Credit
1.	OE	Intellectual Property Rights	3
2.	OE	Biosafety Management	3
3.	OE	Digital Health	3

LIST OF VALUE ADDED COURSES SUGGESTED

Sl no	Category	Name of the Course	Components
1.	PMC	R Program and R Studio for Biotechnologist	Employability
2.	PMC	Python for Biotechnologist	Employability
3.	PMC	Training on Hospital's Clinical Research Lab	Research Skill and Employability
4.	PMC	Downstream Manufacturing (Microbial)	Employability

NoteL – Lecture, T – Tutorial, P – Practical, C – Credit

Each faculty made presentation on their suggestions on the courses allotted to them before the Board of studies members.

Semester	Credits	Hours / Week	Number of courses
I	20	25	8
11	22	27	8
III	25	33	10
IV	19	33	9
V	22	35	10
VI	20	31	8
VII	20	35	10
VIII	18	29	5
I – VIII	**166**	**248**	**69**

Summary of the credits and hours

Year	Semester	Total Credits	Total Hours / Week	No. of courses	Value Addition Suggested
I	I	20	25	8	No
	II	22	27	8	No
II	III	25	33	10	Yes
	IV	19	33	9	Yes
III	V	22	35	10	Yes
	VI	20	31	9	Yes
IV	VII	20	35	10	Yes
	VIII	18	29	5	Yes
	I – VIII	**166**	**248**	**69**	

8th BOS/BIOTECH/Date: 19.08.2021

COURSE CODE	XMA 101			L	T	P	C
COURSE NAME	Mathematics I (Calculus and Linear Algebra)			3	1	0	4
C	P	A		L	T	P	H
3	0.5	0.5		3	1	0	4

PREREQUISITE: Differentiation and Integration

COURSE OUTCOMES:

Course outcomes:		Domain	Level
CO1	**Apply** the orthogonal transformation to reduce quadratic form to canonical forms.	Cognitive	Remember Apply
CO2	**Apply** power series to tests the convergence of the Sequences and series andHalf range Fourier sine and cosine series.	Cognitive Psychomotor	Remember Apply Guided Response
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian	Cognitive Psychomotor	Remember Guided Response
CO4	**Explain** the functions of two variables by Taylor's expansion, by finding maxima and minima with and without constraints using Lagrangian Method Directional derivatives, Gradient, Curl and Divergence.	Cognitive Affective	Remember Understand Receive
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.	Cognitive	Apply

UNIT -I	**Matrices**	12

Linear Transformation - Eigen values and Eigen vectors -Properties of Eigen values and Eigen vectors - Cayley-Hamilton Theorem – Diagonalisation of Matrices – Real Matrices: Symmetric - Skew-Symmetric and Orthogonal Quadratic form – canonical form - Nature of Quadratic form and Transformation of Quadratic form to Canonical form (Orthogonal only).

UNIT -II	**Sequences and series**	12

Sequences: Definition and examples-Series: Types and convergence- Series of positive terms – Tests of convergence: comparison test, Integral test and D'Alembert's ratio test-. Fourier series: Half range sine and cosine series- Parseval's Theorem.

UNIT -III	**Multivariable Calculus: Partial Differentiation**	12

Limits and continuity –Partial differentiation – Total Derivative – Partial differentiation of Composite Functions: Change of Variables – Differentiation of an Implicit Function - Euler's Theorem- Jacobian.

UNIT -IV	**Multivariable Calculus: Maxima and Minima and Vector Calculus**	12

Taylor's theorem for function of Two variables- Maxima, Minima of functions of two variables: with and without constraints - Lagrange's Method of Undetermined Multipliers – Directional Derivatives - Gradient, Divergence and Curl.

UNIT -V	**Differential and Integral Calculus**	12

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

LECTURE	TUTORIAL	TOTAL
45	**15**	**60**

Text Books:
1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015. **(Unit-1, Unit-3 and Unit-4).**
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi **Publications**, Reprint, 2014. **(Unit-2).**
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2010. **(Unit-5).**

Reference Books:
1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/Cole, 2005.
4. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

Cos versus GA mapping

		Graduates Attributes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

CourseCode	:	XCP102	L	T	P	C
CourseName	:	**PROGRAMMINGFORPROBLEMSOLVING**	3	0	0	3
Prerequisite	:	**BasicUnderstandingSkills**	L	T	P	H
C	**P**	**A**	3	0	0	3
3	0	0				

CourseObjectives

- Tolearnprogramminglanguagebasicsand syntax

- Toignite logicalthinking

- Tounderstandstructured programmingapproach

- Todealwith userdefined datatypes

- To knowaboutdatastorage in secondarymemory

CourseOutcome:Afterthecompletionofthecourse, studentswillbe able to			Domain	Level
CO1	*Define* programming fundamentals and *Solve* simpleprogramsusingI/O statements		Cognitive	Apply

CO2	*Explain simple programs* using controlstructuresandarrays		Cognitive	Understand
CO3	*Explain the simple programs* using functions andpointers		Cognitive	Understand
CO4	*Explain simple programs* using structures andunions		Cognitive	Understand
CO5	*Explain simpleprograms* usingfiles and **Build** simpleprojects		Cognitive	Understand

COURSECONTENT

UNIT-I	PROGRAMMINGFUNDAMENTALSANDI/OSTATEMENTS	9

Introduction to componentsofa computersystem,Program–Flowchart –Pseudo code– Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, andOperators – sample program structure -Header files – Data Types- Variables - Output statements –Inputstatements.

UNIT -II	CONTROLSTRUCTURE ANDARRAYS	9

ControlStructures–ConditionalControlstatements:Branching,Looping-Unconditionalcontrolstructures:switch,break,continue,gotostatements–Arrays:OneDimensionalArray–Declaration –Initialization–AccessingArrayElements–Searching–Sorting–TwoDimensionalarrays-Declaration–Initialization–MatrixOperations–MultiDimensionalArrays-Declaration–Initialization.Storage classes:auto –extern–static.Strings:Basicoperationsonstrings.

UNIT -III	FUNCTIONS ANDPOINTERS	9

Functions:Built-infunctions–UserDefinedFunctions-Parameterpassingmethods-Passingarraystofunctions–Recursion-Programsusingarraysandfunctions.Pointers-PointerdeclarationAddressoperator-Pointerexpressions&pointerarithmetic-Pointersandfunction-CallbyvalueCall byReference-Pointertoarrays-UseofPointersitself-referentialstructures-Notionoflinkedlist

UNIT -IV	STRUCTURESANDUNIONS	9

StructuresandUnions-Givingvaluestomembers-Initializingstructure-Functionsandstructures -Passingstructuretoelementstofunctions-Passingentire function ofunction's-Arraysofstructure-Structurewithin a structureandUnion.

UNIT -V	FILES	9
	FilemanagementinC-FileoperationfunctionsinC-Definingandopeningafile-Closingafile-Thegetandputfunctions-Theprint&scanfunctions-seekfunction–FilesandStructures.	

L	T	P	Total
45	0	0	45

TEXTBOOKS

1. ByronGottfried,"ProgrammingwithC",IIIEdition,(IndianAdaptedEdition),TMHpublications,2010
2. YeshwantKanethker, "LetusC",BPBPublications,2008

REFERENCEBOOKS

1. E.Balaguruswamy, ProgramminginANSIC,TataMcGraw-Hill,7thedition2017.
2. BrianW.Kernighanand DennisM.Ritchie,"TheCProgrammingLanguage",PearsonEducationInc.2005
3. JohnsonbaughR.andKalinM.,"ApplicationsProgramminginANSIC", IIIEdition,Pearson EducationIndia,2003

E-REFERENCES

1. https://www.indiabix.com/c-programming/questions-and-answers/
2. https://www.javatpoint.com/c-programming-language-tutorial
3. https://www.w3schools.in/c-tutorial/

Mapping of CO's with PO:

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue	3	2	1	1	3	0	0	1	0	1	2	3	2	0

$1-5 \rightarrow 1$,	$6-10 \rightarrow 2$,	$11-15 \rightarrow 3$
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation		

COURSE CODE	XAP103	L	T	P	C
COURSE NAME	**APPLIED PHYSICS FOR ENGINEERS**	3	1	0	4
C:P:A	**2.8:0.8:0.4**	L	T	P	H
PREREQUISITE:	**Basic Physics in HSC level**	3	1	0	4

COURSE OUTCOMES		Domain	Level
CO1	*Identify* the basics of mechanics, *explain* the principles of elasticity and *determine* its significance in engineering systems and technological advances.	Cognitive: Psychomotor:	Remember, Understand Mechanism
CO2	*Illustrate* the laws of electrostatics, magneto-statics and electromagnetic induction; *use* and *locate* basic applications of electromagnetic induction to technology.	Cognitive: Psychomotor: Affective:	Remember, Analyze, Mechanism Respond
CO3	*Understand* the fundamental phenomena in optics by measurement and *describe* the working principle and application of various lasers and fibre optics.	Cognitive: Psychomotor: Affective:	Understand, Apply Mechanism Receive
CO4	*Analyse* energy bands in solids, *discuss* and *use* physics principles of latest technology using semiconductor devices.	Cognitive: Psychomotor: Affective:	Understand, Analyze Mechanism Receive
CO5	*Develop* Knowledge on particle duality and *solve* Schrodinger equation for simple potential.	Cognitive:	Understand, Apply

UNIT - I MECHANICS OF SOLIDS	**9+3**

Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction.
Elasticity: Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending.

UNIT -II ELECTROMAGNETIC THEORY	**9+3**

Laws of electrostatics - Electrostatic field and potential of a dipole; Dielectric Polarisation, Dielectric constant, internal field – ClausiusMossotti Equation - Laws of magnetism - Ampere's Faraday's law; Lenz's law - Maxwell's equation - Plane electromagnetic waves; their transverse nature - expression for plane, circularly and elliptically polarized light - quarter and half wave plates - production and detection of plane, circularly and elliptically polarized light.

UNIT –III OPTICS, LASERS AND FIBRE OPTICS	**9+3**

Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating.

LASER: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser - Applications

Fibre Optics: Principle and propagation of light in optical fibre - Numerical aperture and acceptance angle - Types of optical fibre - Fibre optic communication system (Block diagram).

UNIT –IV SEMICONDUCTOR PHYSICS	9+3

Semiconductors: Energy bands in solids - Energy band diagram of good conductors, insulators and semiconductors - Concept of Fermi level - Intrinsic semiconductors - Concept of holes - doping - Extrinsic semiconductors - P type and N type semiconductors - Hall effect.

Diodes and Transistors: P-N junction diode - Forward bias and reverse bias - Rectification action of diode - Working of full wave rectifier using P N junction diodes - PNP and NPN transistors - Three different configurations - Advantages of common emitter configuration - working of NPN transistor as an amplifier in common emitter configuration.

UNIT –V QUANTUM PHYSICS	9+3

Introduction to quantum physics, black body radiation, Compton effect, de Broglie hypothesis, wave – particle duality, uncertainty principle, Schrodinger wave equation (Time dependent and Time independent), particle in a box, Extension to three dimension - Degeneracy.

TEXT BOOKS

1. Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publications, 2009.
2. Avadhanulu M. N. "Engineering Physics" (Volume I and II), S. Chand & Company Ltd., New Delhi, 2010.

REFERENCE BOOKS

1. Palanisamy P. K., "Engineering Physics", Scitech Publications (India) Pvt. Ltd, Chennai.
2. Arumugam M., "Engineering Physics" (Volume I and II), Anuradha Publishers, 2010.
3. Senthil Kumar G., "Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers, Chennai, 2011.
4. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2007.

E RESOURCES

NPTEL , Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**45**	**15**	**-**	**60**

Mapping of CO's with PO:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
CO5	3		2			-	-	-		-	-	1		
CO6														
Total	**15**	**6**	**9**	**6**	**4**				**3**			**5**		
ScaledValue	3	2	2	2	1	-	-	-	1	-	-	1		
	1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3													
	0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation													

XBT104			**BIOLOGY FOR ENGINEERS**	**`L**	**T**	**P**	**C**
C	**P**	**A**		**3**	**0**	**0**	**3**
3	**0**	**0**		**L**	**T**	**P**	**H**
				3	**0**	**0**	**3**

Course outcome		Domain	Level
CO1	***Describe*** how biological observations of 18th Century that lead to major discoveries.	Cognitive	Understand
CO2	***Explain*** the cell morphology and their functions	Cognitive	Understand
CO3	***Explain*** the Human anatomy and Physiology	Cognitive	Understand
CO4	**Recall** the types of Tissue and its functions	Cognitive	Understand
CO5	**Illustrate** the essential of Amino Acids DNA/RNA	Cognitive	Understand

UNIT I	**Introduction**	6
	Fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. - Why we need to study biology? - Biological observations of 18th Century that lead to major discoveries. - Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor.	
UNIT II	**Cell Biology**	9
	Introduction to the cell biology – Cell size and shape - Chemical composition -Classification of cell and its properties; structure of Cell membrane and cellular organelles; Cell cycle; Cell signaling, Transport across cell membrane	
UNIT III	**Human physiology and anatomy**	9
	Introduction to Human Anatomy and Physiology-Anatomical Terminology; Structural Organization of the Human Body-Skin and the Integumentary System- Skeletal System-Muscular Systems -Nervous System-Cardiovascular System -Lymphatic and Immune System-Respiratory System- Digestive System -Urinary System	
UNIT IV	**Biomolecules**	9
	Molecules of life - Monomeric units and polymeric structures - Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	
UNIT V	**Modern Applications from Biological Sciences**	12
	Principles and Application of Biosensor; Basics of Biochips – Bio fertilizer – Bioinformatics – Bio fuel – Introduction to Bio mechanics - Neural Network: Artificial Intelligence (AI) - Stem Cell; Introduction to Genetics; Genetic Engineering and its Application, Biosafety Hazardous Effect.	

LECTURE	TUTORIAL	TOTAL
45	**0**	**45**

Text Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Dr. Sohini Singh and Dr. Tanu Allen, "Biology for Engineers", Vayu Education of India, New Delhi, 2014.

References Books:

1. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
2. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
3. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher

4. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers
5. Biology for Engineers (ISBN: 9781121439931), TMH

Online References:
1. www.bio12.com/ch3/RaycroftNotes.pdf
2. www.engineering.uiowa.edu/bme050/cvb-solids.pdf
3. www.biologyjunction.com/mendelian_genetics.html

Mapping Of Course Outcomes with Program Outcomes

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	2	2	3	1	2	1	2	2	3	0	1	1
CO2	2	3	2	2	3	2	2	1	1	2	3	1	1	1
CO3	2	2	1	1	3	2	2	1	1	2	3	1	0	1
CO4	3	2	1	2	3	2	2	1	1	2	3	0	1	1
CO5	3	3	2	3	3	2	3	1	1	2	3	0	1	2
Original Value	14	14	9	11	17	10	12	6	7	10	16	3	5	7
Scaled Value	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**2**

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XGS105			**Speech Communication**	**L**	**T**	**P**	**SS**	**C**
				0	**0**	**3**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**SS**	**H**
2.6	**0.4**	**0**		**0**	**0**	**3**	**0**	**3**

Course Outcomes : After completion of the course, students will be able to			**Domain**	**Level**
CO1	Ability to recall the types of speeches		Cognitive	Remember
CO2	Apply the techniques in public speaking		Cognitive	Apply
CO3	Identify the common patterns in organizing a speech		Cognitive	Remember
CO4	Construct the nature and style of speaking		Cognitive	Create
CO5	Practicing the speaking skills		Psychomotor	Guided Response

UNIT-I	**Types of Speeches**	**9**

1.1 – Four types of speeches- 1.2 – Analyzing the audience-1.3 - Developing ideas and supporting materials

UNIT –II	**Public Speaking**	**9**

2.1 - Introduction to Public Speaking
2.2 - Competencies Needed for successful speech making
2.3 – Speaking about everyday life situations

UNIT-III	**Organization of Speech**	**9**

3.1 – Developing a speech out line - 3.2 - Organizing the speech- 3.3 – Introduction - development – conclusion

UNIT-IV	**Presentation**	**9**

4.1 - Tips for preparing the draft speech
4.2 – Presentation techniques using ICT tools
4.3 – Using examples from different sources

UNIT-V	**Activities**	**9**

5.1 – Reading activities -5.2 – Creative presentations -5.3 – Media presentation techniques

LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
0	**0**	**45**	**45**

| Suggested Readings: (i) Michael Swan. *Practical English Usage*. OUP. 1995 |
| (ii) Sanjay Kumar and Pushp Lata. *Communication Skills*. Oxford University Press. 2011 |

Mapping Of Course Outcomes with Program Outcomes

		PROGRAM OUTCOMES												
		1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1		2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO2		2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO3		1	0	0	0	0	0	1	0	1	0	0	0	0	0
CO4		2	0	0	0	0	0	1	0	1	0	0	0	0	0
CO5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		7	0	0	0	0	0	6	0	4	0	0	0	0	0
ScaledValue		2	0	0	0	0	0	2	0	1	0	0	0	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation

XUM 106			CONSTITUTION OF INDIA	L	T	P	C
				0	0	0	0
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Course Outcomes : After completion of the course, students will be able to		Domain	Level
CO1	**Study** History of Constitution.	Cognitive	Understand
CO2	**Explain** the Union Executive	Cognitive	Understand
CO3	**Identify** the concept of Union Legislature	Cognitive	Understand
CO4	**Analysis** the Union Judiciary	Cognitive	Analyse
CO5	**Explain** the Centre State Relation	Cognitive	Understand

Course Content	Hours
UNIT-I	9
Constitutional History- The Constitutional Rights- Preamble- Fundamental Rights- Fundamental Duties- Directive principles of State Policy.	
UNIT –II	9
The Union Executive- The President of India (powers and functions)- Vice-President of India-The Council of Ministers-Prime Minister- Powers and Functions.	
UNIT-III	9
Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committees of Lok Sabha- Speaker of the Lok Sabha.	
UNIT-IV	9
The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction- Appelete jurisdictions- Advisory Jurisdiction- Judicial review.	
UNIT-V	9
Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-Legislative Assembly- State Judiciary- Powers and Functions of the High Courts.	

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

REFERENCES:
1. W.H.Morris Shores- Government and politics of India, NewDelhi, B.1.Publishers, 1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House, 1977.
3. R.Thanker- The Government and politics of India, London:Macmillon, 1995.
4. B.C.Rout- Democractic Constitution of India.
5. Gopal K.Puri- Constitution of India, India 2005.

Mapping Of Course Outcomes with Program Outcomes

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	0	0	1	0	0	0	0	0	0	0	0	0	0
CO2	2	0	0	1	0	0	0	0	0	0	0	0	0	0
CO3	2	0	0	1	0	0	0	0	1	0	0	0	0	0
CO4	2	0	0	1	0	0	0	1	1	0	0	0	0	0
CO5	2	2	0	1	0	0	0	1	1	0	0	0	0	0
Total	10	2	0	5	0	0	0	2	3	0	0	0	0	0
Scaled value	2	1	0	1	0	0	0	1	1	0	0	0	0	0

$1 – 5 \rightarrow 1, \quad 6 – 10 \rightarrow 2, \quad 11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSECODE	XCP107		L	T	P	C
COURSENAME	**Programming For ProblemSolvingLaboratory**		0	0	1	1
PREREQUISITES	**BasicUnderstandingSkills**		L	T	P	H
C	P	A		0	0	2	3
0.75	1	0.25					

LEARNINGOBJECTIVES

- Tolearnprogramminglanguagebasicsand syntax
- Toignitelogicalthinking
- Tounderstandstructured programmingapproach
- Todealwithuserdefined datatypes
- To knowaboutdatastorage in secondarymemory

COURSEOUTCOMES		DOMAIN	LEVEL
CO1	*Solve*simpleprograms using I/Ostatements	Cognitive Psycomotor	Apply Respond
CO2	*Solve*programs usingcontrolstructuresandarrays	Cognitive Psycomotor	Apply Respond
CO3	*Solve*programs usingfunctionsandpointers	Cognitive Psycomotor	Apply Respond
CO4	*Solve*programs usingstructures	Cognitive Psycomotor	Apply Respond
CO5	*Solve*programs usingfiles	Cognitive Psycomotor	Apply Respond

S.No.	List of Experiments	COs
1	Program to display a Leave Letter as per proper format	CO1
2	i. Program for addition of two numbers ii. Program to solve any mathematical formula.	CO1
3	Program to find greatest of 3 numbers using Branching Statements	CO2
4	Program to display divisible numbers between n1 and n2 using looping Statement	CO2
5	Program to search an array element in an array.	CO2
6	Program to find largest/smallest element in an array.	CO2
7	Program to perform string operations.	CO3
8	Program to find area of a rectangle of a given number use four function types.	CO3
9	Programs to pass and receive array and pointers using four function types	CO3
10	Programs using Recursion for finding factorial of a number	CO3
11	Program to read and display student marksheet of a student structures With variables	CO4
12	Program to read and display student marks of a class using structures With arrays	CO4
13	Program to create linked list using structures with pointers	CO4
14	Program for copying contents of one file to another file.	CO5
15	Program using files to store and display student marklist of a class using Structures with array	CO5

HOURS	TUTORIAL	PRACTICAL	TOTAL
	0	30	30

Mapping of CO with PO's

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
Scaled Value	3	2	1	1	3	0	0	1	0	1	2	3	2	0
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$														
0-No Relation, 1-Low Relation, 2-Medium Relation, 3-High Relation														

COURSE CODE	XAP108				L	T	P	C
COURSE NAME	APPLIED PHYSICS FOR ENGINEERS LABORATORY				0	0	2	2
C:P:A	0:2:0				L	T	P	H
PREREQUISITE:	Basic Physics in HSC level				0	0	3	3

COURSE OUTCOMES		Domain	Level
CO1	*Determine* the significance of elasticity in engineering systems and technological advances.	Psychomotor:	Mechanism
CO2	*use* and *locate* basic applications of electromagnetic induction to technology.	Psychomotor: Affective:	Mechanism Respond
CO3	*Describe* the working principle and application of various lasers and fibre optics.	Psychomotor:	Mechanism
CO4	*use* physics principles of latest technology using semiconductor devices.	Psychomotor:	Mechanism

LABORATORY

1.	Torsional Pendulum - determination of moment of inertia and rigidity modulus of the given material of the wire.
2.	Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3.	Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4.	Meter Bridge - Determination of specific resistance of the material of the wire.
5.	Spectrometer - Determination of dispersive power of the give prism.
6.	Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7.	Air wedge - Determination of thickness of a given thin wire.
8.	Laser - Determination of wavelength of given laser source and size of the given micro particle using Laser grating.
9.	Post office Box - Determination of band gap of a given semiconductor.
10.	PN Junction Diode - Determination of V-I characteristics of the given diode.

REFERENCE BOOKS:
1. Samir Kumar Ghosh, "A text book of Advanced Practical Physics", New Central Agency (P) Ltd, 2008.
2. Arora C.L., "Practical Physics", S. Chand & Company Ltd., New Delhi, 2013.
3. UmayalSundari AR., "Applied Physics Laboratory Manual", PMU Press, Thanjavur, 2012.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	0	0	30	30

Mapping Of Course Outcomes with Program Outcomes

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
Total	12	6	7	6	4				3			5		
ScaledValue	3	2	2	2	1				1			1		
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

II Semester

COURSE CODE			COURSE NAME		L	T	P	C
XMA201			Calculus, Ordinary Differential Equations and Complex Variable		3	1	0	4
C	P	A			L	T	P	H
3	0.5	0.5			3	1	0	4
PREREQUISITE: Mathematics I (Calculus and Linear Algebra)								
COURSE OUTCOMES:								

Course outcomes:		Domain	Level
CO1	**Find** double and triple integrals and to find line, surface and volume of an integral by **Applying** Greens, Gauss divergence and Stokes theorem.	Cognitive	Apply Remember
CO2	**Solve** first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	Cognitive	Apply
CO3	**Solve** Second order ordinary differential equations with variable coefficients using various methods.	Cognitive	Apply
CO4	**Use** CR equations to verify analytic functions and to findharmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	Cognitive Psychomotor	Remember Apply Guided Response
CO5	**Apply** Cauchy residue theorem to evaluate contour integrals involving sine and cosine function and to state Cauchy integral formula, Liouvilles theorem. Taylor's series, zeros of analytic functions, singularities, Laurent's series.	Cognitive Affective	Apply Receive

Unit -I	Multivariable Calculus (Integration)	12

Multiple Integration: Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Triple integrals (Cartesian), Scalar line integrals - vector line integrals - scalar surface integrals - vector surface integrals - Theorems of Green, Gauss and Stokes.

Unit -II	First order ordinary differential equations	12

Exact - linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p - equations solvable for y- equations solvable for x and Clairaut's type.

Unit -III	Ordinary differential equations of higher orders	12

Second order linear differential equations with variable coefficients- method of variation of parameters - Cauchy-Euler equation- Power series solutions- Legendre polynomials- Bessel functions of the first kind and their properties

Unit -IV	Complex Variable – Differentiation	12

Differentiation-Cauchy-Riemann equations- analytic functions-harmonic functions-finding harmonic conjugate- elementary analytic functions (exponential, trigonometric, logarithm) and their properties- Conformal mappings- Mobius transformations and their properties

Unit -V	Complex Variable – Integration	12

Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof)- Liouville's theorem (without proof)- Taylor's series- zeros of analytic functions- singularities- Laurent's series – Residues- Cauchy Residue theorem (without proof)- Evaluation of definite integral involving sine and cosine- Evaluation of certain improper integrals using the Bromwich contour.

LECTURE	TUTORIAL	TOTAL
45	15	60

Text Book: B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40thth Edition, 2008.

Reference Books:
1.G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.

2. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

3.W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value   Problems", 9thEdn. Wiley India, 2009.

4. S. L. Ross, "Differential Equations", 3rd Ed., Wiley India, 1984.

5.E. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India,   1995.

6. E. L. Ince, "Ordinary Differential Equations", Dover Publications, 1958.

7.J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., McGraw   Hill, 2004.

8. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi   Publications, Reprint, 2008.

Cos versus GA mapping

	**Graduates Attributes**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

COURSE CODE	COURSE NAME			L	T	P	C
XBE202	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS**			**3**	**1**	**0**	**4**
Prerequisites	**Physics**			L	T	P	H
C:P: A	**3:0:0**			**3**	**1**	**0**	**4**
Course Outcomes			**Domain**		**Level**		
CO1	**Relate** the fundamentals of electrical parameters and **build** and **explain** AC, DC circuits by Using measuring devices		Cognitive		Understand		
CO2	**Explain** the operation of DC and AC machines.		Cognitive		Understand		
CO3	**Illustrate** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.		Cognitive		Understand		
CO4	**Explain the** number systems and logic gates. **Construct** the different digital circuit.		Cognitive		Understand		
CO5	**Outline the** different types of microprocessors and their applications.		Cognitive		Understand		
UNIT-I: FUNDAMENTALS OF DC AND AC CIRCUITS, MEASUREMENTS				**9**+3			
Fundamentals of DC– Ohm's Law – Kirchhoff's Laws - Sources - Voltage and Current Relations – Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities - Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).							
UNIT -II: ELECTRICAL MACHINES				**9 + 3**			
Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC							

motors - Basics of Single-Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single-Phase Transformer, Three phase transformers, Auto transformer.

UNIT- III: SEMICONDUCTOR DEVICES	9 + 3

Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications.

UNIT- IV: DIGITAL ELECTRONICS	9 + 3

Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subtractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.

UNIT- V: MICROPROCESSORS	9+ 3

Architecture, 8085, pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, Instruction types, classification of instructions, addressing modes, Interfacing Basics: Data transfer concepts – Simple Programming concepts.

LECTURE	TUTORIAL	TOTAL
45	15	60

TEXT BOOKS
1. Metha V.K, Rohit Mehta, 2020. Principles of Electronics,12th ed, S Chand Publishing.
2. Albert Malvino, David J.Bates., 2017. Electronics Principles. 7th ed, Tata McGraw-Hill. New Delhi.
3. Rajakamal, 2014. Digital System-Principle & Design. 2nd ed. Pearson education.
4. Morris Mano, 2015. Digital Design. Prentice Hall of India.
5. Ramesh, S. Gaonkar, 2013, Microprocessor Architecture, Programming and its Applications with the 8085, 6th ed , India: Penram International Publications.

REFERENCE BOOKS
1. Corton, H.,2004 Electrical Technology. CBS Publishers & Distributors.
2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.
3. Jacob Millman and Christos, C. Halkias, 1967, Electronics Devices, New Delhi: McGraw-Hill.
4. Millman, J. and Halkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and Systems, Tokyo: McGraw-Hill, Kogakusha Ltd.
5. Mohammed Rafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E-REFERENCES
1. NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya and Prof. G.D. Roy, IIT Kharagpur.
2. Prof.L.Umanand, http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.
3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura, IIT Madras.
4. Dr.L.Umanand, http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Bangalore.

Mapping of COs with Pos

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	1	1			1	1	1		3	3
CO2	3	3	1	1	1	1			1	1	1		3	3
CO3	2	2	2	1	2	2	1	1	1	1	1		3	3
CO4	2	2	1	1	1	1	1	1	1	1	1		3	3
CO5	2	2	1	1	1	1	1	1	1	1	1		3	3
Total	12	12	6	5	6	6	3	3	5	5	5		15	15
ScaledValue	3	3	2	1	2	2	1	1	1	1	1		5	5
$1-5 \rightarrow 1$, $6-10 \rightarrow 2$, $11-15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	XAC203		L	T	P	C
COURSE NAME	Applied Chemistry For Engineers		3	1	0	4
PREREQUISITES	Nil		L	T	P	H
C:P:A	3.5:1.0:0.5		3	1	0	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Identify* the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. *Describe* the various water quality parameters like hardness and alkalinity.	Cognitive	Understand
CO2	*Explain* and *Measure* microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	Cognitive Psychomotor	Understand Set
CO3	*Interpret* bulk properties and processes using thermodynamic and kinetic considerations.	Cognitive Psychomotor	Apply Mechanism
CO4	*Describe, Illustrate* and *Discuss* the chemical reactions that are used in the synthesis of molecules.	Cognitive	Understand Analyze
CO5	*Apply, Measure* and *Distinguish* the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	Cognitive Psychomotor	Remember Apply Mechanism

UNIT – I	PERIODIC PROPERTIES AND WATER CHEMISTRY	8+3

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries. **Water Chemistry**-Water quality parameters Definition and explanation of hardness, determination of hardness by EDTA method-Introduction to alkalinity.

UNIT–II	USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA	12+3

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion-Types, factors affecting corrosion rate and Control methods. Use of free energy considerations in metallurgy through Ellingham diagrams. Advantages of electroless plating, electroless plating of nickel and copper on Printed Circuit Board (PCB).

UNIT–III	ATOMIC AND MOLECULAR STRUCTURE	10+3

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles.. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures. *Intermolecular forces and potential energy surfaces* Ionic, dipolar and Vander waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

UNIT-IV	SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	7+3

Principles of spectroscopy and selection rules. Electronic spectroscopy-chromophore, auxochromes, types of electronic transition and application. Fluorescence and its applications in medicine. Vibrational spectroscopy-types of vibrations, Instrumentation and applications. Rotational spectroscopy of diatomic molecules. Nuclear magnetic resonance spectroscopy-concept of chemical shift and applications-magnetic resonance imaging. Diffraction and scattering.

UNIT–V	STEREOCHEMISTRY AND ORGANIC REACTIONS	8+3

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds *Organic reactions and synthesis of a drug molecule* Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization reactions and ring opening reactions. Synthesis of a commonly used drug molecule- Aspirin and paracetamol.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	45	15	0	60

TEXT BOOKS

1. Puri B.R. Sharma, L.R., Kalia K.K. Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993
2. Lee. J.D. Concise Inorganic Chemistry, UK, Black well science, 2006.
3. Trapp. C, Cady, M. Giunta. C, Atkins's Physical Chemistry, 10th Edition, Oxford publishers, 2014.
4. Glasstone S., Lewis D., Elements of Physical Chemistry, London, Mac Millan & Co. Ltd, 1983.
5. Morrison R.T. and Boyd R.N. Organic Chemistry (6th edition), New York, Allyn & Bacon Ltd., 1976.
6. Banwell. C.N, Fundamentals of Molecular Spectroscopy, (3th Edition), McGraw-Hill Book Company, Europe 1983.
7. Bahl B.S. and Arun Bahl, Advanced Organic Chemistry, (4th edition), S./ Chand & Company Ltd. New Delhi, 1977.
8. P. S. Kalsi, Stereochemistry: Conformation and mechanism, (9th Edition), New Age International Publishers, 2017.

REFERENCE BOOKS

1. Puri B R Sharma L R and Madan S Pathania, " Principles of Physical Chemistry", Vishal publishing Co., Edition 2004
2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000

E Resources - MOOCs:
1. http://www.mooc-list.com/course/chemistry-minor-saylororg
2. https://www.canvas.net/courses/exploring-chemistry
3. http://freevideolectures.com/Course/2263/Engineering-Chemistry-I
4. http://freevideolectures.com/Course/3001/Chemistry-I
5. http://freevideolectures.com/Course/3167/Chemistry-II
6. http://ocw.mit.edu/courses/chemistry/

Mapping of CO's with PO's:

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO4	3	0	0	0	0	0	3	3	3	0	0	0	0	0
CO5	3	0	0	0	0	0	2	2	3	0	0	0	0	0
Total	14	0	0	0	0	0	10	13	14	0	0	0	0	0
ScaledValue	3	0	0	0	0	0	2	3	3	0	0	0	0	0
	$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$													
	0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation													

					L	**T**	**P**	**SS**	**C**
	XGS204				2	0	0	0	2
			Technical Communication						
C	**P**	**A**			**L**	**T**	**P**	**SS**	**H**
3	**0**	**0**			2	0	0	0	2

Course Outcomes	Domain	Level
After completion of the course, students will be able to		

		Domain	Level
CO1	**Associate** the basic principles of Technical writing.	Cognitive	Understand
CO2	**Identity**the Special techniques in writing.	Cognitive	Apply
CO3	**Explain**the communicative styles of writing.	Cognitive	Evaluate
CO4	**Classify** thenature of Report writing.	Cognitive	Understand

Course Content		Hours
UNIT-I	**Basic Principles**	**8**
1.1 – Basic Principles of Technical Writing		
1.2 – Styles used in Technical Writing		
1.3 – Language and Tone		
UNIT –II	**Techniques**	**8**
2.1 – Special Techniques used in writing		
2.2 – Definition & Description of mechanism2.3 – Description- Classification-Interpretation		
UNIT-III	**Communication**	**7**
3.1 – Modern development in style of writing3.2 - New letter writing formats		
UNIT-IV	**Report writing**	**7**
4.1 – Types of Report writing 4.2 – Project writing formats		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
30	**0**	**0**	**30**

TEXT BOOKS: Suggested Readings:
  (i)   John Sealy, Writing and Speaking Author; Oxford University Press, New Delhi, 2009
  (ii)   Williams K.S, Communicating Business. Engage Learning India Pvt Ltd, 2012

Mapping of COs with Pos

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
					PROGRAM OUTCOMES									
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue	3	2	1	1	3	0	0	1	0	1	2	3	2	0
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE			COURSE NAME		L	T	P	C
XWP205			**Workshop Practices**		1	0	2	3
C	**P**	**A**			L	T	P	H
1.0	**2.0**	**0**			1	0	3	4

PRE REQUISITE: NIL

	Course outcomes:	Domain	Level
CO1:	*Summarize* the machining methods and *Practice* machining operation.	Cognitive Psychomotor	Understand Guided response
CO2:	*Defining* metal casting process, moulding methods and **relates** Casting and Smithy applications.	Cognitive Psychomotor	Remember Perception
CO3:	*Plan* basic carpentry and fitting operation and *Practice* carpentry and fitting operations.	Cognitive Psychomotor	ApplyGuided response
CO4:	*Summarize* metal joining operation and *Practice* welding operation.	Cognitive Psychomotor	Understand Guided response
CO5:	*Illustrate* the, electrical and electronics basics and *Makes* appropriate electrical connections*.*	Cognitive Psychomotor	Understand Remember Guided response

COURSE CONTENT

EXP.NO	TITLE	CO RELATION
1	Introduction to machining process	CO1
2	Plain turning using lathe operation	CO1
3	Introduction about CNC machining and machines	CO1
4	Demonstration of plain turning using CNC	CO1
5	Study of metal casting operation	CO2
6	Demonstration of moulding process	CO2
7	Study of smithy operation	CO2
8	Study of carpentry tools	CO3
9	Half lap joint – Carpentry	CO3
10	Mortise and Tenon joint – Carpentry	CO3
11	Study of fitting tools	CO3
12	Square fitting	CO3
13	Triangular fitting	CO3
14	Study of welding tools	CO4
15	Square butt joint - welding	CO4
16	Tee joint – Welding	CO4

17	Introduction to house wiring	CO5
18	One lamp controlled by one switch	CO5
19	Two lamps controlled by single switch	CO5
20	Staircase wiring	CO5

TEXT BOOKS

1. Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay
2. Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.

REFERENCES

1. Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.
2. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi
3. Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.
4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

E RESOURCES http://nptel.ac.in/courses/112107145/

Mapping of CO's with PO'S:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO2	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO3	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO4	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO5	2	1	1	1	1	1	-	1	1	-	1	2	0	0
Total	10	5	5	5	5	5	-	5	5	-	5	10	0	0
ScaledValue	2	1	1	1	1	1	-	1	1	-	1	2	0	0

$1 – 5 \rightarrow 1$,	$6 – 10 \rightarrow 2$,	$11 – 15 \rightarrow 3$
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation		

				L	T	P	C
XBT206		**CHEMICAL ENGINEERING THERMODYNAMICS**		**2**	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**2**	**1**	**0**	**3**

Course Outcomes		Domain	Level
After completion of the course, students will be able to			
CO1	**State** the basic laws of thermodynamics and the fundamentals of thermodynamics.	Cognitive	Remember Understand
CO2	**Interpret** the PVT relationship for various systems.	Cognitive	Interpretation
CO3	**Estimate** the thermodynamic relations and the thermodynamic properties.	Cognitive	Remember Understand
CO4	**Apply** the phase equilibrium in various systems like miscible and immiscible systems.	Cognitive	Apply
CO5	**Knows** the chemical equilibrium for industrial reactions	Cognitive	Remember Understand

Course Content	Hours

UNIT-I	Fundamentals Of Thermodynamics	6+3
Definitions of System, Surroundings and Processes, Open and Closed systems, State properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase Rule, Reversible and Irreversible processes, Overall view on laws of thermodynamics.		
UNIT –II	PVT Relationships for Gases and Liquids	6+3
PVT behaviour of pure fluids-Equations of state and the concept of ideal gas –Processes involving ideal gases – Equation of state for real gases -Compressibility charts –heat effects on chemical reactions.		
UNIT-III	Solution Thermodynamics	6+3
Classification of thermodynamic properties –relationship on thermodynamic properties – method of Jacobians – Fugacity – properties of solution – chemical potential – Effect of temperature and pressure on chemical potential - fugacity in solutions –Activity in solutions – heat effects of mixing processes.		
UNIT-IV	Phase Equilibria	6+3
Criteria of phase equilibria, phase equilibria in multi-component systems, phase rule for nonreacting systems, Vapour-Liquid Equilibria, P-xy, T-xy and VLE for ideal systems; Bubble and Dew Point for ideal binary or ternary component systems, Non-Ideal solutions: azeotropes, Calculation of activity coefficients using Van laar and Margules equation and azeotropic data - Liquid-Liquid Equilibrium diagrams.		
UNIT-V	Reaction Equilibria	6+3
Reaction stoichiometry – Criteria of chemical Reaction Equilibrium – Equilibrium Constant – Equilibrium constant and standard free Energy change – Effect of temperature on equilibrium constant – Effect of pressure on equilibrium – Factors affecting equilibrium conversion - Liquid phase reactions – Ligand binding – Membrane potential – Energetics of metabolic pathways, Oxidation and reduction reactions.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
30	15		45

TEXT BOOKS:

1. Narayanan K.V.A textbook of Chemical Engineering Thermodynamics'', PHI 2006.
2. Smith, J.M., Van Ness HC and Abbott MM.2005. Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw-Hill International Edition,2005

REFERENCES:

1. S.I.Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Edition, Wiley India, 2006.
2. Rao., Y.V.C., Chemical engineering Thermodynamics, University Press, Hyderabad, 2005.
3. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.

EREFERENCES: ThermodynamicsofBiomolecularSystems:
http://ocw.mit.edu/courses/biologicalengineering/20-110j-thermodynamics-of-biomolecular-systems-fall-2005/

Mapping of COs with POs

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	0	0	0	0	0	0	0	0	2	2	0	2
CO2	3	3	2	2	1	0	2	0	0	0	2	2	3	2
CO3	3	3	2	2	1	0	2	0	0	0	2	2	3	2
CO4	3	3	2	3	1	1	2	0	0	0	2	2	2	2
CO5	3	3	3	3	1	1	2	1	1	0	2	3	3	3
	1	1	1		1	1		1			1	1	1	1
Total	16	15	10	10	5	3	8	2	1	0	11	12	12	12
ScaledValue	3	3	2	2	1	1	2	1	1	0	3	3	3	3
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	COURSE NAME	L	T	P	C
XBE207	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS LABORATORY**	**0**	**0**	**1**	**1**
Prerequisite	Physics	L	T	P	H
C : P : A	**1.5 : 1 : 0.5**	**0**	**0**	**3**	**3**

COURSE OBJECTIVES:

The course helps toLearn the basic concepts of electrical and electronics components.
   a. Understand the basic wiring methods and connection.
   b. Study the characteristics of diodes, Zener diodes, NPN transistors.
   c. Verify the working of simple logic gates, adders and subtractors.

Course Outcomes:		Domain	Level
CO1	**Apply** the fundamental electrical concepts and **differentiate** the various electronic components.	Cognitive Psychomotor Affective	Understand Set Valuing
CO2	**Implement** and **execute** the different types of wiring connections.	Cognitive Psychomotor Affective	Understand Set Valuing
CO3	**Demonstrate** the Fluorescent lamp connection with choke.	Cognitive Psychomotor Affective	Understand Set Valuing
CO4	**Characterize** and **display** the basic knowledge on the working of PN junction and Zener diode.	Cognitive Psychomotor Affective	Understand Set Valuing
CO5	**Implement** and **execute** the various digital electronic circuits such as Adders and Subtractors.	Cognitive Psychomotor Affective	Understand Set Valuing

List of Experiments:

1. Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.
2. Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
3. Testing of DC Voltage and Current in series and parallel resistors which are connected in breadboard by using Voltmeter, Ammeter and Multimeter.
4. Fluorescent lamp connection with choke.
5. Staircase Wiring
6. Forward and Reverse bias characteristics of PN junction diode.
7. Forward and Reverse bias characteristics of zener diode.
8. Input and Output Characteristics of NPN transistor.
9. Construction and verification of simple logic gates.
10. Construction and verification of adders and subtractors.

	PRACTICAL	TOTAL
	30	**30**

Cos versus GA mapping

	Graduates Attributes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	1	1	1	1			1	1	1	
CO2	3	3	1	1	1	1			1	1	1	
CO3	2	2	2	1	2	2	1	1	1	1	1	
CO4	2	2	1	1	1	1	1	1	1	1	1	
CO5	2	2	1	1	1	1	1	1	1	1	1	
Total	12	12	6	5	6	6	3	3	5	5	5	
Scaled Value	3	3	2	1	2	2	1	1	1	1	1	

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$

COURSE CODE	XAC208	L	T	P	C
COURSE NAME	**Applied Chemistry For Engineers laboratory**	0	0	1	1
PREREQUISITES	**Nil**	L	T	P	H
C:P:A	**3.5:1.0:0.5**	0	0	3	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Identify* the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. *Describe* the various water quality parameters like hardness and alkalinity.	Cognitive Psychomotor	Understand Perception
CO2	*Explain* and *Measure* microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	Cognitive Psychomotor	Understand Set
CO3	*Interpret* bulk properties and processes using thermodynamic and kinetic considerations.	Cognitive Psychomotor Affective	Apply Mechanism Receive
CO4	*Describe, Illustrate* and *Discuss* the chemical reactions that are used in the synthesis of molecules.	Cognitive Psychomotor Affective	Understand Analyze
CO5	*Apply, Measure* and *Distinguish* the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	Cognitive Psychomotor	Apply Mechanism
Laboratory Part			**30 hrs**

Experiments :	
1. Determination of chloride ion present in the water sample by Argentometric method.	**CO1**
	CO1
2. Determination of total, temporary and permanent hardness of water sample by EDTA method.	**CO2**
3. Determination of cell constant and conductance of solutions.	**CO2**
4. Potentiometry - determination of redox potentials and emfs.	**CO3**
5. Determination of surface tension and viscosity.	**CO3**
6. Adsorption of acetic acid by charcoal.	
7. Determination of the rate constant of a reaction.	**CO4**
8. Estimation of iron by colorimetric method.	**CO4**
9. Synthesis of a polymer/drug.	**CO5**
10. Saponification/acid value of oil.	**CO5**

REFERENCE BOOKS

1. Mendham, Denney R.C,. Barnes J.D and Thomas N.J.K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th Edition, Pearson Education, 2004.

2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. "Experiments in Physical Chemistry", 8th Ed.; McGraw-Hill: New York, 2003.

3. **E Resources -** MOOCs:

   1.http://freevideolectures.com/Course/2380/Chemistry-Laboratory-Techniques
   2. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Chemistry-Fall-2011
3.http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques

LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
0	**0**	**45**	**45**

Mapping of CO's with PO's:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO4	3	0	0	0	0	0	3	3	3	0	0	0	0	0
CO5	3	0	0	0	0	0	2	2	3	0	0	0	0	0
Total	**14**	**0**	**0**	**0**	**0**	**0**	**10**	**13**	**14**	**0**	**0**	**0**	**0**	**0**
ScaledValue	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**3**	**0**	**0**	**0**	**0**	**0**
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE		XPS301		L	T	P	C
COURSE NAME		**PROBABILITY AND STATISTICS**		3	0	0	3
C	P	A		L	T	P	H
2.5	0.5	0		3	0	0	3

PREREQUISITE:Nil

Learning Objectives

1. Appreciate the importance of probability and statistics in computing and research.
2. Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries and to use appropriate statistical method in the analysis of simple datasets.
3. Interpret and clearly present output from statistical analyses in a clear concise and understandable manner.
4. The main objective of this course is to provide students with the foundations of probabilities and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.

COURSE OUTCOMES:

Course outcomes:		Domain	Level
CO1	**Explain** conditional probability, independent events; **find** expected values and Moments of Discrete random variables with properties.	Cognitive	Understand
CO2	**Find** distribution function, Marginal density function, conditional density function, **Define** density function of conditional distribution functions normal, exponential and gamma distributions.	Cognitive	Remember
CO3	**Find** measures of central tendency, statistical parameters of Binomial, Poisson and Normal, correlation, regression. Rank Correlation coefficient of two variables. Moments, Skewness and Kurtosis	Cognitive	Remember
		Psychomotor	Guided Response
CO4	**Explain** large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviations with simple problems.	Cognitive	Understand
CO5	**Explain** small sample test for single mean, difference of mean and correlation coefficients, variance test, chi-square test with simple Problems.	Cognitive	Understand

UNIT I: Basic Probability	9
Probability spaces, conditional probability, independence, Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Chebyshev's Inequality.	
UNIT II: Continuous Probability Distributions & Bivariate Distributions	9
Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities.	
UNIT III: Basic Statistics	9
Measures of Central tendency: Moments, Skewness and Kurtosis - Probability distributions: Binomial, Poisson and normal - evaluation of statistical parameters for these three distributions, Correlation and	

regression – Rank correlation.

UNIT IV: Applied Statistics	9

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

UNIT V: Small Samples	9

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXTBOOKS

1.Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw-Hill, New Delhi,2010
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, 2003 (Reprint).
3. S. Ross, "A First Course in Probability", 6th Ed., Pearson Education India, 2002.
4. W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, 3rd Ed., Wiley, 1968.
5. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2010.

E – REFERENCE nptel

Probability and Statistics by Prof.Someshkumar, Department of Mathematics, IIT Kharagpur.
(http://nptel.ac.in/noc/noc_courselist.php)

Cos versus GA mapping

		Graduates Attributes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	1						1	1		1
CO2	3	2	1						1	1		1
CO3	3	2	1	1					1	1		1
CO4	3	2	1	1	1	1			1	1	1	1
CO5	3	2	1	1	1	1	1		1	1	1	1
Total	15	10	5	3	2	2	1		5	5	2	5
Scaled Value	3	2	1	1	1	1	1		1	1	1	1
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation												
$1 – 5 \rightarrow 1$, $\quad$ $6 – 10 \rightarrow 2$, $\quad$ $11 – 15 \rightarrow 3$												

				L	T	P	C
XBT302			**BIOCHEMISTRY**	**2**	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**1**	**0**	**4**

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Would have learn the fundamentals of biomolecules.
- Would have learn the functions of proteins and biosignalling.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1 *Recognize* and *Understand* about role of water and amino acids.	Cognitive	Remember
CO2 *Recognize* and *Understand* proteins and their structures. Also, will learn about enzymes.	Cognitive	Recall
CO3 *Recognize* and *Understand* about carbohydrate and glycol biology.	Cognitive	Understand
CO4 *Recognize* and *Understand* about Nucleotides and Nucleic acids.	Cognitive	Understand
CO5 *Recognize* and *Understand* lipids and biosignalling.	Cognitive	Understand

I – Water, Amino acids and Proteins	**6+3**

Water, Weak Interactions in Aqueous Systems, Ionization of Water, Weak Acids, and Weak Bases, Buffering against pH changes in biological systems. Water as a reactant.Amino acids, structures of 20 common acids and properties, Peptides, Proteins, Genetic codon.Structure of Proteins- Primary, Secondary, Tertiary structure and Quaternary Structures – Fibrous Proteins.

II – Protein Function and Enzymes	**6+3**

Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins: Complementary Interactions between Proteins and Ligands: Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors: An Introduction to Enzymes: How Enzymes Work, Mechanism, Examples of Enzymatic Reactions, Regulatory Enzymes.

III – Carbohydrates and Glycobiology	**6+3**

Monosaccharides and Disaccharides: Polysaccharides: Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids: Carbohydrates as Informational Molecules: The Sugar Code: Working with Carbohydrates.

IV – Nucleotides and Nucleic acids	**6+3**

Fundamentals of nucleotides and nucleic acids: Nucleic Acid Structure: Nucleic Acid Chemistry: Other Functions of Nucleotides.

V – Lipids, biological membranes and transport	**6+3**

Storage Lipids: Structural Lipids in Membranes: Lipids as Signals, Cofactors, and Pigments: Working with Lipids: Biological membranes and transport: Composition and architecture of membranes, membrane dynamics and solute transport across membranes.

Lecture	Tutorial	Practical	Total
30	**15**	**0**	**45**

Text Books:

1. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.
2. Biochemistry, Donald Voet, Judith G. Voet 4th Edition, 2011, 1520 pages ISBN: 978-0-470-91410-6.

| | 3. | Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999. |

Reference Books:
1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
3. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
4. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993.

E-References:
1. http://vlab.amrita.edu/?sub=3&brch=63
2. https://www.youtube.com/channel/UCbWTmSK7bYM9kRZAdfy_gyg

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO 2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
CO 4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO 5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
	5	5	10	0	5	0	0	5	5	5	5	7	8	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	5	5	10	0	5	0	0	5	5	5	5	7	8	6
Scaled Value	3	3	6	0	3	0	0	3	3	0	3	4	5	3

$1 - 5 \rightarrow 1,$ $\qquad 6 - 10 \rightarrow 2,$ $\qquad 11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 303			**MICROBIOLOGY**	**L**	**T**	**P**	**C**
				3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

PREREQUISITE: Biology

Learning Objectives:
Upon completion of this course, the students will be able to understand the existence of microbial world through the study of the characteristics of microorganisms, their classification, their interaction with various environments, growth in different media and their control.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Comprehend* knowledgeabout historical perspective of microbiology and its developments. *Recognize* the fundamental concepts in the structure and functioning of a prokaryotic cell. *Perform* staining techniques to observe	Cognitive	Understand Remember

	microorganisms		
CO2	*Acquire* knowledge about microbial taxonomy and microbial classification methods	Cognitive	Understand Remember
CO3	*Acquire* knowledge about microbial ecosystem and their interactions in different environments	Cognitive	Understand Remember
CO4	*Acquire* knowledge on the bacterial growth, growth curveandmicrobial nutritional requirements,*Perform* culturing techniques to isolate microorganisms, **Choose** the appropriate media for the cultivation of microorganisms	Cognitive	Understand Remember
CO5	**Demonstrate** the mechanisms of various antimicrobial drugs against pathogens applications of microorganisms, *Acquire* knowledge on the drug resistance of pathogens	Cognitive	Understand Remember

I	**INTRODUCTION TO MICROBIOLOGY**	**7**

History and Scope of Microbiology – Overview of Prokaryotic cell structure: Cell membrane, Cytoplasmic matrix, Cell wall, Flagella, Capsule – Study of microbial structure: Microscopy (light, dark-field, phase contrast, electron), Staining techniques (simple and differential).

II	**CLASSIFICATION OF MICROORGANISMS**	**9**

Microbial Taxonomy: Binomial Nomenclature – Five Kingdom classification system: Monera, Protista, Fungi, Plantae, Animalia – Three Domain classification system: Bacteria, Archea, Eukarya – Methods of Classification: Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Molecular characteristics – Viruses: Structure and Classification.

III	**MICROBIAL ECOLOGY AND MICROBIAL INTERACTIONS**	**11**

Microbial Ecology: Microorganisms in Marine Ecosystems, Freshwater Ecosystems, Terrestrial Ecosystems – Microbial Interactions: Microbe-Microbe interactions, Human-Microbe interactions.

IV	**MICROBIAL GROWTH AND NUTRITION**	**11**

Microbial Growth: Growth curve (lag, exponential, stationary, death phase), Measurement (cell number, cell mass), Factors influencing growth (water activity, pH, temperature, oxygen, pressure, radiation) – Microbial Nutrition: Culture media (defined, complex), Culture techniques (spread plate, streak plate, pour plate).

V	**ANTIBIOTICS AND ANTIMICROBIAL RESISTANCE**	**7**

Antibiotics: Antibacterial, Antifungal, Antiviral, Antiprotozoan, Antihelminthic drugs – Antimicrobial Resistance: Mechanisms of resistance, Prevention of resistance.

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

TEXT BOOKS:

1. Prescott, L. M., Harley, J. P., and Klein, D. A. Microbiology. 5th. *McGrawJ Hill Higher Education*, 2005.

REFERENCES:

1. Morcello, J. A., Mizer, H. E., &Granato, P. A. Laboratory manual and workbook in Microbiology: Application to patient care, 2003
2. Prescott, L. M., Harley, J. P., & Klein, D. A. Laboratory exercises in microbiology, 2002.
3. Black, Jacquelyn G. *Microbiology: principles and explorations.* John Wiley & Sons, 2008.
4. Tortora, Gerard J., Berdell R. Funke, Christine L. Case, and Ted R. Johnson. *Microbiology: an introduction*. Vol. 9. San Francisco, CA: Benjamin Cummings, 2004.

E-REFERENCES:

1. http://www.austincc.edu/rohde/noteref.htm
2. http://www.uwyo.edu/molb2210_lect/lecture/lectures.html
3. http://nptel.ac.in/courses/102103012/

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	1	1	1	0	1	0	1	1	1	1	0	0
CO2	3	3	1	1	1	2	2	1	1	1	1	1	0	0
CO3	3	1	2	3	1	2	1	0	1	1	1	1	2	0
CO4	3	3	2	0	1	0	2	0	1	1	1	1	0	2
CO5	3	2	2	3	1	2	2	1	1	0	1	1	2	2
	15	**12**	**8**	**8**	**5**	**6**	**8**	**2**	**5**	**4**	**5**	**5**	**4**	**2**

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	12	8	8	5	6	8	2	5	4	5	5	4	2
Scaled Value	6	4	3	3	2	2	3	1	1	1	1	1	0	1

1 – 5 → 1,   6 – 10 → 2,   11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT304	**MATERIAL AND ENERGY BALANCES**		**L**	**T**	**P**	**C**
			2	**1**	**0**	**3**
C	**P**	**A**	**L**	**T**	**P**	**H**
3	**0**	**0**	**2**	**1**	**0**	**3**

	Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	*Interpret* different unit systems and *Express* the composition gas liquid and solid systems	Cognitive	Understand Remember
CO2	*Compute* the material balances across different unit operations	Cognitive	Understand Analyse
CO3	**Compute** the material balances across chemical reactors	Cognitive	Understand Analyse
CO4	*Explain* the energy balance calculations for systems with and without chemical reactions	Cognitive	Understand
CO5	*Describe* the Biotechnology stoichiometry system	Cognitive	Understand Receive

Course Content		**Hours**
Unit-I	**Stoichiometric Principles and Basic Calculations**	**6**+**3**
Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations - Methods of expression, compositions of mixture and solutions. Gases, Vapors and Liquids: Equations of state, Vapor pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.		
Unit-II	**Material Balances for Non-Reacting System**	**6**+**3**
Material balances to different unit operations - recycle - bypass and purging. Distillation, extraction, mixing, drying, crystallization, evaporation, adsorption and absorption, Material balance for multiple unit		

Unit-III	Material Balances for Reacting System	6+3

Material balances with chemical reaction - Limiting and excess reactants – Combustion – Yield, conversion and selectivity calculations, Material balance for multiple unit

Unit-IV	Energy Balances	6+3

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats. Energy balances with chemical reaction: Heat of reaction, Heat of combustion.

Unit-V	Biological Stoichiometry	6+3

Stoichiometry growth and product formation, Degree of reduction, Electron balance, Theoretical Oxygen demand.

Lecture	Tutorial	Practical	Total
30	15	0	45

Text Books:

1. K.V.Narayanan and Lakshmikutty, *Chemical Process Calculations*, Prentice Hall, 2004.
2. D. M. Himmelblau and J. B. Riggs, *Basic Principles and Calculations in Chemical Engineering*, Pearson India Education Services, 8th Edition, 2015.
3. B. I. Bhatt and S.M. Vora, **Stoichiometry**, Tata McGraw Hill Publishing Company Ltd, 4thEdition, 2004.
4. Richard M. Felder and Ronald W. Rousseau, *Elementary Principles of Chemical Processes*, John Wiley & Sons, INC. 3rd Edition, 2000.

Reference Books:

1. V. Venkataramani, N. Anantharaman, and Begum, K. M. MeeraSheriffa, Process Calculations, Prentice Hall of India, 2nd Edition.
2. D. C. Sikdar, Chemical Process Calculations, Prentice Hall of India.
3. Bailey and Ollis, Biochemical Engineering Fundamentals, McGraw Hill, Co. 2004.

E-References:

1. http://nptel.ac.in/syllabus/103106076/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 2	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 3	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 4	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 5	3	3	2	3	2	0	2	0	0	0	0	0	2	2
	15	15	10	15	10	0	10	0	0	0	0	0	10	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	10	15	10	0	10	0	0	0	0	0	10	10
Scaled Value	3	3	2	3	2	0	2	0	0	0	0	0	7	6

$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

					L	T	P	C
XBT305			**GENETICS AND EVOLUTIONARY BIOLOGY**		3	0	0	3
C	**P**	**A**			**L**	**T**	**P**	**H**
3	0	0			3	0	0	3

Prerequisite: Biochemistry and Microbiology

Learning Objectives:

Upon completion of this course, the students
- Would have learnt the fundamentals of genetics
- Would have learnt the gene mutations

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Relate* and *Interpret* Reproduction as the basis of heredity and Gene interactions	Cognitive	Remember, Understand
CO2	*Explain* and *Apply* principles of dominance and segregation	Cognitive	Understand, Apply
CO3	*Classify* and *Develop* Quantitative traits and polygenic inheritance	Cognitive	Analyze
CO4	*Classify* and *Dissect* linking the inheritance of genes to chromosomes and chromosomes as arrays of genes	Cognitive	Understand, Analyze
CO5	*List* and respond DNA Replication and Transcription	Cognitive	Remember

Course content	Hours
I –Mendelian Principles of Genetics and Gene Interactions	**9**
The relationship between genes and traits, the branches of genetics, The principles of dominance and segregation, the principle of independent assortment, applications of Mendelian principles. Gene interactions that produce new phenotypes, epistasis.	
II-Microbial genetics and quantitative Inheritance	**9**
Microbial genetics – transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Quantitative traits, polygenic inheritance, heritability, Extranuclear genomes and inheritance: Organization of extranuclear genomes, role of extranuclear inheritance, examples of extranuclear inheritance, maternal effect, genomic imprinting; Gene interaction; Complementation.	
III – Chromosomal Basis of Inheritance and Linkage	**9**
Experimental evidence linking the inheritance of genes to chromosomes, chromosomes as arrays of genes, non-disjunction as proof of the chromosome theory, the chromosomal basis of Mendelian principles;Chromosomal variation;Extra chromosomal inheritance;	
IV –Genetics and Society	**9**
Genetic disorders;Population screening for genetic diseases, Ethical issues involved in medical genetics, Human genome project and its practical implications, Eugenic and dysgenic effects.	
V – Evolutionary biology	**9**
Basic Principles of Evolution and Population Genetics;Population genetics: factors determining the composition and change in allale and genotype frequencies.; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation. Phylogeny: methods to analyse evolutionary relatedness between populations	

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:
1. Lewin's Lewin's Genes XII, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017.

Reference Books:

1. Basic genetics : a human approach / BSCS. Dubuque, IA, Kendall/Hunt Pub. Co., c1999. 147 p. QH431.B305 1999.
2. Beighton, Peter and Greta Beighton. The person behind the syndrome. London, New York, Springer, c1997. 231 p. R134.B45 1997, Foreword by Hans-R. Wiedemann.
3. Bland, Jeffrey with Sara Benum. Genetic nutritioneering. Los Angeles, Keats Pub., c1999. 272 p. B155.B59 1999.
4. Bouchard, Claude, Robert M. Malina and Louis Pérusse. Genetics of fitness and physical performance. Champaign, IL, Human Kinetics, c1997. 400 p. QP301.B76 1997
5. Childs, Barton. Genetic medicine : a logic of disease. Baltimore, Johns Hopkins University Press, c1999. 326 p. RB155.C496 1999.
6. Connor, J. M. and Malcolm Ferguson-Smith. Essential medical genetics. Oxford, Eng., Malden, MA, Blackwell Science, 1997. 236 p. RB155.C66 1997.
7. Culture, kinship, and genes : towards cross-cultural genetics. Edited by Angus Clarke and Evelyn Parsons. New York, St. Martin's Press, 1997. 272 p.   GN289.C55 1997.

E-References:

1. https://nptel.ac.in/syllabus/102107030/
2. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-6-genetics-1/
3. https://cosmolearning.org/courses/principles-mendelian-molecular-genetics/video-lectures/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	1	1	1
CO 2	1	1	2	0	1	0	0	1	1	1	1	1	1	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	3
CO 4	1	1	2	0	1	0	0	1	1	1	1	3	3	1
CO 5	1	1	2	0	1	0	0	1	1	1	1	1	1	2
	5	5	10	0	5	0	0	5	5	5	5	8	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5	8	8	9
Scaled Value	3	3	4	0	2	0	0	1	1	1	1	3	3	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Subject Code			XUM 306	L	T	P		C	
Subject Name			**Entrepreneurship Development**	2	0	0		2	
C	P	A		L	T	P	SS	H	
2.7	0	0.3		2	0	0	1	3	

Prerequisite	NIL

CourseObjectives
Throughthiscoursethestudentswill

- UnderstandtheEntrepreneurial motivation and inclination
- Idea about the market assessment
- Togetfamiliaringovernment policies and global opportunities for Entrepreneurship Development

Course Outcome:		Domain	Level	
CO1	*Recognise* and *describe* the role of innovation and motivation for an entrepreneur.	Cognitive	K2	Understand
CO2	*Self-assess* and *appraise* your entrepreneurship interest with your chosen entrepreneur.	Cognitive	K2	Understand
CO3	*Outline* the importance of generation of new ideas for entrepreneurship and *illustrate* market assessment.	Cognitive	K2	Understand
CO4	*Explain* the competition in business and *sketch/demonstrate/comply* business model for dealing with competition.	Cognitive/	K2	Understand
			K3	Apply
		Affective	A3	Value
			A2	Response
CO5	*Describe* and *Explain* venture creation and launching of small business and its management.	Cognitive	K1	Remember
			K2	Understand
CO6	*Describe* and *Discuss* various government policies and global opportunities for Entrepreneurship Development	Cognitive/	K1	Remember
			K2	Understand

COURSE CONTENT		
UNIT-I	**INNOVATION AND ENTREPRENEURSHIP**	**5**
	Definition of Innovation, Creativity and Entrepreneurship; role of innovation in entrepreneurship development - Entrepreneurial motivation - Competencies and traits of an entrepreneur -Role of Family and Society; Entrepreneurship as a career and its role in national development	
UNIT –II	**SELF ASSESSMENT OF ENTREPRENEURIAL INCLININATION**	**4**
	Self-assessment of entrepreneurial inclination -Presentation by students on their entrepreneurial inclination rating -Case study of successful entrepreneurs	
UNIT-III	**NEW IDEA GENERATION TO MARKET ASSESSMENT**	**9**
	Importance of Idea generation-filtering-refinement - opportunity recognition - Description of chosen idea - value proposition, customer-problem-Solution statement -benefits; development status; IP ownership -Market Validation- Technology/ user/decision makers/ partners -market need; segmentation -market TAM,SAM and SOM -case study on market segmentation by popular companies	

UNIT –IV	CUSTOMER – COMPETITION- BUSINESS MODEL	9
	Customer-Target primary customer research, Decision making unit/ process-Beach head market; Cost of Customer Acquisition - Competition- comparative analysis, competitive advantages-; -Business model -Financial planning -Pitch documentation and presentation	
UNIT – V	VENTURE CREATION AND LAUNCHING OF SMALL BUSINESS AND ITS MANAGEMENT	9
	New enterprise creation - organizational and legal matters -Operational plan -Sales and distribution plan - Accounting -Team recruitment and management -Fund raising and management -Profile of a startup – case studies	
UNIT– VI	GOVERNMENT INITIATIVES AND GLOBAL OPPORTUNITIES	9
	Incubators and accelerators - capacity building -Startup policies- Startup India-Support for MSME; GeM Portal. Funding–national and international sources-Bilateral programmes by Govt. of India -Global reach for promoting cross-cultural entrepreneurship (1)	

	L	T	P	SS	Total
	30	---	---	15	45

REFERENCE BOOKS

1. A.P.Aruna, " Lecture Notes on Entrepreneurship Development", available as softcopy @ www.brain.net

2. Thomas W. Zimmerer, Norman M. Scarborough, "Essentials of Entrepreneurship and Small Business Management", Pearson; 3rd edition, 2001.

3. John Burnett, "Introducing Marketing", Open Text Book available at http://solr.bccampus.ca:8001/bcc/file/ddbe3343-9796-4801-a0cb-7af7b02e3191/1/Core%20Concepts%20of%20Marketing.pdf

4. Toubia, Olivier. "Idea Generation, Creativity, and Incentives", Marketing Science. Vol. 25. pp.411-425. 10.1287/mksc.1050.0166, 2006.

5. Alexander Osterwalder and Yves Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers",Wiley; 1st edition, 2010.

6. Gerardus Blokdyk,"3C's model The Ultimate Step-By-Step Guide"5starcooks, 2018.

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO2	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO3	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO4	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO5	1	0	1	0	1	1	1	0	0	0	0	0	``1	0
CO 6	1	0	1	0	1	1	1	0	0	0	0	0	`1	0
Total	6	0	6	0	6	6	6	0	0	0	0	0	6	0
ScaledValue	2	0	2	0	2	2	2	0	0	0	0	0	2	0
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

Subject Code			XUM 307	L	T	P	C
Subject Name			**UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY**	2	1	0	3
C	**P**	**A**		L	T	P	H
3	0	0		2	1	0	3
Prerequisite			None. Universal Human Values 1 (desirable)				

Course Objective: 1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcome:		Domain	Level
CO1	*Present* sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them	Cognitive	Understand
CO2	**Grasp** the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfillment. Ex. mutually enriching production system with rest of nature.	Cognitive	Understand
CO3	*Outline* the importance of generation of new ideas for entrepreneurship and *illustrate* market assessment.	Cognitive	Understand

UNIT - I :	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education	6+3

Purpose and motivation for the course, recapitulation from Universal Human Values I - Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration - Continuous Happiness and Prosperity - A look at basic Human Aspirations - Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority - Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT - II :	Understanding Harmony in the Human Being - Harmony in Myself	6+3

Understanding human being as a co-existence of the sentient 'I' and the material 'Body' - Understanding the needs of Self ('I') and 'Body' - happiness and physical facility - Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) - Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail - Programs to ensure Sanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT - III :	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship	5+3

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship - Understanding the meaning of Trust; Difference between intention and competence - Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship - Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT - IV :	Understanding Harmony in the Nature and Existence - Whole existence as Coexistence	4+2

Understanding the harmony in the Nature 1 - Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature - Understanding Existence as Co-existence of mutually interacting units in all-pervasive space - Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT - V :	Implications of the above Holistic Understanding of Harmony on Professional Ethics	7+3

Natural acceptance of human values - Definitiveness of Ethical Human Conduct - Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order - Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of peoplefriendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. - Case studies of typical holistic technologies, management models and production systems - Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations - Sum up. Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

LECTURE	TUTORIAL	TOTAL
28	14	42+3(SS)

TEXT BOOKS:

Human Values and Professional Ethics - R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

REFERENCE BOOKS :

1. Jeevan VidyaEk- Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values - A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Leonard, Annie. 2011. The Story of Stuff. New York, NY: Simon & Schuster.
4. The Story of My Experiments with Truth - Mohandas Karamchand Gandhi
5. AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology)
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa.
9. Bharat Mein Angreji Raj – PanditSunderlal.
10. Rediscovering India - by Dharampal.
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
Total	3	3	6	0	3	0	0	3	3	3	3	5	7	6
ScaledValue	1	1	1	0	1	0	0	1	1	1	1	1	2	2
$1 – 5 \rightarrow 1$, $\qquad$ $6 – 10 \rightarrow 2$, $\qquad$ $11 – 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSECODE			XBT308		L	T	P	C
COURSE NAME			**Biochemistry Laboratory**		0	0	2	2
PREREQUISITE								
C	P	A			L	T	P	H
1	2	1			0	0	2	6
COURSE OBJECTIVES The course will provide a.Hands on experience in using Biochemistry Lab b.Practice on handling chemicals c.Will help to make understanding on research.								
COURSE OUTCOMES					DOMAIN		LEVEL	
CO1	Apply theoretical knowledge to perform experiment in Biochemistry principles.				Cognitive, Psychomotor ,Affective		Apply, Mechanism, Respond	
CO2	Practice on handling chemicals for the Biochemistry experiments.				Cognitive, Psychomotor ,Affective		Apply Mechanism Respond	

CO3	Getting trained on analytical calculations from the result of biochemistry experiments.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond
CO4	Understanding the Biochemistry Phenomena through the practical experience.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond
CO5	Apply the practical knowledge to make scientific report.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond

1. Buffer preparation and calculation of molar extinction coefficient
2. Separation of Amino Acids by Thin Layer Chromatography
3. Qualitative/Qualitative analysis of proteins
4. Qualitative/Qualitative analysis of Carbohydrates
5. Determination of β-carotene, Flavonoid
6. Estimation and purity of DNA
7. Acid hydrolysis and action of salivary amylase on starch
8. Detection of Adulteration in Milk
9. Titration Curves of Aminoacids
10. Quantitative estimation of serum cholesterol by Zak's method
11. Estimation of Saponification Value of Fats/Oils

HOURS	LECTURE	PRACTICAL	TUTORIAL	TOTAL
	0	**30**	**0**	**30**

REFERENCE BOOK
1. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO 2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
CO 4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO 5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
	5	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**7**	**8**	**6**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**5**	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**7**	**8**	**6**
Scaled Value	3	3	6	0	3	0	0	3	3	0	3	4	5	3

$1 - 5 \rightarrow 1$, $\qquad 6 - 10 \rightarrow 2$, $\qquad 11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XBT 309	L	T	P	C
COURSE NAME	MICROBIOLOGY LAB	0	0	2	2
PREREQUISITES	-	L	T	P	H
C:P:A:1:1.5:0.5		0	0	2	6

LEARNING OBJECTIVES

Upon completion of this course, the students will be able to apply their knowledge of microbiology to demonstrate aseptic microbiological techniques in the laboratory

COURSE OUTCOMES		DOMAIN	LEVEL
After the completion of course the students will be able to			
CO1	*Experiment* and *Demonstrate* media preparation and sterilization techniques	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO2	*Understand* and *Perform* staining techniques, antimicrobial and cell counting assays	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO3	*Practice* and *Demonstrate* different culturing techniques	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO4	*Perform* and *Determine* the characteristics of bacteria	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO5	*Understand* and *Experiment* on isolation of microbes for metabolites production	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond

S.No	List of Experiments	COs
1	Media preparation and Sterilization	CO1
2	Preparation of slants /plates and aseptic transfer of microbial cultures	CO1
3	Staining and identification of microbes using simple and differential staining	CO2
4	Isolation of microbes using spread plate method	CO3
5	Isolation of microbes using streak plate method	CO3
6	Isolation of microbes using pour plate method	CO3
7	Microbial growth control using Kirby-Bauer method	CO2
8	Cell counting	CO2
9	Biochemical characterization of microbes	CO4
10	Screening of microorganisms for enzyme production	CO5

	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	1	1	1	0	1	0	1	1	1	1	0	0
CO2	3	3	1	1	1	2	2	1	1	1	1	1	0	0
CO3	3	1	2	3	1	2	1	0	1	1	1	1	2	0
CO4	3	3	2	0	1	0	2	0	1	1	1	1	0	2
CO5	3	2	2	3	1	2	2	1	1	0	1	1	2	2
	15	**12**	**8**	**8**	**5**	**6**	**8**	**2**	**5**	**4**	**5**	**5**	**4**	**2**

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	12	8	8	5	6	8	2	5	4	5	5	4	2
Scaled Value	6	4	3	3	2	2	3	1	1	1	1	1	0	1

$1 – 5 \rightarrow 1$, $\qquad$ $6 – 10 \rightarrow 2$, $\qquad$ $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 310			**INPLANT TRAINING - I**	**L**	**T**	**P**	**SS**	**C**
				0	**0**	**0**	**0**	**1**
C	**P**	**A**		**L**	**T**	**P**	**SS**	**H**
1	**1**	**1**		**0**	**0**	**0**	**0**	**0**

PREREQUISITE: Nil

COURSE OUTCOMES:

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Relate* classroom theory with workplace practice	Cognitive	Understand
CO2: *Comply with* Factory discipline, management and business practices.	Affective	Respond
CO3: *Demonstrates teamwork* and time management	Affective	Value
CO4: *Describe* and *Display* hands-on experience on practical skills obtained during the programme.	Psychomotor	Perception Set
CO5: *Summarize* the tasks and activities done by technical documents and oral presentations.	Cognitive	Evaluate

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Mapping COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5				3						3			1	1
Total	2	1	2	4	3		1	3	3	4	4	0	6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

IV Semester

					L	T	P	C
XBT401			**Basic Transport Processes**		**2**	**1**	**0**	**3**
C	**P**	**A**			**L**	**T**	**P**	**H**
3	**0**	**0**			**2**	**1**	**0**	**3**

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Apply* the fluid transport properties in flow of fluids	Cognitive	Understand
CO2	*Apply* the particle transport properties in flow of fluids	Cognitive	Apply
CO3	*Describe* the heat and mass transfer equipments	Cognitive	Understand
CO4	*Compute* the heat transport properties in flow of fluids	Cognitive	Apply
CO5	*Determine* the mass transport properties in flow of fluids	Cognitive	Apply

Unit-I	**Fluid Transport**		**6+3**

Units and Dimensions, Newtonian and non-Newtonian Fluids, Laminar and turbulent flow, Continuity equation, Bernoulli equation, Hagen-Poiseuille equation,

Unit-II	**Particle Transport**		**6+3**

Characterization of particles shape and size, Size reduction, settling and sedimentation. Agitation and Mixing - power consumption in mixing, Mixing in bioreactors, Mixing time, Centrifugation, Filtration theory.

Unit-III	**Heat Transport**		**6+3**

Conductive and convective heat transfer, LMTD, Overall heat transfer coefficient, Heat exchangers.

Unit-IV	**Mass Transport**		**6+3**

Molecular diffusion and film theory, Mass transfer coefficients, Oxygen transfer and uptake in bioreactor, $k_L a$ and its measurement, Mass transfer operations.

Unit-V	**Computational Tools for the Transport Process**		**6+3**

Introduction to Computation – Excel – MATLAB – Rprogram - RStudio

Lecture	Tutorial	Practical	Total
30	**15**	**-**	**45**

Text Books:

1. McCabe, Warren L., Julian C. Smith, and Peter Harriott, Unit Operations of Chemical Engineering, McGraw-Hill, 2010.

2. Warren, L. M., C. S. Julian, and H. Peter, Unit operations of chemical engineering, McGraw Hill Book Company, 2005.

3. Geankoplis, Christie John, Allen H. Hersel, and Daniel H. Lepek, Transport processes and separation process principles, prentice hall, 2018.

4. Welty J, Rorrer GL, Foster DG.,Fundamentals of Momentum, Heat, and Mass Transfer,. Wiley, Revised 6th Edition; 2014.

Reference Books:
1. Benitez, Jaime, Principles and modern applications of mass transfer operations, John Wiley & Sons, 2016.
2. Ravi, R., R. Vinu, and Sathyanarayana N. Gummadi, eds. Coulson and Richardson's Chemical Engineering: Volume 3A: ,Chemical and Biochemical Reactors and Reaction Engineering, Butterworth-Heinemann, 2017.

E-References:
1. https://nptel.ac.in/courses/103/103/103103037/
2. http://ce-iitb.vlabs.ac.in/List%20of%20experiments.html?domain=Chemical%20Engineering
3. http://uorepc-nitk.vlabs.ac.in/#
4. http://iitg.vlab.co.in/?sub=58

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT 402		**BIOENERGETICS AND METABOLISM**	2	1	0	3
C	**P**	**A**	**L**	**T**	**P**	**H**
3	0	0	2	1	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students

- Would have learn various metabolic pathways.
- Would have learn how all the metabolic pathways related to each other.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1 *Discuss* and *Remember* fundamental andmetabolism pathways	Cognitive	Remember
CO2 *Discuss* and *Remember* biosynthesis of fatty acid and cholesterol	Cognitive	Recall
CO3 *Discuss* and *Remember* oxidative phosphorylation and photophosphorylation	Cognitive	Remember
CO4 *Discuss* and *Remember* biosynthesis of amino acids and nucleotides	Cognitive	Remember
CO5 *Discuss* and *Remember* report on metabolic order and disease	Cognitive	Create

Course content	Hours
I – Bioeneregetics and Glycolytic pathways	**6+3**
Bioenergetics and Thermodynamics, Phosphoryl Group Transfers and ATP, Biological Oxidation-Reduction Reactions, metabolic pathways: Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway, The Citric Acid Cycle.	
II – Fatty acid, Cholestrol, Lipid and amino acid metabolism	**6+3**
Biosynthesis of fatty acids, Oxidation of fatty acid – beta oxidation and omega oxidation, Ketone Bodies, Biosynthesis of Cholesterol, Biosynthesis of phospholipids and glycolipids, Metabolic Fates of Amino Groups, Pathways of Amino Acid Degradation.	
III – Oxidative phosphorylation and photophoshorylation	**6+3**
Electron-Transfer Reactions in Mitochondria, ATP Synthesis, Regulation of Oxidative Phosphorylation, General Features of Photophosphorylation – Photosystem I and II.	
IV – Biosynthesis of amino acids and nucleotides	**6+3**
Overview of Nitrogen Metabolism, Biosynthesis of amino acids, biosynthesis and degradation of nucleotides – De Novo Purine Nucleotide synthesis – Purine Nucleotide Biosynthesis – Pyrimidine Nucleotide-Nucleotide Monophosphates-Ribosomal – Purine and Pyrimidine bases are restricted by Salvage Pathways.	
V – Metabolic disorders and diseases	**6+3**
Overall view on enegetics of metabolic pathways - Qualitative and quantitative analysis of metabolism involving in disease and disorders. Report writing on metabolic disorders or diseases.	

Lecture	Tutorial	Practical	Total
30	**15**	**0**	**45**

Text Books:

1. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.
2. Biochemistry, Donald Voet, Judith G. Voet 4th Edition, 2011, 1520 pages ISBN: 978-0-470-91410-6.

| | 3. Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999. |

Reference Books:

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
3. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
4. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993.

E-References:

1. https://nptel.ac.in/courses/102104063/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	1	3	2
CO 2	1	1	2	0	1	0	0	1	1	1	1	2	2	3
CO 3	1	1	2	0	1	0	0	1	1	1	1	3	1	2
CO 4	1	1	2	0	1	0	0	1	1	1	1	2	1	1
CO 5	1	1	2	0	1	0	0	1	1	1	1	1	1	1
	5	5	10	0	5	0	0	5	5	5	5	9	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5	9	8	9
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

				L	T	P	C
XBT 403			**CELL BIOLOGY**	3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Prerequisite:-

Learning Objectives:

Upon completion of this course, the students

- Would develop a deeper understanding of cell structure and how it relates to cell functions.
- Would understand how cells grow, divide, and die and how these important processes are regulated.
- Would understand cell signaling and how it regulates cellular functions.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		

CO1	*Study* and *understand* the origin of eukaryotic cells and cells specialization	Cognitive	Understand Remember Apply
CO2	*Recognize* the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive	Understand Remember Apply
CO3	*Acquire* knowledge on the transport of proteins between intracellular compartments	Cognitive	Understand Remember
CO4	*Acquire* knowledge about cell cycles mitosis and meiosis	Cognitive	Understand Remember
CO5	*Describe* cellular 61ignaling and types of signaling receptors	Cognitive	Understand Remember

I – Cells and Tissues	9

Unity and Diversity of Cells – Origin of Eukaryotic cells – Plant cells – Viruses – Cell specialization: Epithelia, Connective tissue, Nervous tissue, Muscle – Cells as experimental models – Extracellular Matrix.

II – Cellular Organization and Membrane Transport	9

Overview of Eukaryotic cell structure: Cytoplasmic matrix, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Nucleus – Functions of cell organelles – Membrane Transport: Passive and Active transport – Sodium/potassium pumps, Ca2+, ATPase pumps, Uniport, Symport and Antiport system.

III – Intracellular Protein Trafficking	9

Transport to and from the Nucleus – Transport Across Membranes – Vesicular Trafficking Between Intracellular Compartments

IV – Cell Division and Control	9

The cell cycle – General description and different stages of mitosis and meiosis (Interphase, Prophase, Metaphase, Anaphase, Telophase) – Cell Growth Control: Apoptosis

V – Cell Signaling	9

Cell Signaling: Types of Cell Signaling, General Principles of Cell Signaling – Receptors in Signaling: Types of Receptors, Signaling via G-Protein-linked Cell Surface Receptors, Signaling via Enzyme-linked Cell-Surface Receptors.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Bolsover, S. R., Shephard, E. A., White, H. A., and Hyams, J. S. *Cell biology: a short course*. John Wiley & Sons, 2011.

References:

1. Sadava, D. E. *Cell biology: organelle structure and function*. Jones & Bartlett Learning, 1993.
2. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. *Essential cell biology*. Garland Science, 2013.
3. Julio E. Celis. *Cell biology: A Laboratory Handbook*. 3rd Edition, Vol. 1, Elsevier Academic Press, 2006.

E-References:

1. http://nptel.ac.in/courses/102103012/
2. https://cellbiology.med.unsw.edu.au/cellbiology/index.php/Cell_Biology_Introduction

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	0	0	0	1	0	0	0	0	0	1	1	0	0
CO 2	3	1	0	1	1	1	0	0	1	1	0	0	0	0
CO 3	3	1	0	0	1	0	0	0	0	0	1	1	0	0
CO 4	3	1	0	1	1	1	0	0	1	1	1	1	0	0
CO 5	3	1	0	1	1	1	0	0	1	1	1	1	0	0
	15	4	0	3	5	3	0	0	3	3	4	4	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	4	0	3	5	3	0	0	3	3	4	4	0	0
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

$1 - 5 \rightarrow 1$, $\qquad 6 - 10 \rightarrow 2$, $\qquad 11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 404			IMMUNOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
2.5	0	0.5		3	0	0	3

Prerequisite: Genetics

Learning Objectives:
Upon completion of this course, the students
- Would be able to explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development.
- Would apply the knowledge of immune associated mechanisms in medical biotechnology research.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Outline* the general concepts of immune system and *describe* the cells and organs of the immune system	Cognitive	Remember Evaluate
CO2	*Explains* the properties of antigens and antibodies and *identify* their interactions via various tests.	Cognitive	Understand Perception
CO3	*Describe* various mechanisms of antigen presentation and *discuss* the role of MHC in Ag Presentation.	Cognitive Affective	Remember Responds Phenomena
CO4	*Compares* the different types of hypersensitive reactions and *explain* the autoimmune diseases.	Cognitive	Analyze Understand
CO5	*Comprehend* the types, mechanism of vaccines and *respond* to the various immunization techniques	Cognitive	Understand

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I- Immune System	9
Organization of the immune system – Types of immune system: Innate and adaptive – Structure and functions of important immune cells: T cell, B cell development , Macrophage, Neutrophil, NK cell, Dendritic cell, Stem cells – Immune organs: Bone marrow, Spleen, Thymus, Lymph node, Mucosal and Cutaneous associated Lymphoid tissue (MALT & CALT).	
II- Antigens and Antibodies	9
Antigens: Immunogenicity, Antigenicity, Epitope, haptens and Adjuvants – Antibody: Structure, Classes and Biological Activities;Molecular basis of antibody diversity; Polyclonal antibiotics,Monoclonal antibodies – Antigen-antibody reaction: Cross-Reactivity, Affinity, Avidity, Precipitation and agglutination reactions. Immunotechniques: ELISA, RIA, Flow cytometry, Immunoelectrophoresis, Western Blotting	
III- MHC and Antigen Presentation	9
Major Histocompatibility Complex: Structure, Function and classes of MHC molecules, Immune responsiveness to MHC – Antigen processing and presentation: Endogenous antigens (The Cytosolic Pathway), Exogenous antigens (The Endocytic Pathway)	
IV- Complement, Hypersensitivity and Autoimmunity	9
Regulation of immune response; Complement System: Functions, Components, Activation and Regulation of complement system – Allergy and hypersensitivity: Types of hypersensitivity – Autoimmunity, Auto immune disorders; immune tolerance; Graft versus host reaction.	
V- Vaccines and Cancer Immunology	9
Vaccines: Active and Passive Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA and Multivalent Subunit Vaccines. Tumors of the Immune System - Tumor Antigens - Immune Response to Tumors – Cancer immunotheraphy.	

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

 1. Janes Kuby., Immunology, WH Freeman and Company, Newyork.,7th Edition, 2013.
2. Roitt, I., Essential Immunology, Blackwell Scientific Publications, Oxford, 12th Edition, 2011.

References:

1. Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). Cellular and Molecular
   Immunology, 4th Edn., W. B. Saunders Co., Pennsylvania, USA.
2. Tizard, R.I. (2007). Immunology: An Introduction 1st Edition (English) 4th Edition,
    Brooks/Cole publishers.

E - References:

1. http://www.raymondcheong.com/Year1/immuno.html
2. http://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-andmolecular
   immunology-fall-2005/lecture-notes/
3. http://www.umich.edu/~bmsteach/lopatin/Immunology/Immunology.html

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3	2	2	1	1	1	1				1	1	3	3
CO 2	3	2	2	1		1	1				1	1	2	2
CO 3	2				1								2	1
CO 4	3	2	1										1	2
CO 5	3	2	2	1	1	1	1				1	1	1	1

	14	8	7	3	3	3	3				3	3	9	9

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	14	8	7	3	3	3	3				3	3	9	9
Scaled Value	3	2	2	0	0	0	0	0	0	0	0	0	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XUM405	L	T	P	C
COURSE NAME	ECONOMICS FOR ENGINEERS	3	0	0	3
PREREQUISITES	NIL	L	T	P	H
C:P:A	2.64:0:0.12	3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Explain* the concepts of economics in engineering and *identify* element of cost to prepare cost sheet	Cognitive	Understand
CO2	*Calculate and Explain* the Break-even point and marginal costing	Cognitive	Understand &Apply
CO3	*Summarize* and *Use* value engineering procedure for cost analysis	Cognitive Affective	Understand Receive
CO4	*Estimate* replacement problem	Cognitive	Understand
CO5	*Compute, Explain* and *make Use of* different methods of depreciation	Cognitive	Understand & Apply

UNIT I	INTRODUCTION TO ECONOMICS	8

Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- types of costing, element of costs, preparation of cost sheet and estimation, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost

UNIT II	BREAK-EVEN ANALYSIS&SOCIAL COST BENEFIT ANALYSIS	12

Margin of Safety, Profit, Cost & Quantity analysis-Product Mix decisions and CVP analysis, Profit/Volume Ratio (P/V Ratio), Application of Marginal costing, Limitations
Social Cost Benefit Analysis: compare different project alternatives, Calculate direct, indirect and external effects; Monetizing effects; Result of a social cost benefit analysis.

UNIT III	VALUE ENGINEERING &COST ACCOUNTING:	10

Value engineering – Function, aims, Value engineering procedure - Make or buy decision
Business operating costs, Business overhead costs, Equipment operating costs

UNIT IV	REPLACEMENT ANALYSIS	7

Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.

UNIT V	DEPRECIATION	8

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation, Annuity method of depreciation, service output method of depreciation.

LECTURE:45	TUTORIAL:0	PRACTICAL:0	TOTAL:45

TEXT BOOKS

1.	Sp Gupta, Ajay Sharma & Satish Ahuja, "Cost Accounting", V K Global Publications, Faridabad, Haryana, 2012.
2.	S.P.Jain&Narang, "Cost accounting – Principles and Practice", Kalyani Publishers, Calcutta, 2012.
3.	PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
4.	William G.Sullivan, James A.Bontadelli& Elin M.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.

REFERENCES

1.	Luke M Froeb / Brian T Mccann, "Managerial Economics – A problem solving approach" Thomson learning 2007
2.	Truett&Truett, "Managerial economics- Analysis, problems & cases "Wiley India 8th edition 2004.
3.	Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4.	Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

Mapping of CO with PO

CO Vs PO	CO1	CO2	CO3	CO4	CO5	Total	Scaled to 0,1,2 and 3
PO$_1$	1	2	2	1	2	8	2
PO$_2$	1	2	2	1	3	9	2
PO$_3$	1	1	2	1	2	7	2
PO$_4$	1	1	2	0	1	5	1
PO$_5$	1	2	2	1	2	8	2
PO$_6$	1	2	2	1	3	9	2
PO$_7$	1	1	2	1	2	7	2
PO$_8$	1	1	2	0	1	5	1
PO$_9$	1	2	2	1	2	8	2
PO$_{10}$	1	2	2	1	3	9	2
PO$_{11}$	1	1	2	1	2	7	2
PO$_{12}$	1	1	2	0	1	5	1
PSO$_1$	1	2	2	1	2	8	2
PSO$_2$	1	2	2	1	3	9	2
TOTAL	14	22	28	11	29	-	-

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

Course Code	:	XUM 406	L	T	P	C
Course Name	:	**DISASTER MANAGEMENT**	0	0	0	0
Prerequisite	:	NIL	L	T	P	H

C	P	A					3	0	0	3
3	0	0								

Course Outcome: After the completion of the course, students will be able to		**Domain** **C or P or A**	**Level**
CO1	Understand the concepts of disasters, their significance and types	Cognitive	Understand
CO2	Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction	Cognitive	Understand
CO3	Able to understanding of preliminary approaches of Disaster Risk Reduction (DRR)	Cognitive	Understand
CO4	Develop awareness of institutional processes in the country	Cognitive	Application
CO5	Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity	Cognitive	Application

COURSE CONTENT

UNIT I	**INTRODUCTION TO DISASTERS**	6
	Importance &Significance, Types of Disasters, Climate Change, DM cycle	
UNIT II	**RISK ASSESSMENT**	12
	Risk, Vulnerability, Types of Risk, Risk identification, Emerging Risks, Risk Assessment, Damage Assessment, Risk modeling.	
UNIT III	**DISASTER MANAGEMENT**	10
	Phases, Cycle of Disaster Management, Institutional Framework, Incident Command System, DM Plan, Community Based DM, Community health and safety, Early Warning and Disaster Monitoring, Disaster Communication, Role of GIS and Remote Sensing, Do's and Don'ts in various disasters.	
UNIT IV	**DISASTER RISK MANAGEMENT IN INDIA**	10
	Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness), Disaster Management Act and Policy – Other related policies, plans, programmes and legislation	
UNIT V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES**	7
	Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Forest Fire, Man Made disasters, Space Based Inputs for Disaster Mitigation and Management, Cast Study	

		L	T	P	Total
		45	0	0	45

TEXT BOOKS

1. Singhal J.P. Disaster Management, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423

2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361)

3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011

4. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010

REFERENCE BOOKS

1. Siddhartha Gautam and K Leelakrisha Rao, "Disaster Management Programmes and Policies", Vista International Pub House, 2012

2. Arun Kumar, "Global Disaster Management", SBS Publishers, 2008

3. PardeepSahni, AlkaDhameja and Uma medury, "Disaster mitigation: Experiences and reflections", PHI, 2000

4. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005

5. Government of India, National Disaster Management Policy, 2009

E-REFERENCES

- NIDM Publications at http://nidm.gov.in- Official Website of National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India

- http://cwc.gov.in , http://ekdrm.net , http://www.emdat.be , http://www.nws.noaa.gov , http://pubs.usgs.gov , http://nidm.gov.ini http://www.imd.gov.ini

Mapping of COs with POs

		PROGRAM OUTCOMES												
		1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1				2	1	1		1		1		1	1		
CO2		1	1	3	2	3		1	1						
CO3					2			1		1					
CO4		1	1	2	2	2		1				1	1		
CO5		2	3		2	3		1	2	1			2		
Total		4	5	7	7	11		5	3	3		2	4		
Scaled Value		1	1	2	2	3		1	1	1		1	1		
$1-5 \rightarrow 1$, $\quad\quad$ $6-10 \rightarrow 2$, $\quad\quad$ $11-15 \rightarrow 3$															
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation															

COURSE CODE	XBT407	L	T	P	C
COURSE NAME	**BASIC TRANSPORT PROCESSES LABORATORY**	0	0	1	1
PREREQUISITES	-	L	T	P	H
C:P:A	2:0.5:0.5	0	0	2	4

LEARNING OBJECTIVES
- To understand the existence of transport processes involved in unit operations through the experiments of the characteristics of fluid mechanics, particle mechanics, heat transfer, mass transfer and process control system.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Experiment* and *Demonstrate*Fluid Flow System	Cognitive Psycomotor	Understand Respond
CO2	*Experiment* and *Demonstrate*Particle Mechanics phenomena	Cognitive Psycomotor	Understand Respond

		Affective	
CO3	*Experiment* and *Demonstrate*Heat Transfer phenomena.	Cognitive Psycomotor	Understand Respond
CO4	*Experiment* and *Demonstrate*Mass Transfer phenomena.	Cognitive Psycomotor	Understand Respond
CO5	*Understanding*Process control system and *Aware* of MATLAB in Unit operation.	Cognitive Affective	Understand Respond

S.No	List of Experiments		COs
1	I. Experiment on fluid flow meters (U tube manometer, Orifice meter, Venturi meter, Pitot tube meter). II. Centrifugal and Reciprocating pumps characteristics	6 Experiments (9 hrs)	CO1
2	I. Settling and Sedimentation of the particles II. Experiment on Centrifugation process III. Determination of Mixing power consumption. IV. Study on Rotary Drum Filter, Leaf Filter, Filter Press, Size Reduction Equipment and Sieve analysis]	3 Experiments 5 Study Experiments (9 hrs)	CO2
3	I. Heat Transfer by Conduction, Convection II. Heat Exchanger	3 Experiments (4 hrs)	CO3
4	I. Simple Extraction II. Batch Adsorption	2 Experiments (4 hrs)	CO4
5	I. Study on Interacting and non-Interacting system II. Introduction to MATLAB and SIMULINK	3 Study Experiments (4hrs)	CO5
Reference: McCabe, Warren L., Julian C. Smith, and Peter Harriott, Unit Operations of ChemicalEngineering,McGraw-Hill, 2010.			

Any Ten Experiments may choose from all COs	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	**15**	**9**	**12**	**6**	**10**	**10**	**0**	**0**	**0**	**9**	**13**	**8**	**9**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSECODE			XBT408		L	T	P	C
COURSE NAME			**Cell Biology Laboratory**		0	0	2	2
PREREQUISITE								
C	P	A			L	T	P	H
1	1	1			0	0	2	6

COURSE OBJECTIVES

Upon completion of this course, the students

- Would develop a deeper understanding of cell structure and how it relates to cell functions.
- Would understand how cells grow, divide, and die and how these important processes are regulated.
- Would understand cell signaling and how it regulates cellular functions.

	COURSE OUTCOMES	DOMAIN	LEVEL
CO1	*Study* and *understand* the origin of eukaryotic cells and cells specialization	Cognitive, Psychomotor, Affective	Apply, Mechanism, Respond
CO2	*Recognize* the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive, Psychomotor, Affective	Applyand apply, Mechanism Respond
CO3	*Acquire* knowledge on the transport of proteins between intracellular compartments	Cognitive, Psychomotor, Affective	Apply. Mechanism Responding
CO4	*Acquire* knowledge about cell cycles mitosis and meiosis	Cognitive, Psychomotor, Affective	Analysing and applying, Responding
CO5	*Describe* cellular 69ignaling and types of signaling receptors	Cognitive, Affective	Analysing, organizing. - valuing

List Of Practical Experiments

1. Staining and observation of eukaryotic cells
2. Cell viability assay by trypan blue exclusion method.
3. Isolation of chloroplasts from spinach leaves
4. Osmosis and Tonicity
5. Extraction of lipids from tissues
6. Extraction of proteins from tissues
7. Separation of proteins by SDS-PAGE electrophoresis
8. Study of different stages of mitosis in onion root tip cells.
9. Study of different stages of meiosis in grasshopper testis cells

HOURS	LECTURE	PRACTICAL	TUTORIAL	TOTAL
	0	30	0	30

REFERENCE BOOK

1. Julio E. Celis. *Cell biology: A Laboratory Handbook*. 3rd Edition, Vol. 1, Elsevier Academic Press, 2006.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	0	0	0	1	0	0	0	0	0	1	1	0	0
CO 2	3	1	0	1	1	1	0	0	1	1	0	0	0	0
CO 3	3	1	0	0	1	0	0	0	0	0	1	1	0	0
CO 4	3	1	0	1	1	1	0	0	1	1	1	1	0	0
CO 5	3	1	0	1	1	1	0	0	1	1	1	1	0	0
	15	4	0	3	5	3	0	0	3	3	4	4	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	4	0	3	5	3	0	0	3	3	4	4	0	0
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

COURSE CODE	**XBT 409**	L	T	P	C
COURSE NAME	**IMMUNOLOGY LABORATORY**	0	0	1	1
PREREQUISITES		L	T	P	H
C:P:A = 1:1:1		0	0	2	6

LEARNING OBJECTIVES
- To introduce the different types of qualitative and quantitative immunoassays.
- To expose the students to various immunological terms.
- To establish analytical ability to interpret the real time experimental results.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Demonstrate* separation of different components of whole blood using density gradient centrifugation.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO2	*Demonstrate* and *determine* the count of each type of blood components present in the blood using dyes.	Cognitive Psycomotor Affective	Apply Responds to Phenomena
CO3	*Demonstrate* the ABO blood grouping system and *determine* the blood group.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO4	*Carry out* the coupling technique to label the Antibody with Enzyme HRP.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO5	*Demonstrate* qualitative and quantitative assays for identifying the reaction pattern, similarity pattern, unknown concentration, separation of desired antigen.	Cognitive Psycomotor Affective	Remember Responds to Phenomena .

S.No	List of Experiments	COs
1	Collection of Serum from Blood	CO1
2	Isolation of lymphocytes from whole blood	CO1
3	Differential Leukocyte count	CO2
4	Total Leukocyte count	CO2
5	Total and differential count of RBC	CO2
6	Blood Grouping Experiment	CO3
7	Antibody Labelling with HRP	CO4
8	Ouchterlony double diffusion	CO5
9	Single radial immunodifussion	CO5
10	Immunoelectrophoresis	CO5

11.	DIRECT Elisa	CO5
12.	Widal test	CO5
13.	Latex Agglutination	CO5

Reference:

1. Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). Cellular and Molecular Immunology, 4th Edn., W. B. Saunders Co., Pennsylvania, USA.

	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3	2	2	1	1	1	1				1	1	3	3
CO 2	3	2	2	1		1	1				1	1	2	2
CO 3	2				1								2	1
CO 4	3	2	1										1	2
CO 5	3	2	2	1	1	1	1				1	1	1	1
	14	8	7	3	3	3	3				3	3	9	9

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	14	8	7	3	3	3	3				3	3	9	9
Scaled Value	3	2	2	0	0	0	0	0	0	0	0	0	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

V Semester

XBT 501				L	T	P	C
				3	0	0	3
			BIOANALYTICAL TOOLS				
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Physics, Applied Physics

Learning Objectives:

Upon completion of this course, the students

- Will be able to understand the principles of instrumentation
- Will be able to impart the knowledge of different techniques and methods in biotechnology
- Will be able to improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Explain* the basics and fundamentals of analytical techniques and *describe* the various calibration techniques Understand the basic measurement methods.	Cognitive	Understand Remember
CO2	*Illustrate* the instrumentation and applications of different spectroscopic techniques	Cognitive	Understand Remember

CO3	***Understand*** the immunologicaland radioactive techniques and their applications in biotechnology.	Cognitive	Understand Remember
CO4	***Know*** the principle of instrumentation and ***applications*** of various imaging techniques in biological field.	Cognitive	Understand Remember
CO5	***Classify*** the various techniques of Chromatography, ***Elaborate*** the importance of electrophoresis	Cognitive	Understand Remember

Course content	Hours
I – Introduction	**9**
Classification of instrumental methods – Concepts of accuracy, precision – Limits of detection (LOD) – Types of errors: Random and Systematic – Calibration of instrumental methods: External, Internal and standard addition methods –Signal to Noise ratio.	
II – Spectroscopic Techniques	**9**
Basics of electromagnetic radiation – Absorption, Transmittance and their relationship – Beer-Lambert's law – Principle, Instrumentation and applications of UV-Visible, IR, FTIR and Circular Dichroism Spectroscopy.	
III – Immunological and Radioactive Techniques	**9**
Immunoassays – Enzyme-Linked Immunosorbent Assay (ELISA), Radioimmunoassay (RIA) – Immunohistochemistry – Immunoblotting – Flow cytommetry– Principle, Instrumentation and applications of Geiger-Muller counter, Solid & Liquid scintillation counters.	
IV – Imaging and Characterization Techniques	**9**
Scanning Electron Microscope – Transmission Electron Microscope – Mass spectrometry and MALDI – TOF Analysis – Crystalline structure analysis: XRD and NMR.	
V – Separation Techniques	**9**
Affinity-based separations – Chromatography: Column chromatography, Thin-layer chromatography (TLC),Gas chromatography (GC) andHigh-performance liquid chromatography (HPLC) – Electrophoresis: Agarose Gel and SDS-Polyacrylamide Gel electrophoresis.	

Lecture	Tutorial	Total
45	**0**	**45**

Text Books:

1. Robinson, J. W., Frame, E. M. S., Frame, G. M., Eileen, M., & Skelly, F. (2005). Undergraduate instrumental analysis.
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis. Cengage learning.

Reference Books:

1. Gordon, M. H., Macrae, R., & Mac Rae, R. (1987). Instrumental analysis in the biological sciences. Blackie.
2. Bisen, P. S., & Sharma, A. (2012). Introduction to instrumentation in life sciences. Crc Press.

E-References:

1. https://nptel.ac.in/courses/103/108/103108100/
2. https://nptel.ac.in/courses/103/108/103108100/
3. https://nptel.ac.in/courses/102/103/102103083/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	0	0	1	0	0	0	0	2	0	1
CO 2	3	3	2	2	0	0	1	0	0	0	0	0	0	1
CO 3	3	2	2	1	0	0	1	0	0	0	0	0	0	1
CO 4	2	3	2	2	0	0	0	0	0	0	0	1	0	1
CO 5	3	2	3	1	0	0	1	0	0	0	0	1	0	1
	14	12	11	7	0	0	4	0	0	0	0	4	0	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

8th BOS/BIOTECH/Date: 19.08.2021

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	14	12	11	7	0	0	4	0	0	0	0	4	0	5
Scaled Value	3	3	3	2	0	0	2	0	0	0	0	2	0	2

$1 - 5 \rightarrow 1$, $\quad\quad\quad$ $6 - 10 \rightarrow 2$, $\quad\quad\quad$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 502			**MOLECULAR BIOLOGY**	L	T	P	C
				3	0	0	3
C	**P**	**A**		L	T	P	H
3	0	0		3	0	0	3

Learning Objectives:

Upon completion of this course, the students
- Would have learnt structures of DNA, RNA and its replication and repair
- Would have learnt gene regulations

	Course Outcomes	Domain	Level
After the completion of the course, students will be able to			
CO1	*Relate* and *Interpret* DNA and RNA structure and its role	Cognitive	Understand Remember
CO2	*Explain* and *Apply* and its replication and repair	Cognitive	Understand Apply
CO3	*Classify* and *Develop* transcription and post transcriptional modifications	Cognitive	Analyze
CO4	*Classify* and *Dissect* translation and post translational processing	Cognitive	Understand Analyze
CO5	*List* and respond gene regulations	Cognitive	Remember

Course content	Hours
I – Introduction	**9**
Definition of Gene – Chromosomal organization of gene – Functional rearrangements in chromosomal DNA – Organizing cellular DNA into chromosome – Morphology and functional elements of eukaryotic chromosomes.	
II – Replication and Repair	**9**
Chemistry of DNA synthesis – Modes of DNA replication – Enzymes of replication – Models of replication – Prokaryotic replication – Eukaryotic replication – DNA mutations – Types of mutations – Types of DNA damage – DNA repair mechanisms	
III – Transcription and RNA processing	**9**
Types of RNA – RNA polymerase enzymes (prokaryotic & eukaryotic) – Transcription initiation factors – Transcriptional elongation (prokaryotic & eukaryotic) – Transcriptional termination (prokaryotic & eukaryotic) – Prokaryotic RNA processing – Eukaryotic RNA processing (3'-polyadenylation, 5'-CAP formation, RNA decapping, mRNA splicing).	
IV – Translation and its regulation	**9**
Protein synthesis machinery (t-RNA, m-RNA, ribosomes, aminoacyl tRNA synthetases) – Initiation of protein translation (prokaryotic & eukaryotic) – Elongation of protein translation (prokaryotic & eukaryotic) – Termination of protein translation (prokaryotic & eukaryotic) – Regulation of translation.	
V – Regulation of gene expression	**9**
Prokaryotic gene regulation (activator, inducer & repressor) – Eukaryotic gene regulation (histone	

modification, DNA modification & chromatin remodelling).

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Verma P.S. (Author), Agarwal V.K. Molecular Biology, 2010.
2. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge   University Press; Eighth edition, 2018.

Reference Books:

1. Molecular Biology of the Gene, James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael, Losick Richard, Pearson Education; Seventh edition, 2017.
2. Molecular Biology Made Simple and Fun, David P. Clark (Author), Lonnie Dee Russell (Author), 2010.

E-References:

1. https://nptel.ac.in/courses/102106025/
2. https://www.embl.de/training/e-learning/
3. https://swayam.gov.in/course/5065-molecular-biology
4. https://www.ox.ac.uk/admissions/undergraduate/courses-listing/biochemistry-molecular-and-cellular?wssl=1
5. https://vlab.amrita.edu/?sub=3&brch=77
6. https://www.youtube.com/watch?v=V4CRCQfXUrg

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1			
CO 2	1	1	2	0	1	0	0	1	1	1	1			
CO 3	1	1	2	0	1	0	0	1	1	1	1			
CO 4	1	1	2	0	1	0	0	1	1	1	1			
CO 5	1	1	2	0	1	0	0	1	1	1	1			
	5	5	10	0	5	0	0	5	5	5	5			

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5			
Scaled Value	1	1	2	0	1	0	0	1	1	1	1			

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

				L	T	P	C
XBT 503			**BIOREACTION ENGINEERING**	2	1	0	3
C	**P**	**A**		L	T	P	H
2	**0**	**1**		3	1	0	4

Learning Objectives:

Upon completion of this course, the students

- Would able to known about the basics of biochemical process.
- Would have understood the concepts of enzyme kinetics.
- Would have knowledge on the kinetic model for biochemical reactions.

	Course Outcomes	Domain	Level
• Would able to design a bioreactor for a particular biochemical process.			
After the completion of the course, students will be able to			
CO1	*Understand* and *describe* the fundamentals of reaction kinetics	Cognitive Affective	Remember Receive
CO2	*Outline* the enzyme production and *choose* an appropriate production method based on kinetics.	Cognitive	Understand
CO3	*Recognize*, *perform* and *detect* various immobilization techniques for a bioreaction process.	Cognitive	Understand
CO4	*Identify* and *select* a kinetic model and design a bioreactor according to a biochemical process	Cognitive Affective	Understand Responds
CO5	*Identify,select* and *follow* a bioreactor for a particular process.	Cognitive Affective	Understand Receive

Course content	Hours
Unit-I – Reaction Kinetics	**6+3**
Rate law – Order of reaction kinetics: Zero, First and Second Order reactions – Ideal reactors: Batch, Mixed flow, and Plug flow - Temperature effect on rate constant.	
Unit-II – Enzymes Production and Its Kinetics	**6+3**
M-M kinetics – enzyme inhibition – enzyme stability& specificity- factors affecting reaction rates – industrial production process- Industrial production and applications of enzymes: α-amylase – cellulase – protease – lipase, Vitamins: Cyanaocobalamin – Riboflavin.	
– Monod Model – modeling of batch and continuous cell growth Batch growth-quantifying cell concentration, growth patterns and kinetics in batch culture, environmental conditions affect growth kinetics. Quantifying growth kinetics- Unstructured non segregated models to predict specific growth rate, cell growth in continuous cultures Definitions and stoichiometric calculations-elemental balances, Degree of reduction, Theoretical predictions of yield coefficients	
Unit-III – Immobilization System	**6+3**
Enzyme Immobilization – Diffusion Effects – Thiele modulus, Effectiveness factor, Damkoehler number - Application of hydrolytic enzymes-Immobilized microbial cells, carrier binding, Entrapping, Cross linking, Advantages and disadvantages of immobilized cells.	
Unit-IV – Cell Growth Kinetics	**6+3**
Kinetics of cell growth – Substrate utilization and product formation –Structured, Unstructured non segregated models to predict specific growth rate, cell growth in continuous cultures Definitions and stoichiometric calculations-elemental balances, Degree of reduction, Theoretical predictions of yield coefficients - Microbial, animal and plant cell cultivation –factors affecting the growth.	
Unit -V – Bioreactors	**6+3**
Microbial and enzyme reactors - Ideal Bioreactors-Type of bioreactor-Airlift bioreactors-Airlift pressure cycle bioreactors—Fluidized bed reactors-trickle bed reactors-loop reactor-Stirred tank reactors-Bubble column fermenter – Optimization and scaleup.	

Lecture	Tutorial	Practical	Total
30	**15**	**0**	**45**

Text Books:
1. Bailey J.E. and Ollis D.F, Biochemical Engineering Fundamentals, Second edition, McGraw Hill Co, Newyork, 2010.
2. Rajiv Dutta, Fundamentals of Biochemical Engineering, First Edition, Springer, 2008.

Reference Books:
1. Jens Nielsen, John Villadsen and Gunnar Liden, Bioreaction Engineering Principles, Second edition, Kluwer Academic/Plenum Publishers, Newyork, 2003.

2. GhasemNajafpour, Biochemical Engineering and Biotechnology, Elsevier, 2007.

E-References:

1. http://nptel.ac.in/courses/103105054/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3										1	1	1	
CO 2	2	3		1					1			1	2	
CO 3		1	3									2	3	1
CO 4		1	2									3	1	2
CO 5	1	2	3	1								2	1	3
	6	7	8	2	0	0	0	0	1	0	1	9	8	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	6	7	8	2	0	0	0	0	1	0	1	9	8	6
Scaled Value	2	2	2	1	0	0	0	0	1	0	1	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 504			PLANT BIOTECHNOLOGY	L	T	P	C
				3	0	0	3
C	**P**	**A**		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Cell biology, Genetics and Molecular biology

Learning Objectives:

Upon completion of this course, the students

- Would have understand the fundamentals of plant cells.
- Would have learn the techniques in Plant Tissue Culture.
- Would have understood various techniques of gene transfer in plants.
- Would have learn production of Biomolecules from plants for various applications.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Describe* the plant genomeand*knows*various terminology related to plant tissue culture.	Cognitive	Remember Understand
CO2	*Describe* Fundamentals of plantcells and plant tissue culture and *knows*various media for tissue culture.	Cognitive	Remember Understand
CO3	*Compare* the various gene transfer methods in plants and *Relate*each other with its pros and cons	Cognitive	Remember Understand
CO4	*Relate* and *Analyze* various vectors and genetic manipulation techniques	Cognitive	Understand Analyze
CO5	*Choose* and *Apply*Herbicide tolerance pesticide, GMOs and molecular farming.	Cognitive	Understand Apply

Course content	Hours
Unit-I – Introduction to Plant Tissue Culture	**9**
Scope of plant biotechnology – Plasticity and totipotency - History of plant tissue culture – Types and composition of tissue culture media – Role of plant growth regulators and elicitors– Physiochemical	

conditions for tissue culture – kinetics of growth and nutrient optimization; viability in the tissue culture; somaclonal variation.

Unit-II – *In vitro* Propagation	9

Types of plant tissue culture –Regeneration of plants-Organogenesis and somatic embryogenesis - Culture types: Callus, cell-suspension culture, shoot and root tip culture, hairy root culture, Meristem culture, pollen culture, Anther culture and haploid production – protoplast culture: isolation, fusion-somatic hybrid and cybrid and regeneration of protoplast – Germplasm conservation and cryopreservation.

Unit-III – Plant Breeding Techniques	9

Simple and complex inheritance - back cross – selection marker and reporter gene; Molecular Markers: RFLP and PCR based SSR markers - Marker-Assisted selection, Hybrid seeds production - Herbicide tolerant plants: Different strategies to achieve, strategy to generate glyphosate tolerant plants and their related problems – Production of marker free transgenic plants; plastid transformation

Unit-IV – Genetic Transformation of Plants	9

Agrobacterium mediated gene transfer – Crown gall disease, Genes involved in DNA transfer, Ti plasmid, Ri plasmid - Binary vector system - Plant viruses and different types of Viral Vectors – Gemini virus, Cauliflower mosaic virus – Direct gene transfer methods – particle gun bombardment, electroporation.Indirect gene transfer techniques.

V – Applications of Plant Biotechnology	9

Molecular farming/Pharming of proteins – Bioreactors for recombinant protein, Secondary metabolite production using plant cell culture. Antisense technology in crop improvement - Therapeutic/Industrial applications of plant products - Plant vaccines, custom-made antibodies, Transgenic plants - their issues and solutions.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:
1. Slater A., Nigel W., Scott, and Fowler MR., Plant biotechnology: The Genetic Manipulation of Plants, Oxford University Press, London, 2nd Edition, 2008.
2. Neal Stewart, Jr., Plant Biotechnology and Genetics: Principles, Techniques, and Applications. John Wiley & Sons Inc. USA, 2008.

Reference Books:
1. Chawla HS. Introduction to Plant Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 2nd Edition, 2003.
2. Neumann, Karl-Hermann, Ashwani Kumar, and Sudhir K. Sopory. Recent Advances in Plant Biotechnology and Its Applications: Prof. Dr. Karl-Hermann Neumann Commemorative Volume. IK International Pvt Ltd, 2008.
3. Hammond, John, Peter McGarvey, and VidadiYusibov, eds. Plant biotechnology: new products and applications. Vol. 240. Springer Science & Business Media, 2012.

E-References:
1. http://www.ncbi.nlm.nih.gov/books/NBK26851/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	0	1	1	2	1	0	0	1	1	1	3	3	3
CO 2	3	2	2	2	3	2	1	1	2	1	1	2	2	2
CO 3	2	1	3	1	2	2	1	0	2	2	1	2	2	2
CO 4	3	2	2	2	2	2	1	1	1	1	0	3	2	2
CO 5	3	3	3	2	3	2	3	2	2	2	2	3	1	1
	13	8	11	8	14	9	5	4	8	7	5	13	10	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**13**	**8**	**11**	**8**	**14**	**9**	**5**	**4**	**8**	**7**	**5**	**13**	**10**	**10**
Scaled Value	3	2	3	2	3	2	1	1	2	2	1	3	2	2

$1 - 5 \rightarrow 1,$ $\qquad$ $6 - 10 \rightarrow 2,$ $\qquad$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 505A	**FOOD BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

PREREQUISITE: -

Learning Objectives:

Upon completion of this course, the students
- Will be able to understand the application of biotechnology in animal, plant and food production
- Will be able todescribe selected industrial food biotechnology processes
- Will be able to describe selected classical fermentation processes and to describe how fermentation can deliver nutrition
- Will be able to understand safety aspects of fermented food products

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Know* the principles and *defines* the concepts of food biotechnology.	Cognitive	Remember
CO2:*Describe* the role of microbes associated with food products.	Cognitive	Understand
CO3:*Outlines* the methods for Genetically modified food production.	Cognitive	Analyze
CO4:*Discuss* and *compiles* the various methods of food preservation and packaging	Cognitive	Understand
CO5:*Describe* the importance of food quality and regulations	Cognitive	Evaluate
Unit-I	**Introduction to food biotechnology**	**9**

Introduction – Scope and importance of food biotechnology – Biotechnological approaches to improve nutritional quality and shelf life of commercialized fruits and vegetables – Functional foods: Concept of Prebiotics, Probiotics and Nutraceuticals.

| **Unit-II** | **Utilization of microorganisms in food industries** | **9** |

Fermented dairy products: Cheese, Yoghurt –Fermented food products – Natto, Miso, Sufu, meat and sausages – Single cell protein production– Cocoa, Tea and Coffee fermentation.

| **Unit-III** | **Genetically modified food products** | **9** |

Herbicide tolerant Soybean – Insect resistantCorn – Altered fatty acid composition Canola – Virus resistant Plum – Vitamin enriched Golden rice – Faster maturation Coho Salmon.

| **Unit-IV** | **Food Preservation and Packaging** | **9** |

Mechanisms of food spoilage – Food preservation by low-temp: Refrigeration, freezing and freeze-drying – Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization – Non-thermal preservation: ionizing radiation, high hydrostatic pressure, pulsed electric field – Packaging of foods: packaging materials, packaging atmosphere

Unit-V	Food safety and regulations	9
Safety of fermented foods – Approval process forfood additives – Hazard Analysis Critical Control Points (HACCP) – FSSAI		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS:
1. Byong H. Lee., Fundamentals of food biotechnology. John Wiley & Sons, 2014.
REFERENCE BOOKS:
1. Bhatia, S. C. (2017). *Food biotechnology*. Wpi Publishing.
2. Ray B., "Fundamental Food Microbiology", Third Edition, CRC Press LLC, 2003.
3. Shetty, Kalidas, et al., eds. Food biotechnology. CRC Taylor & Francis, 2006.
E- REFERENCES
1.   http://nptel.ac.in/courses/103107088/
2.   http://nptel.ac.in/courses/103103029/34

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	3	1	2						3	3	3
CO 2	2	1	3	2	2	2						2	2	2
CO 3	2		3	2	3	1					2	2	2	2
CO 4	2		2	2	3	1					3	3	2	2
CO 5	2		3		3	3						3	1	1
	10	3	12	9	12	9					5	13	10	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	10	3	12	9	12	9	0	0	0	0	5	13	10	10
Scaled Value	2	1	3	2	3	2	0	0	0	0	1	3	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 505B	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3
C	**P**	**A**		L	T	P	H
3	**0**	**0**		3	0	0	3

PREREQUISITE: -

Learning Objectives:

Upon completion of this course, the students
- Will be able to understand the application of biotechnology in Agricultural fields
- Will be able to describe selected industrial agri biotechnology processes

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Know* the principles and *defines* the concepts of Agricultural biotechnology.	Cognitive	Remember
CO2:*Describe* the role of plant breeding in agriculture.	Cognitive	Understand
CO3:*Outlines* the tools and techniques of genetic engineering	Cognitive	Understand
CO4:*Discuss* and *compiles* the biodiversity in agricultural field	Cognitive	Understand
CO5:*Describe* the importance of IPR in agricultural products.	Cognitive	Evaluate
Unit-I	**Genomes and Genes**	**9**
Chromatin structure, Karyotype analysis, Genome organization – C-Value para, dox, Cot curves &significance, Chromosome behaviour.		
Unit-II	**Agriculture and Plant Breeding**	**9**
Breeding of crops, Heterosis, Apomixis, Mutations, Polyploidy in crop improvement, and Principles ofintegrated Pest Management.		
Unit-III	**Tools and Techniques of Genetic Engineering**	**9**
Recombinant DNA technology; Concept of Genetic makers; gene interaction, multiple allelism,pleiotropism and multiple factor inheritance. Genetic, Chromosomal and Molecular map, Techniques ingeneticengineering;Genome Analysis: Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, SequenceAnalysis and Molecular Phylogeny.		
Unit-IV	**Biodiversity**	**9**
Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservationof biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centres of origins ofplants; Biodiversity hot spots.		
Unit-V	**IPR on Agricultural Products**	**9**
IPR Introduction - IPR in relation to Indian Flora- Basmati Rice, Turmeric and Neem.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**0**	**0**	**45**

TEXT BOOKS:

2. Ahindra Nag., Text Book of Agricultural Biotechnology. PHI Learning Publisher New Delhi, 2008.

REFERENCE BOOKS:

1. Anshuman Singh, Ashutosh Singh, Ashutosh Kumar Srivastava2. Ray B., "Agricultural Biotechnology" Medtech Publisher, Edition-1, 2019

E- REFERENCES

3. https://nptel.ac.in/content/syllabus_pdf/102103016.pdf

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	3	1	2						3	3	3
CO 2	2	1	3	2	2	2						2	2	2
CO 3	2		3	2	3	1					2	2	2	2
CO 4	2		2	2	3	1					3	3	2	2
CO 5	2		3		3	3						3	3	1
	10	3	12	9	12	9					5	13	12	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	10	3	12	9	12	9	0	0	0	0	5	13	12	10
Scaled Value	2	1	3	2	3	2	0	0	0	0	1	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT505C	**PHARMACEUTICAL BIOTECHNOLOGY**	L	T	P	C
		3	0	0	3

C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Biochemistry, Immunology, r-DNA technology

Learning Objectives:
Upon completion of this course, the students
- Would able to understand principles of biotechnology in pharmaceutical product development.
- Would apply advanced biotechnology methods in novel drug development
- Would able to review the production processes for antibiotics, vitamins, alkaloids and steroids

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*identify* the potential avenues and requirements from the biotechnologists in pharmaceutical industries and *describe e*the scope and applications of biotechnology in pharmacy	Cognitive	Analyze Understand
CO2	*Outline*thepharmacodynamics, pharmacokinetics of drugs	Cognitive	Analyze Understand
CO3	*Describe* various adverse effects of drugs	Cognitive	Analyze Understand
CO4	*Explain* the manufacturing process for various therapeutical products including vaccines, enzymes, interleukins, hormones	Cognitive	Analyze Understand
CO5	*Comprehend* the methods applied to test the quality of drugs and other biopharmaceuticals	Cognitive	Analyze Understand
I- Introduction			**7**
Introduction to Pharmaceutical industry & development of drugs; types of therapeutic agents and their uses. Pharmaceutical Biotechnology and Drug discovery. Scope and applications of biotechnology in			

pharmacy, biological /research advances and approved biologicals for pharmaceutical uses.

II- Drugs and Their Metabolism	10

Physiochemical properties of drugs, factors modifying drug action. Pharmacodynamics, pharmacokinetics and drug metabolism.

III- Drugs and Their Interaction	10

Adverse effects of drugs and drug toxicology: Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity, Drug tolerance, Drug intolerance, drug allergy, drug induced side effects. Tachyphylaxis, biological effects of drug abuse and drug dependence.

IV- Production of Biopharmaceuticals	11

Biopharmaceutical and biological drug development, Manufacturing of biopharmaceutical, therapeutic proteins and peptides. Recombinant growth hormones, growth factors, therapeutic monoclonal antibodies, therapeutic enzymes and their application in health care.

V- Testing and Analysis of Biopharmaceuticals	7

Pharmaceutical Testing, Analysis and Control: Analysis of pharmaceuticals using physical, chemical and biological methods, quality assurance and control, stability of pharmaceutical products

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:

1. Purohit,Kulkarni,Saluja—Pharmaceutical biotechnology, Agrobios publishers, 2003
2. Pharmaceutical biotechnology edition2 by crommel, Freeman publishers, 2004

References:

1. Crommelin.D.J.A, Robert D. Sindela, Bernd Meibohm "Pharmaceutical Biotechnology: fundamentals and applications", Informa Healthcare, 2008.
2. Pharmaceutical biotechnology:drug discovery and clinical applications by Kayser,Wiley publishers, 1st edition 2007
3. Katzung B.G. Basic and Clinical Pharmacology,(6th Ed) Prentice Hall of Intl., 1995

E- References:

1. https://archive.org/details/PharmaceuticalBiotechnology/page/n111

Mapping Of COs and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	-	1	1	2	2	-	-	1	1	1	1	0	0
CO2	1	1	1	1	2	2	1	2	1	2	2	2	1	0
CO3	2	2	2	2	1	2	2	-	2	2	1	1	2	0
CO4	2	1	3	2	2	3	2	-	1	1	-	-	3	0
CO5	2	3	2	2	3	3	2	2	2	2	1	1	3	0
	9	7	9	8	10	12	7	4	7	8	5	5	9	0

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	9	7	9	8	10	12	7	4	7	8	5	5	9	0
Scaled to 0,1,2,3 scale	2	2	2	2	2	3	2	0	2	2	0	0	2	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 507	**BIOANALYTICAL TOOLS LABORATORY**	L	T	P	C
		0	0	1	1
		L	T	P	H

C	P	A
0.5	1	0.5

(L T P H = 0 0 2 6)

Learning Objectives:
Upon completion of this course, the students
- Will be able to understand the principles of instrumentation
- Will be able to impart the knowledge of different techniques and methods in biotechnology

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Explain*** the basics and fundamentals of analytical techniques and ***describe*** the various calibration techniques.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO2	***Describe*** the spectrophotometric methods and ***perform*** the experiments related to spectroscopy.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO3	***Understand*** the immunological techniques and ***apply*** it in various applications in biotechnology.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO4	***Know*** the principle of instrumentation and ***applications*** of various imaging techniques in biological field.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO5	***Distinguish*** the various separation techniques, ***Classify*** the various techniques of Chromatography and Electrophoresis	Cognitive Psychomotor Affective	Applying Guided Response Respond

S.No	List of Experiments	COs
1	Validation of accuracy and precision of an instrument used in the laboratory	CO1
2	Preparation of calibration curve in spectrophotometry	CO1
3	Determination of drug components by Ultraviolet Spectrophotometry	CO2
4	Interpretation of FTIR spectra	CO2
5	Immunodiffusion assay	CO3
6	Image analysis by electron microscopy	CO4
7	Qualitative analysis of compounds by Thin Layer Chromatography	CO5
8	Separation of compounds using Column Chromatography	CO5
9	Separation of nucleic acids by Agarose gel Electrophoresis	CO5
10	Separation of proteins by SDS-Polyacrylamide gel Electrophoresis	CO5

HOURS	TUTORIAL	PRACTICAL	TOTAL
	0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	0	0	1	0	0	0	0	2	0	1
CO 2	3	3	2	2	0	0	1	0	0	0	0	0	0	1
CO 3	3	2	2	1	0	0	1	0	0	0	0	0	0	1
CO 4	2	3	2	2	0	0	0	0	0	0	0	1	0	1

8th BOS/BIOTECH/Date: 19.08.2021

CO 5	3	2	3	1	0	0	1	0	0	0	0	1	0	1
	14	12	11	7	0	0	4	0	0	0	0	4	0	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	14	12	11	7	0	0	4	0	0	0	0	4	0	5
Scaled Value	3	3	3	2	0	0	2	0	0	0	0	2	0	2

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XBT508	L	T	P	C
COURSE NAME	**Bioreaction Engineering Laboratory**	0	0	2	2
PREREQUISITES	-	L	T	P	H
C:P:A	**0.5:1:0.5**	0	0	2	6

LEARNING OBJECTIVES

Upon completion of this course, the students will be able to apply their knowledge of Bioreaction engineering phenomena to demonstrate aseptic enzyme techniques in the laboratory

COURSE OUTCOMES		DOMAIN	LEVEL
After the completion of course the students will be able to			
CO1	*Experiment* and *Demonstrate* enzyme kinetics M-M and Extraction	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO2	*Understand* and *Perform* enzyme activity at different properties	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO3	*Practice* and *Demonstrate* enzyme immobilization	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO4	*Perform* and *Determine* growth kinetics	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO5	*Understand* and *Experiment* on alcohol concentration in wine production	Cognitive Psychomotor Affective	Apply Guided Response Respond

S.No	List of Experiments	COs
1	Study of M-M kinetics and determination of M-M constants.	CO1
2	Extraction of enzyme from fruits and vegetable	CO1
3	Effect of temperature on Enzyme Activity.	CO2
4	Effect of pH on Enzyme Activity.	CO2
5	Effect of substrate concentration on Enzyme Activity.	CO2
6	Enzyme immobilization by physical adsorption.	CO3
7	Enzyme immobilization by Gel Entrapment.	CO3
8	Study of Production of growth and/or non-growth associated products.	CO4

9	Study of Microbial Growth kinetics and estimation of Monod parameters.	CO4
10	Estimation of alcohol concentration in wine production.	CO5

Reference: 1. Bailey J.E. and Ollis D.F, Biochemical Engineering Fundamentals, Second edition, McGraw Hill Co, Newyork, 2010.

	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3										1	1	1	
CO 2	2	3		1					1			1	2	
CO 3		1	3									2	3	1
CO 4		1	2									3	1	2
CO 5	1	2	3	1								2	1	3
	6	7	8	2	0	0	0	0	1	0	1	9	8	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	6	7	8	2	0	0	0	0	1	0	1	9	8	6
Scaled Value	2	2	2	1	0	0	0	0	1	0	1	3	2	2

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT 509		**INPLANT TRAINING - II**	0	0	0	1
C	**P**	**A**	L	T	P	H
0.66	0.66	0.66	0	0	0	0

PREREQUISITE:- Nil

COURSE OUTCOMES:

	Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to			
CO1	Relate classroom theory with workplace practice	Cog	Understand
CO2	Comply with Factory discipline, management and business practices.	Aff	Response
CO3	Demonstrates teamwork and time management.	Aff	Value
CO4	Describe and display hands-on experience on practical skills obtained during the programme.	Phy	Perception Set
CO5	Summarize the tasks and activities done by technical documents and oral presentations.	Cog	Evaluate

8th BOS/BIOTECH/Date: 19.08.2021

Mapping COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5			3							3			1	1
Total	2	1	2	4	3	0	1	3	3	4	4		6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

1 - Low, 2 – Medium, 3 – High

VI Semester

XBT601	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3
		L	T	P	H
		3	0	0	3

C	P	A
2.5	0	0.5

Prerequisite: Nil

Learning Objective:Upon completion of this course, the students
- Would have learnt animal cell culturing techniques
- Would have learnt designing animal cell culture lab
- Would have learnt knock-out mechanisms of genes
- Would have learnt techniques for production of transgenic animals and cloning

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Explain* animal cell culture media and animal cell culture techniques.	Cognitive	Understand
CO2: *Describe* various gene transfer methods in animal cells.	Cognitive	Evaluate
CO3:*Analyze* various micromanipulation techniques and **reproduce** them in fertilization technology.	Cognitive Affective	Analyze Respond
CO4:*Distinguish* various methods and techniques for production of transgenic animals and cloning.	Cognitive	Understand
CO5: *Describe* manipulation strategies to improve livestock production including meat and milk production	Cognitive	Understand

Unit-I- Cell Culture Techniques	**9**

Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture.
1. Key events in the development of cell and tissue culture
2. Advantage of tissue culture
3. Sub culture of continuous line growth and Cell line Characterization
4. Extracellular Matrix and its role
5. Cell Interaction and signalling pathways
6. Designing of cell culture laboratory
7. Design of CO_2 incubator and laminar flow – safety cabinets
8. Identification of microbial contamination
9. Decontamination techniques

Unit-II- Gene Transfer Techniques	**9**

Kinetics of cell growth; Micro & macro-carrier culture; Hybridoma technology; Stem cell

technology; Animal cloning; Transgenic animals; Knock-out and knock-in animals.
  10. Growth of animal cells culture
  11. Knock-out mechanism using computation biology

Unit-III- Invitro Fertilization and Embryo Transfer	9

invitro fertilization and its limitations - Artificial insemination, Super ovulation, Embryo splitting, Biopsy and Sexing of embryos and Embryo transfer- Embryo cryopreservation techniques – Limitations in embryo transfer - Breeding of farm animals.
  12. Embryo transfer; https://www.uaex.edu/publications/pdf/fsa-3119.pdf

Unit-IV- Manipulations for Product Improvement	9

Manipulation of Growth hormone; Role of Somatotropic and Thyroid hormone in growth - Probiotics as growth promoters; Ideal characteristics, Mode of action and uses of probiotics; Manipulation of lactation – Lactogenesis and galactopoiesis, wool growth and rumen microbial digestive system.
  13. Growth of animal cells in the lab - theoretical and practical

Unit-V- Transgenic Animals	9

Scope and importance of transgenic animal technology - Various strategies for the production of transgenic animals: pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer – Gene knock in and knock out models for studying human disorders - Transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Freshney, R. I., Culture of Animal Cells: A manual of Basic technique, John , Wiley and sons, 6th Edition, 2010.
2. Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1st Edition, 2008.

References:

1. Masters, J.R.W., Animal Cell Culture: Practical Approach, Oxford University Press, New York, 3rd Edition, 2000.
2. Holland, A. and Johnson, A., Animal Biotechnology and Ethics, Springer Verlag, New York,1st Edition, 1998.

E References:

1. http://www.biotechnology4u.com/question_bank_question_answer.html
2. NPTEL course material on Transgenic animals as bioreactors:https://nptel.ac.in/courses/102/103/102103013/

COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	2	2	0	1	1	2	1	1	2	1	2
CO 2	3	1	2	1	2	0	0	1	0	2	1	3	2	1
CO 3	3	1	2	3	3	2	2	1	2	2	2	3	3	3
CO 4	3	2	2	2	3	1	1	1	1	2	2	2	1	2
CO 5	3	2	3	1	2	2	1	1	1	2	2	2	1	1
	15	8	10	9	12	5	4	5	6	9	8	12	8	9

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	15	8	10	9	12	5	4	5	6	9	8	12	0	1
Scaled Value	3	2	2	2	3	1	1	1	2	2	2	3	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT602	PROCESS BIOTECHNOLOGY	L	T	P	C
		3	1	0	4

C	P	A		L	T	P	H
3	0	1		3	2	0	5

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Would be able to identify the parts of a fermenter
- Would be knowing about the media components for fermentation process.
- Would be able to select the parts of a bioreactor for designing a particular production process.
- Would be able to design the scale up procedure of a bioreactor.

	Course Outcomes	Domain	Level
	After the completion of the course, students will be able to		
CO1	*Recall* and *identify* the basic parts of a fermentor and its operations.	Cognitive	Remember Understand
CO2	*Identify,reproduce,* and *demonstrate* the different media components involved in a fermentation process.	Cognitive Affective	Remember Value Apply
CO3	I*nterpret*, *describe* and *differentiate* various control systems involved in bioprocess system.	Cognitive Affective	Understand Receive
CO4	*Recognize, discuss* and *measure* the various phenomena involved in Downstream Processing.	Cognitive Affective	Understand Respond
CO5	*Understand*the product purifications to*Develop* a bio product.	Cognitive Affective	Understand Create

I – Introduction to process Biotechnology	**9+3**

General requirements of fermentation processes – basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled- ; Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models; Batch, fed-batch and continuous processes

II – Media formulation and optimization	**9+3**

Sterilization of air and media,medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, simple and complex media, Medium optimization techniques,

III – Instrumentation and Process Control:	**9+3**

Instrumentation, measurement and control of the bioprocess parameter such as temperature, pressure, pH, dissolved oxygen, redox, microbial biomass, flow measurement-Agitation and aeration-Detection and prevention of foam, Feedback and feed forward control; Types of controllers – proportional, derivative and integral control, tuning of controllers..

IV Downstream Processing Methods	**9+3**

Filtration - membrane filtration, Cell disruption; ultrafiltration; Centrifugation - high speed and ultra; flocculation and sedimentation. Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC;

V-Product Purification and Resolution	

Precipitation methods (with salt, organic solvents, and polymers, extractive separations, aqueous two-phase extraction)- Membrane based separation process, Types of membranes, Membrane process, theory

and types of membrane- Crystallization, theory of crystallization- Freeze drying- Principle, process and application of freeze drying integrated bio-processing- product polishing stages

Lecture	Tutorial	Practical	Total
45	15	0	60

Text Books:

1. Schuler and Kargi, Bioprocess engineering. Prentice Hall
2. Najafpour, Ghasem. Biochemical engineering and biotechnology. Elsevier, 2015.
3. Bailey and Ollis, Biochemical Engineering Fundamentals, McGraw Hill, Co. 2004.

References:

1. Pauline Doran, Bioprocess Principles, Academic press, 2004.
2. Neilson J and Villadsen J, Biochemical Engineering Principles I ed, Plenum Press, 2000.
3. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001.
4. Lee J.M, Biochemical Engineering 2nd ed, Prentice Hall, 2000.

E-References:

1. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029
2. http://users.ox.ac.uk/~dplb0149/publication/NPRBiocatalysisRev.pdf
3. http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3											1	2	2
CO 2	2	3	2		1		1		1		3	2	3	3
CO 3	1	2	2	1					1			1	0	0
CO 4	1	3	2	3								1	0	0
CO 5	1	3	2	3	1		1		2		2		1	1
	8	11	8	7	2	0	2	0	4	0	5	5	6	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	8	11	8	7	2	0	2	0	4	0	5	5	6	6
Scaled Value	2	3	2	2	1	0	1	0	1	0	1	1	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT603A	MASS TRANSFER FUNDAMENTALS	L	T	P	C
		3	0	0	3
		L	T	P	H

C	P	A
2.5	0	0.5

L	T	P	H
3	0	0	3

Prerequisites : Nil

Objectives:

- To facilitate the learners understand the basic concepts and principles of mass transfer and apply them in distillation, absorption adsorption drying and humidification operations.

| **Course Outcomes:** At the end of this course, the students should be | **Domain** | **Level** |

	able to		
CO1	*Explain* the basic principles in diffusional mass transfer and *Calculate* the rate of the mass transfer under one dimensional steady state diffusion	Cognitive Affective	Understand Analyse Receive
CO2	*Describe* the operations of Distillation and absorption and *Calculate* number trays for distillation and absorption tower	Cognitive Affective	Understand Analyse Receive
CO3	*List* situations where liquid–liquid extraction might be preferred to distillation	Cognitive	Understand Analyse
CO4	*Discuss* the salient features of Separation by adsorption, chromatographic separation process and *Explain* the concept of breakthrough in fixed-bed adsorption.	Cognitive	Understand Analyse
CO5	*Describe* the salient features and mechanism involved in Drying	Cognitive	Understand Analyse

Course Content		Hours
Unit-I	**Mass Transfer and Diffusion**	**9**
Steady state molecular diffusion in fluids and solids. One dimensional steady state and unsteady state molecular diffusion through stationary media – molecular diffusion in laminar flow – diffusivity measurements – overall mass transfer coefficients – Diffusion in multi component gaseous mixtures – Diffusion in solids.		
Unit-II	**Distillation**	**9**
Vapour liquid equilibrium – methods of distillation – simple, steam, flash distillation, azeotropic, Extractive and molecular distillation – Continuous distillation – McCabe - Thiele method, ponchonsavarit method		
Unit-III	**Extraction and Leaching**	**9**
L-L equilibrium – staged and continuous extraction concepts, Equipments for extraction – Solid – liquid equilibria, leaching principles – Equipments for leaching		
Unit-IV	**Absorption and Adsorption**	**9**
Theory of absorption – Factors affecting gas absorption-Equilibrium and operating line concept in absorption stage determination - Adsorption and its types -sorbents – equilibrium consideration-kinetic and transport considerations..		
Unit-V	**Humidification and Drying**	**9**
Basic terminologies in humidification – psychrometric chart, construction and use. Methods of humidification and dehumidification – equipments – spray chamber– cooling tower principles, types and operation – Theory and mechanism of drying.		

Lecture	Tutorial	Practicals	Total
45	**0**	**0**	**45**

Text Books

1. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.
2. Anantharaman, N. and K.M. MeeraSherifa Begum, "*Mass Transfer Theory and Practice"*, PHI Learning Private Limited, New Delhi,2011
3. Gavhane K.A "Mass Transfer" 8th Edition, Nirali Prakashan, 2010.

References

1. Dutta, B. K., " *Principles of mass transfer and separation processes"*, Prentice Hall of India, Delhi, 2007
2. Coulson and Richardson, "Chemical Engineering" Vol. I & II, Asian Books Pvt.ltd., 1998.
3. McCabe, W.L., J.C. Smith and P. Harriott, "*Unit Operations of Chemical Engineering"*, 7/e, McGraw-Hill International Edition, 2005.

Mapping of COs Vs Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	13	5	11	8	5	8	5	5	0	8	8	11	11

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	3	3

$1 – 5 \rightarrow 1$,　　　　$6 – 10 \rightarrow 2$,　　　　$11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT603B			**FERMENTATION TECHNOLOGY**	**L**	**T**	**P**	**C**
				3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	0	0		3	0	0	3

Prerequisites : -

Objectives:
- To enhance the student's ability of employability through study the core prime targeted bioprocess, microbial cum biochemical activities in the fermentation technology.

Course Outcomes: At the end of this course, the students should be able to	**Domain**	**Level**
CO1	*Explain* the microbial for industries and *List* the applications	Cognitive	Understand
CO2	*Describe* the primary and secondary metabolism and *Interpret* the fermentation process	Cognitive	Understand
CO3	*Recognize* the microbial culture and *Describe* the growth kinetics.	Cognitive	Understand
CO4	*Discuss* the isolation and characteristics of microorganism and *Interpret* the industrial significant.	Cognitive	Understand
CO5	*Describe* the salient features of industrial fermentation.	Cognitive	Understand

Course Content	**Hours**
Unit-I	**Introduction**	**6**
Microbial Biomass – Microbial Enzymes – Microbial Metabolites – Commercial Applications of Enzymes.	
Unit-II	**Primary and Secondary Metabolism**	**9**

Interrelationship between primary and secondary metabolism – Recombinant products – Transformation processes – History of fermentation industry – The component parts of a fermentation process.

Unit-III	Microbial Growth Kinetics	9

Batch culture – Exponential phase – Declaration and stationary phases - Continuous culture – Feedback systems – Comparison of batch and continuous culture in industrial processes

Unit-IV	Isolation and Improvement of Industrially Significant Microorganisms	9

Isolation and characteristics of microorganisms – Screening methods of microorganisms – Discovery processes and maximizing gene expression – Improvement of Industrial microorganism

Unit-V	Media for Industrial Fermentation	12

Introduction – Typical media and media formulation – Energy sources – Growth factors – Nutrient Recycles – Buffers – Precursors – Inhibitors – Inducers – Oxygen requirements – Fast metabolism – Rheology – Antifoams – Animal cell media – Development of basal media.

Lecture	Tutorial	Practicals	Total
45	0	0	45

Text Books

4. Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.
5. Gregory N. Stephanopoulos, Aristos A. Aristidou., Metabolic engineering: Principlesand Methodologies, Jens Nielsen Academic Press, 1st Edition, 1998.

References

4. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References

1. https://nptel.ac.in/courses/102/105/102105058/

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	13	5	11	8	5	8	5	5	0	8	8	11	11

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	3	3

1 – 5 → 1,   6 – 10 → 2,   11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 603C	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3
C	**P**	**A**		L	T	P	H
3	**0**	**0**		3	0	0	3

Prerequisite: Bioinstrumentation

Learning Objective:
Upon completion of this course, the students
- Would be able to learn fundamentals of nano technology.
- Would be able to learn the nano particle synthesis and its application in biotechnology

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Recall* the basic concepts characterization techniques and *illustrate* the methods of nanoparticles synthesis.	Cognitive	Remember Understand
CO2:*Construct* microfluidic devices and *relate* its advantages.	Cognitive	Create Understand
CO3:*Design* and *Develop* theranostics nanoparticles	Cognitive	Create
CO4:*Outlines* the environmental applications of nanoparticles	Cognitive	Understand
CO5:*Understands* the Fundamentals of Nanocarriers and *design* a drug delivery system.	Cognitive	Create

Unit-I- Introduction to Nanoparticles Synthesis and Characterization	**9**

Nanoparticles- physical, chemical and biological properties- Synthesis- Physical methods: laser vaporization, laser Pyrolysis, ion implantation. Chemical methods for synthesis of Nanomaterials: sol-gel method. Biological synthesis: using microorganisms, plant extracts. Characterization techniques: UV- Spectroscopy, Dynamic Light Scattering, Zeta potential, Energy Dispersive X-Ray Analysis (EDX), Selected Area Diffraction Pattern (SAED), SEM, TEM, AFM.

Unit-II- Microfluidics Meets Nano: Lab-on-a-Chip Devices	**9**

Concepts and advantages of microfluidic devices – Fluid transport – Stacking and sealing – Materials and methods for the manufacture of microfluidic component, fluidic structures, surface modifications.

Unit-III- Nanoparticles As Theranostic Agents	**9**

Theranostic agents- properties- advantages- Carbon dots and Quantum dots- ability to cross across Blood Brain Barriers- theranostic approach for Cancer treatment and neurodegenerative disorders- Alzheimer's, Parkinson's disease.

Unit-IV- Environmental Applications of Nanoparticles	**9**

Role of iron oxide, biopolymers and metal nanoparticles in Waste water treatment- heavy metal removal, nanofilter devices. Role of antimicrobial coating in infectious disease prevention. Nanobiosensors for environmental monitoring.

Unit-V- Nanoparticles and Novel Drug Delivery Systems	**9**

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Drug delivery systems-

microcapsules and microspheres- hydrogels- Polymers - Dendrimers- Dendritic Nanoscafold system. pH based targeted delivery- chitosan and alginate. Copolymers- PLA, PLGA. Lipid Based Nanocarriers - Liposomes, niosomes- Cubosomes. Hydrophobic drug delivery.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Niemeyer, Christof M., and Chad A. Mirkin. Nanobiotechnology: concepts, applications and perspectives. Vol. 1. John Wiley & Sons, 2004.
2. Mirkin, Chad A., and Christof M. Niemeyer, eds. Nanobiotechnology II: more concepts and applications. John Wiley & Sons, 2007.

References:

1. Goodsell, David S. Bionanotechnology: lessons from nature. John Wiley & Sons, 2013.
2. Freitas Jr. R.A., "Nanomedicine", First Edition, Volume IIA, Landes Biosciences, 2004.

E- References:

1. http://www.chem.latech.edu/~ramu/msnt505/lec_notes/Ji/MSNT505_Ji_notes.htm
2. http://nptel.ac.in/courses/118107015/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	2		2		2					2	1	2
CO 2	2	2	2	2	2	2	2				2	3	2	1
CO 3	1	2			3	3					2	3	3	3
CO 4	2	3	3	3	2	3	3				1	2	1	2
CO 5	1	2			3	2		1				2	1	1
	8	12	7	5	12	10	7	1			5	12	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

	PO1	PO2	PO 3	PO4	PO 5	PO6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO1	PSO2
Original value	8	12	7	5	12	10	7	2			5	12	8	9
Scaled Value	2	3	2	1	3	2	2	1			1	3	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XGS605		L	T	P	C
COURSE NAME	PROFESSIONAL SKILLS		1	0	2	3
PREREQUISITES	NIL		L	T	P	H
C:P:A= 2.6:0.4:0	-		1	0	4	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Ability* to understand communications	Cognitive	Remember
CO2	*Apply* the known skills for career	Cognitive	Apply
CO3	*Identify* inner strength	Cognitive	Remember
CO4	*Construct* the attitude as a professional	Cognitive	Create

CO5	*Practicing*Etiquettes		Psychomotor	Guided Response

UNIT I	COMMUNICATION	9
1.1 – Brainstorming		
1.2 – LSRW		

UNIT II	CAREER SKILLS	9
2.1 – Resume & CV preparing Skills		
2.2 – Interview Skills		
2.3 – Exploring Career Opportunities		

UNIT III	TEAM SKILLS	9
3.1 – Listening as a Team Skill		
3.2 – Team Building at work place		

UNIT IV	PROFESSIONAL SKILLS	9
4.1 – Attitude and Goal Setting		
4.2 – Verbal and Non Verbal Communications		

UNIT V	PROFESSIONAL ETIQUETTES	9
5.1 - Social Etiquettes		
5.2 - Cultural Ethics at work place		

LECTURE: 45	TUTORIAL: 0	PRACTICAL:0	TOTAL: 45

SUGGESTED READINGS

1.	Er. A. K. Jain, Dr. Pravin S. R. Bhatia, Dr. A. M. Sheikh Professional Communication Skills S. Chand Publications, 2015
2.	Alan Pannett. *Key Skills for Professionals: How to Succeed in Professional Services*, Kogan Page; 1st edition, 2013

Mapping of CO with PO

CO Vs PO	CO1	CO2	CO3	CO4	CO5	Total	Scaled to 0,1,2 and 3
PO$_1$	0	0	0	0	0	0	0
PO$_2$	0	0	0	0	0	0	0
PO$_3$	0	0	0	0	0	0	0
PO$_4$	0	0	0	0	0	0	0
PO$_5$	0	0	0	0	0	0	0
PO$_6$	0	0	0	0	0	0	0
PO$_7$	0	0	0	0	0	0	0
PO$_8$	3	3	3	3	3	12	3
PO$_9$	2	2	2	2	2	10	2
PO$_{10}$	3	3	3	3	3	12	3
PO$_{11}$	0	0	0	0	0	0	0
PO$_{12}$	0	0	0	0	0	0	0
PSO$_1$	0	0	0	0	0	0	0
PSO$_2$	0	0	0	0	0	0	0
TOTAL	8	8	8	8	8	34	8

1-5 → 1, 6-10 → 2, 11-15 → 3
0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

8th BOS/BIOTECH/Date: 19.08.2021

Course Code	:	XUM 606	L	T	P	C
Course Name	:	Cyber security	0	0	0	0
Prerequisite	:		L	T	P	H
C	P	A	NIL	3	0	0	3
3	0	0					

Course Objectives

- To give knowledge on the cyber space and its security.

- To understand the cyber security structure of organisation

- To Understand the security policy of organisation

- To aware of the Cyber security initiatives and IT Act.

- To make the students to know cyber security ractices.

Course Outcome: After the completion of the course, students will be able to		Domain C or P or A	Level
CO1	Understand the fundamentals of Cyber Security and the technologies.	C	Understand
CO2	Understand the organizational structure of Cyber security	C	Understand
CO3	Understand the Cyber Security policy development	C	Understand
CO4	Understand the Indian IT act and the initiatives	C	Understand
CO5	Understand and Apply the Cyber security practices	C	Understand and Apply

COURSE CONTENT

UNIT I	INTRODUCTION	9
	Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges	
UNIT II	CYBER SECURITY OBJECTIVES AND GUIDANCE	9
	Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – SecurityFrameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.	
UNIT III	CYBER SECURITY POLICY CATALOG	9
	Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright andTrademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation –Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare- Computer Forensics – Steganography	
UNIT IV	UNIT IVCYBER SECURITY INITIATIVES AND IT ACT	9
	Counter Cyber Security Initiatives in India, Cyber Security Excercsie, Cyber	

UNIT V	UNIT V SECURITY PRACTICES	9

Security Incident Handling, Cyber Security Assurance, IT Act, Hackers-Attacker-Counter measures ,Web Application Security , Digital Infrastructure Security ,Defensive Programming. Traditional Problems Associated with Computer Crime, Introduction to Incident Response.

Guidelines to choose web browsers, Securing web browser ,Antivirus ,Email security ,Guidelines for setting up a Secure password ,Two-steps authentication ,Password Manager ,Wi-Fi Security ,Guidelines for social media security ,Tips and best practices for safer Social Networking.Basic Security for Windows, User Account Password Introduction to mobile Smartphone Security ,Android Security ,IOS Security Online Banking Security ,Mobile Banking Security ,Security of Debit and Credit Card ,UPI Security Security of Micro ATMs e-wallet Security Guidelines Security Guidelines for Point of Sales(POS)

	L	T	P	Total
	45	0	0	45

REFERENCE BOOKS

1.Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.

2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.

3. Cyber Laws & Information Technology, JothiRathan,VijayRathan,Bhrath Pubishers,7th Edition January 2019.

4.Modern Cyber security Practices by Pascal Ackerman, BPB Publications,2020

5. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011

6. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.

E-REFERENCES

https://www.coursera.org/specializations/cyber-security

www. nptel.ac.in

http://professional.mit.edu/programs/short-programs/applied-cybersecurity

https://us.norton.com/internetsecurity-how-to-cyber-security-best-practices-for-employees.html

https://www.meity.gov.in/content/cyber-laws

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	0	0	0	0	0	2	0	3	0	0	0	0	0	0
CO2	0	0	0	0	0	0	2	0	1	0	0	0	0	0
CO3	3	0	0	0	0	2	3	0	1	0	0	0	3	0
CO4	0	0	0	0	0	0	0	0	0	2	0	0	0	0
CO5	3	0	0	0	0	0	0	0	0	0	0	0	3	0
Total	6	0	0	0	0	4	5	3	2	2	0	0	6	0
ScaledValue	2	0	0	0	0	1	1	1	1	1	0	0	2	0
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT607	PROCESS BIOTECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	4
C P A		L	T	P	H
0.5 2.5 1		0	0	8	8

Prerequisite: Process biotechnology

Learning Objectives: Upon completion of this course, the students
- Would be able to identify the parts of a fermenter
- Would be able to design industrial media for fermentation process.
- Would be able design a particular production process.

Course Outcomes		Domain	Level
CO1	*Infer the* basic parts of a fermentor and its operations.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO2	*Demonstrate* the different media components involved in a fermentation process.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO3	*Interpret* various control systems involved in bioreactor.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO4	*Measure* the various transport phenomena involved in bioprocesses.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO5	*Demostarte* the scale up procedure of mixing ,aeration	Cognitive Psychomotor Affective	Apply Mechanism Respond

List of Practical Experiments
1. Determination of thermal death rate constant for a fermentation process. (CO1)
2. Comparison of bioprocess efficiencies in synthetic and complex industrial media. (CO2)
3. Medium formulation and optimization studies. (CO2)
4. Estimation of biomass concentration for microbial production. (CO3)
5. Determination of oxygen mass transfer coefficient by Sulphite oxidation method. (CO3)
6. Yeast cell disruption studies by sonication.
7. High-resolution purification preparative liquid chromatographic techniques. (CO3)
8. Ammonium Sulfate precipitation of protein using yeast cell suspension. (CO4)
9. Crystallization of a product. (CO4)
10. Determination of drying time for the given sample in vacuum tray drier. (CO5)
11. Lyophilization (CO5

Lecture	Tutorial	Practical	Total
0	0	30	30

Text Books:

Schuler and Kargi, Bioprocess engineering. Prentice Hall

References:

Pauline Doran, Bioprocess Principles, Academic press, 2004.

E-References:

http://38.100.110.143/model/bb/theory.html

http://38.100.110.143/model/bb/procedure.html

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3		2	2								1	2	2
CO2	2	3	2	1	1		1		1		3	2	3	3
CO3	1	3	3	2					1			1	0	0
CO4	1	3	3	2								1	0	0
CO5	1	3	2	2	1		1		2		2		1	1
Total	9	12	12	9	2	0	2	0	4	0	5	5	6	6
ScaledValue	2	3	3	2	1	0	1	0	1	0	1	1	2	2
$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

VII Semester

				L	**T**	**P**	**C**
XBT701				**3**	**0**	**0**	**3**
			Microbial Biotechnology				
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Prerequisite: -

Learning Objectives:
Upon completion of this course, the students
- Would be able to explain industrial production of various metabolites.
- Would apply the knowledge of process associated mechanisms in Industrial biotechnology research.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Outline* the general concepts of microbial system and *describe* the development	Cognitive	Remember Understand
CO2	*Describe* various mechanisms of medium and *discuss* the medium role in Bioreactor.	Cognitive	Understand
CO3	*Discuss* the rDNA concept and *explain* the related microbial processes	Cognitive	Remember Understand
CO4	. *Explains* the production of primary metabolites and *identify* their interactions.	Cognitive	Remember Understand
CO5	*Explains* the production of secondary metabolites and *identify* their interactions.	Cognitive	Remember Understand

Unit-I Introduction and Historical developments in microbial Biotechnology	**9**
Introduction and Historical developments in industrial microbiology; industrially important microbes and metabolic pathways; Various Microbial metabolites and their Overproduction; Isolation and selection of industrially important microorganisms; Preservation and maintenance of microbial cultures.	
Unit-II Medium and Bioreactor	**9**

$\qquad$ 8th BOS/BIOTECH/Date: 19.08.2021

Microbial substrates and Media formulation; Components of microbial fermentation process; Types offermentation processes- Solid state, Static and submerged fermentations; Design of laboratory bioreactor;Types of Bioreactor: Stirred tank reactor, bubble column.

Unit-III Recombinant DNA technologies for microbial processes	9

Introduction to rDNA technology, Strategies for development of industrial microbial strains with scale up production capacities; metabolic pathway engineering of microbes for production of novel product for industry ,Screening strategies for new products.

Unit-IV Production of Microbial primary Metabolites	9

Production of Microbial Biomass - Baker's Yeast, Mushroom; Production of fermented foods; Alcoholic beverages- wine, beer, etc.; Production of Ethanol, Citric acid; Amino acids and vitamins; Microbial enzymes for food, detergent and pharma industry; Biopesticides and biofertilizers

Unit-VProduction of microbial secondary metabolites	9

Production of Antibiotics- penicillin and other antibiotics; Pigments, Microbial transformation, Production of Insulin, Interleukin, growth hormones, Bioplastic production, Large scale production and purification of recombinant proteins and metabolites;

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:

1. Process Biotechnology Fundamentals, Satya Narayan Mukhopadhyay 4th Edn , 2018
2. Pauline Doran, Bioprocess Principles, Academic press, 2004.

References:

5. Neilson J and Villadsen J, Biochemical Engineering Principles I ed, Plenum Press, 2000.
6. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001.

E – References

1. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029
2. http://users.ox.ac.uk/~dplb0149/publication/NPRBiocalysisRev.pdf
3. http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3											1	2	2
CO 2	2	3	2		1		1		1		3	2	3	3
CO 3	1	2	2	1					1			1	0	0
CO 4	1	3	2	3								1	0	0
CO 5	1	3	2	3	1		1		2		2		1	1
	8	**11**	**8**	**7**	**2**	**0**	**2**	**0**	**4**	**0**	**5**	**5**	**6**	**6**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	8	11	8	7	2	0	2	0	4	0	5	5	6	6
Scaled Value	2	3	2	2	1	0	1	0	1	0	1	1	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT702	RECOMBINANT DNA TECHNOLOGY		L	T	P	C
			3	0	0	3
C	**P**	**A**	L	T	P	H
3	**0**	**0**	3	0	0	3

Prerequisite: Genetics, Molecular biology

Learning Objectives:

Upon completion of this course, the students
- Would have learned the concepts of gene cloning and its application.
- Would have learned the various techniques involved in Recombinant DNA Technology.

	Course Outcomes	Domain	Level
After the completion of the course, students will be able to			
CO1	***Recall*** the basic concepts of gene cloning and various Restriction and modification enzymes	Cognitive	Remember
CO2	***Explain*** and ***distinguish*** various vector systems	Cognitive	Remember Understand
CO3	***Describes***, ***Compares*** and ***Identifies*** various techniques involved.	Cognitive	Remember Analyze
CO4	***Discusses, Manipulates*** and ***Describes*** various screening and selection methods.	Cognitive	Understand Apply
CO5	***Explain*** and ***Apply*** the applications of rDNA technology under Biosafety guidelines.	Cognitive	Remember Apply

Course content	Hours
I – Basic Concepts Of Gene Cloning	**9**
Introduction to recombinant DNA technology- Restriction & modification enzymes (restriction endonuclease II, DNA polymerases, Polynucleotide kinases and alkaline phosphatases, DNA ligases and RNase)- Restriction mapping, Design of linkers and adaptors.	
II – Plasmids and Vectors	**9**
Characteristics of cloning vectors, types of bacterial plasmid vectors (pBR322, pUC57, pSC101), λ vectors, M13 vectors, cosmids, phagemids, yeast artificial chromosome, bacterial artificial chromosome and *Mammalian artificial chromosomes as cloning vector.*Expression vectors**:** pET vectors, Baculovirus vectors.	
III – Molecular Techniques	**9**
DNA labelling (radioactive and non-radioactive method); DNA sequencing (Maxum& Gilbert, Sangers, pyro-sequencing, shotgun sequencing method)'; Southern, northern and western blotting- PCR – Principle- types- applications- DNA fingerprinting (RAPD; RFLP, AFLP).biosensing and biosensor	
IV – Screening and Selection of Transformants	**9**
Transfer of rDNA into cells- transformation, transfection, Sonoporation, Microinjection and Calcium phosphate methods- Genomic and cDNA library construction- Selection and screening of recombinants – nucleic acid hybridization- Grunsteinhogness and benten- Davis plaque method, immunological screening- Blue – white selection- Reporter gene based selection- GUS, GFP and Luciferase.	
V – Applications of Recombinant DNA Technology	**9**
Production of recombinant- insulin, human growth factor, vaccine and gene therapy- gene silencing using RNAi. Genetic manipulation of animal cells – early methods and Crispr-Cas9. Transgenic plants and animals. Bioethics regarding rDNA techniques-	

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:
1. Primrose S.B. and Twymann R.H., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Sixth Edition, Blackwell Scientific Publications, 2004.

Reference Books:
1. Brown T.A., "GeneCloning and DNA Analysis", Fourth Edition, Blackwell Scientific Publications, 2003.
2. Glick B.R. and Pasternak J.J., "Molecular Biotechnology", Third Edition, ASM Press, 2003.
3. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References:
1. http://nptel.ac.in/courses/102103013/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO 2	3	0	3	2	2	1	0	0	0	0	1	0	1	1
CO 3	3	0	3	1	3	0	0	1	0	2	0	0	1	1
CO 4	3	0	3	1	3	0	0	2	0	1	0	0	1	0
CO 5	3	0	3	2	3	2	3	3	0	1	2	0	1	0
	13	1	14	7	12	4	3	6	1	4	4	0	4	2

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	13	1	14	7	12	4	3	6	1	4	4	0	0	0
Scaled Value	3	1	3	2	3	1	1	2	1	1	1	0	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT703A	STEM CELL BIOTECHNOLOGY	L	T	P	C
		2	1	0	3

C	P	A
3	0	0

L	T	P	H
2	1	0	3

Prerequisite: - Cell biology, Immunology

Learning Objective:

Upon completion of this course, the students
- Would able to explain about various categories of stem cells.
- Would have learned the application of stem cell technology.

Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to		
CO1: Able to r*ecall* and *interpret* the biology of stem cells.	Cognitive	Remember Understand
CO2: *Explain* and **develop** the embryonic stem cell culturing.	Cognitive	Understand Apply

CO3:*Discuss*and*analyze*the differentiation of stem cells	Cognitive	Understand Analyze
CO4:*Explain* and *evaluate* thevarious techniques involved in stem cell assay.	Cognitive	Understand Evaluate
CO5: *Discuss and apply* the various applications of stem cells.	Cognitive	Understand

I- Basics of Stem Cell	**6+3**

Unique properties of stem cells – embryonic stem cells , history and development, characteristics,- Adult stem cells ,Properies, types, clinical applications umbilical cord stem cells– Similarities and differences between embryonic and adult stem cells - Properties of stem cells – pluripotency – totipotency.

II- Embryonic Stem Cells	**6+2**

In vitro fertilization –culturing of embryos-isolation of human embryonic stem cells – blastocyst – inner cell mass – growing ES cells in lab – laboratory tests to identify ES cells – stimulation ES cells for differentiation – properties of ES cells.

III - Adult Stem Cells , iPSCs	**5+2**

Somatic stem cells – test for identification of adult stem cells – adult stem cell differentiation – trans differentiation – plasticity – different types of adult stem cells.

IV- Stem Cell in Drug Discovery and Assay	**6+3**

Target identification – Manipulating differentiation pathways – stem cell therapy Vs cell protection –Hematopoietic colony forming cell assay- stem cell in cellular assays for screening – stem cell based drug discovery, drug screening and toxicology.

V- Applications of Stem Cells	**9+3**

Stem cell therapy for Mental disabilities, Diabetes Mellitus – Therapeutic applications – Parkinsondisease - Neurological disorder – limb amputation – heart disease - spinal cord injuries – diabetes –burns - HLA typing- Alzheimer's disease –tissue engineering application – production of complete organ - kidney – eyes - heart – brain.

Lecture	**Tutorial**	**Practical**	**Total**
32	**13**	**0**	**45**

Text Books

1. Kursad and Turksen, Embryonic Stem Cells; Humana Press; 2002.
2. Dr. LogeswariSelvaraj, Stem Cells MJP Publishers,2015.

References

1. Mohan C. Vemuri, Stem Cell Assays, Springer International Edition; 2010.
2. Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research. 2002. National Academic press.

E References

1. http://nptel.ac.in/courses/102103012/41

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	2	1			2	2	2	2	3	2
CO 2	2	2	2	2	3	3	2	1				3	1	1
CO3	3	3	2	2	2				1	1	2	2	2	3
CO4	2			3	2							1	1	2
CO5	3	3	2	3	2	2	2	1	2	2	1	1	1	1
	13	**10**	**8**	**11**	**11**	**6**	**4**	**2**	**5**	**5**	**5**	**9**	**0**	**0**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	13	10	8	11	11	6	4	2	5	5	5	9	0	0
Scaled Value	3	2	2	3	3	2	0	0	0	0	0	2	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT703B	CANCER BIOLOGY	L	T	P	C
		2	1	0	3
C **P** **A**		L	T	P	H
2.5 0 0.5		2	1	0	3

Prerequisite: Cell biology molecular biology

Learning Objective:
Upon completion of this course, the students
- Would have learn about carcinogenesis.
- Would have learn about a comparative approach to understand the differences in mechanisms and signaling.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Outline* the regulation and modulation of cell cycle in cancer by various signal switches	Cognitive	Understand
CO2:*Explain* and *compare* various types of carcinogenesis and its metabolism	Cognitive	Understand Analyze
CO3:*Illustrate* the role of activation of kinases, ***identification*** of oncogenes, and ***conforms*** the role of telomere.	Cognitive Affective	Understand Analyze Responds to Phenomena
CO4:*Explain* metastasis and its significant clinical markers for invasion and metastasis	Cognitive	Understand
CO5:*Describe* and *compiles* molecular tool for early diagnosis of cancer, different forms of cancer therapy.	Cognitive Affective	Understand Responds to Phenomena
I- Cell Cycle and Cancer		**9**
Cancer: Causes, characteristics and types – Cell cycle phases, cyclins and CDKs, check points , modulation of cell cycle in cancer - Effects on receptor, signal switches, signaling pathways – Telomerase and its role in cancer – Apoptosis, Extrinsic and intrinsic pathways, apoptosome and caspases - mutations that leads to cancer.		
II- Carcinogenesis		**9**
Theory of carcinogenesis – Types: Physical, chemical and radiation carcinogenesis, Direct acting and indirect acting carcinogens, Metabolism of carcinogens, CYP450 reductase mechanism; Mechanism of radiation carcinogenesis, ionizing and non ionizing radiation, Retroviruses - RSV life cycle and its role in cancer, Identification of carcinogens, Long and short term bioassays.		

III- Molecular and Cell Biology of Cancer	6+3

Signal targets and cancer, activation of kinases – Oncogenes - types, c-Myc, Ras, Bcl-2 family - identification and detection of oncogenes, oncogenes and proto oncogene activity - Growth factors related to transformation - epidermal growth factor (EGF), platelet derived growth factor (PDGF), transforming growth factor (TGF), src and myc; RAS cycle – Tumor suppressor genes.

IV- Invasion and Metastasis	9

Clinical significances and three step theory of Invasion, Metastasis – Introduction and cascade, heterogeneity of metastatic phenotype, Significance of proteases in basement membrane disruption, Epithelial- mesenchymal transition, stromal signals, Role of cadherin and integrin, metalloproteinases in cell invasion, Ras like GTPases.

V- Diagnosis and Therapy	6+3

Diagnosis: Detection using biochemical assays, tumor markers - Molecular tools for early diagnosis of cancer, Disease staging - FISH, DNA microarrays, SNPs, CGH and imaging techniques. Treatment: Chemotherapy – Topoisomerase inhibitors – Radiotherapy – Gene therapy – Immuno therapy – Antigen specific and Adaptive therapy – Stem cell therapy - Use of signal targets towards therapy of cancer – New Genomic and proteomic technologies.

Lecture	Tutorial	Practical	Total
39	6	0	45

Text Books:

1. Weinberg, R.A., The Biology of Cancer, Garland Science Taylor and Francis Group, New York, 1st Edition, 2007.
2. Kleinsmith. L.J., Principles of Cancer Biology, Pearson Education Inc., San Francisco, CA, 1st Edition, 2006.

References:

1. DeVita Jr, V.T., Lawrence, T.S., Rosenberg, S.A., DePinho, R.A. and Weinberg, R.A., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Lippincott Williams & Wilkins Philadelphia, PA, 9th Edition, 2011.
2. Ian F.Tannock, Richard P. Hill, Robert G. Bristow and Lea Harrington., The Basic Sciences of Oncology, 4th Edition, The McGraw-Hill Companies, Inc. New Jersey,2005.
3. PelengarisA.,and M. Khan (Eds)., The Molecular Biology of Cancer, Wiley - Blackwell Publishing, USA. 2006.
4. Gareth Thomas.,Medicinal Chemistry – An Introduction, 1st Edition, John Wiley and Sons, USA, 2004.
5. Benjamin Lewin., Genes VIII, International Edition, Pearson Prentice Hall, New Delhi. 2004.

E References:

1. www.nhri.org.tw/NHRI_ADM/userfiles/file/1010510.pdf

Mapping of Cos Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	2	1			2	2	2	2	3	2
CO 2	2	2	2	2	3	3	2	1				3	1	1
CO 3	3	3	2	2	2				1	1	2	2	2	3
CO 4	2			3	2							1	1	2
CO 5	3	3	2	3	2	2	2	1	2	2	1	1	1	1
	13	10	8	11	11	6	4	2	5	5	5	9	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	13	10	8	11	11	6	4	2	5	5	5	9	0	0
Scaled Value	3	2	2	3	3	2	1	1	1	1	1	2	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT703C	DESIGN OF BIOPROCESS EQUIPMENTS	L	T	P	C
		2	1	0	3

C	P	A		L	T	P	H
2	0	1		2	1	0	3

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Interprets* and *Differentiate* Process and Bioprocess	Cognitive Affective	Understand, Apply Guided Response
CO2	*Interprets* and *Design* Pressure units	Cognitive Affective	Understand, Apply Guided Response
CO3	*Interprets* and *Design* Supporting parts	Cognitive Affective	Understand, Apply Guided Response
CO4	*Interprets* and *Design* Heat and Mass Transfer Equipments	Cognitive Affective	Understand, Apply Guided Response
CO5	*Outlines, Interpret* and *Design* the Fermenter unit	Cognitive Affective	Understand, Apply Guided Response

Course content		Hours
Unit-I	**Process and Bioprocess**	6
Material of construction for process and bioprocess plants – Mechanical design of process equipment		
Unit-II	**Design of Pressure Unit**	6
Design of cylindrical and spherical vessel under internal and external pressure		
Unit-III	**Design of Enclosures**	6+3
Selection and design of flat plate, formed heads, torispherical and hemispherical heads, Standard flanges and nozzles.		
Unit-IV	**Design of heat and mass transfer units**	6+6
Design of single pipe and double pipe heat exchangers – Design of perforated plate distillation column and perforated plate packed towers.		
Unit-V	**Design of Fermenter**	6+6
Basic functions of a fermener – Service provisions for a fermentation plant – Geometrical ratios of fermenter with single and three bladed impellers – Safety precautions – Fermenter body construction and construction materials – Types of fermenter – Design parameters of fermenter.		

Lecture	Tutorial	Practical	Total
30	15	-	45

Text Books:

1. Mass Transfer Operations by Rober E Treybal, McGraw Hill, 1981.
2. Process Equipment Design -Vessel Design by Brownell & Young, John Willey, 1951.
3. Chemical Engineering by J. M. Coulson & J. F. Richardson, Vol 6, Pregman Press, 1993.

Reference Books:

1.Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.

2.Process equipment and mechanical aspect, B C Bhattacharya.

E-References:

1.https://nptel.ac.in/courses/103/107/103107143/
2.https://nptel.ac.in/courses/103/107/103107207/
3.https://nptel.ac.in/courses/103/103/103103027/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	6	6

$1 - 5 \rightarrow 1,$ $\qquad 6 - 10 \rightarrow 2,$ $\qquad 11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Course Code	:	**XES 705**			L	T	P	C
Course Name	:	**ENVIRONMENTAL STUDIES**			0	0	0	0
Prerequisite	:				L	T	P	H
C	P	A	**NIL**		3	0	0	3
2.5	0	0.5						

Course Outcome: After the completion of the course, students will be able to		**Domain C or P or A**	**Level**
CO1	*Describe* the significance of natural resources and *explain* anthropogenic impacts.	Cognitive	Rememberand understand
CO2	*Illustrate* the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive	Understand
CO3	*Identify* the facts, consequences, preventive measures of major pollutions and *recognize* the disaster phenomenon	Cognitive Affective	RememberReceive

CO4	*Explain* the socio-economic, policy dynamics and *practice* the control measures of global issues for sustainable development	Cognitive	Understand and Analyse
CO5	*Recognize* the impact of population and *apply* the Environmental ethics towards environmental protection.	Cognitive	Understand And Apply

COURSE CONTENT

UNIT I	INTRODUCTION TO ENVIRONMENTAL STUDIES AND RESOURCES	12

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, flood, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT II	ECOSYSTEMS AND BIODIVERSITY	8

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT III	ENVIRONMENTAL POLLUTION	8

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.

UNIT IV	SOCIAL ISSUES AND THE ENVIRONMENT	9
	Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.Issues involved in enforcement of environmental legislation – Public awareness.	
UNIT V	HUMAN POPULATION AND THE ENVIRONMENT	8
	Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	

	L	T	P	Total
	45	0	0	45

TEXT BOOKS

1. MahuaBasu,S. Xavier, Fundamentals of Environmental Studies, Cambridge University Press, 2019
2. BharuchaErach,Textbook of Environmental Studies for Undergraduate Courses, Orient Blackswan Pvt Ltd, 2018
3. Anubha Kaushik, C.P. Kaushik, Perspectives in Environmental Studies, New Age International Pvt Ltd Publishers,2018
4. Divan Shyam,Environmental Law and Policy in India, OUP India,2019
5. Varun DuttSharma,S.K. Pandey,Vimal Kumar sharma, Environmental Education and Disaster Management, CBS Publishers & Distributors,2019

REFERENCE BOOKS

1. M.V. Subba Rao, Natural Resources, Conservation, Management and Health Care, Discovery Publishing Pvt.Ltd,2020
2. Masters Gilbert M. Introduction to Environmental Engineering 3rd Edition , Pearson Education India, 3rd edition ,2015.
3. P.D. Sharma, Ecology and Environment Thirteenth Edition, Rastogi Publications,2017
4. Dr. Avneesh Gaur, Environmental Engineering and Disaster Management, Vayu Education Of India,2021
5. E-REFERENCES
6. http://www.e-booksdirectory.com/details.php?ebook=10526
7. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Sciencehttps://www.free-ebooks.net/ebook/What-is-Biodiversity

8. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
9. http://bookboon.com/en/pollution-prevention-and-control-ebook

http://www.e-booksdirectory.com/details.php?ebook=8557
http://www.e-booksdirectory.com/details.php?ebook=6804
http://bookboon.com/en/atmospheric-pollution-ebook
http://www.e-booksdirectory.com/details.php?ebook=3749
http://www.e-booksdirectory.com/details.php?ebook=2604
http://www.e-booksdirectory.com/details.php?ebook=2116
http://www.e-booksdirectory.com/details.php?ebook=1026
http://www.faadooengineers.com/threads/7894-Environmental-Science

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1														
CO2	2					2	1			1		1		
CO3	2	1	3			3	1		2	1		1		
CO4	1	1	2			3	2	3				1		
CO5	2	1	1			3						1		
Total	10	3	6			11	4	3	2	2		5		
ScaledValue	2	1	2			3	1	1	1	1	1	1		
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT706			**RECOMBINANT DNA TECHNOLOGY LABORATORY**	**L**	**T**	**P**	**C**
				0	**0**	**2**	**2**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**1**	**0**		**0**	**0**	**2**	**6**

Prerequisite: Genetics, Molecular biology

Learning Objectives:

Upon completion of this course, the students
- Would have learned the concepts of gene cloning and its application.
- Would have learned the various techniques involved in Recombinant DNA Technology.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	*Study and Understand* the basic concepts isolation and digestion.	Cognitive Psychomotor	Understand Perception
CO2	*Explain* and*Analyze*gel electrophoresis and Southern blotting.	Cognitive Psychomotor	UnderstandPerce ption
CO3	*Explain* and*Analyze*SDS PAGE and Western blotting.	Cognitive Psychomotor	Remember Analyze Perception
CO4	*Discusses,* and *Distinguish*digested DNA and genomic DNA.	Cognitive Psychomotor	Apply Perception
CO5	*Explain* and *Apply* the cell preparation and selection of recombinants.	Cognitive Psychomotor	Understand Apply
Recombinant DNA Technology Lab			

List of Practical Experiments
1. Isolation of Plasmid and Genomic DNA. (CO1)
2. Restriction enzyme digestion. (CO1)
3. Agarose gel Electrophoresis. (CO2)
4. Southern blotting (CO2)
5. SDS PAGE. (CO3)
6. Western blotting. (CO3)
7. Purification of digested DNA. (CO4)
8. Ligation of restricted vector and genomic DNA (CO4)
9. Competent cell preparation- calcium chloride method (CO5)
10. Screening and selection of recombinants(CO5)

Lecture	Tutorial	Practical	Total
00	**00**	**30**	**30**

Text Books:
1. Primrose S.B. and Twymann R.H., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Sixth Edition, Blackwell Scientific Publications, 2004.

Reference Books:
1. Brown T.A., "GeneCloning and DNA Analysis", Fourth Edition, Blackwell Scientific Publications, 2003.
2. Glick B.R. and Pasternak J.J., "Molecular Biotechnology", Third Edition, ASM Press, 2003.
3. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References:
http://nptel.ac.in/courses/102103013/

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO 2	3	0	3	2	2	1	0	0	0	0	1	0	0	0
CO 3	3	0	3	1	3	0	0	1	0	2	0	0	0	0
CO 4	3	0	3	1	3	0	0	2	0	1	0	0	0	0
CO 5	3	0	3	2	3	2	3	3	0	1	2	0	0	0
	13	**1**	**14**	**7**	**12**	**4**	**3**	**6**	**1**	**4**	**4**	**0**	**0**	**0**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**13**	**1**	**14**	**7**	**12**	**4**	**3**	**6**	**1**	**4**	**4**	**0**	**0**	**0**
Scaled Value	3	1	3	2	3	1	1	2	1	1	1	0	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

	XBT707			BIOINFORMATICS	L	T	P	C
					1	0	1	2
C	**P**	**A**			**L**	**T**	**P**	**H**
0.5	2	0.5			1	0	2	6

Prerequisite:-

Learning Objectives:

Upon completion of this course, the students

- Will be able identify different databases and will be able to know about the application of the bioinformatics for data retrieval and for drug designing and development.

	Course Outcomes	Domain	Level
After the completion of the course, students will be able to			
CO1	**Explain** the importance and basic concepts in bioinformatics and **differentiate** various databases.	Cognitive Psychomotor	Understand Perception
CO2	**Understands** the significance of sequence analysis and **performs** sequence alignment.	Cognitive Psychomotor	Apply Guided response
CO3	**Explain** and **Construct** phylogenetic trees to study phylogenetic relationships	Cognitive Psychomotor	Understand Guided response
CO4	**Predict** and **Analysis** the protein structure and molecular docking	Cognitive Psychomotor	Create mechanism
CO5	**Understand** the steps involved in drug discovery process.	Affective	Receive

I- Introduction to Bioinformatics	3

Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities – Biological databases- Classification of biological databases- Primary and Secondary databases, Sequence and structure databases, Specialized databases- retrieval system- Entrez- SRS.

II- Introduction to Computational Biology and Sequence Analysis	3

Sequence alignment, Pairwise alignment, Multiple sequence alignment its applications, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, Database similarity searching - FASTA and BLAST.

III- Phylogenetics	3

Introduction to Phylogenetics, Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree, Forms of Tree Representation, Rooted and un-rooted trees, Phylogenetic Tree Construction Methods: Distance based methods- NJ, UPGMA, Character based methods –Maximum Parsimony, Phylogenetic programs, Bootstrapping.

IV- Protein Structure, Modelling and Simulations	3

Protein structure basics, Protein structural visualization and comparison, Secondary structure prediction- Chau-Fasman, GOR, Neural networks, Protein tertiary structure prediction Homology modeling, Threading and Fold recognition.

V- Role of Bioinformatics in Drug Discovery	3

Drug designing- objectives- Rational drug design- Computer assisted drug design and drug development- Molecular docking and its applications- QSAR, In Silico drug design- role of structural bioinformatics in drug design and development- Pharmacogenomics- prospects and uses.

List of Experiments(30 hrs)

1. Accession and retrieval of data from various biological databases.Unix/Linux – basic operations and working with terminal.
2. Perl programs - Simple programs using Operators, Control Structures, Subroutines, Hash, Creating a static HTML file by a Perl Program.
3. Heuristic methods (BLAST, FASTA) of searching for homologous sequences
4. Pair-wise (Needleman – Wunch Algorithm & Smith waterman Algoritghm)and Multiple sequence

5. Phylogenetic tree building using Phylip.
6. Protein Secondary structure prediction.Homology Modeling.Molecular Visualization and 3D structural studies using Rasmol - Commands, Domain identification.
7. Molecular Visualization and 3D structural studies using Chimera.
8. Small molecule building, using ISIS Draw and CHEM SKETCH – Tutorial

Lecture	Tutorial	Practical	Total
15	0	30	45

Text Books:

1. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004
2. Ghosh, Zhumur, and BibekanandMallick. Bioinformatics: Principles and Applications. Oxford University Press, 2008.
3. S. Harisha , "Fundamentals of Bioinformatics", I. K. International Pvt Ltd, 2010

References:

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008
2. T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005
3. Stephen A. Krawetz, David D. Womble, Introduction To Bioinformatics A Theoretical and Practical Approach, Humana Press, 2003

E-References:

1. http://nptel.ac.in/courses/102103044/40
2. vlab.amrita.edu/?sub=3&brch=273

Mapping of Cos Vs PO s

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1			1		2				2					
CO 2		2	2	1	3								1	
CO 3		2	1	1	2							3	3	1
CO 4	1	3	3	1	3						3	1	2	3
CO 5	1	2	3		3						2	1	1	1
	2	9	10	3	13				2		5	4	7	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	2	9	10	3	13	0	0	0	2	0	5	4	7	5
Scaled Value	3	1	3	2	3	1	1	2	1	0	1	1	1	1

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related, 0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 708			PROJECT WORK PHASE-I	L	T	P	C
				0	0	2	2
C	P	A		L	T	P	H
1.5	0.5	0.5		0	0	6	6

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to		

CO1	*Identify* the engineering problem relevant to the domain interest.	Cog	Analyze
CO2	*Interpret* and infer literature survey for its worthiness.	Cog	Analyze Apply
CO3	*Analyse* and *identify* an appropriate technique for solve the problem.	Cog	Analyze Apply
CO4	*Perform* experimentation /Simulation/Programming/Fabrication, *Collect* and *interpret* data.	Phy Cog	Comp. Overt Resp., Create, Apply
CO5	*Record* and report the technical findings as a document.	Cog	Remember, Understand

Mapping of COs with POs

	CO1	CO2	CO3	CO4	CO5	Total
PO1	3	2	1	2	1	9
PO2	3	2	1	2	1	9
PO3	-	-	1	3	1	5
PO4	-	1	2	3	1	6
PO5	-	-	2	3	1	6
PO6	1	-	1	1	-	3
PO7	1		1	1	-	3
PO8	1	-	1	1	-	3
PO9	-	-	-	-	2	2
PO10	-	-	-	-	3	3
PO12	-	-	-	-	2	2
PO12	1	-	-	-	3	4
PSO1	1	1	1	1	1	5
PSO2	1	1	1	1	1	5

1 – Low, 2 – Medium, 3 – High

				L	T	P	C
XBT 709			**INPLANT TRAINING - III**	0	0	2	2
C	**P**	**A**		**L**	**T**	**P**	**H**
1.33	1.33	1.33		0	0	2	2

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes		Domain	Level
On the successful completion of the course, students will be able to			
CO1	*Relate* classroom theory with workplace practice	Cog	Understand
CO2	*Comply* with factory discipline, management and business practices.	Aff	Response
CO3	*Demonstrates* teamwork and time management.	Aff	Value
CO4	*Describe* and *display* hands-on experience on practical skills	Phy	Perception Set

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	obtained during the programme.		
CO5	*Summarize* the tasks and activities done by technical documents and oral presentations.	Cog	Evaluate

Mapping COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5				3						3			1	1
Total	2	1	2	4	3	0	1	3	3	4	4	0	6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

VIII Semester

XBT801A			**INTRODUCTION TO QUANTUM BIOLOGY, ARTIFICIAL INTELLIGENCE (AI) AND DATA SCIENCE**	**L**	**T**	**P**	**C**
				2	1	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		2	1	0	3

Objectives: Students able to inspire on Quantum biology, AI and Data Science to contribute in emerging technology.

	Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	*Interprets* and *Realize*Quantum mechanics in biology.	Cognitive	Understand Remember
CO2	*Interprets* and *Realize*Quantum Biology Applications.	Cognitive	Understand Remember
CO3	*Interprets* and *Realize* Artificial Intelligence in Engineering.	Cognitive	Understand Remember
CO4	*Interprets* and *Realize*Data Science in Engineering.	Cognitive	Understand Remember
CO5	*Outlines* the Resources for AI and Data Science, etc.	Cognitive	Understand Remember

Course content		**Hours**
Unit-I	**Introduction to Quantum Biology**	**6**
General introduction on quantum mechanics – How plant use quantum mechanics – quantum mechanics in respiration – nucleotides separation by 0.3 nm deal with UV photons – transfer of electrons and protons in cells.		
Unit-II	**Quantum Biology Applications**	**6**
Photosynthesis – DNA mutation – Quantum vision implications – Enzyme activity as quantum biochemistry – Antibodies surface proteins on microorganisms.		
Unit-III	**Introduction to Artificial Intelligence**	**6+3**
Introduction to AI concept – History of AI - Concept of AI in Drugs and Vaccination – Health Care Data Analysis – Plant Genome Studies – Gene Editing – Enzyme Compositions.		
Unit-IV	**Introduction to Data Science**	**6+6**
Application of Data Science – Requirements for Data Science – Introduction to R Program and R-Studio.		

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Unit-V	Resources		6+6
Relationship between AI, Data Science, Machine Learning and Deep Learning – Open Resources.				

Lecture	Tutorial	Practical	Total
30	15	-	45

Text Books:

1. Graham R Fleming, Gregory D.Scholes "Quantum Effects in Biology" Cambridge University Press 2014.
2. Stuart J. Russell and Peter Norvig – "Artificial Intelligence – A Modern Approach" 3rd Edition, Pearson Publisher, 2015.
3. R.Ragunathan and N. Shankar, "Data Science for Engineers"

Reference Books:

Davy Cielen, Arno D.B. Meysman, and Mohamed Ali, "Introducing Data Science" Manning Publications, 2016.

E-References:

https://doi.org/10.1017/CBO9780511863189.003
https://royalsocietypublishing.org/doi/10.1098/rsif.2018.0640
https://nptel.ac.in/courses/106/102/106102220/
https://nptel.ac.in/courses/106/106/106106179/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

     8th BOS/BIOTECH/Date: 19.08.2021

XBT801B			ENZYME ENGINEERING	L	T	P	C
				2	1	0	3
C	P	A		L	T	P	H
3	0	0		2	1	0	3

Prerequisites : -

Objectives:

- To enhance the student's ability of employability through study the core enzyme characteristics and products.

Course Outcomes: At the end of this course, the students should be able to	Domain	Level
CO1 *Explain*the enzyme principles and*Study* the properties.	Cognitive	Understand
CO2 *Describe* the extraction and *Interpret* the properties with the bioprocesses.	Cognitive	Understand
CO3 *Recognize* the Immobilization types and *Describe* the techniques.	Cognitive	Understand
CO4 *Discuss*the kinetic properties and *Interpret* withthe techniques.	Cognitive	Understand
CO5 *Describe* the salient features of industrial applications of enzyme.	Cognitive	Understand

Course Content	Hours
Unit-I	**Introduction**	**6+3**
Enzyme catalysis principles – Enzyme catalysis – Enzyme kinetics – Impact of pH and Temperature – Immobilization types.	
Unit-II	**Enzyme Extraction**	**6+3**
Extraction of crude enzyme from plant, animal and sources of microbials – Purification – Characterization – Enzyme activity – Development of enzyme assay.	
Unit-III	**Immobilization Techniques**	**6+3**
Enzyme Adsorption – Matrix Entrapment – Encapsulation – Cross Linking – Covalent binding and their examples – Advantage and disadvantage of immobilization techniques.	
Unit-IV	**Kinetic Properties of Enzymes**	**6+3**
Structure and stability of immobilized enzymes – Effect of partition – Effect of diffusion – Mass balance – Stoichiometry measurement – Role of effector molecules in enzyme kinetics.	
Unit-V	**Applications**	**6+3**
Overview of applications of immobilized enzyme system - Concise overview on large scale enzyme production – Enzyme products.	

Lecture	Tutorial	Practical's	Total
30	**15**	**0**	**45**

Text Books

1.Nicolas C. price and Lewis stevens, "Fundamentals of enzymology", Oxford University Press
2.Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.

References

3.Chaplin and Bucke, "Enzyme technology", Cambridge Univerity Press.
4.James Bailey, David Ollis, "Biochemical Engineering Fundamentals", 2nd Ed., McGraw Hill Education, 2017.

E-References

1.https://nptel.ac.in/courses/102/102/102102033/

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	13	5	11	8	5	8	5	5	0	8	8	11	11

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	9	3

$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT801C	WASTE MANAGEMENT AND BY-PRODUCTS UTILIZATION		L	T	P	C
			2	1	0	3
C	**P**	**A**	**L**	**T**	**P**	**H**
3	**0**	**0**	**2**	**1**	**0**	**3**

PREREQUISITE: Nil

Learning Objectives: Upon completion of this course, the students
- Will be able to understand the origin and type of waste and by products, waste identification, classification and composition.
- Will be able to describe the need for treatment and utilization of waste
- Will be able to know the legal and statutory requirements for waste handling, treatment and disposal

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Acquire* the knowledge of waste generation and the factors for waste accumulation and *Differentiates* the waste disposal vs waste management	Cognitive	Remember
CO2: *Characterize* the type and categories of several wastes	Cognitive	Remember
CO3: *Outlines* the methods for waste management and disposal	Cognitive	Analyze
CO4: *Discuss* and *compiles* the various methods of waste and by-products utilization from different sources	Cognitive	Analyze Understand
CO5: *Describe* the importance of safety and regulations regarding waste management	Cognitive	Remember
Unit-I **Introduction**		**6+3**
Definition of waste – Waste handling – Factors affecting waste generation – Waste disposal vs		

Waste management – Rural waste vs Urban waste – Waste vs Pollution.			
Unit-II	**Waste Characterization**		**6+3**
Types of waste – Categories of solid wastes (Domestic waste, Market waste, Food waste, Agricultural waste, e-Waste, Industrial inert waste, Industrial hazardous waste, Biomedical waste, Radioactive waste, Plastic waste – Next Generation Waste.			
Unit-III	**Waste management**		**6+3**
Direct combustion of solid waste – Effluent treatment and disposal – Biowaste management (Sources, Categories, Impacts on health, Steps involved in Biomedical waste management)			
Unit-IV	**Waste and By-products utilization**		**6+3**
Introduction to by-products and waste generation in agricultural production and processing – Utilization of waste from fruit and vegetable processing – Fish, Meat and Poultry industry's waste utilization – Utilization of by-products from wheat, rice, corn and dal mills – Utilization of by-products from oil mills – Utilization of by-products from dairy industry.			
Unit-V	**Safety and regulations**		**6+3**
Legal aspects: Biomedical waste management and handling rules, CPCB (Central pollution control board) guidelines, Safe disposal of radioactive waste rules, guideline of BARC (Baba Atomic Research Centre), International Scenario: World Health Organization (WHO) guidelines on management of wastes.			

LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
30	**15**	**0**	**45**

TEXT BOOKS:
1.Pichtel, J. (2005). *Waste management practices: municipal, hazardous, and industrial*. CRC press.   2.Arvanitoyannis, I. S. (2010). *Waste management for the food industries*. Academic Press.
REFERENCE BOOKS:
1. Sayler, G. S., Fox, R., & Blackburn, J. (Eds.). (2013). *Environmental biotechnology for waste treatment* (Vol. 41). Springer Science & Business Media.   2. Nigam, P. S. N., & Pandey, A. (Eds.). (2009). *Biotechnology for agro-industrial residues* utilisation: utilisation of *agro-residues*. Springer Science & Business Media.   3. Dhillon, G. S., & Kaur, S. (Eds.). (2016). *Agro-industrial wastes as feedstock for enzyme production: apply and exploit the emerging and valuable use options of waste biomass*. Academic Press.
E- REFERENCES
1.https://nptel.ac.in/courses/120/108/120108005/   2.https://nptel.ac.in/courses/105/106/105106056/   3.http://ecoursesonline.iasri.res.in/course/view.php?id=518

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	0	0	2	0	1	2	0	3	0	0	1	1	0	0
CO 2	0	0	2	0	1	2	0	3	0	0	1	1	0	0
CO 3	3	3	1	2	1	0	3	1	2	1	1	1	0	3
CO 4	3	3	1	3	1	0	3	1	2	1	1	1	3	3
CO 5	0	0	2	0	1	3	0	3	2	1	1	1	0	0
	6	6	8	5	5	7	6	11	6	3	5	5	3	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	6	6	8	5	5	7	6	11	6	3	5	5	3	6
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

XBT 804	PROJECT WORK PHASE-II	L	T	P	C
		0	0	9	9
C **P** **A**		L	T	P	H
6 **3** **3**		0	0	9	18

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to		
CO1 Identify the Engineering Problem relevant to the domain interest.	Cog	Analyze
CO2 Interpret and Infer Literature survey for its worthiness.	Cog	Analyze Apply
CO3 Analyse and identify an appropriate technique for solve the problem.	Cog	Analyze Apply
CO4 Perform experimentation /Simulation/Programming/Fabrication, Collect and interpret data.	Phy Cog	Comp. Overt Resp., Create, Apply
CO5 Record and Report the technical findings as a document.	Cog	Remember, Understand

Mapping of COs with Pos

	CO1	CO2	CO3	CO4	CO5	Total
PO1	3	2	1	2	1	9
PO2	3	2	1	2	1	9
PO3	-	-	1	3	1	5
PO4	-	1	2	3	1	7
PO5	-	-	2	3	1	6
PO6	1	-	1	1	-	3
PO7	1		1	1	-	3
PO8	1	-	1	1	-	3
PO9	-	-	-	-	2	2
PO10	-	-	-	-	3	3
PO11	-				2	2
PO12	1				3	4

| PSO1 | 1 | 1 | 1 | 1 | 1 | 5 |
| PSO2 | 1 | 1 | 1 | 1 | 1 | 5 |

1 - Low, 2 – Medium, 3 – High

Open Electives

XBTOE1			**INTELLECTUAL PROPERTY RIGHTS**	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Would have understood the various types of IPR.
- Would have learnt to search the database, drafting the patent and filing process.
- Would have understood about the IPR audit and related disputes.
- Would have earned knowledge on IPR and earned certificates from WIPO, NPTEL and other portals.
- Would able to identify new GI, protect copyright, design and filing a patent

Course Outcomes		Domain	Level
CO1	*Understand* the significance of IPR and *identify* various types of IPR.	Cognitive	Understand
CO2	*Understand* the process of *registration and infer* the *valuation of IP*.	Cognitive	Understand
CO3	*Understand* the legal framework and *infer* legislative process in India, selected countries and WIPO	Cognitive	Understand
CO4	*Understand* the international commitment and *imply* suitable market for the registered IP.	Cognitive	Understand
CO5	*Apply* your understanding and *create* a new GI, filing patent, novel design or copyright and recognition or commercialization of the IPR	Cognitive	Understand

I - Introduction to IPR	**9**

Creativity, Invention, Innovations; Importance of Intellectual Property; Types of Intellectual Property; History and development of IPR in India – Initiatives by Indian Government towards& WIPO IPR – advancement in S&T, traditional knowledge and biodiversity resources. WIPO distance learning courses in WIPO.

Distance Learning Courses in WIPO (Any three courses; all are free of cost)
1. DL-General Course on Intellectual Property (version 2) [DL101E20S4]
2. e-Tutorial on using Patent Information (DL-177) [DL177E20S2]
3. IP Panorama [DLIPP PanoramaE21]
4. DL-001 Primer on Intellectual Property [DL001E20]
5. DL-301 Patents (Open) [DL301OE19S2]
6. DL-201 Copyright and Related Rights (Open) [DL201OE19]

Study material in IPR -India (Need to submit a page report)
7. https://ipindia.gov.in/index.htm
8. https://ipindiaonline.gov.in/trademarkefiling/user/frmloginNew.aspx Optional Courses

(registration cost is required)	
9. https://e-learning.iptse.com/	

II- Types, Registration and Valuation of IPR (India/Pct)	**9**

Patents – Copyrights and related rights – Trade Marks – Industrial Designs – Protection of Integrated Circuits and Layout Design – Geographical Indications of Goods – Biological Diversity – Plant Varieties and Farmers Rights – Trade Secrets / undisclosed information.

Distance Learning Course in WIPO and study material in IPR-India

10. DL302 Trademarks, Industrial Designs and Geographical Indications (Open) [DL3020E19]
    GATE way in IPR-India
11. https://ipindia.gov.in/designs.htm
    Patent Search (Practice and submit a two pages report)
12. https://ipindiaservices.gov.in/publicsearch

III- Legal and Legislation Framework in India	**9**

IPR Laws – Owner's Rights – Negotiation of International Treaties – Traditional Knowledge Digital Library (TKDL) – Commercialization of IPR – Enforcement and Adjudication – Human Capital Development.

Study material to learn TKDL, Patent Act 1970 (Need to submit a page report)

13. http://tkdl.res.in/tkdl/langdefault/common/Abouttkdl.asp?GL=Eng
14. https://www.indiacode.nic.in/bitstream/123456789/1392/3/a1970-39.pdf

IV- International Conventions and Treaties	**9**

WTO - International conventions – Establishment of WIPO – General Agreement on Trade and Tariff (GATT) – TRIPS – PCT.

15. DL101PCT Distance Learning Course: Introduction to the Patent Cooperation Treaty [PCT101E19]
    Optional: students who are interested can carry out the following course and earn certificate (which is signed from WHO, WIPO and WTO).
16. DL701 Promoting Access to Medical Technologies and Innovation – WHO, WIPO, WTO Executive Course on the intersections between public health, intellectual property and trade [DL7011ENT19S2]

V - IPR Management	**9**

Drafting patent specification – Claims- IPR audit-IP asset management – IP Litigations – Transfer of Rights – IP training and education – IP valuation – Agreement Drafting.

Reading the material and submission of a page note; Optional: earning certificate from NPTEL and WIPO.

17. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-hs14/
18. https://www.wipo.int/sme/en/ip_audit/
19. https://www.wipo.int/ipadvantage/en/
20. http://164.100.236.140/e-gateways.htm#comprehensive-e-filing
    Optional: Identify a GI need to be registered in your place; Filing patent of your innovation; Novel Design need to protected; Copyright of your work registered

Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**0**	**45**

Text Books

1. SubbaramN.R."Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

E-References

1. Neeraj Pandey, KhushdeepDharni, Intellectual Property Rights, PHI Private Limited, Delhi, 2014.
2. Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com].

3. Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. [www.ipmatters.net/features/000707_gibbs.html.

E Resources

1. http://www.wipo.int/patentscope/en/
2. http://www.ipindia.nic.in/
3. http://www.uspto.gov/
4. https://www.epo.org/index.html
5. https://www.jpo.go.jp/

Mapping Of Cos and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

1 – 5 → 1,   6 – 10 → 2,   11 – 15 → 3

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBTOE2			BIOSAFETY MANAGEMENT	**L**	**T**	**P**	**C**
				3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students

- Would have understood the various types of safety aspects.
- Would have learnt to behave with precautions.
- Would have understood about the Biosafety requirements in all areas.
- Would have earned knowledge on Biosafety system to set in their working place to avoid the risks.

Course Outcomes		Domain	Level
CO1	*Understand* the significance of Safety and *identify* Various types of Safety.	Cognitive	Understand
CO2	*Understand* the Biosafety and *infer* with the Management.	Cognitive	Understand
CO3	*Understand* the Guidelines of Biosafety and *infer* with the Various Safety Committee.	Cognitive	Understand

CO4	*Understand* the Hazards and *imply* the Analysis System.	Cognitive	Understand
CO5	*Understand* the risk and *Imply* the various safety Risk Analysis.	Cognitive	Understand

Course Content	Hours
Unit-I **Introduction to Safety**	9
Phenomena of safety –Types of Hazards: Physical, Chemical, Biological, Ergonomics and noise hazards – Concept of Industrial safety apply over Biosafety.	
Unit-II **Introduction to Biosafety**	9
Historical Background of Biological Safety – Primary Contaminants for Biological Safety – Introduction to Microorganisms – Biosafety Level of Specific Microorganisms - Emerging of Biosafety in global – Level of Infectious Agents and Infectious Animals	
Unit-III **Guidelines of Biosafety**	9
Guidelines from Goverment of India – Definitions of GMOs & LMOs – Roles of Institutional Biosafety Committee, RCGM, GEAC – Roles of GMO in Food, Agricultural and Environmental Sectors.	
Unit-IV **Hazard Analysis**	9
Hazard identification and control – HAZOP, job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Safety Survey – Plant inspection – Past accident analysis.	
Unit-V **Risk Analysis**	9
Risk Assesment, Management and Communication –Overview of National Regulations and Relevant International Agreements Including Cartagena Protocol – Safety Procedures: Handling and Storage of Chemicals, Fire Chemistry and its Control – Personal Protections.	

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books
1.Fleming and Hunt, "Biological Safety, Principles and Practices" 5th edition, ASM Press, 2017.   2.Deshmukh, L.M., "Industrial Safety Management (Hazard identification and risk control)", TATA McGraw Hill, 2008.

References
1.Raghavan, K.V. and Khan, A.A., "Methodologies in Hazard Identification and Risk   2.**https://www.who.int/publications-detail-redirect/9241546506** (**Manual from WHO**)

E Resources
1.http://www.geacindia.gov.in/resource-documents/13_2-Regulatory_Framework_for_GE_Plants_in_India.pdf   2.https://ibkp.dbtindia.gov.in/Content/Commitee?AspxAutoDetectCookieSupport=1

Mapping Of Cos and POs

	Program Outcomes												PSO1	PSO2
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBTOE3			DIGITAL HEALTH	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Students will get aware of Digital Health
- Students will learn analytical skill on digital data
- Students can develop employability opportunity

Course Outcomes		Domain	Level
CO1	*Understand* the significance of Digital health and *identify* Various types employability from digital health..	Cognitive	Understand
CO2	*Understand* the functions and goals and *infer* with the Digital Health Management.	Cognitive	Understand
CO3	*Understand* the products of digital health and *infer* with the services.	Cognitive	Understand
CO4	*Understand* the Digital Health Applications and *imply* the Analysis System.	Cognitive	Understand
CO5	*Understand* the innovations and *Imply* the Entrepreneurship from digital health.	Cognitive	Understand

Course Content		Hours
Unit-I	**Fundamentals of Digital Health**	9
Introduction to Healthcare; Application of Technology in Medicine; Information Technology for Health Informatics; Software development for improving healthcare; Public policy for Health Informatics; Current trends in Health Informatics.	
Unit-II	**Function and Goals of Digital Health**	9
The objectives of digital health products and services- strategy to improve the quality of outcomes of digital health products and services; population health; patient experience and health disparities.	
Unit-III	**Digital Health Products and Services**	9
Remote sensing and wearables, Telemedicine, health information exchange, Data analytics and intelligence- Artificial Intelligence and Business Intelligence, predictive modeling, Health and wellness behavior modification tools, Bioinformatics tools(-omics), Medical social media,	

Digitized health record platforms, Patient -physician-patient portals, Decision support systems, Imaging, Personalized and Precision Medicine.

Unit-IV	Applications of Digital Health	9

Diagnosis, Treatment, Prevention and Wellness, Rehabilitation, Behavioral Health, Disease Management, Public Health.

Unit-V	Innovation and Entrepreneurship in Digital Health	9

Intellectual Property Protection, Regulatory Issues, Business Models, Financing Digital Health Startup Ventures, Leading High-Performance digital Health Teams, Product and Customer Development, Startup Methodologies, Clinical Validation and Translational Research, Data Security and Confidentiality.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books

1. Ronquillo Y., Meyers A., and Korvek S.J., "Digital Health" StatpearlsPulishing, Treasure Island (FL), 2021.

References

1. Rivas H., "Digital Health: Scaling Healthcare to the world (Health Informatics)", Springer Publisher, 2018.

E Resources

1.https://www.coursera.org/learn/introduction-to-digital-health
2.https://www.who.int/docs/default-
3.source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf

Mapping Of Cos and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

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APPENDIX A

Value Added Course

8th Board of Studies for the programme B.Tech Biotechnology was conducted on 19.Aug.2021. The following new value added courses were introduced and recommended for ACM approval.

1. R Program and R Studio for Biotechnologist

S.No	Course Description Topic	Hrs
	Course Description	
S.No	**Topic**	**Hrs**
1.	R and Rstudio Installation and Operation	3
2.	Variables and Data Types	3
3.	Data Frames	3
4.	Recasting and Joining of Data Frames	3
5.	Arithmetic, Logical and Matrix Operation in R and Rstudio	3
6.	R Functions	6
7.	Control Structures	3
8.	Basic Data Visualization	3
9.	Introduction to apply on Biotechnology Domain	3
10.	Report Submission	-
	TOTAL	**30**

References:
R.Ragunathan and N. Shankar, "Data Science for Engineers" NPTEL, CSE, IIT Madras.

2. Python for Biotechnologist

S.No	Course Description Topic	Hrs
	Course Description	
S.No	**Topic**	**Hrs**
1.	Python Installation and Operation	3
2.	Fundamentals of the Program – An Introduction	3
3.	Variables and Expressions	3
4.	Math Module	3
5.	Statements and Type	3
6.	Functions	3
7.	Code organizations	3
8.	Conditionals and Exercise	3
9.	Introduction to Biopython	3
10.	Installation of Biopython and Guide to do program in Online	3
11.	Report Submission	-
	TOTAL	**30**

References:
https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1004867
http://biopython.org/DIST/docs/tutorial/Tutorial.html

3. Training on Hospital's Clinical Research Lab

S.No	Topic	Days
**Course Description**		
1.	Clinical Data Management	3
2.	Clinical Research	3
3.	Pharmacovigilance	3
4.	Anatomy and Physiology	3
5.	Infectious Diseases	3
6.	Bacterial Infection Treatment	3
7.	Viral Infection Treatment	3
8.	Fungai Infection Treatment	3
9.	Basic Training on Hospital Equipments for Diagnosis	3
	Combine with Deepam Hospitals – Tambaram (West) Chennai	
	TOTAL	**27**

References:
Materials Provides by Trainers

4. Downstream Manufacturing (Microbial)

S.No	Topic	Hrs
**Course Description**		
1.	Basic Requirements	3
2.	Initiating	3
3.	Microbial Medium preparations	3
4.	Conditions Maintenance	3
5.	Loading and Operating	3
6.	Trouble Shooting	3
7.	Product Yielding	3
8.	Purification	3
9.	Quality and Quantity Analysis	3
10.	Operating Test and Report Writing	3
	Exclusive training on Labscale fermenter Imported from Bioengineering Swizerland	
	TOTAL	**30**

References:
Bioengineering Fermenter Manual Book

4. Curriculum and Syllabus of the programme – After revision

Semester I

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	BSC	XMA101	Calculus and Linear Algebra	3	1	0	4	4	1	0	5
2.	ESC	XCP102	Programming for Problem Solving	3	0	0	3	3	0	0	3
3.	BSC	XAP103	Applied Physics for Engineers	3	1	0	4	3	1	0	4
4.	ESC	XBT104	Biology for Engineers	3	0	0	3	3	0	0	3
5	HSMC	XGS105	Speech Communication	0	0	3	3	0	0	3	3
6	MC	XUM106	Constitution of India *#	0	0	0	0	2	0	0	2
7	ESC	XCP107	Programming for Problem Solving Laboratory	0	0	1	1	0	0	3	3
8	BSC	XAP108	Applied Physics for Engineers Laboratory	0	0	2	2	0	0	3	3
			Total	**12**	**2**	**6**	**20**	**14**	**2**	**9**	**25**

Semester II

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	BSC	XMA201	Calculus, Ordinary Differential Equations and Complex Variable	3	1	0	4	3	1	0	4
2.	ESC	XBE202	Electrical and Electronic Engineering Systems	3	1	0	4	3	1	0	4
3.	BSC	XAC203	Applied Chemistry for Engineers	3	1	0	4	3	1	0	4
4	HSMC	XGS204	Technical Communication	2	0	0	2	2	0	0	2
5	ESC	XWP205	Workshop Practices	1	0	2	3	1	0	3	4
6	ESC	XBT206	Chemical Engineering Thermodynamics	2	1	0	3	2	1	0	3
7	ESC	XBE207	Electrical and Electronic Engineering Systems Laboratory	0	0	1	1	0	0	3	3
8	BSC	XAC208	Applied Chemistry for Engineers Laboratory	0	0	1	1	0	0	3	3
			Total	**14**	**4**	**4**	**22**	**14**	**4**	**9**	**27**

Semester III

S.No.	AICTE Code	Course Code	Courses	Credits				Hour			
				L	T	P	C	L	T	P	Total
1.	BSC	XPS301	Probability and statistics	3	0	0	3	3	0	0	3
2.	PCC	XBT302	Biochemistry	2	1	0	3	3	1	0	4
3.	PCC	XBT303	Microbiology	3	0	0	3	3	0	0	3
4.	PCC	XBT304	Material and Energy Balances	2	1	0	3	2	1	0	3
5.	PCC	XBT305	Genetics and Evolutionary Biology	3	0	0	3	3	0	0	3
6.	HSMC	XUM306	Entrepreneurship Development	2	0	0	2	2	0	0	2
7	MC (HSMC)	XUM307	Universal Human Values 2: Understanding Harmony	2	1	0	3	2	1	0	3
8	PCC	XBT308	Biochemistry Laboratory	0	0	2	2	0	0	6	6
9	PCC	XBT309	Microbiology Laboratory	0	0	2	2	0	0	6	6
10	PROJ	XBT310	In-plant Training - I	-	-	1	1	-	-	2	2
			Total	**17**	**3**	**5**	**25**	**18**	**3**	**14**	**35**

Semester IV

S.No.	AICTE Code	Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	PCC	XBT401	Basic Transport Processes	2	1	0	3	2	1	0	3
2.	PCC	XBT402	Bioenergetics and Metabolism	2	1	0	3	2	1	0	3
3.	PCC	XBT403	Cell Biology	3	0	0	3	3	0	0	3
4.	PCC	XBT404	Immunology	3	0	0	3	3	0	0	3
5.	HSMC	XUM405	Economics for Engineers	3	0	0	3	3	0	0	3
6	MC	XUM406	Disaster Management*#	0	0	0	0	2	0	0	2
7	PCC	XBT407	Basic Transport Processes Laboratory	0	0	1	1	0	0	4	4
8	PCC	XBT408	Cell Biology Laboratory	0	0	2	2	0	0	8	8
9	PCC	XBT409	Immunology Laboratory	0	0	1	1	0	0	4	4
			Total	**13**	**2**	**4**	**19**	**15**	**2**	**16**	**33**

Semester V

S.No.	AICTE Code	Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT501	Bioanalytical Tools	3	0	0	3	3	0	0	3
2	PCC	XBT502	Molecular Biology	3	0	0	3	3	0	0	3
3	PCC	XBT503	Bio reaction Engineering	2	1	0	3	3	1	0	4
4	PCC	XBT504	Plant Biotechnology	3	0	0	3	3	0	0	3
5	PEC	XBT505A	Food Biotechnology	3	0	0	3	3	0	0	3
		XBT505B	Agricultural Biotechnology	3	0	0	3	3	0	0	3
		XBT505C	Pharmaceutical Biotechnology	3	0	0	3	3	0	0	3
6	OE	XOE1	Open Elective Courses	3	0	0	3	3	0	0	3
7	PCC	XBT507	Bioanalytical Tools Laboratory	0	0	1	1	0	0	6	6
8	PCC	XBT508	Bio reaction Engineering Laboratory	0	0	2	2	0	0	8	8
9	PROJ	XBT509	In-plant Training - II	-	-	1	1	-	-	2	2
10	PMC	XBTMO1	Minor Course I*#	0	0	0	0	0	0	2	2
			Total	**17**	**1**	**4**	**22**	**18**	**1**	**18**	**37**

Semester VI

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT601	Animal Biotechnology	3	0	0	3	3	0	0	3
2	PCC	XBT602	Process Biotechnology – Upstream	1	1	0	2	1	2	0	3
3	PCC	XBT603	Process Biotechnology – Downstream	1	1	0	2	1	2	0	3
4	PEC	XBT604A	Mass Transfer Fundamentals	3	0	0	3	3	0	0	3
		XBT604B	Fermentation Technology	3	0	0	3	3	0	0	3
		XBT604C	Nanobiotechnology	3	0	0	3	3	0	0	3
5	OE	XBTOE2	Open Elective Courses	3	0	0	3	3	0	0	3
6	HSMC	XGS606	Professional Skills	1	0	2	3	1	0	4	5
7	MC	XUM607	Cyber Security*#	0	0	0	0	3	0	0	3
8	PCC	XBT608	Process Biotechnology Laboratory	0	0	4	4	0	0	8	8
9	PMC	XBTMO2	Minor Course II*#	0	0	0	0	0	0	2	2
			Total	**12**	**2**	**6**	**20**	**15**	**4**	**14**	**33**

Semester VII

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PCC	XBT701	Microbial Biotechnology	3	0	0	3	3	0	0	3
2	PCC	XBT702	Recombinant DNA Technology	3	0	0	3	3	0	0	3
3	PEC	XBT703A	A. Stem Cell Biotechnology	2	1	0	3	2	1	0	3
		XBT703B	B. Cancer Biology	2	1	0	3	2	1	0	3
		XBT703C	C. Design of Bioprocess Equipments	2	1	0	3	2	1	0	3
4	OE	XOE3	Open Elective Courses	3	0	0	3	3	0	0	3
5	MC	XES705	Environmental studies[*#]	0	0	0	0	3	0	0	3
6	PCC	XBT706	Recombinant DNA Technology Laboratory	0	0	2	2	0	0	6	6
7	PCC	XBT707	Bioinformatics	1	0	1	2	1	0	5	6
8	PROJ	XBT708	Project Work (Phase-I)	0	0	2	2	0	0	6	6
9	PROJ	XBT709	In-plant Training – III	-	-	2	2	-	-	2	2
10	PMC	XBTMO3	Minor Course III[*#]	0	0	0	0	0	0	2	2
			Total	**12**	**1**	**7**	**20**	**15**	**1**	**21**	**37**

Semester VIII

S.No.	AICTE Code	Course Code	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1	PEC	XBT801A	A. Introduction to Quantum Biology, AI and Data Science	2	1	0	3	2	1	0	3
		XBT801B	B. Enzyme Engineering	2	1	0	3	2	1	0	3
		XBT801C	C. Bio waste and Bio products Utilization	2	1	0	3	2	1	0	3
2	OE	XOE4	Open Elective Courses	3	0	0	3	3	0	0	3
3	OE	XOE5	Open Elective Courses	3	0	0	3	3	0	0	3
4	PROJ	XBT804	Project Work (Phase-II)	0	0	9	9	0	0	18	18
5	PMC	XBTMO4	Minor Course IV[*#]	0	0	0	0	0	0	2	2
			Total	**8**	**1**	**9**	**18**	**8**	**1**	**20**	**29**

Grant Total Credits: 166

In Plant Training of 30 days in the vacation periods is mandatory to complete the graduation.

LIST OF SKILL ORIENTED MINOR COURSES

Sl no	Category	Name of the Course	Credit
1.	PMC	Training on GC-MS, HPLC	0
2.	PMC	Training on AFM, SEM	0
3.	PMC	Training on PCR and Electrophoresis	0
4.	PMC	MATLAB Basics for Biotechnology researchers	0
5.	PMC	Training on Lab Scale Fermentor	0

LIST OF OPEN ELECTIVE COURSES OFFERED FROM BIOTECHNOLOGY

Sl no	Category	Name of the Course	Credit
1.	OE	Intellectual Property Rights	3
2.	OE	Biosafety Management	3
3.	OE	Digital Health	3

LIST OF VALUE ADDED COURSES SUGGESTED

Sl no	Category	Name of the Course	Components
1.	PMC	R Program and R Studio for Biotechnologist	Employability
2.	PMC	Python for Biotechnologist	Employability
3.	PMC	Training on Hospital's Clinical Research Lab	Research Skill and Employability
4.	PMC	Downstream Manufacturing (Microbial)	Employability

Note

L – Lecture, T – Tutorial, P – Practical, C - Credit

Each faculty made presentation on their suggestions on the courses allotted to them before the Board of studies members.

Summary of the credits and hours

Year	Semester	Total Credits	Total Hours / Week	No. of courses	Value Addition Suggested
I	I	20	25	8	No
	II	22	27	8	No
II	III	25	33	10	Yes
	IV	19	33	9	Yes
III	V	22	35	10	Yes
	VI	20	32	9	Yes
IV	VII	20	35	10	Yes
	VIII	18	29	5	Yes
	I – VIII	**166**	**248**	**69**	

I Semester

COURSE CODE	XMA 101			**L**	**T**	**P**	**C**
COURSE NAME	**Mathematics I (Calculus and Linear Algebra)**			**3**	**1**	**0**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0.5**	**0.5**		**3**	**1**	**0**	**4**

PREREQUISITE: Differentiation and Integration

COURSE OUTCOMES:

Course outcomes:		Domain	Level
CO1	**Apply** the orthogonal transformation to reduce quadratic form to canonical forms.	Cognitive	Remember Apply
CO2	**Apply** power series to tests the convergence of the Sequences and series andHalf range Fourier sine and cosine series.	Cognitive Psychomotor	Remember Apply Guided Response
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian	Cognitive Psychomotor	Remember Guided Response
CO4	**Explain** the functions of two variables by Taylor's expansion, by finding maxima and minima with and without constraints using Lagrangian Method Directional derivatives, Gradient, Curl and	Cognitive	Remember Understand

			Affective	Receive
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.		Cognitive	Apply

UNIT -I	**Matrices**	12
Linear Transformation - Eigen values and Eigen vectors -Properties of Eigen values and Eigen vectors - Cayley-Hamilton Theorem – Diagonalisation of Matrices – Real Matrices: Symmetric - Skew-Symmetric and Orthogonal Quadratic form – canonical form - Nature of Quadratic form and Transformation of Quadratic form to Canonical form (Orthogonal only).		

UNIT -II	**Sequences and series**	12
Sequences: Definition and examples-Series: Types and convergence- Series of positive terms – Tests of convergence: comparison test, Integral test and D'Alembert's ratio test-. Fourier series: Half range sine and cosine series- Parseval's Theorem.		

UNIT -III	**Multivariable Calculus: Partial Differentiation**	12
Limits and continuity –Partial differentiation – Total Derivative – Partial differentiation of Composite Functions: Change of Variables – Differentiation of an Implicit Function - Euler's Theorem- Jacobian.		

UNIT -IV	**Multivariable Calculus: Maxima and Minima and Vector Calculus**	12
Taylor's theorem for function of Two variables- Maxima, Minima of functions of two variables: with and without constraints - Lagrange's Method of Undetermined Multipliers – Directional Derivatives - Gradient, Divergence and Curl.		

UNIT -V	**Differential and Integral Calculus**	12
Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.		

LECTURE	TUTORIAL	TOTAL
45	**15**	**60**

Text Books:
4. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015**. (Unit-1, Unit-3 and Unit-4).**
5. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi **Publications**, Reprint, 2014. **(Unit-2).**
6. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2010. **(Unit-5).**

Reference Books:
5. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
6. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
7. D. Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/Cole, 2005.
8. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

Cos versus GA mapping

		Graduates Attributes											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1		3	2			2					1		2
CO2		3	1								1		1
CO3		3	1								1		1
CO4		3	2								1		1
CO5		3	2			1					1		2

8th BOS/BIOTECH/Date: 19.08.2021

Total	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

CourseCode	:	**XCP102**	L	T	P	C
CourseName	:	**PROGRAMMINGFORPROBLEMSOLVING**	3	0	0	3
Prerequisite	:	**BasicUnderstandingSkills**	L	T	P	H
C	**P**	**A**	3	0	0	3
3	**0**	**0**				

CourseObjectives

- Tolearnprogramminglanguagebasicsand syntax

- Toignite logicalthinking

- Tounderstandstructured programmingapproach

- Todealwith userdefined datatypes

- To knowaboutdatastorage in secondarymemory

CourseOutcome:Afterthecompletionofthecourse, studentswillbe able to	**Domain**	**Level**
CO1	*Define* programming fundamentals and *Solve* simpleprogramsusingI/O statements	Cognitive	Apply
CO2	*Explain simple programs* using controlstructuresandarrays	Cognitive	Understand
CO3	*Explain the simple programs* using functions andpointers	Cognitive	Understand
CO4	*Explain simple programs* using structures andunions	Cognitive	Understand
CO5	*Explain simpleprograms* usingfiles and *Build* simpleprojects	Cognitive	Understand

COURSECONTENT

UNIT-I	**PROGRAMMINGFUNDAMENTALSANDI/OSTATEMENTS**	9

Introduction to componentsofa computersystem,Program–Flowchart –Pseudo code– Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, andOperators – sample program structure -Header files – Data Types- Variables - Output statements –Inputstatements.

UNIT -II	**CONTROLSTRUCTURE ANDARRAYS**	9

ControlStructures–ConditionalControlstatements:Branching,Looping-
Unconditionalcontrolstructures:switch,break,continue,gotostatements–
Arrays:OneDimensionalArray–Declaration
–Initialization–AccessingArrayElements–Searching–Sorting–TwoDimensionalarrays-Declaration–
Initialization–MatrixOperations–MultiDimensionalArrays-Declaration–Initialization.Storage
classes:auto –extern–static.Strings:Basicoperationsonstrings.

UNIT -III	**FUNCTIONS ANDPOINTERS**	9

Functions:Built-infunctions–UserDefinedFunctions-Parameterpassingmethods-
Passingarraystofunctions–Recursion-Programsusingarraysandfunctions.Pointers-
PointerdeclarationAddressoperator-Pointerexpressions&pointerarithmetic-Pointersandfunction-

CallbyvalueCall byReference-Pointertoarrays-UseofPointersitself-referentialstructures-Notionoflinkedlist			
UNIT -IV	**STRUCTURESANDUNIONS**		**9**
StructuresandUnions-Givingvaluestomembers-Initializingstructure-Functionsandstructures -Passingstructuretoelementstofunctions-Passingentire function ofunction's-Arraysofstructure-Structurewithin a structureandUnion.			
UNIT -V	**FILES**		**9**
	FilemanagementinC-FileoperationfunctionsinC-Definingandopeningafile-Closingafile-The get and put functions-The print &scan functions-seekfunction–FilesandStructures.		

L	**T**	**P**	**Total**
45	0	0	45

TEXTBOOKS

3. ByronGottfried,"ProgrammingwithC",IIIEdition,(IndianAdaptedEdition),TMHpublications,2010

4. YeshwantKanethker, "LetusC",BPBPublications,2008

REFERENCEBOOKS

4. E.Balaguruswamy, ProgramminginANSIC,TataMcGraw-Hill,7thedition2017.

5. BrianW.Kernighanand

   DennisM.Ritchie,"TheCProgrammingLanguage",PearsonEducationInc.2005

6. JohnsonbaughR.andKalinM.,"ApplicationsProgramminginANSIC", IIIEdition,Pearson EducationIndia,2003

E-REFERENCES

4. https://www.indiabix.com/c-programming/questions-and-answers/
5. https://www.javatpoint.com/c-programming-language-tutorial

6. https://www.w3schools.in/c-tutorial/

Mapping of CO's with PO:

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue	3	2	1	1	3	0	0	1	0	1	2	3	2	0
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	XAP103	L	T	P	C
COURSE NAME	APPLIED PHYSICS FOR ENGINEERS	3	1	0	4
C:P:A	2.8:0.8:0.4	L	T	P	H
PREREQUISITE:	Basic Physics in HSC level	3	1	0	4

COURSE OUTCOMES		Domain	Level
CO1	*Identify* the basics of mechanics, *explain* the principles of elasticity and *determine* its significance in engineering systems and technological advances.	Cognitive: Psychomotor :	Remember, Understand Mechanism
CO2	*Illustrate* the laws of electrostatics, magneto-statics and electromagnetic induction; *use* and *locate* basic applications of electromagnetic induction to technology.	Cognitive: Psychomotor : Affective:	Remember, Analyze, Mechanism Respond
CO3	*Understand* the fundamental phenomena in optics by measurement and *describe* the working principle and application of various lasers and fibre optics.	Cognitive: Psychomotor : Affective:	Understand, Apply Mechanism Receive
CO4	*Analyse* energy bands in solids, *discuss* and *use* physics principles of latest technology using semiconductor devices.	Cognitive: Psychomotor : Affective:	Understand, Analyze Mechanism Receive
CO5	*Develop* Knowledge on particle duality and *solve* Schrodinger equation for simple potential.	Cognitive:	Understand, Apply

UNIT - I MECHANICS OF SOLIDS				**9+3**

Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction.

Elasticity: Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending.

UNIT -II ELECTROMAGNETIC THEORY				**9+3**

Laws of electrostatics - Electrostatic field and potential of a dipole; Dielectric Polarisation, Dielectric constant, internal field – ClausiusMossotti Equation - Laws of magnetism - Ampere's Faraday's law; Lenz's law - Maxwell's equation - Plane electromagnetic waves; their transverse nature - expression for plane, circularly and elliptically polarized light - quarter and half wave plates - production and detection of plane, circularly and elliptically polarized light.

UNIT –III OPTICS, LASERS AND FIBRE OPTICS				**9+3**

Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating.

LASER: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser - Applications

Fibre Optics: Principle and propagation of light in optical fibre - Numerical aperture and acceptance angle - Types of optical fibre - Fibre optic communication system (Block diagram).

UNIT –IV SEMICONDUCTOR PHYSICS				**9+3**

Semiconductors: Energy bands in solids - Energy band diagram of good conductors, insulators and semiconductors - Concept of Fermi level - Intrinsic semiconductors - Concept of holes - doping - Extrinsic semiconductors - P type and N type semiconductors - Hall effect.

Diodes and Transistors: P-N junction diode - Forward bias and reverse bias - Rectification action of diode - Working of full wave rectifier using P N junction diodes - PNP and NPN transistors - Three different

configurations - Advantages of common emitter configuration - working of NPN transistor as an amplifier in common emitter configuration.

UNIT –V QUANTUM PHYSICS	9+3

Introduction to quantum physics, black body radiation, Compton effect, de Broglie hypothesis, wave – particle duality, uncertainty principle, Schrodinger wave equation (Time dependent and Time independent), particle in a box, Extension to three dimension - Degeneracy.

TEXT BOOKS

1. Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publications, 2009.
2. Avadhanulu M. N. "Engineering Physics" (Volume I and II), S. Chand & Company Ltd., New Delhi, 2010.

REFERENCE BOOKS

1. Palanisamy P. K., "Engineering Physics", Scitech Publications (India) Pvt. Ltd, Chennai.
2. Arumugam M., "Engineering Physics" (Volume I and II), Anuradha Publishers, 2010.
3. Senthil Kumar G., "Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers, Chennai, 2011.
4. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2007.

E RESOURCES

NPTEL , Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**45**	**15**	**-**	**60**

Mapping of CO's with PO:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
CO5	3		2			-	-	-		-	-	1		
CO6														
Total	15	6	9	6	4				3			5		
ScaledValue	3	2	2	2	1	-	-	-	1	-	-	1		
$1 – 5 \rightarrow 1$, $\quad 6 – 10 \rightarrow 2$, $\quad 11 – 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT104			BIOLOGY FOR ENGINEERS	`L	T	P	C
C	**P**	**A**		**3**	**0**	**0**	**3**
3	**0**	**0**		**L**	**T**	**P**	**H**
				3	**0**	**0**	**3**

Course outcome		Domain	Level
CO1	***Describe*** how biological observations of 18th Century that lead to major discoveries.	Cognitive	Understand
CO2	***Explain*** the cell morphology and their functions	Cognitive	Understand
CO3	***Explain*** the Human anatomy and Physiology	Cognitive	Understand
CO4	**Recall** the types of Tissue and its functions	Cognitive	Understand
CO5	**Illustrate** the essential of Amino Acids DNA/RNA	Cognitive	Understand

UNIT I	**Introduction**	6
	Fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. - Why we need to study biology? - Biological observations of 18th Century that lead to major discoveries. - Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor.	
UNIT II	**Cell Biology**	9
	Introduction to the cell biology – Cell size and shape - Chemical composition -Classification of cell and its properties; structure of Cell membrane and cellular organelles; Cell cycle; Cell signaling, Transport across cell membrane	
UNIT III	**Human physiology and anatomy**	9
	Introduction to Human Anatomy and Physiology-Anatomical Terminology; Structural Organization of the Human Body-Skin and the Integumentary System- Skeletal System-Muscular Systems -Nervous System-Cardiovascular System -Lymphatic and Immune System-Respiratory System- Digestive System -Urinary System	
UNIT IV	**Biomolecules**	9
	Molecules of life - Monomeric units and polymeric structures - Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	
UNIT V	**Modern Applications from Biological Sciences**	12
	Principles and Application of Biosensor; Basics of Biochips – Bio fertilizer – Bioinformatics – Bio fuel – Introduction to Bio mechanics - Neural Network: Artificial Intelligence (AI) - Stem Cell; Introduction to Genetics; Genetic Engineering and its Application, Biosafety Hazardous Effect.	

LECTURE	TUTORIAL	TOTAL
45	**0**	**45**

Text Books:

3. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd

4. Dr. Sohini Singh and Dr. Tanu Allen, "Biology for Engineers", Vayu Education of India, New Delhi, 2014.

References Books:
6. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
7. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
8. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
9. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers
10. Biology for Engineers (ISBN: 9781121439931), TMH

Online References:
4. www.bio12.com/ch3/RaycroftNotes.pdf
5. www.engineering.uiowa.edu/bme050/cvb-solids.pdf
6. www.biologyjunction.com/mendelian_genetics.html

Mapping Of Course Outcomes with Program Outcomes

		PROGRAM OUTCOMES												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1		3	3	2	2	3	1	2	1	2	2	3	0	1	1
CO2		2	3	2	2	3	2	2	1	1	2	3	1	1	1
CO3		2	2	1	1	3	2	2	1	1	2	3	1	0	1
CO4		3	2	1	2	3	2	2	1	1	2	3	0	1	1
CO5		3	3	2	3	3	2	3	1	1	2	3	0	1	2
Original Value		14	14	9	11	17	10	12	6	7	10	16	3	5	7
Scaled Value		**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**2**
$1 - 5 \rightarrow 1, \quad 6 - 10 \rightarrow 2, \quad 11 - 15 \rightarrow 3$															
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation															

XGS105			Speech Communication		L	T	P	SS	C
					0	0	3	0	3
C	P	A			L	T	P	SS	H
2.6	0.4	0			0	0	3	0	3

Course Outcomes : After completion of the course, students will be able to		Domain	Level
CO1	Ability to recall the types of speeches	Cognitive	Remember
CO2	Apply the techniques in public speaking	Cognitive	Apply
CO3	Identify the common patterns in organizing a speech	Cognitive	Remember
CO4	Construct the nature and style of speaking	Cognitive	Create
CO5	Practicing the speaking skills	Psychomotor	Guided Response

UNIT-I	Types of Speeches	9

1.1 – Four types of speeches- 1.2 – Analyzing the audience-1.3 - Developing ideas and supporting materials

UNIT –II	Public Speaking	9

2.1 - Introduction to Public Speaking
2.2 - Competencies Needed for successful speech making
2.3 – Speaking about everyday life situations

UNIT-III	Organization of Speech	9

3.1 – Developing a speech out line - 3.2 - Organizing the speech- 3.3 – Introduction - development – conclusion

UNIT-IV	Presentation	9

4.1 - Tips for preparing the draft speech
4.2 – Presentation techniques using ICT tools
4.3 – Using examples from different sources

UNIT-V	Activities	9

5.1 – Reading activities -5.2 – Creative presentations -5.3 – Media presentation techniques

LECTURE	TUTORIAL	PRACTICAL	TOTAL
0	0	45	45

Suggested Readings: (i) Michael Swan. *Practical English Usage*. OUP. 1995
(ii) Sanjay Kumar and Pushp Lata. *Communication Skills*. Oxford University Press. 2011

Mapping Of Course Outcomes with Program Outcomes

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO2	2	0	0	0	0	0	2	0	1	0	0	0	0	0
CO3	1	0	0	0	0	0	1	0	1	0	0	0	0	0
CO4	2	0	0	0	0	0	1	0	1	0	0	0	0	0
CO5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	7	0	0	0	0	0	6	0	4	0	0	0	0	0
ScaledValue	2	0	0	0	0	0	2	0	1	0	0	0	0	0
$1 – 5 \rightarrow 1$, $\qquad$ $6 – 10 \rightarrow 2$, $\qquad$ $11 – 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XUM 106			CONSTITUTION OF INDIA	L	T	P	C
				0	0	0	0
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Course Outcomes : After completion of the course, students will be able to		Domain	Level
CO1	**Study** History of Constitution.	Cognitive	Understand
CO2	**Explain** the Union Executive	Cognitive	Understand
CO3	**Identify** the concept of Union Legislature	Cognitive	Understand
CO4	**Analysis** the Union Judiciary	Cognitive	Analyse
CO5	**Explain** the Centre State Relation	Cognitive	Understand

Course Content	Hours
UNIT-I	9
Constitutional History- The Constitutional Rights- Preamble- Fundamental Rights- Fundamental Duties- Directive principles of State Policy.	
UNIT –II	9
The Union Executive- The President of India (powers and functions)- Vice-President of India-The Council of Ministers-Prime Minister- Powers and Functions.	
UNIT-III	9
Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committees of Lok Sabha- Speaker of the Lok Sabha.	
UNIT-IV	9
The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction- Appelete jurisdictions- Advisory Jurisdiction- Judicial review.	
UNIT-V	9
Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-Legislative Assembly- State Judiciary- Powers and Functions of the High Courts.	

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

REFERENCES:
1. W.H.Morris Shores- Government and politics of India, NewDelhi, B.1.Publishers, 1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House, 1977.
3. R.Thanker- The Government and politics of India, London:Macmillon, 1995.
4. B.C.Rout- Democractic Constitution of India.
5. Gopal K.Puri- Constitution of India, India 2005.

Mapping Of Course Outcomes with Program Outcomes

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	0	0	1	0	0	0	0	0	0	0	0	0	0
CO2	2	0	0	1	0	0	0	0	0	0	0	0	0	0
CO3	2	0	0	1	0	0	0	0	1	0	0	0	0	0
CO4	2	0	0	1	0	0	0	1	1	0	0	0	0	0
CO5	2	2	0	1	0	0	0	1	1	0	0	0	0	0
Total	10	2	0	5	0	0	0	2	3	0	0	0	0	0
Scaled value	2	1	0	1	0	0	0	1	1	0	0	0	0	0

1 – 5 → 1,   6 – 10 → 2,   11 – 15 → 3
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSECODE	XCP107	L	T	P	C
COURSENAME	**Programming For ProblemSolvingLaboratory**	0	0	1	1
PREREQUISITES	BasicUnderstandingSkills	L	T	P	H

C	P	A		L	T	P	H
0.75	1	0.25		0	0	2	3

LEARNINGOBJECTIVES

- Tolearnprogramminglanguagebasicsand syntax
- Toignitelogicalthinking
- Tounderstandstructured programmingapproach
- Todealwithuserdefined datatypes
- To knowaboutdatastorage in secondarymemory

COURSEOUTCOMES		DOMAIN	LEVEL
CO1	*Solve*simpleprograms using I/Ostatements	Cognitive Psycomotor	Apply Respond
CO2	*Solve*programs usingcontrolstructuresandarrays	Cognitive Psycomotor	Apply Respond
CO3	*Solve*programs usingfunctionsandpointers	Cognitive Psycomotor	Apply Respond
CO4	*Solve*programs usingstructures	Cognitive Psycomotor	Apply Respond
CO5	*Solve*programs usingfiles	Cognitive Psycomotor	Apply Respond

S.No.	ListofExperiments	COs
1	ProgramtodisplayaLeave Letterasperproperformat	CO1
2	iii. Programforaddition oftwonumbers iv. Programtosolveanymathematicalformula.	CO1
3	Programtofindgreatestof3numbersusingBranchingStatements	CO2
4	Programtodisplaydivisiblenumbersbetweenn1andn2usinglooping Statement	CO2
5	Programtosearchanarrayelementinanarray.	CO2
6	Programtofindlargest/smallestelementinanarray.	CO2
7	Programtoperformstringoperations.	CO3
8	Programtofind areaof a rectangle ofagiven numberuse fourfunction types.	CO3
9	Programstopassandreceivearrayandpointersusingfourfunction types	CO3
10	ProgramsusingRecursion forfindingfactorial ofanumber	CO3
11	Programtoreadanddisplaystudentmarksheetofastudentstructures Withvariables	CO4

12	Programtoreadanddisplaystudentmarksofaclassusingstructures Witharrays	CO4
13	Programtocreatelinked listusingstructureswithpointers	CO4
14	Programforcopyingcontents ofonefileto anotherfile.	CO5
15	Programusingfilestostoreanddisplaystudentmarklistofaclass using Structureswith array	CO5

HOURS	TUTORIAL	PRACTICAL	TOTAL
	0	30	30

MappingofCOwithPO's

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue	3	2	1	1	3	0	0	1	0	1	2	3	2	0
$1 - 5 \rightarrow 1$,					$6 - 10 \rightarrow 2$,					$11 - 15 \rightarrow 3$				
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	XAP108	L	T	P	C
COURSE NAME	**APPLIED PHYSICS FOR ENGINEERS LABORATORY**	0	0	2	2
C:P:A	0:2:0	L	T	P	H
PREREQUISITE:	**Basic Physics in HSC level**	0	0	3	3

COURSE OUTCOMES		Domain	Level
CO1	*Determine* the significance of elasticity in engineering systems and technological advances.	Psychomotor:	Mechanism
CO2	*use* and *locate*basic applications of electromagnetic induction to technology.	Psychomotor: Affective:	Mechanism Respond
CO3	*Describe* the working principle and application of various lasers and fibre optics.	Psychomotor:	Mechanism
CO4	*use* physics principles of latest technology using semiconductor devices.	Psychomotor:	Mechanism

LABORATORY	
1.	Torsional Pendulum - determination of moment of inertia and rigidity modulus of the given material of the wire.
2.	Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3.	Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4.	Meter Bridge - Determination of specific resistance of the material of the wire.
5.	Spectrometer - Determination of dispersive power of the give prism.

6.	Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7.	Air wedge - Determination of thickness of a given thin wire.
8.	Laser - Determination of wavelength of given laser source and size of the given micro particle using Laser grating.
9.	Post office Box - Determination of band gap of a given semiconductor.
10.	PN Junction Diode - Determination of V-I characteristics of the given diode.

REFERENCE BOOKS:
4. Samir Kumar Ghosh, "A text book of Advanced Practical Physics", New Central Agency (P) Ltd, 2008.
5. Arora C.L., "Practical Physics", S. Chand & Company Ltd., New Delhi, 2013.
6. UmayalSundari AR., "Applied Physics Laboratory Manual", PMU Press, Thanjavur, 2012.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**0**	**0**	**30**	**30**

Mapping Of Course Outcomes with Program Outcomes

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
Total	12	6	7	6	4				3			5		
ScaledValue	3	2	2	2	1				1			1		
$1-5 \rightarrow 1$, $\qquad 6-10 \rightarrow 2$, $\qquad 11-15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

II Semester

COURSE CODE			COURSE NAME	L	T	P	C
XMA201			**Calculus, Ordinary Differential Equations and Complex Variable**	**3**	**1**	**0**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0.5**	**0.5**		**3**	**1**	**0**	**4**

PREREQUISITE: Mathematics I (Calculus and Linear Algebra)

COURSE OUTCOMES:

Course outcomes:		Domain	Level
CO1	**Find** double and triple integrals and to find line, surface and volume of an integral by **Applying** Greens, Gauss divergence and Stokes theorem.	Cognitive	Apply Remember
CO2	**Solve** first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	Cognitive	Apply
CO3	**Solve** Second order ordinary differential equations with variable coefficients using various methods.	Cognitive	Apply
CO4	**Use** CR equations to verify analytic functions and to find harmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	Cognitive Psychomo	Remember Apply Guided

		tor	Response
CO5	**Apply** Cauchy residue theorem to evaluate contour integrals involving sine and cosine function and to state Cauchy integral formula, Liouvilles theorem.	Cognitive	Apply
	Taylor's series, zeros of analytic functions, singularities, Laurent's series.	Affective	Receive

Unit -I	**Multivariable Calculus (Integration)**	12

Multiple Integration: Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Triple integrals (Cartesian), Scalar line integrals - vector line integrals - scalar surface integrals - vector surface integrals - Theorems of Green, Gauss and Stokes.

Unit -II	**First order ordinary differential equations**	12

Exact - linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p - equations solvable for y- equations solvable for x and Clairaut's type.

Unit -III	**Ordinary differential equations of higher orders**	12

Second order linear differential equations with variable coefficients- method of variation of parameters - Cauchy-Euler equation- Power series solutions- Legendre polynomials- Bessel functions of the first kind and their properties

Unit -IV	**Complex Variable – Differentiation**	12

Differentiation-Cauchy-Riemann equations- analytic functions-harmonic functions-finding harmonic conjugate- elementary analytic functions (exponential, trigonometric, logarithm) and their properties- Conformal mappings- Mobius transformations and their properties

Unit -V	**Complex Variable – Integration**	12

Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof)- Liouville's theorem (without proof)- Taylor's series- zeros of analytic functions- singularities- Laurent's series – Residues- Cauchy Residue theorem (without proof)- Evaluation of definite integral involving sine and cosine- Evaluation of certain improper integrals using the Bromwich contour.

LECTURE	TUTORIAL	TOTAL
45	15	60

Text Book: B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th[th] Edition, 2008.

Reference Books:
1.G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
3.W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 9[th]Edn. Wiley India, 2009.
4. S. L. Ross, "Differential Equations", 3rd Ed., Wiley India, 1984.
5.E. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
6. E. L. Ince, "Ordinary Differential Equations", Dover Publications, 1958.
7.J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., McGraw Hill, 2004.
8. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.

Cos versus GA mapping

	Graduates Attributes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2			2					1		2
CO2	3	1								1		1
CO3	3	1								1		1
CO4	3	2								1		1
CO5	3	2			1					1		2
Total	15	8	0	0	3	0	0	0	0	5	0	7
Scaled Value	3	2			1					1		

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation
$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$

COURSE CODE	COURSE NAME			L	T	P	C
XBE202	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS**			**3**	**1**	**0**	**4**
Prerequisites	**Physics**			**L**	**T**	**P**	**H**
C:P: A	**3:0:0**			**3**	1	**0**	**4**

Course Outcomes		Domain		Level
CO1	**Relate** the fundamentals of electrical parameters and **build** and **explain** AC, DC circuits by Using measuring devices	Cognitive		Understand
CO2	**Explain** the operation of DC and AC machines.	Cognitive		Understand
CO3	**Illustrate** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.	Cognitive		Understand
CO4	**Explain the** number systems and logic gates. **Construc**t the different digital circuit.	Cognitive		Understand
CO5	**Outline the** different types of microprocessors and their applications.	Cognitive		Understand

UNIT-I: FUNDAMENTALS OF DC AND AC CIRCUITS, MEASUREMENTS	**9+3**

Fundamentals of DC– Ohm's Law – Kirchhoff's Laws - Sources - Voltage and Current Relations – Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities - Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).

UNIT -II: ELECTRICAL MACHINES	**9 + 3**

Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single-Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single-Phase Transformer, Three phase transformers, Auto transformer.

UNIT- III: SEMICONDUCTOR DEVICES	9 + 3

Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications.

UNIT- IV: DIGITAL ELECTRONICS	9 + 3

Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subtractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.

UNIT- V: MICROPROCESSORS	9+ 3

Architecture, 8085, pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, Instruction types, classification of instructions, addressing modes, Interfacing Basics: Data transfer concepts – Simple Programming concepts.

LECTURE	TUTORIAL	TOTAL
45	15	60

TEXT BOOKS

1. Metha V.K, Rohit Mehta, 2020. Principles of Electronics,12th ed, S Chand Publishing.
2. Albert Malvino, David J.Bates., 2017. Electronics Principles. 7th ed, Tata McGraw-Hill. New Delhi.
3. Rajakamal, 2014. Digital System-Principle & Design. 2nd ed. Pearson education.
4. Morris Mano, 2015. Digital Design. Prentice Hall of India.
5. Ramesh, S. Gaonkar, 2013, Microprocessor Architecture, Programming and its Applications with the 8085, 6th ed , India: Penram International Publications.

REFERENCE BOOKS

1. Corton, H.,2004 Electrical Technology. CBS Publishers & Distributors.
2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.
3. Jacob Millman and Christos, C. Halkias, 1967, Electronics Devices, New Delhi: McGraw-Hill.
4. Millman, J. and Halkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and Systems, Tokyo: McGraw-Hill, Kogakusha Ltd.
5. Mohammed Rafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E-REFERENCES

1. NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya and Prof. G.D. Roy, IIT Kharagpur.
2. Prof.L.Umanand, http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.
3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura, IIT Madras.
4. Dr.L.Umanand, http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Bangalore.

Mapping of COs with Pos

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	1	1	1	1			1	1	1		3	**3**
CO2	3	3	1	1	1	1			1	1	1		3	**3**
CO3	2	2	2	1	2	2	1	1	1	1	1		3	**3**
CO4	2	2	1	1	1	1	1	1	1	1	1		3	**3**
CO5	2	2	1	1	1	1	1	1	1	1	1		3	**3**
Total	12	12	6	5	6	6	3	3	5	5	5		15	15
ScaledValue	3	3	2	1	2	2	1	1	1	1	1		5	5
$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	XAC203		**L**	**T**	**P**	**C**
COURSE NAME	**Applied Chemistry For Engineers**		**3**	**1**	**0**	**4**
PREREQUISITES	**Nil**		**L**	**T**	**P**	**H**
C:P:A	**3.5:1.0:0.5**		**3**	**1**	**0**	**4**

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Identify* the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. *Describe* the various water quality parameters like hardness and alkalinity.	Cognitive	Understand
CO2	*Explain* and *Measure* microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	Cognitive Psychomotor	Understand Set
CO3	*Interpret* bulk properties and processes using thermodynamic and kinetic considerations.	Cognitive Psychomotor	Apply Mechanism
CO4	*Describe, Illustrate* and *Discuss* the chemical reactions that are used in the synthesis of molecules.	Cognitive	Understand Analyze
CO5	*Apply, Measure* and *Distinguish* the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	Cognitive Psychomotor	Remember Apply Mechanism

UNIT – I	PERIODIC PROPERTIES AND WATER CHEMISTRY	8+3
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries. **Water Chemistry**-Water quality parameters, Definition and explanation of hardness, determination of hardness by EDTA method-Introduction to alkalinity.		

UNIT–II	USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA	12+3	

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion-Types, factors affecting corrosion rate and Control methods. Use of free energy considerations in metallurgy through Ellingham diagrams. Advantages of electroless plating, electroless plating of nickel and copper on Printed Circuit Board (PCB).

UNIT–III	ATOMIC AND MOLECULAR STRUCTURE	10+3	

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles.. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Intermolecular forces and potential energy surfaces

Ionic, dipolar and Vander waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

UNIT-IV	SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	7+3	

Principles of spectroscopy and selection rules. Electronic spectroscopy-chromophore, auxochromes, types of electronic transition and application. Fluorescence and its applications in medicine. Vibrational spectroscopy-types of vibrations, Instrumentation and applications. Rotational spectroscopy of diatomic molecules. Nuclear magnetic resonance spectroscopy-concept of chemical shift and applications-magnetic resonance imaging. Diffraction and scattering.

UNIT–V	STEREOCHEMISTRY AND ORGANIC REACTIONS	8+3	

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization reactions and ring opening reactions. Synthesis of a commonly used drug molecule-Aspirin and paracetamol.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS	
Hours	45	15	0	60	

TEXT BOOKS

9. Puri B.R. Sharma, L.R., Kalia K.K. Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993

10. Lee. J.D. Concise Inorganic Chemistry, UK, Black well science, 2006.

11. Trapp. C, Cady, M. Giunta. C, Atkins's Physical Chemistry, 10th Edition, Oxford publishers, 2014.

12. Glasstone S., Lewis D., Elements of Physical Chemistry, London, Mac Millan & Co. Ltd, 1983.

13. Morrison R.T. and Boyd R.N. Organic Chemistry (6th edition), New York, Allyn & Bacon Ltd., 1976.

14. Banwell. C.N, Fundamentals of Molecular Spectroscopy, (3th Edition), McGraw-Hill Book Company, Europe 1983.

15. Bahl B.S. and Arun Bahl, Advanced Organic Chemistry, (4th edition), S./ Chand & Company Ltd. New Delhi, 1977.

16. P. S. Kalsi, Stereochemistry: Conformation and mechanism, (9th Edition), New Age International Publishers, 2017.

REFERENCE BOOKS

2. Puri B R Sharma L R and Madan S Pathania, " Principles of Physical Chemistry", Vishal publishing Co., Edition 2004

2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000

E Resources - MOOCs:

7. http://www.mooc-list.com/course/chemistry-minor-saylororg
8. https://www.canvas.net/courses/exploring-chemistry
9. http://freevideolectures.com/Course/2263/Engineering-Chemistry-I
10. http://freevideolectures.com/Course/3001/Chemistry-I
11. http://freevideolectures.com/Course/3167/Chemistry-II
12. http://ocw.mit.edu/courses/chemistry/

Mapping of CO's with PO's:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO4	3	0	0	0	0	0	3	3	3	0	0	0	0	0
CO5	3	0	0	0	0	0	2	2	3	0	0	0	0	0
Total	**14**	**0**	**0**	**0**	**0**	**0**	**10**	**13**	**14**	**0**	**0**	**0**	**0**	**0**
ScaledValue	**3**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**3**	**0**	**0**	**0**	**0**	**0**
$1-5 \rightarrow 1$, $\qquad$ $6-10 \rightarrow 2$, $\qquad$ $11-15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XGS204	Technical Communication	L	T	P	SS	C
		2	0	0	0	2

C	P	A		L	T	P	SS	H
3	0	0		2	0	0	0	2

Course Outcomes		Domain	Level

After completion of the course, students will be able to

CO1	**Associate** the basic principles of Technical writing.	Cognitive	Understand
CO2	**Identity** the Special techniques in writing.	Cognitive	Apply
CO3	**Explain** the communicative styles of writing.	Cognitive	Evaluate
CO4	**Classify** thenature of Report writing.	Cognitive	Understand

Course Content		Hours
UNIT-I	**Basic Principles**	**8**

1.1 – Basic Principles of Technical Writing
1.2 – Styles used in Technical Writing
1.3 – Language and Tone

UNIT –II	**Techniques**	**8**

2.1 – Special Techniques used in writing
2.2 – Definition & Description of mechanism2.3 – Description- Classification-Interpretation

UNIT-III	**Communication**	**7**

3.1 – Modern development in style of writing3.2 - New letter writing formats

UNIT-IV	**Report writing**	**7**

4.1 – Types of Report writing 4.2 – Project writing formats

LECTURE	TUTORIAL	PRACTICAL	TOTAL
30	**0**	**0**	**30**

TEXT BOOKS: Suggested Readings:
   (iii)   John Sealy, Writing and Speaking Author; Oxford University Press, New Delhi, 2009
   (iv)   Williams K.S, Communicating Business. Engage Learning India Pvt Ltd, 2012

Mapping of COs with POs

		PROGRAM OUTCOMES												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1		3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2		3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3		2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4		2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5		2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total		12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue		3	2	1	1	3	0	0	1	0	1	2	3	2	0
	1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
	0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE			COURSE NAME	L	T	P	C
XWP205			Workshop Practices	1	0	2	3
C	P	A		L	T	P	H
1.0	2.0	0		1	0	3	4

PRE REQUISITE: NIL

Course outcomes:		Domain	Level
CO1:	*Summarize* the machining methods and *Practice* machining operation.	Cognitive Psychomotor	Understand Guided response
CO2:	*Defining* metal casting process, moulding methods and **relates** Casting and Smithy applications.	Cognitive Psychomotor	Remember Perception
CO3:	*Plan* basic carpentry and fitting operation and *Practice* carpentry and fitting operations.	Cognitive Psychomotor	ApplyGuided response
CO4:	*Summarize* metal joining operation and *Practice* welding operation.	Cognitive Psychomotor	Understand Guided response
CO5:	*Illustrate* the, electrical and electronics basics and *Makes* appropriate electrical connections**.**	Cognitive Psychomotor	Understand Remember Guided response

COURSE CONTENT

EXP.NO	TITLE	CO RELATION
1	Introduction to machining process	CO1
2	Plain turning using lathe operation	CO1
3	Introduction about CNC machining and machines	CO1
4	Demonstration of plain turning using CNC	CO1
5	Study of metal casting operation	CO2
6	Demonstration of moulding process	CO2
7	Study of smithy operation	CO2
8	Study of carpentry tools	CO3
9	Half lap joint – Carpentry	CO3
10	Mortise and Tenon joint – Carpentry	CO3
11	Study of fitting tools	CO3
12	Square fitting	CO3
13	Triangular fitting	CO3
14	Study of welding tools	CO4
15	Square butt joint - welding	CO4
16	Tee joint – Welding	CO4
17	Introduction to house wiring	CO5
18	One lamp controlled by one switch	CO5
19	Two lamps controlled by single switch	CO5
20	Staircase wiring	CO5

TEXT BOOKS

1. Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay
2. Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.

REFERENCES
1. Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.
2. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi
3. Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.
4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.
E RESOURCES **http://nptel.ac.in/courses/112107145/**

Mapping of CO's with PO'S:

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO2	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO3	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO4	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO5	2	1	1	1	1	1	-	1	1	-	1	2	0	0
Total	10	5	5	5	5	5	-	5	5	-	5	10	0	0
ScaledValue	2	1	1	1	1	1	-	1	1	-	1	2	0	0
$1 – 5 \rightarrow 1,$ $\quad\quad 6 – 10 \rightarrow 2,$ $\quad\quad 11 – 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT206			CHEMICAL ENGINEERING THERMODYNAMICS		**L**	**T**	**P**	**C**
					2	**1**	**0**	**3**
C	**P**	**A**			**L**	**T**	**P**	**H**
3	**0**	**0**			**2**	**1**	**0**	**3**

Course Outcomes	Domain	Level
After completion of the course, students will be able to		
CO1	**State** the basic laws of thermodynamics and the fundamentals of thermodynamics.	Cognitive	Remember Understand
CO2	**Interpret** the PVT relationship for various systems.	Cognitive	Interpretation
CO3	**Estimate** the thermodynamic relations and the thermodynamic properties.	Cognitive	Remember Understand
CO4	**Apply** the phase equilibrium in various systems like miscible and immiscible systems.	Cognitive	Apply
CO5	**Knows** the chemical equilibrium for industrial reactions	Cognitive	Remember Understand

Course Content	Hours
UNIT-I **Fundamentals Of Thermodynamics**	**6+3**
Definitions of System, Surroundings and Processes, Open and Closed systems, State properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase Rule,	

Reversible and Irreversible processes, Overall view on laws of thermodynamics.	

UNIT –II	**PVT Relationships for Gases and Liquids**	**6+3**

PVT behaviour of pure fluids-Equations of state and the concept of ideal gas –Processes involving ideal gases – Equation of state for real gases -Compressibility charts –heat effects on chemical reactions.

UNIT-III	**Solution Thermodynamics**	**6+3**

Classification of thermodynamic properties –relationship on thermodynamic properties – method of Jacobians – Fugacity – properties of solution – chemical potential – Effect of temperature and pressure on chemical potential - fugacity in solutions –Activity in solutions – heat effects of mixing processes.

UNIT-IV	**Phase Equilibria**	**6+3**

Criteria of phase equilibria, phase equilibria in multi-component systems, phase rule for nonreacting systems, Vapour-Liquid Equilibria, P-xy, T-xy and VLE for ideal systems; Bubble and Dew Point for ideal binary or ternary component systems, Non-Ideal solutions: azeotropes, Calculation of activity coefficients using Van laar and Margules equation and azeotropic data - Liquid-Liquid Equilibrium diagrams.

UNIT-V	**Reaction Equilibria**	**6+3**

Reaction stoichiometry – Criteria of chemical Reaction Equilibrium – Equilibrium Constant – Equilibrium constant and standard free Energy change – Effect of temperature on equilibrium constant – Effect of pressure on equilibrium – Factors affecting equilibrium conversion - Liquid phase reactions – Ligand binding – Membrane potential – Energetics of metabolic pathways, Oxidation and reduction reactions.

LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
30	**15**		**45**

TEXT BOOKS:

3. Narayanan K.V.A textbook of Chemical Engineering Thermodynamics'', PHI 2006.
4. Smith, J.M., Van Ness HC and Abbott MM.2005. Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw-Hill International Edition,2005

REFERENCES:

4. S.I.Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Edition, Wiley India, 2006.
5. Rao., Y.V.C., Chemical engineering Thermodynamics, University Press, Hyderabad, 2005.
6. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.

EREFERENCES: ThermodynamicsofBiomolecularSystems:
http://ocw.mit.edu/courses/biologicalengineering/20-110j-thermodynamics-of-biomolecular-systems-fall-2005/

Mapping of COs with POs

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
						PROGRAM OUTCOMES								
CO1	3	2	0	0	0	0	0	0	0	0	2	2	0	2
CO2	3	3	2	2	1	0	2	0	0	0	2	2	3	2
CO3	3	3	2	2	1	0	2	0	0	0	2	2	3	2
CO4	3	3	2	3	1	1	2	0	0	0	2	2	2	2
CO5	3	3	3	3	1	1	2	1	1	0	2	3	3	3
	1	1	1		1	1		1			1	1	1	1
Total	16	15	10	10	5	3	8	2	1	0	11	12	12	12
ScaledValue	3	3	2	2	1	1	2	1	1	0	3	3	3	3
$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	COURSE NAME	L	T	P	C
XBE207	**ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS LABORATORY**	**0**	**0**	**1**	**1**
Prerequisite	**Physics**	**L**	**T**	**P**	**H**
C : P : A	**1.5 : 1 : 0.5**	**0**	**0**	**3**	**3**

COURSE OBJECTIVES:

The course helps toLearn the basic concepts of electrical and electronics components.
- d. Understand the basic wiring methods and connection.
- e. Study the characteristics of diodes, Zener diodes, NPN transistors.
- f. Verify the working of simple logic gates, adders and subtractors.

Course Outcomes:		Domain	Level
CO1	**Apply** the fundamental electrical concepts and **differentiate** the various electronic components.	Cognitive Psychomotor Affective	Understand Set Valuing
CO2	**Implement** and **execute** the different types of wiring connections.	Cognitive Psychomotor Affective	Understand Set Valuing
CO3	**Demonstrate** the Fluorescent lamp connection with choke.	Cognitive Psychomotor Affective	Understand Set Valuing
CO4	**Characterize** and **display** the basic knowledge on the working of PN junction and Zener diode.	Cognitive Psychomotor Affective	Understand Set Valuing
CO5	**Implement** and **execute** the various digital electronic circuits such as Adders and Subtractors.	Cognitive Psychomotor Affective	Understand Set Valuing

List of Experiments:

11. Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.
12. Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
13. Testing of DC Voltage and Current in series and parallel resistors which are connected in breadboard by using Voltmeter, Ammeter and Multimeter.
14. Fluorescent lamp connection with choke.
15. Staircase Wiring
16. Forward and Reverse bias characteristics of PN junction diode.
17. Forward and Reverse bias characteristics of zener diode.
18. Input and Output Characteristics of NPN transistor.
19. Construction and verification of simple logic gates.
20. Construction and verification of adders and subtractors.

	PRACTICAL	TOTAL
	30	30

Cos versus GA mapping

		Graduates Attributes										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	1	1	1	1			1	1	1	
CO2	3	3	1	1	1	1			1	1	1	
CO3	2	2	2	1	2	2	1	1	1	1	1	
CO4	2	2	1	1	1	1	1	1	1	1	1	
CO5	2	2	1	1	1	1	1	1	1	1	1	
Total	12	12	6	5	6	6	3	3	5	5	5	
Scaled Value	3	3	2	1	2	2	1	1	1	1	1	
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation												
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$												

COURSE CODE	XAC208	L	T	P	C
COURSE NAME	**Applied Chemistry For Engineers laboratory**	0	0	1	1
PREREQUISITES	**Nil**	L	T	P	H
C:P:A	3.5:1.0:0.5	0	0	3	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Identify* the periodic properties such as ionization energy, electron affinity, oxidation states and electro negativity. *Describe* the various water quality parameters like hardness and alkalinity.	Cognitive Psychomotor	Understand Perception
CO2	*Explain* and *Measure* microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces.	Cognitive Psychomotor	Understand Set
CO3	*Interpret* bulk properties and processes using thermodynamic and kinetic considerations.	Cognitive Psychomotor Affective	Apply Mechanism Receive
CO4	*Describe, Illustrate* and *Discuss* the chemical reactions that are used in the synthesis of molecules.	Cognitive Psychomotor Affective	Understand Analyze
CO5	*Apply, Measure* and *Distinguish* the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques	Cognitive Psychomotor	Apply Mechanism

Laboratory Part	**30 hrs**

Experiments :	
11. Determination of chloride ion present in the water sample by Argentometric method.	**CO1**
	CO1
12. Determination of total, temporary and permanent hardness of water sample by EDTA method.	**CO2**
13. Determination of cell constant and conductance of solutions.	**CO2**
14. Potentiometry - determination of redox potentials and emfs.	**CO3**
15. Determination of surface tension and viscosity.	**CO3**
16. Adsorption of acetic acid by charcoal.	**CO4**
17. Determination of the rate constant of a reaction.	**CO4**
18. Estimation of iron by colorimetric method.	**CO5**
19. Synthesis of a polymer/drug.	**CO5**
20. Saponification/acid value of oil.	

REFERENCE BOOKS

4. Mendham, Denney R.C,. Barnes J.D and Thomas N.J.K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th Edition, Pearson Education, 2004.
5. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. "Experiments in Physical Chemistry", 8th Ed.; McGraw-Hill: New York, 2003.
6. **E Resources -** MOOCs:

1.http://freevideolectures.com/Course/2380/Chemistry-Laboratory-Techniques 2. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Chemistry-Fall-2011 3.http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques		

LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
0	0	45	45

Mapping of CO's with PO's:

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO2	2	0	0	0	0	0	1	2	2	0	0	0	0	0
CO3	3	0	0	0	0	0	2	3	3	0	0	0	0	0
CO4	3	0	0	0	0	0	3	3	3	0	0	0	0	0
CO5	3	0	0	0	0	0	2	2	3	0	0	0	0	0
Total	14	0	0	0	0	0	10	13	14	0	0	0	0	0
ScaledValue	3	0	0	0	0	0	2	3	3	0	0	0	0	0
$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

III Semester

COURSE CODE	XPS301		L	T	P	C
COURSE NAME	**PROBABILITY AND STATISTICS**		3	0	0	3

C	P	A		L	T	P	H
2.5	0.5	0		3	0	0	3

PREREQUISITE:Nil

Learning Objectives

5. Appreciate the importance of probability and statistics in computing and research.

6. Develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries and to use appropriate statistical method in the analysis of simple datasets.

7. Interpret and clearly present output from statistical analyses in a clear concise and understandable manner.

8. The main objective of this course is to provide students with the foundations of probabilities and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.

COURSE OUTCOMES:

Course outcomes:		Domain	Level
CO1	**Explain** conditional probability, independent events; **find** expected values and Moments of Discrete random variables with properties.	Cognitive	Understand
CO2	**Find** distribution function, Marginal density function, conditional density function, **Define** density function of conditional distribution functions normal, exponential and gamma distributions.	Cognitive	Remember
CO3	**Find** measures of central tendency, statistical parameters of	Cognitive	Remember

	Binomial, Poisson and Normal, correlation, regression. Rank Correlation coefficient of two variables. Moments, Skewness and Kurtosis	Psychomotor	Guided Response
CO4	**Explain** large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviations with simple problems.	Cognitive	Understand
CO5	**Explain** small sample test for single mean, difference of mean and correlation coefficients, variance test, chi-square test with simple Problems.	Cognitive	Understand

UNIT I: Basic Probability	**9**
Probability spaces, conditional probability, independence, Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Chebyshev's Inequality.	
UNIT II: Continuous Probability Distributions & Bivariate Distributions	**9**
Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities.	
UNIT III: Basic Statistics	**9**
Measures of Central tendency: Moments, Skewness and Kurtosis - Probability distributions: Binomial, Poisson and normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	
UNIT IV: Applied Statistics	**9**
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	
UNIT V: Small Samples	**9**
Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	0	45

TEXTBOOKS

1.Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw-Hill, New Delhi,2010
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, 2003 (Reprint).
3. S. Ross, "A First Course in Probability", 6th Ed., Pearson Education India, 2002.
4. W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, 3rd Ed., Wiley, 1968.
5. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications,

Reprint, 2010.

E – REFERENCE nptel

Probability and Statistics by Prof.Someshkumar, Department of Mathematics, IIT Kharagpur.
(http://nptel.ac.in/noc/noc_courselist.php)

Cos versus GA mapping

	Graduates Attributes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	1						1	1		1
CO2	3	2	1						1	1		1
CO3	3	2	1	1					1	1		1
CO4	3	2	1	1	1	1			1	1	1	1
CO5	3	2	1	1	1	1	1		1	1	1	1
Total	15	10	5	3	2	2	1		5	5	2	5
Scaled Value	3	2	1	1	1	1	1		1	1	1	1
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation												
$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$												

				L	**T**	**P**	**C**
XBT302			**BIOCHEMISTRY**	**2**	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**1**	**0**	**4**

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Would have learn the fundamentals of biomolecules.
- Would have learn the functions of proteins and biosignalling.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Recognize* and *Understand* about role of water and amino acids.	Cognitive	Remember
CO2	*Recognize* and *Understand* proteins and their structures. Also, will learn about enzymes.	Cognitive	Recall
CO3	*Recognize* and *Understand* about carbohydrate and glycol biology.	Cognitive	Understand
CO4	*Recognize* and *Understand* about Nucleotides and Nucleic acids.	Cognitive	Understand
CO5	*Recognize* and *Understand* lipids and biosignalling.	Cognitive	Understand

I – Water, Amino acids and Proteins	6+3

Water, Weak Interactions in Aqueous Systems, Ionization of Water, Weak Acids, and Weak Bases, Buffering against pH changes in biological systems. Water as a reactant. Amino acids, structures of 20 common acids and properties, Peptides, Proteins, Genetic codon. Structure of Proteins- Primary, Secondary, Tertiary structure and Quaternary Structures – Fibrous Proteins.

II – Protein Function and Enzymes	6+3

Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins: Complementary Interactions between Proteins and Ligands: Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors: An Introduction to Enzymes: How Enzymes Work, Mechanism, Examples of Enzymatic Reactions, Regulatory Enzymes.

III – Carbohydrates and Glycobiology	6+3

Monosaccharides and Disaccharides: Polysaccharides: Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids: Carbohydrates as Informational Molecules: The Sugar Code: Working with Carbohydrates.

IV – Nucleotides and Nucleic acids	6+3

Fundamentals of nucleotides and nucleic acids: Nucleic Acid Structure: Nucleic Acid Chemistry: Other Functions of Nucleotides.

V – Lipids, biological membranes and transport	6+3

Storage Lipids: Structural Lipids in Membranes: Lipids as Signals, Cofactors, and Pigments: Working with Lipids: Biological membranes and transport: Composition and architecture of membranes, membrane dynamics and solute transport across membranes.

Lecture	Tutorial	Practical	Total
30	15	0	45

Text Books:

4. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.
5. Biochemistry, Donald Voet, Judith G. Voet 4th Edition, 2011, 1520 pages ISBN: 978-0-470-91410-6.
6. Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999.

Reference Books:

5. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
6. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
7. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
8. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993.

E-References:

3. http://vlab.amrita.edu/?sub=3&brch=63
4. https://www.youtube.com/channel/UCbWTmSK7bYM9kRZAdfy_gyg

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO 2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
CO 4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO 5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
	5	5	10	0	5	0	0	5	5	5	5	7	8	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5	7	8	6
Scaled Value	3	3	6	0	3	0	0	3	3	0	3	4	5	3

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 303			**MICROBIOLOGY**	L	T	P	C
				3	0	0	3
C	**P**	**A**		L	T	P	H
3	0	0		3	0	0	3

PREREQUISITE: Biology

Learning Objectives:
Upon completion of this course, the students will be able to understand the existence of microbial world through the study of the characteristics of microorganisms, their classification, their interaction with various environments, growth in different media and their control.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Comprehend*** knowledge about historical perspective of microbiology and its developments. ***Recognize*** the fundamental concepts in the structure and functioning of a prokaryotic cell. ***Perform*** staining techniques to observe microorganisms	Cognitive	Understand Remember
CO2	***Acquire*** knowledge about microbial taxonomy and microbial classification methods	Cognitive	Understand Remember

CO3	*Acquire* knowledge about microbial ecosystem and their interactions in different environments	Cognitive	Understand Remember
CO4	*Acquire* knowledge on the bacterial growth, growth curve and microbial nutritional requirements, *Perform* culturing techniques to isolate microorganisms, **Choose** the appropriate media for the cultivation of microorganisms	Cognitive	Understand Remember
CO5	**Demonstrate** the mechanisms of various antimicrobial drugs against pathogens applications of microorganisms, *Acquire* knowledge on the drug resistance of pathogens	Cognitive	Understand Remember

I	INTRODUCTION TO MICROBIOLOGY	7

History and Scope of Microbiology – Overview of Prokaryotic cell structure: Cell membrane, Cytoplasmic matrix, Cell wall, Flagella, Capsule – Study of microbial structure: Microscopy (light, dark-field, phase contrast, electron), Staining techniques (simple and differential).

II	CLASSIFICATION OF MICROORGANISMS	9

Microbial Taxonomy: Binomial Nomenclature – Five Kingdom classification system: Monera, Protista, Fungi, Plantae, Animalia – Three Domain classification system: Bacteria, Archea, Eukarya – Methods of Classification: Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Molecular characteristics – Viruses: Structure and Classification.

III	MICROBIAL ECOLOGY AND MICROBIAL INTERACTIONS	11

Microbial Ecology: Microorganisms in Marine Ecosystems, Freshwater Ecosystems, Terrestrial Ecosystems – Microbial Interactions: Microbe-Microbe interactions, Human-Microbe interactions.

IV	MICROBIAL GROWTH AND NUTRITION	11

Microbial Growth: Growth curve (lag, exponential, stationary, death phase), Measurement (cell number, cell mass), Factors influencing growth (water activity, pH, temperature, oxygen, pressure, radiation) – Microbial Nutrition: Culture media (defined, complex), Culture techniques (spread plate, streak plate, pour plate).

V	ANTIBIOTICS AND ANTIMICROBIAL RESISTANCE	7

Antibiotics: Antibacterial, Antifungal, Antiviral, Antiprotozoan, Antihelminthic drugs – Antimicrobial Resistance: Mechanisms of resistance, Prevention of resistance.

LECTURE	TUTORIAL	TOTAL
45	0	45

TEXT BOOKS:
2. Prescott, L. M., Harley, J. P., and Klein, D. A. Microbiology. 5th. *McGrawJ Hill Higher Education*, 2005.

REFERENCES:
5. Morcello, J. A., Mizer, H. E., &Granato, P. A. Laboratory manual and workbook in Microbiology: Application to patient care, 2003
6. Prescott, L. M., Harley, J. P., & Klein, D. A. Laboratory exercises in microbiology, 2002.
7. Black, Jacquelyn G. *Microbiology: principles and explorations.* John Wiley & Sons, 2008.
8. Tortora, Gerard J., Berdell R. Funke, Christine L. Case, and Ted R. Johnson. *Microbiology: an introduction*. Vol. 9. San Francisco, CA: Benjamin Cummings, 2004.

E-REFERENCES:
4.   http://www.austincc.edu/rohde/noteref.htm

5. http://www.uwyo.edu/molb2210_lect/lecture/lectures.html
6. http://nptel.ac.in/courses/102103012/

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	1	1	1	0	1	0	1	1	1	1	0	0
CO2	3	3	1	1	1	2	2	1	1	1	1	1	0	0
CO3	3	1	2	3	1	2	1	0	1	1	1	1	2	0
CO4	3	3	2	0	1	0	2	0	1	1	1	1	0	2
CO5	3	2	2	3	1	2	2	1	1	0	1	1	2	2
	15	**12**	**8**	**8**	**5**	**6**	**8**	**2**	**5**	**4**	**5**	**5**	**4**	**2**

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	15	12	8	8	5	6	8	2	5	4	5	5	4	2
Scaled Value	6	4	3	3	2	2	3	1	1	1	1	1	0	1

$1 - 5 \to 1,$ $\qquad$ $6 - 10 \to 2,$ $\qquad$ $11 - 15 \to 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT304			**MATERIAL AND ENERGY BALANCES**	**L**	**T**	**P**	**C**
				2	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**2**	**1**	**0**	**3**

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	*Interpret* different unit systems and *Express* the composition gas liquid and solid systems	Cognitive	Understand Remember
CO2	*Compute* the material balances across different unit operations	Cognitive	Understand Analyse
CO3	**Compute** the material balances across chemical reactors	Cognitive	Understand Analyse
CO4	*Explain* the energy balance calculations for systems with and without chemical reactions	Cognitive	Understand
CO5	*Describe* the Biotechnology stoichiometry system	Cognitive	Understand Receive

Course Content	**Hours**
Unit-I **Stoichiometric Principles and Basic Calculations**	**6+3**
Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis"	

of calculations - Methods of expression, compositions of mixture and solutions. Gases, Vapors and Liquids: Equations of state, Vapor pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

Unit-II	Material Balances for Non-Reacting System	6+3

Material balances to different unit operations - recycle - bypass and purging. Distillation, extraction, mixing, drying, crystallization, evaporation, adsorption and absorption, Material balance for multiple unit

Unit-III	Material Balances for Reacting System	6+3

Material balances with chemical reaction - Limiting and excess reactants – Combustion – Yield, conversion and selectivity calculations, Material balance for multiple unit

Unit-IV	Energy Balances	6+3

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats. Energy balances with chemical reaction: Heat of reaction, Heat of combustion.

Unit-V	Biological Stoichiometry	6+3

Stoichiometry growth and product formation, Degree of reduction, Electron balance, Theoretical Oxygen demand.

Lecture	Tutorial	Practical	Total
30	15	0	45

Text Books:

5. K.V.Narayanan and Lakshmikutty, *Chemical Process Calculations*, Prentice Hall, 2004.
6. D. M. Himmelblau and J. B. Riggs, *Basic Principles and Calculations in Chemical Engineering*, Pearson India Education Services, 8th Edition, 2015.
7. B. I. Bhatt and S.M. Vora, **Stoichiometry**, Tata McGraw Hill Publishing Company Ltd, 4thEdition, 2004.
8. Richard M. Felder and Ronald W. Rousseau, *Elementary Principles of Chemical Processes*, John Wiley & Sons, INC. 3rd Edition, 2000.

Reference Books:

4. V. Venkataramani, N. Anantharaman, and Begum, K. M. MeeraSheriffa, Process Calculations, Prentice Hall of India, 2nd Edition.
5. D. C. Sikdar, Chemical Process Calculations, Prentice Hall of India.
6. Bailey and Ollis, Biochemical Engineering Fundamentals, McGraw Hill, Co. 2004.

E-References:

2. http://nptel.ac.in/syllabus/103106076/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 2	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 3	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 4	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 5	3	3	2	3	2	0	2	0	0	0	0	0	2	2
	15	15	10	15	10	0	10	0	0	0	0	0	10	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l Value	15	15	10	15	10	0	10	0	0	0	0	0	10	10
Scaled Value	3	3	2	3	2	0	2	0	0	0	0	0	7	6

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT305	GENETICS AND EVOLUTIONARY BIOLOGY	L	T	P	C
		3	0	0	3

C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Biochemistry and Microbiology

Learning Objectives:

Upon completion of this course, the students
- Would have learnt the fundamentals of genetics
- Would have learnt the gene mutations

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Relate* and *Interpret* Reproduction as the basis of heredity and Gene interactions	Cognitive	Remember, Understand
CO2	*Explain* and *Apply* principles of dominance and segregation	Cognitive	Understand, Apply
CO3	*Classify* and *Develop* Quantitative traits and polygenic inheritance	Cognitive	Analyze
CO4	*Classify* and *Dissect* linking the inheritance of genes to chromosomes and chromosomes as arrays of genes	Cognitive	Understand, Analyze
CO5	*List* and respond DNA Replication and Transcription	Cognitive	Remember

Course content	Hours
I –Mendelian Principles of Genetics and Gene Interactions	9
The relationship between genes and traits, the branches of genetics, The principles of dominance and segregation, the principle of independent assortment, applications of Mendelian principles. Gene interactions that produce new phenotypes, epistasis.	
II-Microbial genetics and quantitative Inheritance	9
Microbial genetics – transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Quantitative traits, polygenic inheritance, heritability, Extranuclear genomes and inheritance: Organization of extranuclear genomes, role of extranuclear inheritance, examples of extranuclear inheritance, maternal effect, genomic imprinting; Gene interaction; Complementation.	

III – Chromosomal Basis of Inheritance and Linkage	9

Experimental evidence linking the inheritance of genes to chromosomes, chromosomes as arrays of genes, non-disjunction as proof of the chromosome theory, the chromosomal basis of Mendelian principles;Chromosomal variation;Extra chromosomal inheritance;

IV –Genetics and Society	9

Genetic disorders;Population screening for genetic diseases, Ethical issues involved in medical genetics, Human genome project and its practical implications, Eugenic and dysgenic effects.

V – Evolutionary biology	9

Basic Principles of Evolution and Population Genetics;Population genetics: factors determining the composition and change in allale and genotype frequencies.; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation. Phylogeny: methods to analyse evolutionary relatedness between populations

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

2. Lewin's Lewin's Genes XII, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017.

Reference Books:

8. Basic genetics : a human approach / BSCS. Dubuque, IA, Kendall/Hunt Pub. Co., c1999. 147 p. QH431.B305 1999.
9. Beighton, Peter and Greta Beighton. The person behind the syndrome. London, New York, Springer, c1997. 231 p. R134.B45 1997, Foreword by Hans-R. Wiedemann.
10. Bland, Jeffrey with Sara Benum. Genetic nutritioneering. Los Angeles, Keats Pub., c1999. 272 p. B155.B59 1999.
11. Bouchard, Claude, Robert M. Malina and Louis Pérusse. Genetics of fitness and physical performance. Champaign, IL, Human Kinetics, c1997. 400 p. QP301.B76 1997
12. Childs, Barton. Genetic medicine : a logic of disease. Baltimore, Johns Hopkins University Press, c1999. 326 p. RB155.C496 1999.
13. Connor, J. M. and Malcolm Ferguson-Smith. Essential medical genetics. Oxford, Eng., Malden, MA, Blackwell Science, 1997. 236 p. RB155.C66 1997.
14. Culture, kinship, and genes : towards cross-cultural genetics. Edited by Angus Clarke and Evelyn Parsons. New York, St. Martin's Press, 1997. 272 p. GN289.C55 1997.

E-References:

4. https://nptel.ac.in/syllabus/102107030/
5. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-6-genetics-1/
6. https://cosmolearning.org/courses/principles-mendelian-molecular-genetics/video-lectures/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	1	1	1
CO 2	1	1	2	0	1	0	0	1	1	1	1	1	1	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	3
CO 4	1	1	2	0	1	0	0	1	1	1	1	3	3	1
CO 5	1	1	2	0	1	0	0	1	1	1	1	1	1	2
	5	5	10	0	5	0	0	5	5	5	5	8	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	5	5	10	0	5	0	0	5	5	5	5	8	8	9
Scaled Value	3	3	4	0	2	0	0	1	1	1	1	3	3	2

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Subject Code	XUM 306	L	T	P	C	
Subject Name		**2**	**0**	**0**	**2**	
C | **P** | **A**	**Entrepreneurship Development**	**L**	**T**	**P**	**SS**	**H**
2.7 | **0** | **0.3**		**2**	**0**	**0**	**1**	**3**

Prerequisite	NIL

CourseObjectives
Throughthiscoursethestudentswill

- UnderstandtheEntrepreneurial motivation and inclination
- Idea about the market assessment
- Togetfamiliaringovernment policies and global opportunities for Entrepreneurship Development

Course Outcome:		**Domain**		**Level**	
CO1	*Recognise* and *describe* the role of innovation and motivation for an entrepreneur.	Cognitive	K2	Understand	
CO2	*Self-assess* and *appraise* your entrepreneurship interest with your chosen entrepreneur.	Cognitive	K2	Understand	
CO3	*Outline* the importance of generation of new ideas for entrepreneurship and *illustrate* market assessment.	Cognitive	K2	Understand	
CO4	*Explain* the competition in business and *sketch/demonstrate/comply* business model for dealing with competition.	Cognitive/	K2	Understand	
			K3	Apply	
		Affective	A3	Value	
			A2	Response	
CO5	*Describe* and *Explain* venture creation and launching of small business and its management.	Cognitive	K1	Remember	
			K2	Understand	
CO6	*Describe* and *Discuss* various government policies and global opportunities for Entrepreneurship Development	Cognitive/	K1	Remember	
			K2	Understand	
COURSE CONTENT					

UNIT-I	INNOVATION AND ENTREPRENEURSHIP	5
	Definition of Innovation, Creativity and Entrepreneurship; role of innovation in entrepreneurship development - Entrepreneurial motivation - Competencies and traits of an entrepreneur -Role of Family and Society; Entrepreneurship as a career and its role in national development	
UNIT –II	SELF ASSESSMENT OF ENTREPRENEURIAL INCLININATION	4
	Self-assessment of entrepreneurial inclination -Presentation by students on their entrepreneurial inclination rating -Case study of successful entrepreneurs	
UNIT-III	NEW IDEA GENERATION TO MARKET ASSESSMENT	9
	Importance of Idea generation-filtering-refinement - opportunity recognition - Description of chosen idea - value proposition, customer-problem-Solution statement -benefits; development status; IP ownership -Market Validation- Technology/ user/decision makers/ partners -market need; segmentation -market TAM,SAM and SOM -case study on market segmentation by popular companies	
UNIT –IV	CUSTOMER – COMPETITION- BUSINESS MODEL	9
	Customer-Target primary customer research, Decision making unit/ process-Beach head market; Cost of Customer Acquisition - Competition- comparative analysis, competitive advantages-; -Business model -Financial planning -Pitch documentation and presentation	
UNIT – V	VENTURE CREATION AND LAUNCHING OF SMALL BUSINESS AND ITS MANAGEMENT	9
	New enterprise creation - organizational and legal matters -Operational plan -Sales and distribution plan - Accounting -Team recruitment and management -Fund raising and management -Profile of a startup – case studies	
UNIT– VI	GOVERNMENT INITIATIVES AND GLOBAL OPPORTUNITIES	9
	Incubators and accelerators - capacity building -Startup policies- Startup India-Support for MSME; GeM Portal. Funding–national and international sources-Bilateral programmes by Govt. of India -Global reach for promoting cross-cultural entrepreneurship (1)	

		L	T	P	SS	Total
		30	---	---	15	45

REFERENCE BOOKS

7. A.P.Aruna, " Lecture Notes on Entrepreneurship Development", available as softcopy @ www.brain.net

8. Thomas W. Zimmerer, Norman M. Scarborough, "Essentials of Entrepreneurship and Small Business Management", Pearson; 3rd edition, 2001.

9. John Burnett, "Introducing Marketing", Open Text Book available at http://solr.bccampus.ca:8001/bcc/file/ddbe3343-9796-4801-a0cb-

7af7b02e3191/1/Core%20Concepts%20of%20Marketing.pdf

10. Toubia, Olivier. "Idea Generation, Creativity, and Incentives", Marketing Science. Vol. 25. pp.411-425. 10.1287/mksc.1050.0166, 2006.

11. Alexander Osterwalder and Yves Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers",Wiley; 1st edition, 2010.

12. Gerardus Blokdyk,"3C's model The Ultimate Step-By-Step Guide"5starcooks, 2018.

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO2	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO3	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO4	1	0	1	0	1	1	1	0	0	0	0	0	1	0
CO5	1	0	1	0	1	1	1	0	0	0	0	0	``1	0
CO 6	1	0	1	0	1	1	1	0	0	0	0	0	`1	0
Total	6	0	6	0	6	6	6	0	0	0	0	0	6	0
ScaledValue	2	0	2	0	2	2	2	0	0	0	0	0	2	0
$1-5 \rightarrow 1,$ $6-10 \rightarrow 2,$ $11-15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

Subject Code			XUM 307	L	T	P	C
Subject Name			**UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY**	**2**	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**2**	**1**	**0**	**3**
Prerequisite			None. Universal Human Values 1 (desirable)				

Course Objective: 1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

3. Strengthening of self-reflection.

4. Development of commitment and courage to act.

Course Outcome:		Domain	Level
CO1	*Present* sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them	Cognitive	Understand
CO2	**Grasp** the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfillment. Ex. mutually enriching production system with rest of nature.	Cognitive	Understand

CO3	*Outline* the importance of generation of new ideas for entrepreneurship and *illustrate* market assessment.	Cognitive	Understand

UNIT - I :	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**	**6+3**

Purpose and motivation for the course, recapitulation from Universal Human Values I - Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration - Continuous Happiness and Prosperity - A look at basic Human Aspirations - Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority - Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT - II :	**Understanding Harmony in the Human Being - Harmony in Myself**	**6+3**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body' - Understanding the needs of Self ('I') and 'Body' - happiness and physical facility - Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) - Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail - Programs to ensure Sanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT - III :	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**	**5+3**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship - Understanding the meaning of Trust; Difference between intention and competence - Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship - Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT - IV :	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**	**4+2**

Understanding the harmony in the Nature 1 - Interconnectedness and mutual fulfilment

among the four orders of nature- recyclability and self regulation in nature - Understanding Existence as Co-existence of mutually interacting units in all-pervasive space - Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT - V :	Implications of the above Holistic Understanding of Harmony on Professional Ethics	7+3

Natural acceptance of human values - Definitiveness of Ethical Human Conduct - Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order - Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of peoplefriendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. - Case studies of typical holistic technologies, management models and production systems - Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations - Sum up. Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

LECTURE	TUTORIAL	TOTAL
28	14	42+3(SS)

TEXT BOOKS:

Human Values and Professional Ethics - R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

REFERENCE BOOKS :

15. Jeevan VidyaEk- Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

16. Human Values - A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

17. Leonard, Annie. 2011. The Story of Stuff. New York, NY: Simon & Schuster.

18. The Story of My Experiments with Truth - Mohandas Karamchand Gandhi

19. AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology)

20. Small is Beautiful - E. F Schumacher.

21. Slow is Beautiful - Cecile Andrews.

22. Economy of Permanence - J C Kumarappa.

23. Bharat Mein Angreji Raj – PanditSunderlal.

24. Rediscovering India - by Dharampal.

25. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.

26. India Wins Freedom - Maulana Abdul Kalam Azad

27. Vivekananda - Romain Rolland (English)

28. Gandhi - Romain Rolland (English)

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
Total	3	3	6	0	3	0	0	3	3	3	3	5	7	6
ScaledValue	1	1	1	0	1	0	0	1	1	1	1	1	2	2
$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSECODE			XBT308	**L**	**T**	**P**	**C**
COURSE NAME			**Biochemistry Laboratory**	**0**	**0**	**2**	**2**
PREREQUISITE							
C	**P**	**A**		**L**	**T**	**P**	**H**
1	2	1		**0**	**0**	**2**	**6**

COURSE OBJECTIVES
The course will provide
    a.Hands on experience in using Biochemistry Lab
    b.Practice on handling chemicals
    c.Will help to make understanding on research.

	COURSE OUTCOMES	DOMAIN	LEVEL
CO1	Apply theoretical knowledge to perform experiment in Biochemistry principles.	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO2	Practice on handling chemicals for the Biochemistry experiments.	Cognitive, Psychomotor ,Affective	Apply Mechanism Respond
CO3	Getting trained on analytical calculations from the result of biochemistry experiments.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond
CO4	Understanding the Biochemistry Phenomena through the practical experience.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond
CO5	Apply the practical knowledge to make scientific report.	Cognitive, Psychomotor ,Affective	Apply. Mechanism Respond

11. Buffer preparation and calculation of molar extinction coefficient
12. Separation of Amino Acids by Thin Layer Chromatography
13. Qualitative/Qualitative analysis of proteins
14. Qualitative/Qualitative analysis of Carbohydrates
15. Determination of β-carotene, Flavonoid
16. Estimation and purity of DNA
17. Acid hydrolysis and action of salivary amylase on starch
18. Detection of Adulteration in Milk
19. Titration Curves of Aminoacids
20. Quantitative estimation of serum cholesterol by Zak's method
11. Estimation of Saponification Value of Fats/Oils

HOURS	LECTURE	PRACTICAL	TUTORIAL	TOTAL
	0	30	0	30

REFERENCE BOOK
2. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	3	2	3
CO 2	1	1	2	0	1	0	0	1	1	1	1	0	3	2
CO 3	1	1	2	0	1	0	0	1	1	1	1	2	2	1
CO 4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO 5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
	5	5	10	0	5	0	0	5	5	5	5	7	8	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5	7	8	6
Scaled Value	3	3	6	0	3	0	0	3	3	0	3	4	5	3

$1 - 5 \rightarrow 1$, $\qquad$ $6 - 10 \rightarrow 2$, $\qquad$ $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XBT 309	L	T	P	C
COURSE NAME	MICROBIOLOGY LAB	0	0	2	2
PREREQUISITES	-	L	T	P	H
C:P:A:1:1.5:0.5		0	0	2	6

LEARNING OBJECTIVES

Upon completion of this course, the students will be able to apply their knowledge of microbiology to demonstrate aseptic microbiological techniques in the laboratory

	COURSE OUTCOMES	DOMAIN	LEVEL
After the completion of course the students will be able to			
CO1	*Experiment* and *Demonstrate* media preparation and sterilization techniques	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO2	*Understand* and *Perform* staining techniques, antimicrobial and cell counting assays	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO3	*Practice* and *Demonstrate* different culturing techniques	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO4	*Perform* and *Determine* the characteristics of bacteria	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond
CO5	*Understand* and *Experiment* on isolation of microbes for metabolites production	Cognitive, Psychomotor ,Affective	Apply, Mechanism, Respond

S.No	List of Experiments	COs
1	Media preparation and Sterilization	CO1
2	Preparation of slants /plates and aseptic transfer of microbial cultures	CO1
3	Staining and identification of microbes using simple and differential staining	CO2
4	Isolation of microbes using spread plate method	CO3
5	Isolation of microbes using streak plate method	CO3
6	Isolation of microbes using pour plate method	CO3
7	Microbial growth control using Kirby-Bauer method	CO2
8	Cell counting	CO2
9	Biochemical characterization of microbes	CO4
10	Screening of microorganisms for enzyme production	CO5
	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PROGRAM OUTCOMES													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	1	0	1	0	1	1	1	1	0	0
CO2	3	3	1	1	1	2	2	1	1	1	1	1	0	0
CO3	3	1	2	3	1	2	1	0	1	1	1	1	2	0
CO4	3	3	2	0	1	0	2	0	1	1	1	1	0	2
CO5	3	2	2	3	1	2	2	1	1	0	1	1	2	2
	15	12	8	8	5	6	8	2	5	4	5	5	4	2

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l Value	15	12	8	8	5	6	8	2	5	4	5	5	4	2
Scaled Value	6	4	3	3	2	2	3	1	1	1	1	1	0	1

$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

				L	T	P	SS	C
XBT 310			**INPLANT TRAINING - I**	0	0	0	0	1
C	**P**	**A**		L	T	P	SS	H
1	**1**	**1**		0	0	0	0	0

PREREQUISITE: Nil

COURSE OUTCOMES:

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Relate* classroom theory with workplace practice	Cognitive	Understand
CO2: *Comply with* Factory discipline, management and business practices.	Affective	Respond
CO3:*Demonstrates teamwork* and time management	Affective	Value
CO4: *Describe* and *Display* hands-on experience on practical skills obtained during the programme.	Psychomotor	Perception Set
CO5: *Summarize* the tasks and activities done by technical documents and oral presentations.	Cognitive	Evaluate

Mapping COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5				3						3			1	1
Total	2	1	2	4	3		1	3	3	4	4	0	6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

IV Semester

					L	T	P	C
XBT401			**Basic Transport Processes**		2	1	0	3
C	**P**	**A**			L	T	P	H
3	**0**	**0**			2	1	0	3

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Apply* the fluid transport properties in flow of fluids	Cognitive	Understand
CO2	*Apply* the particle transport properties in flow of fluids	Cognitive	Apply
CO3	*Describe* the heat and mass transfer equipments	Cognitive	Understand
CO4	*Compute* the heat transport properties in flow of fluids	Cognitive	Apply
CO5	*Determine* the mass transport properties in flow of fluids	Cognitive	Apply

Unit-I	**Fluid Transport**		**6+3**

Units and Dimensions, Newtonian and non-Newtonian Fluids, Laminar and turbulent flow, Continuity equation, Bernoulli equation, Hagen-Poiseuille equation,

Unit-II	**Particle Transport**		**6+3**

Characterization of particles shape and size, Size reduction, settling and sedimentation. Agitation and Mixing - power consumption in mixing, Mixing in bioreactors, Mixing time, Centrifugation, Filtration theory.

Unit-III	**Heat Transport**		**6+3**

Conductive and convective heat transfer, LMTD, Overall heat transfer coefficient, Heat exchangers.

Unit-IV	**Mass Transport**		**6+3**

Molecular diffusion and film theory, Mass transfer coefficients, Oxygen transfer and uptake in bioreactor, k_La and its measurement, Mass transfer operations.

Unit-V	**Computational Tools for the Transport Process**		**6+3**

Introduction to Computation – Excel – MATLAB – Rprogram - RStudio

Lecture	Tutorial	Practical	Total
30	**15**	**-**	**45**

Text Books:

5.	McCabe, Warren L., Julian C. Smith, and Peter Harriott, Unit Operations of Chemical Engineering,McGraw-Hill, 2010.
6.	Warren, L. M., C. S. Julian, and H. Peter, Unit operations of chemical engineering, McGraw Hill Book Company, 2005.
7.	Geankoplis, Christie John, Allen H. Hersel, and Daniel H. Lepek, Transport processes and separation process principles, prentice hall, 2018.
8.	Welty J, Rorrer GL, Foster DG.,Fundamentals of Momentum, Heat, and Mass Transfer,. Wiley, Revised 6th Edition; 2014.

Reference Books:

| 3. | Benitez, Jaime, Principles and modern applications of mass transfer operations, John Wiley & Sons, 2016. |
| 4. | Ravi, R., R. Vinu, and Sathyanarayana N. Gummadi, eds. Coulson and Richardson's Chemical Engineering: Volume 3A: ,Chemical and Biochemical Reactors and Reaction Engineering, Butterworth-Heinemann, 2017. |

E-References:

5.	https://nptel.ac.in/courses/103/103/103103037/
6.	http://ce-iitb.vlabs.ac.in/List%20of%20experiments.html?domain=Chemical%20Engineering
7.	http://uorepc-nitk.vlabs.ac.in/#
8.	http://iitg.vlab.co.in/?sub=58

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	**15**	**9**	**12**	**6**	**10**	**10**	**0**	**0**	**0**	**9**	**13**	**8**	**9**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 402	BIOENERGETICS AND METABOLISM	L	T	P	C
		2	1	0	3
C **P** **A**		L	T	P	H
3 **0** **0**		2	1	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Would have learn various metabolic pathways.
- Would have learn how all the metabolic pathways related to each other.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Discuss* and *Remember* fundamental and metabolism pathways	Cognitive	Remember
CO2	*Discuss* and *Remember* biosynthesis of fatty acid and cholesterol	Cognitive	Recall
CO3	*Discuss* and *Remember* oxidative phosphorylation and photophosphorylation	Cognitive	Remember
CO4	*Discuss* and *Remember* biosynthesis of amino acids and nucleotides	Cognitive	Remember
CO5	*Discuss* and *Remember* report on metabolic order and disease	Cognitive	Create

Course content	Hours
I – Bioeneregetics and Glycolytic pathways	**6+3**
Bioenergetics and Thermodynamics, Phosphoryl Group Transfers and ATP, Biological Oxidation-Reduction Reactions, metabolic pathways: Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway, The Citric Acid Cycle.	
II – Fatty acid, Cholestrol, Lipid and amino acid metabolism	**6+3**
Biosynthesis of fatty acids, Oxidation of fatty acid – beta oxidation and omega oxidation, Ketone Bodies, Biosynthesis of Cholesterol, Biosynthesis of phospholipids and glycolipids, Metabolic Fates of Amino Groups, Pathways of Amino Acid Degradation.	
III – Oxidative phosphorylation and photophoshorylation	**6+3**
Electron-Transfer Reactions in Mitochondria, ATP Synthesis, Regulation of Oxidative Phosphorylation, General Features of Photophosphorylation – Photosystem I and II.	
IV – Biosynthesis of amino acids and nucleotides	**6+3**
Overview of Nitrogen Metabolism, Biosynthesis of amino acids, biosynthesis and degradation of nucleotides – De Novo Purine Nucleotide synthesis – Purine Nucleotide Biosynthesis – Pyrimidine Nucleotide-Nucleotide Monophosphates-Ribosomal – Purine and Pyrimidine bases are restricted by Salvage Pathways.	
V – Metabolic disorders and diseases	**6+3**
Overall view on enegetics of metabolic pathways - Qualitative and quantitative analysis of metabolism involving in disease and disorders. Report writing on metabolic disorders or diseases.	

Lecture	Tutorial	Practical	Total
30	**15**	**0**	**45**

Text Books:

4. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.
5. Biochemistry, Donald Voet, Judith G. Voet 4th Edition, 2011, 1520 pages ISBN: 978-0-470-91410-6.
6. Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999.

Reference Books:

5. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
6. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.
7. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.
8. Creighton T.E. Proteins, Freeman WH, Second Edition, 1993.

E-References:

2. https://nptel.ac.in/courses/102104063/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1	1	3	2
CO 2	1	1	2	0	1	0	0	1	1	1	1	2	2	3
CO 3	1	1	2	0	1	0	0	1	1	1	1	3	1	2
CO 4	1	1	2	0	1	0	0	1	1	1	1	2	1	1
CO 5	1	1	2	0	1	0	0	1	1	1	1	1	1	1
	5	5	10	0	5	0	0	5	5	5	5	9	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	5	5	10	0	5	0	0	5	5	5	5	9	8	9
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 403			CELL BIOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite:-

Learning Objectives:

Upon completion of this course, the students
- Would develop a deeper understanding of cell structure and how it relates to cell functions.
- Would understand how cells grow, divide, and die and how these important processes are regulated.
- Would understand cell signaling and how it regulates cellular functions.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Study* and *understand* the origin of eukaryotic cells and cells specialization	Cognitive	Understand Remember Apply
CO2	*Recognize* the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive	Understand Remember Apply
CO3	*Acquire* knowledge on the transport of proteins between intracellular compartments	Cognitive	Understand Remember
CO4	*Acquire* knowledge about cell cycles mitosis and meiosis	Cognitive	Understand Remember
CO5	*Describe* cellular 182ignaling and types of signaling receptors	Cognitive	Understand Remember

I – Cells and Tissues	9

Unity and Diversity of Cells – Origin of Eukaryotic cells – Plant cells – Viruses – Cell specialization: Epithelia, Connective tissue, Nervous tissue, Muscle – Cells as experimental models – Extracellular Matrix.

II – Cellular Organization and Membrane Transport	9

Overview of Eukaryotic cell structure: Cytoplasmic matrix, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Nucleus – Functions of cell organelles – Membrane Transport: Passive and Active transport – Sodium/potassium pumps, Ca2+, ATPase pumps, Uniport, Symport and Antiport system.

III – Intracellular Protein Trafficking	9

Transport to and from the Nucleus – Transport Across Membranes – Vesicular Trafficking Between Intracellular Compartments

IV – Cell Division and Control	9

The cell cycle – General description and different stages of mitosis and meiosis (Interphase, Prophase, Metaphase, Anaphase, Telophase) – Cell Growth Control: Apoptosis

V – Cell Signaling	9

Cell Signaling: Types of Cell Signaling, General Principles of Cell Signaling – Receptors in Signaling: Types of Receptors, Signaling via G-Protein-linked Cell Surface Receptors, Signaling via Enzyme-linked Cell-Surface Receptors.

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:

    2. Bolsover, S. R., Shephard, E. A., White, H. A., and Hyams, J. S. *Cell biology: a short course*. John Wiley & Sons, 2011.

References:

    4. Sadava, D. E. *Cell biology: organelle structure and function*. Jones & Bartlett Learning, 1993.

    5. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. *Essential cell biology*. Garland Science, 2013.

    6. Julio E. Celis. *Cell biology: A Laboratory Handbook*. 3rd Edition, Vol. 1, Elsevier Academic Press, 2006.

E-References:

    3. http://nptel.ac.in/courses/102103012/

    4. https://cellbiology.med.unsw.edu.au/cellbiology/index.php/Cell_Biology_Introduction

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	0	0	0	1	0	0	0	0	0	1	1	0	0
CO 2	3	1	0	1	1	1	0	0	1	1	0	0	0	0
CO 3	3	1	0	0	1	0	0	0	0	0	1	1	0	0
CO 4	3	1	0	1	1	1	0	0	1	1	1	1	0	0
CO 5	3	1	0	1	1	1	0	0	1	1	1	1	0	0
	15	**4**	**0**	**3**	**5**	**3**	**0**	**0**	**3**	**3**	**4**	**4**	**0**	**0**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	4	0	3	5	3	0	0	3	3	4	4	0	0
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 404			**IMMUNOLOGY**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.5	**0**	**0.5**		**3**	**0**	**0**	**3**

Prerequisite: Genetics

Learning Objectives:
Upon completion of this course, the students
- Would be able to explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development.
- Would apply the knowledge of immune associated mechanisms in medical biotechnology research.

	Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	*Outline* the general concepts of immune system and *describe* the cells and organs of the immune system	Cognitive	Remember Evaluate
CO2	*Explains* the properties of antigens and antibodies and *identify* their interactions via various tests.	Cognitive	Understand Perception
CO3	*Describe* various mechanisms of antigen presentation and *discuss* the role of MHC in Ag Presentation.	Cognitive Affective	Remember Responds Phenomena
CO4	*Compares* the different types of hypersensitive reactions and *explain* the autoimmune diseases.	Cognitive	Analyze Understand
CO5	*Comprehend* the types, mechanism of vaccines and *respond* to the various immunization techniques	Cognitive	Understand

I- Immune System	**9**

Organization of the immune system – Types of immune system: Innate and adaptive – Structure and functions of important immune cells: T cell, B cell development , Macrophage, Neutrophil, NK cell, Dendritic cell, Stem cells – Immune organs: Bone marrow, Spleen, Thymus, Lymph node, Mucosal and Cutaneous associated Lymphoid tissue (MALT & CALT).

II- Antigens and Antibodies	**9**

Antigens: Immunogenicity, Antigenicity, Epitope, haptens and Adjuvants – Antibody: Structure, Classes and Biological Activities;Molecular basis of antibody diversity; Polyclonal antibiotics,Monoclonal antibodies – Antigen-antibody reaction: Cross-Reactivity, Affinity, Avidity, Precipitation and agglutination reactions. Immunotechniques: ELISA, RIA, Flow cytometry, Immunoelectrophoresis, Western Blotting

III- MHC and Antigen Presentation	**9**

Major Histocompatibility Complex: Structure, Function and classes of MHC molecules, Immune responsiveness to MHC – Antigen processing and presentation: Endogenous antigens (The Cytosolic Pathway), Exogenous antigens (The Endocytic Pathway)

IV- Complement, Hypersensitivity and Autoimmunity		9

Regulation of immune response; Complement System: Functions, Components, Activation and Regulation of complement system – Allergy and hypersensitivity: Types of hypersensitivity – Autoimmunity, Auto immune disorders; immune tolerance; Graft versus host reaction.

V- Vaccines and Cancer Immunology		9

Vaccines: Active and Passive Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA and Multivalent Subunit Vaccines. Tumors of the Immune System - Tumor Antigens - Immune Response to Tumors – Cancer immunotheraphy.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

2. Janes Kuby., Immunology, WH Freeman and Company, Newyork.,7th Edition, 2013.
2. Roitt, I., Essential Immunology, Blackwell Scientific Publications, Oxford, 12th Edition, 2011.

References:

3. Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). Cellular and Molecular
   Immunology, 4th Edn., W. B. Saunders Co., Pennsylvania, USA.
4. Tizard, R.I. (2007). Immunology: An Introduction 1st Edition (English) 4th Edition,
   Brooks/Cole publishers.

E - References:

4. http://www.raymondcheong.com/Year1/immuno.html
5. http://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-andmolecular
   immunology-fall-2005/lecture-notes/
6. http://www.umich.edu/~bmsteach/lopatin/Immunology/Immunology.html

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3	2	2	1	1	1	1				1	1	3	3
CO 2	3	2	2	1		1	1				1	1	2	2
CO 3	2				1								2	1
CO 4	3	2	1										1	2
CO 5	3	2	2	1	1	1	1				1	1	1	1
	14	8	7	3	3	3	3				3	3	9	9

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l Value	14	8	7	3	3	3	3				3	3	9	9
Scaled Value	3	2	2	0	0	0	0	0	0	0	0	0	2	2

$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XUM405	L	T	P	C
COURSE NAME	ECONOMICS FOR ENGINEERS	3	0	0	3
PREREQUISITES	NIL	L	T	P	H
C:P:A	2.64:0:0.12	3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Explain* the concepts of economics in engineering and *identify* element of cost to prepare cost sheet	Cognitive	Understand
CO2	*Calculate and Explain* the Break-even point and marginal costing	Cognitive	Understand &Apply
CO3	*Summarize* and *Use* value engineering procedure for cost analysis	Cognitive Affective	Understand Receive
CO4	*Estimate* replacement problem	Cognitive	Understand
CO5	*Compute, Explain* and *make Use of* different methods of depreciation	Cognitive	Understand & Apply

UNIT I	INTRODUCTION TO ECONOMICS	8

Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- types of costing, element of costs, preparation of cost sheet and estimation, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost

UNIT II	BREAK-EVEN ANALYSIS&SOCIAL COST BENEFIT ANALYSIS	12

Margin of Safety, Profit, Cost & Quantity analysis-Product Mix decisions and CVP analysis, Profit/Volume Ratio (P/V Ratio), Application of Marginal costing, Limitations
Social Cost Benefit Analysis: compare different project alternatives, Calculate direct, indirect and external effects; Monetizing effects; Result of a social cost benefit analysis.

UNIT III	VALUE ENGINEERING &COST ACCOUNTING:	10

Value engineering – Function, aims, Value engineering procedure - Make or buy decision
Business operating costs, Business overhead costs, Equipment operating costs

UNIT IV	REPLACEMENT ANALYSIS	7

Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.

UNIT V	DEPRECIATION	8

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation, Annuity method of depreciation, service output method of depreciation.

LECTURE:45	TUTORIAL: 0	PRACTICAL: 0	TOTAL: 45

TEXT BOOKS	
1.	Sp Gupta, Ajay Sharma & Satish Ahuja, "Cost Accounting", V K Global Publications, Faridabad, Haryana, 2012.
2.	S.P.Jain&Narang, "Cost accounting – Principles and Practice", Kalyani Publishers, Calcutta, 2012.

3.	PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
4.	William G.Sullivan, James A.Bontadelli& Elin M.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.
REFERENCES	
1.	Luke M Froeb / Brian T Mccann, "Managerial Economics – A problem solving approach" Thomson learning 2007
2.	Truett&Truett, "Managerial economics- Analysis, problems & cases "Wiley India 8th edition 2004.
3.	Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4.	Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

Mapping of CO with PO

CO Vs PO	CO1	CO2	CO3	CO4	CO5	Total	Scaled to 0,1,2 and 3
PO$_1$	1	2	2	1	2	8	2
PO$_2$	1	2	2	1	3	9	2
PO$_3$	1	1	2	1	2	7	2
PO$_4$	1	1	2	0	1	5	1
PO$_5$	1	2	2	1	2	8	2
PO$_6$	1	2	2	1	3	9	2
PO$_7$	1	1	2	1	2	7	2
PO$_8$	1	1	2	0	1	5	1
PO$_9$	1	2	2	1	2	8	2
PO$_{10}$	1	2	2	1	3	9	2
PO$_{11}$	1	1	2	1	2	7	2
PO$_{12}$	1	1	2	0	1	5	1
PSO$_1$	1	2	2	1	2	8	2
PSO$_2$	1	2	2	1	3	9	2
TOTAL	14	22	28	11	29	-	-

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

Course Code	:	XUM 406		L	T	P	C
Course Name	:	DISASTER MANAGEMENT		0	0	0	0
Prerequisite	:			L	T	P	H
C	P	A	NIL	3	0	0	3
3	0	0					

Course Outcome: After the completion of the course, students will be able to		Domain C or P or A	Level
CO1	Understand the concepts of disasters, their significance and types	Cognitive	Understand
CO2	Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction	Cognitive	Understand
CO3	Able to understanding of preliminary approaches of Disaster Risk Reduction (DRR)	Cognitive	Understand
CO4	Develop awareness of institutional processes in the country	Cognitive	Application
CO5	Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity	Cognitive	Application

COURSE CONTENT			
UNIT I	INTRODUCTION TO DISASTERS		6
	Importance &Significance, Types of Disasters, Climate Change, DM cycle		
UNIT II	RISK ASSESSMENT		12
	Risk, Vulnerability, Types of Risk, Risk identification, Emerging Risks, Risk Assessment, Damage Assessment, Risk modeling.		
UNIT III	DISASTER MANAGEMENT		10
	Phases, Cycle of Disaster Management, Institutional Framework, Incident Command System, DM Plan, Community Based DM, Community health and safety, Early Warning and Disaster Monitoring, Disaster Communication, Role of GIS and Remote Sensing, Do's and Don'ts in various disasters.		
UNIT IV	DISASTER RISK MANAGEMENT IN INDIA		10
	Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness), Disaster Management Act and Policy – Other related policies, plans, programmes and legislation		
UNIT V	DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES		7
	Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Forest Fire, Man Made disasters, Space Based Inputs for Disaster Mitigation and Management, Cast Study		

	L	T	P	Total
	45	0	0	45

TEXT BOOKS

5. Singhal J.P. Disaster Management, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423

6. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361)

7. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011

8. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010

REFERENCE BOOKS

6. Siddhartha Gautam and K Leelakrisha Rao, "Disaster Management Programmes and Policies", Vista International Pub House, 2012

7. Arun Kumar, "Global Disaster Management", SBS Publishers, 2008

8. PardeepSahni, AlkaDhameja and Uma medury, "Disaster mitigation: Experiences and reflections", PHI, 2000

9. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005

10. Government of India, National Disaster Management Policy, 2009

E-REFERENCES

- NIDM Publications at http://nidm.gov.in- Official Website of National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India

- http://cwc.gov.in , http://ekdrm.net , http://www.emdat.be , http://www.nws.noaa.gov , http://pubs.usgs.gov , http://nidm.gov.ini http://www.imd.gov.ini

Mapping of COs with POs

		PROGRAM OUTCOMES												
		1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1				2	1	1		1		1		1	1		
CO2		1	1	3	2	3		1	1						
CO3					2		1		1						
CO4		1	1	2	2	2		1				1	1		
CO5		2	3		2	3		1	2	1			2		
Total		4	5	7	7	11		5	3	3		2	4		
Scaled Value		1	1	2	2	3		1	1	1		1	1		
$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$															
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation															

COURSE CODE	XBT407	L	T	P	C
COURSE NAME	BASIC TRANSPORT PROCESSES LABORATORY	0	0	1	1
PREREQUISITES	-	L	T	P	H
C:P:A	2:0.5:0.5	0	0	2	4

LEARNING OBJECTIVES

- To understand the existence of transport processes involved in unit operations through the experiments of the characteristics of fluid mechanics, particle mechanics, heat transfer, mass transfer and process control system.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Experiment* and *Demonstrate* Fluid Flow System	Cognitive Psycomotor	Understand Respond
CO2	*Experiment* and *Demonstrate* Particle Mechanics phenomena	Cognitive Psycomotor Affective	Understand Respond
CO3	*Experiment* and *Demonstrate* Heat Transfer phenomena.	Cognitive Psycomotor	Understand Respond
CO4	*Experiment* and *Demonstrate* Mass Transfer phenomena.	Cognitive Psycomotor	Understand Respond
CO5	*Understanding* Process control system and *Aware* of MATLAB in Unit operation.	Cognitive Affective	Understand Respond

S.No	List of Experiments		COs
1	III. Experiment on fluid flow meters (U tube manometer, Orifice meter, Venturi meter, Pitot tube meter). IV. Centrifugal and Reciprocating pumps characteristics	6 Experiments (9 hrs)	CO1
2	V. Settling and Sedimentation of the particles VI. Experiment on Centrifugation process VII. Determination of Mixing power consumption. VIII. Study on Rotary Drum Filter, Leaf Filter, Filter Press, Size Reduction Equipment and Sieve analysis]	3 Experiments 5 Study Experiments (9 hrs)	CO2
3	III. Heat Transfer by Conduction, Convection IV. Heat Exchanger	3 Experiments (4 hrs)	CO3
4	III. Simple Extraction IV. Batch Adsorption	2 Experiments (4 hrs)	CO4
5	III. Study on Interacting and non-Interacting system IV. Introduction to MATLAB and SIMULINK	3 Study Experiments (4hrs)	CO5
Reference: McCabe, Warren L., Julian C. Smith, and Peter Harriott, Unit Operations of Chemical Engineering,McGraw-Hill, 2010.			

Any Ten Experiments may choose from all COs	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSECODE	XBT408			L	T	P	C
COURSE NAME	**Cell Biology Laboratory**			0	0	2	2
PREREQUISITE							
C	**P**	**A**		**L**	**T**	**P**	**H**
1	1	1		0	0	2	6

COURSE OBJECTIVES

Upon completion of this course, the students

- Would develop a deeper understanding of cell structure and how it relates to cell functions.
- Would understand how cells grow, divide, and die and how these important processes are regulated.
- Would understand cell signaling and how it regulates cellular functions.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Study* and *understand* the origin of eukaryotic cells and cells specialization	Cognitive, Psychomotor, Affective	Apply, Mechanism, Respond
CO2	*Recognize* the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive, Psychomotor, Affective	Apply and apply, Mechanism Respond
CO3	*Acquire* knowledge on the transport of proteins between intracellular compartments	Cognitive, Psychomotor, Affective	Apply. Mechanism Responding
CO4	*Acquire* knowledge about cell cycles mitosis and meiosis	Cognitive, Psychomotor, Affective	Analysing and applying, Responding
CO5	*Describe* cellular 192ignaling and types of signaling receptors	Cognitive, Affective	Analysing, organizing. - valuing

List Of Practical Experiments

9. Staining and observation of eukaryotic cells
10. Cell viability assay by trypan blue exclusion method.
11. Isolation of chloroplasts from spinach leaves
12. Osmosis and Tonicity
13. Extraction of lipids from tissues
14. Extraction of proteins from tissues
15. Separation of proteins by SDS-PAGE electrophoresis
16. Study of different stages of mitosis in onion root tip cells.
9. Study of different stages of meiosis in grasshopper testis cells

HOURS	LECTURE	PRACTICAL	TUTORIAL	TOTAL
	0	30	0	30

REFERENCE BOOK

1. Julio E. Celis. *Cell biology: A Laboratory Handbook*. 3rd Edition, Vol. 1, Elsevier Academic Press, 2006.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	0	0	0	1	0	0	0	0	0	1	1	0	0
CO 2	3	1	0	1	1	1	0	0	1	1	0	0	0	0
CO 3	3	1	0	0	1	0	0	0	0	0	1	1	0	0
CO 4	3	1	0	1	1	1	0	0	1	1	1	1	0	0
CO 5	3	1	0	1	1	1	0	0	1	1	1	1	0	0
	15	4	0	3	5	3	0	0	3	3	4	4	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	4	0	3	5	3	0	0	3	3	4	4	0	0
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

COURSE CODE	**XBT 409**	L	T	P	C
COURSE NAME	**IMMUNOLOGY LABORATORY**	0	0	1	1
PREREQUISITES		L	T	P	H
C:P:A = 1:1:1		0	0	2	6

LEARNING OBJECTIVES
- To introduce the different types of qualitative and quantitative immunoassays.
- To expose the students to various immunological terms.
- To establish analytical ability to interpret the real time experimental results.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	*Demonstrate* separation of different components of whole blood using density gradient centrifugation.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO2	*Demonstrate* and *determine* the count of each type of blood components present in the blood using dyes.	Cognitive Psycomotor Affective	Apply Responds to Phenomena
CO3	*Demonstrate* the ABO blood grouping system and *determine* the blood group.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO4	*Carry out* the coupling technique to label the Antibody with Enzyme HRP.	Cognitive Psycomotor Affective	Remember Responds to Phenomena
CO5	*Demonstrate* qualitative and quantitative assays for identifying the reaction pattern, similarity pattern, unknown concentration, separation of desired antigen.	Cognitive Psycomotor Affective	Remember Responds to Phenomena .

S.No	List of Experiments	COs
1	Collection of Serum from Blood	CO1
2	Isolation of lymphocytes from whole blood	CO1
3	Differential Leukocyte count	CO2
4	Total Leukocyte count	CO2
5	Total and differential count of RBC	CO2
6	Blood Grouping Experiment	CO3
7	Antibody Labelling with HRP	CO4
8	Ouchterlony double diffusion	CO5
9	Single radial immunodifussion	CO5
10	Immunoelectrophoresis	CO5
11.	DIRECT Elisa	CO5
12.	Widal test	CO5
13.	Latex Agglutination	CO5

Reference:
1. Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). Cellular and Molecular Immunology, 4th Edn., W. B. Saunders Co., Pennsylvania, USA.

	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3	2	2	1	1	1	1				1	1	3	3
CO 2	3	2	2	1		1	1				1	1	2	2
CO 3	2				1								2	1
CO 4	3	2	1										1	2
CO 5	3	2	2	1	1	1	1				1	1	1	1
	14	8	7	3	3	3	3				3	3	9	9

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	14	8	7	3	3	3	3				3	3	9	9
Scaled Value	3	2	2	0	0	0	0	0	0	0	0	0	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 501	BIOANALYTICAL TOOLS	L	T	P	C
		3	0	0	3
C	**P**	**A**		L	T	P	H
3	**0**	**0**		3	0	0	3

Prerequisite: Physics, Applied Physics

Learning Objectives:

Upon completion of this course, the students
- Will be able to understand the principles of instrumentation
- Will be able to impart the knowledge of different techniques and methods in biotechnology
- Will be able to improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1 *Explain* the basics and fundamentals of analytical techniques and *describe* the various calibration techniques Understand the basic measurement methods.	Cognitive	Understand Remember
CO2 *Illustrate* the instrumentation and applications of different spectroscopic techniques	Cognitive	Understand Remember
CO3 *Understand* the immunological and radioactive techniques and their applications in biotechnology.	Cognitive	Understand Remember
CO4 *Know* the principle of instrumentation and *applications* of various imaging techniques in biological field.	Cognitive	Understand Remember
CO5 *Classify* the various techniques of Chromatography, *Elaborate* the importance of electrophoresis	Cognitive	Understand Remember

Course content	Hours
I – Introduction	**9**
Classification of instrumental methods – Concepts of accuracy, precision – Limits of detection (LOD) – Types of errors: Random and Systematic – Calibration of instrumental methods: External, Internal and standard addition methods –Signal to Noise ratio.	
II – Spectroscopic Techniques	**9**
Basics of electromagnetic radiation – Absorption, Transmittance and their relationship – Beer-Lambert's law – Principle, Instrumentation and applications of UV-Visible, IR, FTIR and Circular Dichroism Spectroscopy.	
III – Immunological and Radioactive Techniques	**9**
Immunoassays – Enzyme-Linked Immunosorbent Assay (ELISA), Radioimmunoassay (RIA) – Immuno histochemistry – Immunoblotting – Flow cytommetry– Principle, Instrumentation and applications of Geiger-Muller counter, Solid & Liquid scintillation counters.	
IV – Imaging and Characterization Techniques	**9**
Scanning Electron Microscope – Transmission Electron Microscope – Mass spectrometry and MALDI – TOF Analysis – Crystalline structure analysis: XRD and NMR.	
V – Separation Techniques	**9**
Affinity-based separations – Chromatography: Column chromatography, Thin-layer chromatography	

(TLC),Gas chromatography (GC) andHigh-performance liquid chromatography (HPLC) – Electrophoresis: Agarose Gel and SDS-Polyacrylamide Gel electrophoresis.

Lecture	Tutorial	Total
45	0	45

Text Books:
3. Robinson, J. W., Frame, E. M. S., Frame, G. M., Eileen, M., & Skelly, F. (2005). Undergraduate instrumental analysis.
4. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis. Cengage learning.

Reference Books:
3. Gordon, M. H., Macrae, R., & Mac Rae, R. (1987). Instrumental analysis in the biological sciences. Blackie.
4. Bisen, P. S., & Sharma, A. (2012). Introduction to instrumentation in life sciences. Crc Press.

E-References:
4. https://nptel.ac.in/courses/103/108/103108100/
5. https://nptel.ac.in/courses/103/108/103108100/
6. https://nptel.ac.in/courses/102/103/102103083/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	0	0	1	0	0	0	0	2	0	1
CO 2	3	3	2	2	0	0	1	0	0	0	0	0	0	1
CO 3	3	2	2	1	0	0	1	0	0	0	0	0	0	1
CO 4	2	3	2	2	0	0	0	0	0	0	0	1	0	1
CO 5	3	2	3	1	0	0	1	0	0	0	0	1	0	1
	14	12	11	7	0	0	4	0	0	0	0	4	0	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l Value	14	12	11	7	0	0	4	0	0	0	0	4	0	5
Scaled Value	3	3	3	2	0	0	2	0	0	0	0	2	0	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 502	MOLECULAR BIOLOGY		L	T	P	C
			3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Learning Objectives:

Upon completion of this course, the students
- Would have learnt structures of DNA, RNA and its replication and repair
- Would have learnt gene regulations

	Course Outcomes	Domain	Level
	After the completion of the course, students will be able to		
CO1	*Relate* and *Interpret* DNA and RNA structure and its role	Cognitive	Understand Remember
CO2	*Explain* and *Apply* and its replication and repair	Cognitive	Understand Apply
CO3	*Classify* and *Develop* transcription and post transcriptional modifications	Cognitive	Analyze
CO4	*Classify* and *Dissect* translation and post translational processing	Cognitive	Understand Analyze
CO5	*List* and respond gene regulations	Cognitive	Remember

Course content	Hours
I – Introduction	**9**
Definition of Gene – Chromosomal organization of gene – Functional rearrangements in chromosomal DNA – Organizing cellular DNA into chromosome – Morphology and functional elements of eukaryotic chromosomes.	
II – Replication and Repair	**9**
Chemistry of DNA synthesis – Modes of DNA replication – Enzymes of replication – Models of replication – Prokaryotic replication – Eukaryotic replication – DNA mutations – Types of mutations – Types of DNA damage – DNA repair mechanisms	
III – Transcription and RNA processing	**9**
Types of RNA – RNA polymerase enzymes (prokaryotic & eukaryotic) – Transcription initiation factors – Transcriptional elongation (prokaryotic & eukaryotic) – Transcriptional termination (prokaryotic & eukaryotic) – Prokaryotic RNA processing – Eukaryotic RNA processing (3'-polyadenylation, 5'-CAP formation, RNA decapping, mRNA splicing).	
IV – Translation and its regulation	**9**
Protein synthesis machinery (t-RNA, m-RNA, ribosomes, aminoacyl tRNA synthetases) – Initiation of protein translation (prokaryotic & eukaryotic) – Elongation of protein translation (prokaryotic & eukaryotic) – Termination of protein translation (prokaryotic & eukaryotic) – Regulation of translation.	
V – Regulation of gene expression	**9**
Prokaryotic gene regulation (activator, inducer & repressor) – Eukaryotic gene regulation (histone modification, DNA modification & chromatin remodelling).	

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:

3. Verma P.S. (Author), Agarwal V.K. Molecular Biology, 2010.
4. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press; Eighth edition, 2018.

Reference Books:

3. Molecular Biology of the Gene, James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael, Losick Richard, Pearson Education; Seventh edition, 2017.
4. Molecular Biology Made Simple and Fun, David P. Clark (Author), Lonnie Dee Russell (Author), 2010.

E-References:

7. https://nptel.ac.in/courses/102106025/
8. https://www.embl.de/training/e-learning/
9. https://swayam.gov.in/course/5065-molecular-biology
10. https://www.ox.ac.uk/admissions/undergraduate/courses-listing/biochemistry-molecular-and-cellular?wssl=1
11. https://vlab.amrita.edu/?sub=3&brch=77
12. https://www.youtube.com/watch?v=V4CRCQfXUrg

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	0	1	0	0	1	1	1	1			
CO 2	1	1	2	0	1	0	0	1	1	1	1			
CO 3	1	1	2	0	1	0	0	1	1	1	1			
CO 4	1	1	2	0	1	0	0	1	1	1	1			
CO 5	1	1	2	0	1	0	0	1	1	1	1			
	5	5	10	0	5	0	0	5	5	5	5			

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	5	5	10	0	5	0	0	5	5	5	5			
Scaled Value	1	1	2	0	1	0	0	1	1	1	1			

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 503			**BIOREACTION ENGINEERING**	L	T	P	C
				2	1	0	3
C	**P**	**A**		L	T	P	H
2	0	1		3	1	0	4

Learning Objectives:

Upon completion of this course, the students
- Would able to known about the basics of biochemical process.
- Would have understood the concepts of enzyme kinetics.
- Would have knowledge on the kinetic model for biochemical reactions.
- Would able to design a bioreactor for a particular biochemical process.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1 *Understand* and *describe* the fundamentals of reaction kinetics	Cognitive Affective	Remember Receive
CO2 *Outline* the enzyme production and *choose* an appropriate production method based on kinetics.	Cognitive	Understand
CO3 *Recognize*, *perform* and *detect* various immobilization techniques for a bio reaction process.	Cognitive	Understand
CO4 *Identify* and *select* a kinetic model and design a bioreactor according to a biochemical process	Cognitive Affective	Understand Responds
CO5 *Identify, select* and *follow* a bioreactor for a particular process.	Cognitive Affective	Understand Receive

Course content	Hours
Unit-I – Reaction Kinetics	**6+3**

Rate law – Order of reaction kinetics: Zero, First and Second Order reactions – Ideal reactors: Batch, Mixed flow, and Plug flow - Temperature effect on rate constant.

Unit-II – Enzymes Production and Its Kinetics	**6+3**

M-M kinetics – enzyme inhibition – enzyme stability& specificity- factors affecting reaction rates – industrial production process- Industrial production and applications of enzymes: α-amylase – cellulase – protease – lipase, Vitamins: Cyanaocobalamin – Riboflavin.

– Monod Model – modeling of batch and continuous cell growth Batch growth-quantifying cell concentration, growth patterns and kinetics in batch culture, environmental conditions affect growth kinetics. Quantifying growth kinetics- Unstructured non segregated models to predict specific growth rate, cell growth in continuous cultures Definitions and stoichiometric calculations-elemental balances, Degree of reduction, Theoretical predictions of yield coefficients

Unit-III – Immobilization System	**6+3**

Enzyme Immobilization – Diffusion Effects – Thiele modulus, Effectiveness factor, Damkoehler number - Application of hydrolytic enzymes-Immobilized microbial cells, carrier binding, Entrapping, Cross linking, Advantages and disadvantages of immobilized cells.

Unit-IV – Cell Growth Kinetics	**6+3**

Kinetics of cell growth – Substrate utilization and product formation –Structured, Unstructured non segregated models to predict specific growth rate, cell growth in continuous cultures Definitions and

stoichiometric calculations-elemental balances, Degree of reduction, Theoretical predictions of yield coefficients - Microbial, animal and plant cell cultivation –factors affecting the growth.

Unit -V – Bioreactors	6+3

Microbial and enzyme reactors - Ideal Bioreactors-Type of bioreactor-Airlift bioreactors-Airlift pressure cycle bioreactors—Fluidized bed reactors-trickle bed reactors-loop reactor-Stirred tank reactors-Bubble column fermenter – Optimization and scale up.

Lecture	Tutorial	Practical	Total
30	15	0	45

Text Books:
3. Bailey J.E. and Ollis D.F, Biochemical Engineering Fundamentals, Second edition, McGraw Hill Co, Newyork, 2010.
4. Rajiv Dutta, Fundamentals of Biochemical Engineering, First Edition, Springer, 2008.

Reference Books:
3. Jens Nielsen, John Villadsen and Gunnar Liden, Bioreaction Engineering Principles, Second edition, Kluwer Academic/Plenum Publishers, Newyork, 2003.
4. GhasemNajafpour, Biochemical Engineering and Biotechnology, Elsevier, 2007.

E-References:
2. http://nptel.ac.in/courses/103105054/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3										1	1	1	
CO 2	2	3		1					1			1	2	
CO 3		1	3									2	3	1
CO 4		1	2									3	1	2
CO 5	1	2	3	1								2	1	3
	6	**7**	**8**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**9**	**8**	**6**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	6	7	8	2	0	0	0	0	1	0	1	9	8	6
Scaled Value	2	2	2	1	0	0	0	0	1	0	1	3	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 504			PLANT BIOTECHNOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Cell biology, Genetics and Molecular biology

Learning Objectives:

Upon completion of this course, the students
- Would have understand the fundamentals of plant cells.
- Would have learn the techniques in Plant Tissue Culture.
- Would have understood various techniques of gene transfer in plants.
- Would have learn production of Biomolecules from plants for various applications.

	Course Outcomes	Domain	Level
After the completion of the course, students will be able to			
CO1	*Describe* the plant genome and *knows* various terminology related to plant tissue culture.	Cognitive	Remember Understand
CO2	*Describe* Fundamentals of plant cells and plant tissue culture and *knows* various media for tissue culture.	Cognitive	Remember Understand
CO3	*Compare* the various gene transfer methods in plants and *Relate* each other with its pros and cons	Cognitive	Remember Understand
CO4	*Relate* and *Analyze* various vectors and genetic manipulation techniques	Cognitive	Understand Analyze
CO5	*Choose* and *Apply* Herbicide tolerance pesticide, GMOs and molecular farming.	Cognitive	Understand Apply

Course content	Hours
Unit-I – Introduction to Plant Tissue Culture	**9**

Scope of plant biotechnology – Plasticity and totipotency - History of plant tissue culture – Types and composition of tissue culture media – Role of plant growth regulators and elicitors– Physiochemical conditions for tissue culture – kinetics of growth and nutrient optimization; viability in the tissue culture; somaclonal variation.

Unit-II – *In vitro* Propagation	**9**

Types of plant tissue culture –Regeneration of plants-Organogenesis and somatic embryogenesis - Culture types: Callus, cell-suspension culture, shoot and root tip culture, hairy root culture, Meristem culture, pollen culture, Anther culture and haploid production – protoplast culture: isolation, fusion-somatic hybrid and cybrid and regeneration of protoplast – Germplasm conservation and cryopreservation.

Unit-III – Plant Breeding Techniques	**9**

Simple and complex inheritance - back cross – selection marker and reporter gene; Molecular Markers: RFLP and PCR based SSR markers - Marker-Assisted selection, Hybrid seeds production - Herbicide tolerant plants: Different strategies to achieve, strategy to generate glyphosate tolerant plants and their related problems – Production of marker free transgenic plants; plastid transformation

Unit-IV – Genetic Transformation of Plants	**9**

Agrobacterium mediated gene transfer – Crown gall disease, Genes involved in DNA transfer, Ti plasmid, Ri plasmid - Binary vector system - Plant viruses and different types of Viral Vectors – Gemini virus, Cauliflower mosaic virus – Direct gene transfer methods – particle gun bombardment,

electroporation. Indirect gene transfer techniques.

V – Applications of Plant Biotechnology	9

Molecular farming/ Pharming of proteins – Bioreactors for recombinant protein, Secondary metabolite production using plant cell culture. Antisense technology in crop improvement - Therapeutic/Industrial applications of plant products - Plant vaccines, custom-made antibodies, Transgenic plants - their issues and solutions.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:
3. Slater A., Nigel W., Scott, and Fowler MR., Plant biotechnology: The Genetic Manipulation of Plants, Oxford University Press, London, 2nd Edition, 2008.
4. Neal Stewart, Jr., Plant Biotechnology and Genetics: Principles, Techniques, and Applications. John Wiley & Sons Inc. USA, 2008.

Reference Books:
4. Chawla HS. Introduction to Plant Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 2nd Edition, 2003.
5. Neumann, Karl-Hermann, Ashwani Kumar, and Sudhir K. Sopory. Recent Advances in Plant Biotechnology and Its Applications: Prof. Dr. Karl-Hermann Neumann Commemorative Volume. IK International Pvt Ltd, 2008.
6. Hammond, John, Peter McGarvey, and VidadiYusibov, eds. Plant biotechnology: new products and applications. Vol. 240. Springer Science & Business Media, 2012.

E-References:
2. http://www.ncbi.nlm.nih.gov/books/NBK26851/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	0	1	1	2	1	0	0	1	1	1	3	3	3
CO 2	3	2	2	2	3	2	1	1	2	1	1	2	2	2
CO 3	2	1	3	1	2	2	1	0	2	2	1	2	2	2
CO 4	3	2	2	2	2	2	1	1	1	1	0	3	2	2
CO 5	3	3	3	2	3	2	3	2	2	2	2	3	1	1
	13	8	11	8	14	9	5	4	8	7	5	13	10	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	13	8	11	8	14	9	5	4	8	7	5	13	10	10
Scaled Value	3	2	3	2	3	2	1	1	2	2	1	3	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 505A	FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	0	0		3	0	0	3

PREREQUISITE: -

Learning Objectives:

Upon completion of this course, the students

- Will be able to understand the application of biotechnology in animal, plant and food production
- Will be able to describe selected industrial food biotechnology processes
- Will be able to describe selected classical fermentation processes and to describe how fermentation can deliver nutrition
- Will be able to understand safety aspects of fermented food products

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Know* the principles and *defines* the concepts of food biotechnology.	Cognitive	Remember
CO2: *Describe* the role of microbes associated with food products.	Cognitive	Understand
CO3: *Outlines* the methods for Genetically modified food production.	Cognitive	Analyze
CO4: *Discuss* and *compiles* the various methods of food preservation and packaging	Cognitive	Understand
CO5: *Describe* the importance of food quality and regulations	Cognitive	Evaluate

Unit-I	**Introduction to food biotechnology**	9

Introduction – Scope and importance of food biotechnology – Biotechnological approaches to improve nutritional quality and shelf life of commercialized fruits and vegetables – Functional foods: Concept of Prebiotics, Probiotics and Nutraceuticals.

Unit-II	**Utilization of microorganisms in food industries**	9

Fermented dairy products: Cheese, Yoghurt –Fermented food products – Natto, Miso, Sufu, meat and sausages – Single cell protein production– Cocoa, Tea and Coffee fermentation.

Unit-III	**Genetically modified food products**	9

Herbicide tolerant Soybean – Insect resistant Corn – Altered fatty acid composition Canola – Virus resistant Plum – Vitamin enriched Golden rice – Faster maturation Coho Salmon.

Unit-IV	**Food Preservation and Packaging**	9

Mechanisms of food spoilage – Food preservation by low-temp: Refrigeration, freezing and freeze-drying – Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization – Non-thermal preservation: ionizing radiation, high hydrostatic pressure, pulsed electric field – Packaging of foods: packaging materials, packaging atmosphere

Unit-V	**Food safety and regulations**	9

Safety of fermented foods – Approval process for food additives – Hazard Analysis Critical Control Points (HACCP) – FSSAI

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS:
3. Byong H. Lee., Fundamentals of food biotechnology. John Wiley & Sons, 2014.
REFERENCE BOOKS:
1. Bhatia, S. C. (2017). *Food biotechnology*. Wpi Publishing.
2. Ray B., "Fundamental Food Microbiology", Third Edition, CRC Press LLC, 2003.
3. Shetty, Kalidas, et al., eds. Food biotechnology. CRC Taylor & Francis, 2006.
E- REFERENCES
4.   http://nptel.ac.in/courses/103107088/
5.   http://nptel.ac.in/courses/103103029/34

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	3	1	2						3	3	3
CO 2	2	1	3	2	2	2						2	2	2
CO 3	2		3	2	3	1					2	2	2	2
CO 4	2		2	2	3	1					3	3	2	2
CO 5	2		3		3	3						3	1	1
	10	**3**	**12**	**9**	**12**	**9**					**5**	**13**	**10**	**10**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	10	3	12	9	12	9	0	0	0	0	5	13	10	10
Scaled Value	2	1	3	2	3	2	0	0	0	0	1	3	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 505B	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

PREREQUISITE: -

Learning Objectives:

Upon completion of this course, the students
- Will be able to understand the application of biotechnology in Agricultural fields
- Will be able to describe selected industrial agri biotechnology processes

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Know* the principles and *defines* the concepts of Agricultural biotechnology.	Cognitive	Remember
CO2:*Describe* the role of plant breeding in agriculture.	Cognitive	Understand
CO3:*Outlines* the tools and techniques of genetic engineering	Cognitive	Understand
CO4:*Discuss* and *compiles* the biodiversity in agricultural field	Cognitive	Understand
CO5:*Describe* the importance of IPR in agricultural products.	Cognitive	Evaluate
Unit-I	**Genomes and Genes**	**9**

Chromatin structure, Karyotype analysis, Genome organization – C-Value para, dox, Cot curves &significance, Chromosome behaviour.

Unit-II	**Agriculture and Plant Breeding**	**9**

Breeding of crops, Heterosis, Apomixis, Mutations, Polyploidy in crop improvement, and Principles of integrated Pest Management.

Unit-III	**Tools and Techniques of Genetic Engineering**	**9**

Recombinant DNA technology; Concept of Genetic makers; gene interaction, multiple allelism, pleiotropism and multiple factor inheritance. Genetic, Chromosomal and Molecular map, Techniques in genetic engineering; Genome Analysis: Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny.

Unit-IV	**Biodiversity**	**9**

Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centres of origins of plants; Biodiversity hot spots.

Unit-V	**IPR on Agricultural Products**	**9**

IPR Introduction - IPR in relation to Indian Flora- Basmati Rice, Turmeric and Neem.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS:

4. Ahindra Nag., Text Book of Agricultural Biotechnology. PHI Learning Publisher New Delhi, 2008.

REFERENCE BOOKS:

1. Anshuman Singh, Ashutosh Singh, Ashutosh Kumar Srivastava2. Ray B., "Agricultural Biotechnology" Medtech Publisher, Edition-1, 2019

E- REFERENCES

6.   https://nptel.ac.in/content/syllabus_pdf/102103016.pdf

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	3	1	2						3	3	3
CO 2	2	1	3	2	2	2						2	2	2
CO 3	2		3	2	3	1					2	2	2	2
CO 4	2		2	2	3	1					3	3	2	2
CO 5	2		3		3	3						3	3	1
	10	3	12	9	12	9					5	13	12	10

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	10	3	12	9	12	9	0	0	0	0	5	13	12	10
Scaled Value	2	1	3	2	3	2	0	0	0	0	1	3	2	2

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT505C		**PHARMACEUTICAL BIOTECHNOLOGY**	3	0	0	3
C	**P**	**A**	**L**	**T**	**P**	**H**
3	0	0	3	0	0	3

Prerequisite: Biochemistry, Immunology, r-DNA technology

Learning Objectives:
Upon completion of this course, the students
- Would able to understand principles of biotechnology in pharmaceutical product development.
- Would apply advanced biotechnology methods in novel drug development
- Would able to review the production processes for antibiotics, vitamins, alkaloids and steroids

	Course Outcomes	**Domain**	**Level**
	After the completion of the course, students will be able to		
CO1	*identify* the potential avenues and requirements from the biotechnologists in pharmaceutical industries and *describe e* the scope and applications of biotechnology in pharmacy	Cognitive	Analyze Understand
CO2	*Outline* the pharma codynamics, pharmacokinetics of drugs	Cognitive	Analyze Understand
CO3	*Describe* various adverse effects of drugs	Cognitive	Analyze Understand
CO4	*Explain* the manufacturing process for various therapeutical products including vaccines, enzymes, interleukins, hormones	Cognitive	Analyze Understand
CO5	*Comprehend* the methods applied to test the quality of drugs and other biopharmaceuticals	Cognitive	Analyze Understand

I- Introduction	**7**

Introduction to Pharmaceutical industry & development of drugs; types of therapeutic agents and their uses. Pharmaceutical Biotechnology and Drug discovery. Scope and applications of biotechnology in pharmacy, biological /research advances and approved biologicals for pharmaceutical uses.

II- Drugs and Their Metabolism	**10**

Physiochemical properties of drugs, factors modifying drug action. Pharmaco dynamics, pharmacokinetics and drug metabolism.

III- Drugs and Their Interaction	**10**

Adverse effects of drugs and drug toxicology: Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity, Drug tolerance, Drug intolerance, drug allergy, drug induced side effects. Tachyphylaxis, biological effects of drug abuse and drug dependence.

IV- Production of Biopharmaceuticals	**11**

Biopharmaceutical and biological drug development, Manufacturing of biopharmaceutical, therapeutic proteins and peptides. Recombinant growth hormones, growth factors, therapeutic monoclonal antibodies, therapeutic enzymes and their application in health care.

V- Testing and Analysis of Biopharmaceuticals	**7**

Pharmaceutical Testing, Analysis and Control: Analysis of pharmaceuticals using physical, chemical and biological methods, quality assurance and control, stability of pharmaceutical products			
Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**0**	**45**

Text Books:

3. Purohit, Kulkarni,Saluja—Pharmaceutical biotechnology, Agrobios publishers, 2003
4. Pharmaceutical biotechnology edition2 by crommel, Freeman publishers, 2004

References:

4. Crommelin.D.J.A, Robert D. Sindela, Bernd Meibohm "Pharmaceutical Biotechnology: fundamentals and applications", Informa Healthcare, 2008.
5. Pharmaceutical biotechnology:drug discovery and clinical applications by Kayser,Wiley publishers, 1st edition 2007
6. Katzung B.G. Basic and Clinical Pharmacology,(6th Ed) Prentice Hall of Intl., 1995

E- References:

2. https://archive.org/details/PharmaceuticalBiotechnology/page/n111

Mapping Of COs and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	-	1	1	2	2	-	-	1	1	1	1	0	0
CO2	1	1	1	1	2	2	1	2	1	2	2	2	1	0
CO3	2	2	2	2	1	2	2	-	2	2	1	1	2	0
CO4	2	1	3	2	2	3	2	-	1	1	-	-	3	0
CO5	2	3	2	2	3	3	2	2	2	2	1	1	3	0
	9	**7**	**9**	**8**	**10**	**12**	**7**	**4**	**7**	**8**	**5**	**5**	**9**	**0**

Mapping of Subject Vs POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
Origina l value	9	7	9	8	10	12	7	4	7	8	5	5	9	0
Scaled to 0,1,2,3 scale	2	2	2	2	2	3	2	0	2	2	0	0	2	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 507			BIOANALYTICAL TOOLS LABORATORY	L	T	P	C
				0	0	1	1
C	P	A		L	T	P	H
0.5	1	0.5		0	0	2	6

Learning Objectives:
Upon completion of this course, the students
- Will be able to understand the principles of instrumentation
- Will be able to impart the knowledge of different techniques and methods in biotechnology

	Course Outcomes	Domain	Level
	After the completion of the course, students will be able to		
CO1	*Explain* the basics and fundamentals of analytical techniques and *describe* the various calibration techniques.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO2	*Describe* the spectrophotometric methods and *perform* the experiments related to spectroscopy.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO3	*Understand* the immunological techniques and *apply* it in various applications in biotechnology.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO4	*Know* the principle of instrumentation and *applications* of various imaging techniques in biological field.	Cognitive Psychomotor Affective	Applying Guided Response Respond
CO5	*Distinguish* the various separation techniques, *Classify* the various techniques of Chromatography and Electrophoresis	Cognitive Psychomotor Affective	Applying Guided Response Respond

S.No	List of Experiments	COs
1	Validation of accuracy and precision of an instrument used in the laboratory	CO1
2	Preparation of calibration curve in spectrophotometry	CO1
3	Determination of drug components by Ultraviolet Spectrophotometry	CO2
4	Interpretation of FTIR spectra	CO2
5	Immuno diffusion assay	CO3
6	Image analysis by electron microscopy	CO4
7	Qualitative analysis of compounds by Thin Layer Chromatography	CO5
8	Separation of compounds using Column Chromatography	CO5
9	Separation of nucleic acids by Agarose gel Electrophoresis	CO5
10	Separation of proteins by SDS-Polyacrylamide gel Electrophoresis	CO5

	HOURS	TUTORIAL	PRACTICAL	TOTAL
		0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	0	0	1	0	0	0	0	2	0	1
CO 2	3	3	2	2	0	0	1	0	0	0	0	0	0	1
CO 3	3	2	2	1	0	0	1	0	0	0	0	0	0	1
CO 4	2	3	2	2	0	0	0	0	0	0	0	1	0	1
CO 5	3	2	3	1	0	0	1	0	0	0	0	1	0	1
	14	12	11	7	0	0	4	0	0	0	0	4	0	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	14	12	11	7	0	0	4	0	0	0	0	4	0	5
Scaled Value	3	3	3	2	0	0	2	0	0	0	0	2	0	2

$1 – 5 \rightarrow 1,$ $6 – 10 \rightarrow 2,$ $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XBT508	L	T	P	C
COURSE NAME	**Bio reaction Engineering Laboratory**	0	0	2	2
PREREQUISITES	-	L	T	P	H
C:P:A	**0.5:1:0.5**	0	0	2	6

LEARNING OBJECTIVES

Upon completion of this course, the students will be able to apply their knowledge of Bioreaction engineering phenomena to demonstrate aseptic enzyme techniques in the laboratory

COURSE OUTCOMES		DOMAIN	LEVEL
After the completion of course the students will be able to			
CO1	**Experiment** and **Demonstrate** enzyme kinetics M-M and Extraction	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO2	**Understand** and **Perform** enzyme activity at different properties	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO3	**Practice** and **Demonstrate** *enzyme* immobilization	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO4	**Perform** and **Determine** growth kinetics	Cognitive Psychomotor Affective	Apply Guided Response Respond
CO5	**Understand** and **Experiment** on alcohol concentration in wine production	Cognitive Psychomotor Affective	Apply Guided Response Respond

S.No	List of Experiments	COs
1	Study of M-M kinetics and determination of M-M constants.	CO1
2	Extraction of enzyme from fruits and vegetable	CO1
3	Effect of temperature on Enzyme Activity.	CO2
4	Effect of pH on Enzyme Activity.	CO2
5	Effect of substrate concentration on Enzyme Activity.	CO2
6	Enzyme immobilization by physical adsorption.	CO3
7	Enzyme immobilization by Gel Entrapment.	CO3
8	Study of Production of growth and/or non-growth associated products.	CO4
9	Study of Microbial Growth kinetics and estimation of Monod parameters.	CO4
10	Estimation of alcohol concentration in wine production.	CO5

Reference:1. Bailey J.E. and Ollis D.F, Biochemical Engineering Fundamentals, Second edition, McGraw Hill Co, Newyork, 2010.

HOURS	TUTORIAL	PRACTICAL	TOTAL
	0	30	30

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3										1	1	1	
CO 2	2	3		1					1			1	2	
CO 3		1	3									2	3	1
CO 4		1	2									3	1	2
CO 5	1	2	3	1								2	1	3
	6	**7**	**8**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**9**	**8**	**6**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**6**	**7**	**8**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**9**	**8**	**6**
Scaled Value	2	2	2	1	0	0	0	0	1	0	1	3	2	2

$1 – 5 \rightarrow 1,$ $\qquad$ $6 – 10 \rightarrow 2,$ $\qquad$ $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT 509			0	0	0	1
		INPLANT TRAINING - II				
			L	T	P	H
C	**P**	**A**				
0.66	**0.66**	**0.66**	0	0	0	0

PREREQUISITE:- Nil

COURSE OUTCOMES:

	Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to			
CO1	Relate classroom theory with workplace practice	Cog	Understand
CO2	Comply with Factory discipline, management and business practices.	Aff	Response
CO3	Demonstrates teamwork and time management.	Aff	Value
CO4	Describe and display hands-on experience on practical skills obtained during the programme.	Phy	Perception Set
CO5	Summarize the tasks and activities done by technical documents and oral presentations.	Cog	Evaluate

Mapping COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5				3						3			1	1
Total	2	1	2	4	3	0	1	3	3	4	4		6	6
Scale d	1	1	2	1	1	0	1	1	1	1	1	1	2	2

1 - Low, 2 – Medium, 3 – High

XBT601	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

C	P	A		L	T	P	H
2.5	0	0.5		3	0	0	3

Prerequisite: Nil

Learning Objective: Upon completion of this course, the students
- Would have learnt animal cell culturing techniques
- Would have learnt designing animal cell culture lab
- Would have learnt knock-out mechanisms of genes
- Would have learnt techniques for production of transgenic animals and cloning

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Explain* animal cell culture media and animal cell culture techniques.	Cognitive	Understand
CO2: *Describe* various gene transfer methods in animal cells.	Cognitive	Evaluate
CO3:*Analyze* various micromanipulation techniques and **reproduce** them in fertilization technology.	Cognitive Affective	Analyze Respond
CO4:*Distinguish* various methods and techniques for production of transgenic animals and cloning.	Cognitive	Understand
CO5: *Describe* manipulation strategies to improve livestock production including meat and milk production	Cognitive	Understand
Unit-I- Cell Culture Techniques		9

Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture.
14. Key events in the development of cell and tissue culture
15. Advantage of tissue culture
16. Sub culture of continuous line growth and Cell line Characterization
17. Extracellular Matrix and its role
18. Cell Interaction and signalling pathways
19. Designing of cell culture laboratory
20. Design of CO_2 incubator and laminar flow – safety cabinets
21. Identification of microbial contamination
22. Decontamination techniques

Unit-II- Gene Transfer Techniques	9

Kinetics of cell growth; Micro & macro-carrier culture; Hybridoma technology; Stem cell technology; Animal cloning; Transgenic animals; Knock-out and knock-in animals.
23. Growth of animal cells culture
24. Knock-out mechanism using computation biology

Unit-III- Invitro Fertilization and Embryo Transfer	9

invitro fertilization and its limitations - Artificial insemination, Super ovulation, Embryo splitting, Biopsy and Sexing of embryos and Embryo transfer- Embryo cryopreservation techniques – Limitations in embryo transfer - Breeding of farm animals.

25. Embryo transfer; https://www.uaex.edu/publications/pdf/fsa-3119.pdf	
Unit-IV- Manipulations for Product Improvement	**9**
Manipulation of Growth hormone; Role of Somatotropic and Thyroid hormone in growth - Probiotics as growth promoters; Ideal characteristics, Mode of action and uses of probiotics; Manipulation of lactation – Lactogenesis and galactopoiesis, wool growth and rumen microbial digestive system. 26. Growth of animal cells in the lab - theoretical and practical	
Unit-V- Transgenic Animals	**9**
Scope and importance of transgenic animal technology - Various strategies for the production of transgenic animals: pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer – Gene knock in and knock out models for studying human disorders - Transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutics.	

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books:

3. Freshney, R. I., Culture of Animal Cells: A manual of Basic technique, John , Wiley and sons, 6th Edition, 2010.
4. Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1st Edition, 2008.

References:

3.Masters, J.R.W., Animal Cell Culture: Practical Approach, Oxford University Press, New York, 3rd Edition, 2000.
4.Holland, A. and Johnson, A., Animal Biotechnology and Ethics, Springer Verlag, New York,1st Edition, 1998.

E References:

3. http://www.biotechnology4u.com/question_bank_question_answer.html
4. NPTEL course material on Transgenic animals as bioreactors:https://nptel.ac.in/courses/102/103/102103013/

COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	2	2	0	1	1	2	1	1	2	1	2
CO 2	3	1	2	1	2	0	0	1	0	2	1	3	2	1
CO 3	3	1	2	3	3	2	2	1	2	2	2	3	3	3
CO 4	3	2	2	2	3	1	1	1	1	2	2	2	1	2
CO 5	3	2	3	1	2	2	1	1	1	2	2	2	1	1
	15	**8**	**10**	**9**	**12**	**5**	**4**	**5**	**6**	**9**	**8**	**12**	**8**	**9**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	15	8	10	9	12	5	4	5	6	9	8	12	0	1
Scaled Value	3	2	2	2	3	1	1	1	2	2	2	3	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT602	XBT602 Process Biotechnology – Upstream	L	T	P	C
		1	1	0	2

C	P	A		L	T	P	H
3	0	0		1	2	0	3

Prerequisite: -

Learning Objectives: Upon completion of this course, the students
- Would be able to identify the parts of a fermenter
- Would know about the media components for fermentation process.
- Would be able to select the parts of a bioreactor for designing a particular production process.
- Would be able to design the scale up procedure of a bioreactor.

	Course Outcomes	Domain	Level
CO1	*Recall* the basic parts of a fermentor and its operations.	Cognitive	Remember
CO2	*Demonstrate* the different media components involved in a fermentation process.	Cognitive	Apply
CO3	*Differentiate* various control systems involved in bioprocess system.	Cognitive	Apply
CO4	*Measure* the various transport phenomena involved in bioprocesses.	Cognitive	Apply
CO5	*Explain* the scale up procedure of mixing, aeration and know the applications	Cognitive	Understand

I – Introduction to process Biotechnology	**6+3**

General requirements of fermentation processes – basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled- ; Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models; Batch, fed-batch and continuous processes

II – Media formulation and optimization	**6+3**

Sterilization of air and media,medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, simple and complex media, Medium optimization techniques,

III – Instrumentation and Process Control:	**6+3**

Instrumentation, measurement and control of the bioprocess parameter such as temperature, pressure, pH, dissolved oxygen, redox, microbial biomass, flow measurement-Agitation and aeration-Detection and prevention of foam, Feedback and feed forward control; Types of controllers – proportional, derivative and integral control, tuning of controllers..

IV -Transport Phenomena in Bioreactors	**6+3**

Flow properties of Fermentation Broths, Factors affecting broth viscosity. Mixing in a Bioreactor – Flow regimes - Power Requirements for Mixing, Un gassed Newtonian Fluids, Gassed Fluids, Improving Mixing in Fermenters, and Effect of Rheological Properties on Mixing. Application of heat transfer in bioprocessing, Heat transfer in Bioreactors, Oxygen requirements of microbial cultures .Determination of oxygen mass transfer coefficient by various methods.

V – Applications to Biological Systems	**6+3**

Scale up consideration for constant K_{La}, shear forces, mixing time-Bioprocess considerations in using Animal and Plant cell cultures. Case studies on Single Cell protein Production, Bioethanol - Case studies

Lecture	Tutorial	Practical	Total
on Applications of Bioprocess Engineering.			
30	15	0	45

Text Books:

4. Schuler and Kargi, Bioprocess engineering. Prentice Hall
5. Najafpour, Ghasem. Biochemical engineering and biotechnology. Elsevier, 2015.
6. Bailey and Ollis, Biochemical Engineering Fundamentals, McGraw Hill, Co. 2004.

References:

7. Pauline Doran, Bioprocess Principles, Academic press, 2004.
8. Neilson J and Villadsen J, Biochemical Engineering Principles I ed, Plenum Press, 2000.
9. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001.
10. Lee J.M, Biochemical Engineering 2nd ed, Prentice Hall, 2000.

E-References:

4. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029
5. http://users.ox.ac.uk/~dplb0149/publication/NPRBiocatalysisRev.pdf
6. http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3											1	2	2
CO2	2	3	2		1		1		1		3	2	3	3
CO3	1	2	2	1					1			1	0	0
CO4	1	3	2	3								1	0	0
CO5	1	3	2	3	1		1		2		2		1	1
Total	8	11	8	7	2	0	2	0	4	0	5	5	6	6
ScaledValue	2	3	2	2	1	0	1	0	1	0	1	1	2	2
$1-5 \rightarrow 1$, $\qquad 6-10 \rightarrow 2$, $\qquad 11-15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT603	XBT603 PROCESS BIOTECHNOLOGY – Downstream	L	T	P	C
		1	1	0	2
C **P** **A**		**L**	**T**	**P**	**H**
3 0 0		1	2	0	3

Prerequisite: -

Learning Objectives: Upon completion of this course, the students
- Would be able to identify the parts of a fermenter
- Would know about the media components for fermentation process.
- Would be able to select the parts of a bioreactor for designing a particular production process.
- Would be able to design the scale up procedure of a bioreactor.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	**Recall** the fundamentals of downstream processing for product recovery	Cognitive	Remember
CO2	**Compute** the problem solving techniques required in multi-factorial manufacturing unit by physical methods. **Apply** principles of various unit operations used in downstream processing	Cognitive	Apply
CO3	**Analyze** the different methods involved in isolation products.	Cognitive	Analyze
CO4	**Explain** the principles of chromatography techniques	Cognitive	Understand
CO5	**Calculate** the drying time for various dryers used in the purification of products.	Cognitive	Apply

Unit –I DOWNSTREAM PROCESSING	6+3

Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilization of bio products

Unit –II PHYSICAL METHODS OF SEPERATION	6+3

Unit operations for solid-liquid separation - filtration and centrifugation.

Unit –III ISOLATION OF PRODUCTS	6+3

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation– ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

Unit –IV PRODUCT PURIFICATION	6+3

Chromatography – principles, instruments (GC, HPLC and FPLC) and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, and bioaffinity and pseudo affinity chromatographic techniques.

Unit – V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS	6+3

Crystallization, drying and Lyophilization in final product formulation.

Lecture	Tutorial	Practical	Total
30	15	0	45

Text Books:

1. Nooralabettu Krishna Prasad,Downstream Process Technology, A New Horizon in Biotechnology,PHI Pvt Ltd,2nd Edition, 2012.
2. Sivasankar, B. Biosperations: Principles and Techniques. PHI Learning Pvt. Ltd., 2005.

References:

1. Hatti-Kaul, Rajni, and Bo Mattiasson. "Downstream processing in biotechnology." Basic biotechnology. Cambridge University Press, Cambridge, 2001.
2. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides1, " Bioseparations Science and Engineering, oxford University Press, 2015.
3. J. A.Wesselingh, Johannes Krijgsman, "Downstream Processing in Biotechnology" , Delft Academic Press/VSSD, 2013.

E-References:

1. http://vlab.amrita.edu/?sub=2&brch=191&sim=341&cnt=1
2. http://vlab.amrita.edu/?sub=2&brch=191&sim=1547&cnt=1
3. http://vlab.amrita.edu/?sub=2&brch=190&sim=606&cnt=1
4. vlab.amrita.edu/?sub=3&brch=273

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3		2	1		1	1		1					1
CO2	2	3	2	1		1			1			1	1	1
CO3	2	3	1	2					1			1	1	2
CO4	2	1	3	2			3		1			1	2	1
CO5	2	2	3	1		2	1		1		2	2	3	3
Total	**11**	**9**	**11**	**7**		**4**	**5**		**5**		**2**	**5**	**7**	**8**
ScaledValue	**3**	**2**	**3**	**2**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**2**	**2**
1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

XBT604A			MASS TRANSFER FUNDAMENTALS	L	T	P	C
				3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
2.5	**0**	**0.5**		**3**	**0**	**0**	**3**

Prerequisites : Nil

Objectives:
- To facilitate the learners understand the basic concepts and principles of mass transfer and apply them in distillation, absorption adsorption drying and humidification operations.

Course Outcomes: At the end of this course, the students should be able to		**Domain**	**Level**
CO1	***Explain*** the basic principles in diffusional mass transfer and ***Calculate*** the rate of the mass transfer under one dimensional steady state diffusion	Cognitive Affective	Understand Analyse Receive
CO2	***Describe*** the operations of Distillation and absorption and ***Calculate*** number trays for distillation and absorption tower	Cognitive Affective	Understand Analyse Receive
CO3	***List*** situations where liquid–liquid extraction might be preferred to distillation	Cognitive	Understand Analyse
CO4	***Discuss*** the salient features of Separation by adsorption, chromatographic separation process and ***Explain*** the concept of breakthrough in fixed-bed adsorption.	Cognitive	Understand Analyse
CO5	***Describe*** the salient features and mechanism involved in Drying	Cognitive	Understand Analyse

Course Content		Hours
Unit-I	**Mass Transfer and Diffusion**	**9**
Steady state molecular diffusion in fluids and solids. One dimensional steady state and unsteady state molecular diffusion through stationary media – molecular diffusion in laminar flow – diffusivity measurements – overall mass transfer coefficients – Diffusion in multi component gaseous mixtures – Diffusion in solids.		
Unit-II	**Distillation**	**9**
Vapour liquid equilibrium – methods of distillation – simple, steam, flash distillation, azeotropic, Extractive and molecular distillation – Continuous distillation – McCabe - Thiele method, ponchonsavarit method		
Unit-III	**Extraction and Leaching**	**9**
L-L equilibrium – staged and continuous extraction concepts, Equipments for extraction – Solid – liquid equilibria, leaching principles – Equipments for leaching		
Unit-IV	**Absorption and Adsorption**	**9**
Theory of absorption – Factors affecting gas absorption-Equilibrium and operating line concept in absorption stage determination - Adsorption and its types -sorbents – equilibrium consideration-kinetic and transport considerations..		
Unit-V	**Humidification and Drying**	**9**
Basic terminologies in humidification – psychrometric chart, construction and use. Methods of humidification and dehumidification – equipments – spray chamber– cooling tower principles, types and operation – Theory and mechanism of drying.		

Lecture	Tutorial	Practicals	Total
45	0	0	45

Text Books

6. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.
7. Anantharaman, N. and K.M. MeeraSherifa Begum, "*Mass Transfer Theory and Practice*", PHI Learning Private Limited, New Delhi,2011
8. Gavhane K.A "Mass Transfer" 8th Edition, Nirali Prakashan, 2010.

References

5. Dutta, B. K., " *Principles of mass transfer and separation processes*", Prentice Hall of India, Delhi, 2007
6. Coulson and Richardson, "Chemical Engineering" Vol. I & II, Asian Books Pvt.ltd., 1998.
7. McCabe, W.L., J.C. Smith and P. Harriott, "*Unit Operations of Chemical Engineering*", 7/e, McGraw-Hill International Edition, 2005.

Mapping of COs Vs Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	13	5	11	8	5	8	5	5	0	8	8	11	11

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	3	3

$1 - 5 \rightarrow 1,$　　　　$6 - 10 \rightarrow 2,$　　　　$11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

					L	T	P	C
XBT604B			**FERMENTATION TECHNOLOGY**		3	0	0	3
C	**P**	**A**			**L**	**T**	**P**	**H**
3	0	0			3	0	0	3

Prerequisites : -

Objectives:
- To enhance the student's ability of employability through study the core prime targeted bioprocess, microbial cum biochemical activities in the fermentation technology.

Course Outcomes: At the end of this course, the students should be able to		**Domain**	**Level**
CO1	*Explain* the microbial for industries and *List* the applications	Cognitive	Understand
CO2	*Describe* the primary and secondary metabolism and *Interpret* the fermentation process	Cognitive	Understand
CO3	*Recognize* the microbial culture and *Describe* the growth kinetics.	Cognitive	Understand
CO4	*Discuss* the isolation and characteristics of micro organism and *Interpret* the industrial significant.	Cognitive	Understand
CO5	*Describe* the salient features of industrial fermentation.	Cognitive	Understand

Course Content	**Hours**
Unit-I **Introduction**	6
Microbial Biomass – Microbial Enzymes – Microbial Metabolites – Commercial Applications of Enzymes.	
Unit-II **Primary and Secondary Metabolism**	9
Interrelationship between primary and secondary metabolism – Recombinant products – Transformation processes – History of fermentation industry – The component parts of a fermentation process.	
Unit-III **Microbial Growth Kinetics**	9
Batch culture – Exponential phase – Declaration and stationary phases - Continuous culture – Feedback systems – Comparison of batch and continuous culture in industrial processes	
Unit-IV **Isolation and Improvement of Industrially Significant Microorganisms**	9
Isolation and characteristics of microorganisms – Screening methods of microorganisms – Discovery processes and maximizing gene expression – Improvement of Industrial microorganism	
Unit-V **Media for Industrial Fermentation**	12
Introduction – Typical media and media formulation – Energy sources – Growth factors – Nutrient Recycles – Buffers – Precursors – Inhibitors – Inducers – Oxygen requirements – Fast metabolism – Rheology – Antifoams – Animal cell media – Development of basal media.	

Lecture	**Tutorial**	**Practicals**	**Total**
45	**0**	**0**	**45**

Text Books

9. Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.
10. Gregory N. Stephanopoulos, Aristos A. Aristidou., Metabolic engineering: Principlesand Methodologies, Jens Nielsen Academic Press, 1st Edition, 1998.

References

8. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References

2. https://nptel.ac.in/courses/102/105/102105058/

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	13	5	11	8	5	8	5	5	0	8	8	11	11

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	3	3

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 604C	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3
C	**P**	**A**		**L**	**T**	**P**	**H**
3	0	0		3	0	0	3

Prerequisite: Bioinstrumentation

Learning Objective:
Upon completion of this course, the students
- Would be able to learn fundamentals of nano technology.
- Would be able to learn the nano particle synthesis and its application in biotechnology

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: *Recall* the basic concepts characterization techniques and *illustrate* the methods of nanoparticles synthesis.	Cognitive	Remember Understand
CO2: *Construct* microfluidic devices and *relate* its advantages.	Cognitive	Create Understand
CO3: *Design* and *Develop* theranostics nanoparticles	Cognitive	Create
CO4: *Outlines* the environmental applications of nanoparticles	Cognitive	Understand
CO5: *Understands* the Fundamentals of Nanocarriers and *design* a drug delivery system.	Cognitive	Create

Unit-I- Introduction to Nanoparticles Synthesis and Characterization	**9**

Nanoparticles- physical, chemical and biological properties- Synthesis- Physical methods: laser vaporization, laser Pyrolysis, ion implantation. Chemical methods for synthesis of Nanomaterials: sol-gel method. Biological synthesis: using microorganisms, plant extracts. Characterization techniques: UV- Spectroscopy, Dynamic Light Scattering, Zeta potential, Energy Dispersive X-Ray Analysis (EDX), Selected Area Diffraction Pattern (SAED), SEM, TEM, AFM.

Unit-II- Microfluidics Meets Nano: Lab-on-a-Chip Devices	**9**

Concepts and advantages of microfluidic devices – Fluid transport – Stacking and sealing – Materials and methods for the manufacture of microfluidic component, fluidic structures, surface modifications.

Unit-III- Nano particles As Theranostic Agents	**9**

Theranostic agents- properties- advantages- Carbon dots and Quantum dots- ability to cross across Blood Brain Barriers- theranostic approach for Cancer treatment and neurodegenerative disorders- Alzheimer's, Parkinson's disease.

Unit-IV- Environmental Applications of Nano particles	**9**

Role of iron oxide, biopolymers and metal nanoparticles in Waste water treatment- heavy metal removal, nanofilter devices. Role of antimicrobial coating in infectious disease prevention. Nanobiosensors for environmental monitoring.

Unit-V- Nanoparticles and Novel Drug Delivery Systems	9

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Drug delivery systems-microcapsules and microspheres- hydrogels- Polymers - Dendrimers- Dendritic Nanoscafold system. pH based targeted delivery- chitosan and alginate. Copolymers- PLA, PLGA. Lipid Based Nanocarriers - Liposomes, niosomes- Cubosomes. Hydrophobic drug delivery.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

3. Niemeyer, Christof M., and Chad A. Mirkin. Nanobiotechnology: concepts, applications and perspectives. Vol. 1. John Wiley & Sons, 2004.
4. Mirkin, Chad A., and Christof M. Niemeyer, eds. Nanobiotechnology II: more concepts and applications. John Wiley & Sons, 2007.

References:

3. Goodsell, David S. Bionanotechnology: lessons from nature. John Wiley & Sons, 2013.
4. Freitas Jr. R.A., "Nanomedicine", First Edition, Volume IIA, Landes Biosciences, 2004.

E- References:

3. http://www.chem.latech.edu/~ramu/msnt505/lec_notes/Ji/MSNT505_Ji_notes.htm
4. http://nptel.ac.in/courses/118107015/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	3	2		2		2					2	1	2
CO 2	2	2	2	2	2	2	2				2	3	2	1
CO 3	1	2			3	3					2	3	3	3
CO 4	2	3	3	3	2	3	3				1	2	1	2
CO 5	1	2			3	2		1				2	1	1
	8	12	7	5	12	10	7	1			5	12	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	8	12	7	5	12	10	7	2			5	12	8	9
Scaled Value	2	3	2	1	3	2	2	1			1	3	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE	XGS606			L	T	P	C
COURSE NAME	**PROFESSIONAL SKILLS**			1	0	2	3
PREREQUISITES	NIL			L	T	P	H
C:P:A= 2.6:0.4:0	-			1	0	4	5

COURSE OUTCOMES			DOMAIN	LEVEL
CO1	*Ability* to understand communications		Cognitive	Remember
CO2	*Apply* the known skills for career		Cognitive	Apply
CO3	*Identify* inner strength		Cognitive	Remember
CO4	*Construct* the attitude as a professional		Cognitive	Create
CO5	*Practicing* Etiquettes		Psychomotor	Guided Response

UNIT I	**COMMUNICATION**	9
1.1 – Brainstorming 1.2 – LSRW		

UNIT II	**CAREER SKILLS**	9
2.1 – Resume & CV preparing Skills 2.2 – Interview Skills 2.3 – Exploring Career Opportunities		

UNIT III	**TEAM SKILLS**	9
3.1 – Listening as a Team Skill 3.2 – Team Building at work place		

UNIT IV	**PROFESSIONAL SKILLS**	9
4.1 – Attitude and Goal Setting 4.2 – Verbal and Non Verbal Communications		

UNIT V	**PROFESSIONAL ETIQUETTES**	9
5.1 - Social Etiquettes 5.2 - Cultural Ethics at work place		

LECTURE: 45	TUTORIAL: 0	PRACTICAL:0		TOTAL: 45
SUGGESTED READINGS				
1.	Er. A. K. Jain, Dr. Pravin S. R. Bhatia, Dr. A. M. Sheikh Professional Communication Skills S. Chand Publications, 2015			
2.	Alan Pannett. *Key Skills for Professionals: How to Succeed in Professional Services*, Kogan Page; 1st edition, 2013			

Mapping of CO with PO

CO Vs PO	CO1	CO2	CO3	CO4	CO5	Total	Scaled to 0,1,2 and 3
PO$_1$	0	0	0	0	0	0	0
PO$_2$	0	0	0	0	0	0	0
PO$_3$	0	0	0	0	0	0	0
PO$_4$	0	0	0	0	0	0	0
PO$_5$	0	0	0	0	0	0	0
PO$_6$	0	0	0	0	0	0	0
PO$_7$	0	0	0	0	0	0	0
PO$_8$	3	3	3	3	3	12	3
PO$_9$	2	2	2	2	2	10	2
PO$_{10}$	3	3	3	3	3	12	3
PO$_{11}$	0	0	0	0	0	0	0
PO$_{12}$	0	0	0	0	0	0	0
PSO$_1$	0	0	0	0	0	0	0
PSO$_2$	0	0	0	0	0	0	0
TOTAL	8	8	8	8	8	34	8

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

Course Code	:	XUM 607		L	T	P	C
Course Name	:	Cyber security		0	0	0	0
Prerequisite	:			L	T	P	H
C	**P**	**A**	**NIL**	3	0	0	3
3	**0**	**0**					

Course Objectives
• To give knowledge on the cyber space and its security.
• To understand the cyber security structure of organisation
• To Understand the security policy of organisation
• To aware of the Cyber security initiatives and IT Act.
• To make the students to know cyber security ractices.

Course Outcome: After the completion of the course, students will be able to	Domain C or P or A	Level
CO1	Understand the fundamentals of Cyber Security and the technologies.	C	Understand
CO2	Understand the organizational structure of Cyber security	C	Understand
CO3	Understand the Cyber Security policy development	C	Understand
CO4	Understand the Indian IT act and the initiatives	C	Understand
CO5	Understand and Apply the Cyber security practices	**C**	Understand and Apply

COURSE CONTENT		
UNIT I	**INTRODUCTION**	**9**
	Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges	
UNIT II	**CYBER SECURITY OBJECTIVES AND GUIDANCE**	**9**
	Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – SecurityFrameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.	
UNIT III	**CYBER SECURITY POLICY CATALOG**	**9**
	Cyber Governance Issues – Net Neutrality – Internet Names and Numbers –	

	Copyright andTrademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation –Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare- Computer Forensics – Steganography	
UNIT IV	**UNIT IVCYBER SECURITY INITIATIVES AND IT ACT**	**9**
	Counter Cyber Security Initiatives in India, Cyber Security Excercsie, Cyber Security Incident Handling, Cyber Security Assurance, IT Act, Hackers-Attacker-Counter measures ,Web Application Security , Digital Infrastructure Security ,Defensive Programming. Traditional Problems Associated with Computer Crime, Introduction to Incident Response.	
UNIT V	**UNIT V SECURITY PRACTICES**	**9**
	Guidelines to choose web browsers, Securing web browser ,Antivirus ,Email security ,Guidelines for setting up a Secure password ,Two-steps authentication ,Password Manager ,Wi-Fi Security ,Guidelines for social media security ,Tips and best practices for safer Social Networking.Basic Security for Windows, User Account Password Introduction to mobile Smartphone Security ,Android Security ,IOS Security Online Banking Security ,Mobile Banking Security ,Security of Debit and Credit Card ,UPI Security Security of Micro ATMs e-wallet Security Guidelines Security Guidelines for Point of Sales(POS)	

	L	**T**	**P**	**Total**
	45	**0**	**0**	**45**

REFERENCE BOOKS

1.Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.

2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.

3. Cyber Laws & Information Technology, JothiRathan,VijayRathan,Bhrath Pubishers,7th Edition January 2019.

4.Modern Cyber security Practices by Pascal Ackerman, BPB Publications,2020

5. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011

6. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.

E-REFERENCES

https://www.coursera.org/specializations/cyber-security
www. nptel.ac.in
http://professional.mit.edu/programs/short-programs/applied-cybersecurity
https://us.norton.com/internetsecurity-how-to-cyber-security-best-practices-for-employees.html
https://www.meity.gov.in/content/cyber-laws

Mapping of COs with POs

	PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	0	0	0	0	0	2	0	3	0	0	0	0	0	0
CO2	0	0	0	0	0	0	2	0	1	0	0	0	0	0
CO3	3	0	0	0	0	2	3	0	1	0	0	0	3	0
CO4	0	0	0	0	0	0	0	0	0	2	0	0	0	0
CO5	3	0	0	0	0	0	0	0	0	0	0	0	3	0
Total	6	0	0	0	0	4	5	3	2	2	0	0	6	0
ScaledValue	2	0	0	0	0	1	1	1	1	1	0	0	2	0
1 – 5 ⯀ 1, 6 – 10 ⯀ 2, 11 – 15 ⯀ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

				L	**T**	**P**	**C**
XBT608			**PROCESS BIOTECHNOLOGY LABORATORY**	**0**	**0**	**4**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
0.5	**2.5**	**1**		**0**	**0**	**8**	**8**

Prerequisite: Process biotechnology

Learning Objectives: Upon completion of this course, the students
- Would be able to identify the parts of a fermenter
- Would be able to design industrial media for fermentation process.
- Would be able design a particular production process.

	Course Outcomes	**Domain**	**Level**
CO1	***Infer the*** basic parts of a fermentor and its operations.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO2	***Demonstrate*** the different media components involved in a fermentation process.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO3	***Interpret*** various control systems involved in bioreactor.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO4	***Measure*** the various transport phenomena involved in bioprocesses.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO5	***Demostarte*** the scale up procedure of mixing ,aeration	Cognitive Psychomotor Affective	Apply Mechanism Respond

List of Practical Experiments
    12. Determination of thermal death rate constant for a fermentation process. (CO1)

13. Comparison of bioprocess efficiencies in synthetic and complex industrial media. (CO2)

14. Medium formulation and optimization studies. (CO2)

15. Estimation of biomass concentration for microbial production. (CO3)

16. Determination of oxygen mass transfer coefficient by Sulphite oxidation method. (CO3)

17. Yeast cell disruption studies by sonication.

18. High-resolution purification preparative liquid chromatographic techniques. (CO3)

19. Ammonium Sulfate precipitation of protein using yeast cell suspension. (CO4)

20. Crystallization of a product. (CO4)

21. Determination of drying time for the given sample in vacuum tray drier. (CO5)

22. Lyophilization (CO5

Lecture	Tutorial	Practical	Total
0	0	30	30

Text Books:
Schuler and Kargi, Bioprocess engineering. Prentice Hall
References:
Pauline Doran, Bioprocess Principles, Academic press, 2004.
E-References:
http://38.100.110.143/model/bb/theory.html
http://38.100.110.143/model/bb/procedure.html

Mapping of COs with POs

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3		2	2								1	2	2
CO2	2	3	2	1	1		1		1		3	2	3	3
CO3	1	3	3	2					1			1	0	0
CO4	1	3	3	2								1	0	0
CO5	1	3	2	2	1		1		2		2		1	1
Total	9	12	12	9	2	0	2	0	4	0	5	5	6	6
ScaledValue	2	3	3	2	1	0	1	0	1	0	1	1	2	2
$1 – 5 \rightarrow 1$, $\qquad$ $6 – 10 \rightarrow 2$, $\qquad$ $11 – 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

					L	T	P	C
XBT701			**Microbial Biotechnology**		3	0	0	3
C	**P**	**A**			**L**	**T**	**P**	**H**
3	**0**	**0**			**3**	**0**	**0**	**3**

Prerequisite: -

Learning Objectives:
Upon completion of this course, the students
- Would be able to explain industrial production of various metabolites.
- Would apply the knowledge of process associated mechanisms in Industrial biotechnology research.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Outline* the general concepts of microbial system and *describe* the development	Cognitive	Remember Understand
CO2	*Describe* various mechanisms of medium and *discuss* the medium role in Bioreactor.	Cognitive	Understand
CO3	*Discuss* the rDNA concept and *explain* the related microbial processes	Cognitive	Remember Understand
CO4	. *Explains* the production of primary metabolites and *identify* their interactions.	Cognitive	Remember Understand
CO5	*Explains* the production of secondary metabolites and *identify* their interactions.	Cognitive	Remember Understand

Unit-I Introduction and Historical developments in microbial Biotechnology	**9**

Introduction and Historical developments in industrial microbiology; industrially important microbes and metabolic pathways; Various Microbial metabolites and their Overproduction; Isolation and selection of industrially important microorganisms; Preservation and maintenance of microbial cultures.

Unit-II Medium and Bioreactor	**9**

Microbial substrates and Media formulation; Components of microbial fermentation process; Types offermentation processes- Solid state, Static and submerged fermentations; Design of laboratory bioreactor;Types of Bioreactor: Stirred tank reactor, bubble column.

Unit-III Recombinant DNA technologies for microbial processes	**9**

Introduction to rDNA technology, Strategies for development of industrial microbial strains with scale up production capacities; metabolic pathway engineering of microbes for production of novel product for industry ,Screening strategies for new products.

Unit-IV Production of Microbial primary Metabolites	**9**

Production of Microbial Biomass - Baker's Yeast, Mushroom; Production of fermented foods; Alcoholic beverages- wine, beer, etc.; Production of Ethanol, Citric acid; Amino acids and vitamins; Microbial enzymes for food, detergent and pharma industry; Biopesticides and biofertilizers

Unit-VProduction of microbial secondary metabolites	9

Production of Antibiotics- penicillin and other antibiotics; Pigments, Microbial transformation, Production of Insulin, Interleukin, growth hormones, Bioplastic production, Large scale production and purification of recombinant proteins and metabolites;

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

3. Process Biotechnology Fundamentals, Satya Narayan Mukhopadhyay 4th Edn , 2018
4. Pauline Doran, Bioprocess Principles, Academic press, 2004.

References:

11. Neilson J and Villadsen J, Biochemical Engineering Principles I ed, Plenum Press, 2000.
12. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001.

E – References

4. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=102107029
5. http://users.ox.ac.uk/~dplb0149/publication/NPRBiocalysisRev.pdf
6. http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3											1	2	2
CO 2	2	3	2		1		1		1		3	2	3	3
CO 3	1	2	2	1					1			1	0	0
CO 4	1	3	2	3								1	0	0
CO 5	1	3	2	3	1		1		2		2		1	1
	8	11	8	7	2	0	2	0	4	0	5	5	6	6

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	8	11	8	7	2	0	2	0	4	0	5	5	6	6
Scaled Value	2	3	2	2	1	0	1	0	1	0	1	1	2	2

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

					L	T	P	C
XBT702			RECOMBINANT DNA TECHNOLOGY		3	0	0	3
C	**P**	**A**			**L**	**T**	**P**	**H**
3	**0**	**0**			**3**	**0**	**0**	**3**

Prerequisite: Genetics, Molecular biology

Learning Objectives:

Upon completion of this course, the students
- Would have learned the concepts of gene cloning and its application.
- Would have learned the various techniques involved in Recombinant DNA Technology.

	Course Outcomes	Domain	Level
After the completion of the course, students will be able to			
CO1	***Recall*** the basic concepts of gene cloning and various Restriction and modification enzymes	Cognitive	Remember
CO2	***Explain*** and ***distinguish*** various vector systems	Cognitive	Remember Understand
CO3	***Describes***, ***Compares*** and ***Identifies*** various techniques involved.	Cognitive	Remember Analyze
CO4	***Discusses, Manipulates*** and ***Describes*** various screening and selection methods.	Cognitive	Understand Apply
CO5	***Explain*** and ***Apply*** the applications of rDNA technology under Biosafety guidelines.	Cognitive	Remember Apply
Course content			**Hours**
I – Basic Concepts Of Gene Cloning			**9**
Introduction to recombinant DNA technology- Restriction & modification enzymes (restriction endonuclease II, DNA polymerases, Polynucleotide kinases and alkaline phosphatases, DNA ligases and RNase)- Restriction mapping, Design of linkers and adaptors.			
II – Plasmids and Vectors			**9**
Characteristics of cloning vectors, types of bacterial plasmid vectors (pBR322, pUC57, pSC101), λ vectors, M13 vectors, cosmids, phagemids, yeast artificial chromosome, bacterial artificial chromosome and *Mammalian artificial chromosomes as cloning vector*.Expression vectors**:** pET vectors, Baculovirus vectors.			
III – Molecular Techniques			**9**
DNA labelling (radioactive and non-radioactive method); DNA sequencing (Maxum& Gilbert, Sangers, pyro-sequencing, shotgun sequencing method)'; Southern, northern and western blotting- PCR – Principle- types- applications- DNA fingerprinting (RAPD; RFLP, AFLP).biosensing and biosensor			
IV – Screening and Selection of Transformants			**9**
Transfer of rDNA into cells- transformation, transfection, Sonoporation, Microinjection and Calcium phosphate methods- Genomic and cDNA library construction- Selection and screening of recombinants – nucleic acid hybridization- Grunsteinhogness and benten- Davis plaque method, immunological screening- Blue – white selection- Reporter gene based selection- GUS, GFP and Luciferase.			

V – Applications of Recombinant DNA Technology	9

Production of recombinant- insulin, human growth factor, vaccine and gene therapy- gene silencing using RNAi. Genetic manipulation of animal cells – early methods and Crispr-Cas9. Transgenic plants and animals. Bioethics regarding rDNA techniques-

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

2. Primrose S.B. and Twymann R.H., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Sixth Edition, Blackwell Scientific Publications, 2004.

Reference Books:

4. Brown T.A., "GeneCloning and DNA Analysis", Fourth Edition, Blackwell Scientific Publications, 2003.
5. Glick B.R. and Pasternak J.J., "Molecular Biotechnology", Third Edition, ASM Press, 2003.
6. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References:

2. http://nptel.ac.in/courses/102103013/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO 2	3	0	3	2	2	1	0	0	0	0	1	0	1	1
CO 3	3	0	3	1	3	0	0	1	0	2	0	0	1	1
CO 4	3	0	3	1	3	0	0	2	0	1	0	0	1	0
CO 5	3	0	3	2	3	2	3	3	0	1	2	0	1	0
	13	1	14	7	12	4	3	6	1	4	4	0	4	2

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	13	1	14	7	12	4	3	6	1	4	4	0	0	0
Scaled Value	3	1	3	2	3	1	1	2	1	1	1	0	0	0

$1 – 5 \rightarrow 1$, $6 – 10 \rightarrow 2$, $11 – 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT703A		**STEM CELL BIOTECHNOLOGY**	2	1	0	3
C	**P**	**A**	**L**	**T**	**P**	**H**
3	**0**	**0**	**2**	**1**	**0**	**3**

Prerequisite: - Cell biology, Immunology

Learning Objective:

Upon completion of this course, the students

- Would able to explain about various categories of stem cells.
- Would have learned the application of stem cell technology.

Course Outcomes	Domain	Level
On the successful completion of the course, students will be able to		
CO1: Able to r*ecall* and **interpret** the biology of stem cells.	Cognitive	Remember Understand
CO2: *Explain* and **develop** the embryonic stem cell culturing.	Cognitive	Understand Apply
CO3: *Discuss* and *analyze* the differentiation of stem cells	Cognitive	Understand Analyze
CO4: *Explain* and *evaluate* the various techniques involved in stem cell assay.	Cognitive	Understand Evaluate
CO5: *Discuss and apply* the various applications of stem cells.	Cognitive	Understand

I- Basics of Stem Cell	**6+3**

Unique properties of stem cells – embryonic stem cells , history and development, characteristics,- Adult stem cells ,Properies, types, clinical applications umbilical cord stem cells– Similarities and differences between embryonic and adult stem cells - Properties of stem cells – pluripotency – totipotency.

II- Embryonic Stem Cells	**6+2**

In vitro fertilization –culturing of embryos-isolation of human embryonic stem cells – blastocyst – inner cell mass – growing ES cells in lab – laboratory tests to identify ES cells – stimulation ES cells for differentiation – properties of ES cells.

III - Adult Stem Cells , iPSCs	**5+2**

Somatic stem cells – test for identification of adult stem cells – adult stem cell differentiation – trans differentiation – plasticity – different types of adult stem cells.

IV- Stem Cell in Drug Discovery and Assay	**6+3**

Target identification – Manipulating differentiation pathways – stem cell therapy Vs cell protection –Hematopoietic colony forming cell assay- stem cell in cellular assays for screening – stem cell based drug discovery, drug screening and toxicology.

V- Applications of Stem Cells	**9+3**

Stem cell therapy for Mental disabilities, Diabetes Mellitus – Therapeutic applications – Parkinsondisease - Neurological disorder – limb amputation – heart disease - spinal cord injuries – diabetes –burns - HLA typing- Alzheimer's disease –tissue engineering application – production of complete organ - kidney – eyes - heart – brain.

Lecture	**Tutorial**	**Practical**	**Total**
32	**13**	**0**	**45**

Text Books
1. Kursad and Turksen, Embryonic Stem Cells; Humana Press; 2002.
2. Dr. LogeswariSelvaraj, Stem Cells MJP Publishers,2015.
References
3. Mohan C. Vemuri, Stem Cell Assays, Springer International Edition; 2010.
4. Stem cell and future of regenerative medicine. By committee on the Biological and Biomedical applications of Stem cell Research. 2002. National Academic press.
E References
2. http://nptel.ac.in/courses/102103012/41

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	2	1			2	2	2	2	3	2
CO 2	2	2	2	2	3	3	2	1				3	1	1
CO3	3	3	2	2	2				1	1	2	2	2	3
CO4	2			3	2							1	1	2
CO5	3	3	2	3	2	2	2	1	2	2	1	1	1	1
	13	**10**	**8**	**11**	**11**	**6**	**4**	**2**	**5**	**5**	**5**	**9**	**0**	**0**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	13	10	8	11	11	6	4	2	5	5	5	9	0	0
Scaled Value	3	2	2	3	3	2	0	0	0	0	0	2	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT703B			CANCER BIOLOGY	L	T	P	C
				2	1	0	3
C	P	A		L	T	P	H
2.5	0	0.5		2	1	0	3

Prerequisite: Cell biology molecular biology

Learning Objective:
Upon completion of this course, the students
- Would have learn about carcinogenesis.
- Would have learn about a comparative approach to understand the differences in mechanisms and signaling.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Outline* the regulation and modulation of cell cycle in cancer by various signal switches	Cognitive	Understand
CO2:*Explain* and *compare* various types of carcinogenesis and its metabolism	Cognitive	Understand Analyze
CO3:*Illustrate* the role of activation of kinases, *identification* of oncogenes, and *conforms* the role of telomere.	Cognitive Affective	Understand Analyze Responds to Phenomena
CO4:*Explain* metastasis and its significant clinical markers for invasion and metastasis	Cognitive	Understand
CO5:*Describe* and *compiles* molecular tool for early diagnosis of cancer, different forms of cancer therapy.	Cognitive Affective	Understand Responds to Phenomena

I- Cell Cycle and Cancer	**9**

Cancer: Causes, characteristics and types – Cell cycle phases, cyclins and CDKs, check points , modulation of cell cycle in cancer - Effects on receptor, signal switches, signaling pathways – Telomerase and its role in cancer – Apoptosis, Extrinsic and intrinsic pathways, apoptosome and caspases - mutations that leads to cancer.

II- Carcinogenesis	**9**

Theory of carcinogenesis – Types: Physical, chemical and radiation carcinogenesis, Direct acting and indirect acting carcinogens, Metabolism of carcinogens, CYP450 reductase mechanism; Mechanism of radiation carcinogenesis, ionizing and non ionizing radiation, Retroviruses - RSV life cycle and its role in cancer, Identification of carcinogens, Long and short term bioassays.

III- Molecular and Cell Biology of Cancer	**6+3**

Signal targets and cancer, activation of kinases – Oncogenes - types, c-Myc, Ras, Bcl-2 family - identification and detection of oncogenes, oncogenes and proto oncogene activity - Growth factors related to transformation - epidermal growth factor (EGF), platelet derived growth factor (PDGF), transforming growth factor (TGF), src and myc; RAS cycle – Tumor suppressor genes.

IV- Invasion and Metastasis	9

Clinical significances and three step theory of Invasion, Metastasis – Introduction and cascade, heterogeneity of metastatic phenotype, Significance of proteases in basement membrane disruption, Epithelial- mesenchymal transition, stromal signals, Role of cadherin and integrin, metalloproteinases in cell invasion, Ras like GTPases.

V- Diagnosis and Therapy	6+3

Diagnosis: Detection using biochemical assays, tumor markers - Molecular tools for early diagnosis of cancer, Disease staging - FISH, DNA microarrays, SNPs, CGH and imaging techniques.

Treatment: Chemotherapy – Topoisomerase inhibitors – Radiotherapy – Gene therapy – Immuno therapy – Antigen specific and Adaptive therapy – Stem cell therapy - Use of signal targets towards therapy of cancer – New Genomic and proteomic technologies.

Lecture	Tutorial	Practical	Total
39	6	0	45

Text Books:

1.   Weinberg, R.A., The Biology of Cancer, Garland Science Taylor and Francis Group, New York, 1st Edition, 2007.
2.   Kleinsmith. L.J., Principles of Cancer Biology, Pearson Education Inc., San Francisco, CA, 1st Edition, 2006.

References:

1. DeVita Jr, V.T., Lawrence, T.S., Rosenberg, S.A., DePinho, R.A. and Weinberg, R.A., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Lippincott Williams & Wilkins Philadelphia, PA, 9th Edition, 2011.
2. Ian F.Tannock, Richard P. Hill, Robert G. Bristow and Lea Harrington., The Basic Sciences of Oncology, 4th Edition, The McGraw-Hill Companies, Inc. New Jersey,2005.
3. PelengarisA.,and M. Khan (Eds)., The Molecular Biology of Cancer, Wiley - Blackwell Publishing, USA. 2006.
4. Gareth Thomas.,Medicinal Chemistry – An Introduction, 1st Edition, John Wiley and Sons, USA, 2004.
5. Benjamin Lewin., Genes VIII, International Edition, Pearson Prentice Hall, New Delhi. 2004.

E References:

 2.   www.nhri.org.tw/NHRI_ADM/userfiles/file/1010510.pdf

Mapping of Cos Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	1	2	1			2	2	2	2	3	2
CO 2	2	2	2	2	3	3	2	1				3	1	1
CO 3	3	3	2	2	2				1	1	2	2	2	3
CO 4	2			3	2							1	1	2
CO 5	3	3	2	3	2	2	2	1	2	2	1	1	1	1
	13	10	8	11	11	6	4	2	5	5	5	9	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	13	10	8	11	11	6	4	2	5	5	5	9	0	0
Scaled Value	3	2	2	3	3	2	1	1	1	1	1	2	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

			L	T	P	C
XBT703C		**DESIGN OF BIOPROCESS EQUIPMENTS**	2	1	0	3
C	**P**	**A**	L	T	P	H
2	**0**	**1**	2	1	0	3

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Interprets* and *Differentiate* Process and Bioprocess	Cognitive Affective	Understand, Apply Guided Response
CO2	*Interprets* and *Design* Pressure units	Cognitive Affective	Understand, Apply Guided Response
CO3	*Interprets* and *Design* Supporting parts	Cognitive Affective	Understand, Apply Guided Response
CO4	*Interprets* and *Design* Heat and Mass Transfer Equipments	Cognitive Affective	Understand, Apply Guided Response
CO5	*Outlines, Interpret* and *Design* the Fermenter unit	Cognitive Affective	Understand, Apply Guided Response

Course content		Hours
Unit-I	**Process and Bioprocess**	**6**
Material of construction for process and bioprocess plants – Mechanical design of process equipment		
Unit-II	**Design of Pressure Unit**	**6**
Design of cylindrical and spherical vessel under internal and external pressure		
Unit-III	**Design of Enclosures**	**6+3**
Selection and design of flat plate, formed heads, torispherical and hemispherical heads, Standard flanges and nozzles.		
Unit-IV	**Design of heat and mass transfer units**	**6+6**
Design of single pipe and double pipe heat exchangers – Design of perforated plate distillation column and perforated plate packed towers.		
Unit-V	**Design of Fermenter**	**6+6**
Basic functions of a fermener – Service provisions for a fermentation plant – Geometrical ratios of fermenter with single and three bladed impellers – Safety precautions – Fermenter body construction and construction materials – Types of fermenter – Design parameters of fermenter.		

Lecture	Tutorial	Practical	Total
30	**15**	**-**	**45**

Text Books:

4. Mass Transfer Operations by Rober E Treybal, McGraw Hill, 1981.
5. Process Equipment Design -Vessel Design by Brownell & Young, John Willey, 1951.
6. Chemical Engineering by J. M. Coulson & J. F. Richardson, Vol 6, Pregman Press, 1993.

Reference Books:

1. Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.
2. Process equipment and mechanical aspect, B C Bhattacharya.

E-References:

1.https://nptel.ac.in/courses/103/107/103107143/
2.https://nptel.ac.in/courses/103/107/103107207/
3.https://nptel.ac.in/courses/103/103/103103027/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	6	6

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Course Code	:	XES 705	L	T	P	C
Course Name	:	ENVIRONMENTAL STUDIES	0	0	0	0
Prerequisite	:		L	T	P	H
C	P	A	NIL	3	0	0	3
2.5	0	0.5					

Course Outcome: After the completion of the course, students will be able to	Domain C or P or A	Level
CO1	*Describe* the significance of natural resources and *explain* anthropogenic impacts.	Cognitive	Remember and understand
CO2	*Illustrate* the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive	Understand
CO3	*Identify* the facts, consequences, preventive measures of major pollutions and *recognize* the disaster phenomenon	Cognitive Affective	Remember Receive
CO4	*Explain* the socio-economic, policy dynamics and *practice* the control measures of global issues for sustainable development	Cognitive	Understand and Analyse
CO5	*Recognize* the impact of population and *apply* the Environmental ethics towards environmental protection.	Cognitive	Understand And Apply

COURSE CONTENT

UNIT I	INTRODUCTION TO ENVIRONMENTAL STUDIES AND RESOURCES	12
	Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, flood, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies	

	– Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.	
UNIT II	**ECOSYSTEMS AND BIODIVERSITY**	**8**
	Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
UNIT III	**ENVIRONMENTAL POLLUTION**	**8**
	Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.	
UNIT IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
	Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. Issues involved in enforcement of environmental legislation – Public awareness.	

UNIT V	HUMAN POPULATION AND THE ENVIRONMENT	8
	Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	

		L	T	P	Total
		45	0	0	45

TEXT BOOKS

6. MahuaBasu,S. Xavier, Fundamentals of Environmental Studies, Cambridge University Press, 2019
7. BharuchaErach,Textbook of Environmental Studies for Undergraduate Courses, Orient Blackswan Pvt Ltd, 2018
8. Anubha Kaushik, C.P. Kaushik, Perspectives in Environmental Studies, New Age International Pvt Ltd Publishers,2018
9. Divan Shyam,Environmental Law and Policy in India, OUP India,2019
10. Varun DuttSharma,S.K. Pandey,Vimal Kumar sharma, Environmental Education and Disaster Management, CBS Publishers & Distributors,2019

REFERENCE BOOKS

10. M.V. Subba Rao, Natural Resources, Conservation, Management and Health Care, Discovery Publishing Pvt.Ltd,2020
11. Masters Gilbert M. Introduction to Environmental Engineering 3rd Edition , Pearson Education India, 3rd edition ,2015.
12. P.D. Sharma, Ecology and Environment Thirteenth Edition, Rastogi Publications,2017
13. Dr. Avneesh Gaur, Environmental Engineering and Disaster Management, Vayu Education Of India,2021
14. E-REFERENCES
15. http://www.e-booksdirectory.com/details.php?ebook=10526
16. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Sciencehttps://www.free-ebooks.net/ebook/What-is-Biodiversity
17. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
18. http://bookboon.com/en/pollution-prevention-and-control-ebook

http://www.e-booksdirectory.com/details.php?ebook=8557

http://www.e-booksdirectory.com/details.php?ebook=6804

http://bookboon.com/en/atmospheric-pollution-ebook

http://www.e-booksdirectory.com/details.php?ebook=3749

http://www.e-booksdirectory.com/details.php?ebook=2604

http://www.e-booksdirectory.com/details.php?ebook=2116

http://www.e-booksdirectory.com/details.php?ebook=1026

http://www.faadooengineers.com/threads/7894-Environmental-Science

Mapping of COs with POs

		PROGRAM OUTCOMES													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1														
CO2	2					2	1			1		1		
CO3	2	1	3			3	1		2	1		1		
CO4	1	1	2			3	2	3				1		
CO5	2	1	1			3						1		
Total	10	3	6			11	4	3	2	2		5		
ScaledValue	2	1	2			3	1	1	1	1	1	1		
$1 - 5 \rightarrow 1,$ $\qquad$ $6 - 10 \rightarrow 2,$ $\qquad$ $11 - 15 \rightarrow 3$														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

					L	T	P	C
XBT706			**RECOMBINANT DNA TECHNOLOGY LABORATORY**		0	0	2	2
C	**P**	**A**			**L**	**T**	**P**	**H**
1	**1**	**0**			**0**	**0**	**2**	**6**

Prerequisite: Genetics, Molecular biology

Learning Objectives:

Upon completion of this course, the students
- Would have learned the concepts of gene cloning and its application.
- Would have learned the various techniques involved in Recombinant DNA Technology.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Study and Understand*** the basic concepts isolation and digestion.	Cognitive Psychomotor	Understand Perception
CO2	***Explain*** and ***Analyze*** gel electrophoresis and Southern blotting.	Cognitive Psychomotor	Understand Perception
CO3	***Explain*** and ***Analyze*** SDS PAGE and Western blotting.	Cognitive Psychomotor	Remember Analyze Perception
CO4	***Discusses,*** and ***Distinguish*** digested DNA and genomic DNA.	Cognitive Psychomotor	Apply Perception
CO5	***Explain*** and ***Apply*** the cell preparation and selection of recombinants.	Cognitive Psychomotor	Understand Apply

Recombinant DNA Technology Lab

List of Practical Experiments
10. Isolation of Plasmid and Genomic DNA. (CO1)
11. Restriction enzyme digestion. (CO1)
12. Agarose gel Electrophoresis. (CO2)
13. Southern blotting (CO2)
14. SDS PAGE. (CO3)
15. Western blotting. (CO3)
16. Purification of digested DNA. (CO4)
17. Ligation of restricted vector and genomic DNA (CO4)
18. Competent cell preparation- calcium chloride method (CO5)
10. Screening and selection of recombinants(CO5)

Lecture	Tutorial	Practical	Total
00	**00**	**30**	**30**

Text Books:

2. Primrose S.B. and Twymann R.H., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Sixth Edition, Blackwell Scientific Publications, 2004.

Reference Books:

4. Brown T.A., "Gene Cloning and DNA Analysis", Fourth Edition, Blackwell Scientific Publications, 2003.
5. Glick B.R. and Pasternak J.J., "Molecular Biotechnology", Third Edition, ASM Press, 2003.

6. Sandhu, Sardul Singh. Recombinant DNA technology. IK International Pvt Ltd, 2010.

E-References:
http://nptel.ac.in/courses/102103013/

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO 2	3	0	3	2	2	1	0	0	0	0	1	0	0	0
CO 3	3	0	3	1	3	0	0	1	0	2	0	0	0	0
CO 4	3	0	3	1	3	0	0	2	0	1	0	0	0	0
CO 5	3	0	3	2	3	2	3	3	0	1	2	0	0	0
	13	1	14	7	12	4	3	6	1	4	4	0	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	13	1	14	7	12	4	3	6	1	4	4	0	0	0
Scaled Value	3	1	3	2	3	1	1	2	1	1	1	0	0	0

$1 - 5 \rightarrow 1,$ $\qquad$ $6 - 10 \rightarrow 2,$ $\qquad$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT707	BIOINFORMATICS			L	T	P	C
				1	0	1	2
C	P	A		L	T	P	H
0.5	2	0.5		1	0	2	6

Prerequisite:-

Learning Objectives:

Upon completion of this course, the students

- Will be able identify different databases and will be able to know about the application of the bioinformatics for data retrieval and for drug designing and development.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1 **Explain** the importance and basic concepts in bioinformatics and **differentiate** various databases.	Cognitive Psychomotor	Understand Perception
CO2 **Understands** the significance of sequence analysis and **performs** sequence alignment.	Cognitive Psychomotor	Apply Guided response
CO3 **Explain** and **Construct** phylogenetic trees to study phylogenetic relationships	Cognitive Psychomotor	Understand Guided response
CO4 **Predict** and **Analysis** the protein structure and molecular docking	Cognitive Psychomotor	Create mechanism
CO5 **Understand** the steps involved in drug discovery process.	Affective	Receive

I- Introduction to Bioinformatics	**3**

Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities – Biological databases- Classification of biological databases- Primary and Secondary databases, Sequence and structure databases, Specialized databases- retrieval system- Entrez- SRS.

II- Introduction to Computational Biology and Sequence Analysis	**3**

Sequence alignment, Pairwise alignment, Multiple sequence alignment its applications, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, Database similarity searching - FASTA and BLAST.

III- Phylogenetics	**3**

Introduction to Phylogenetics, Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree, Forms of Tree Representation, Rooted and un-rooted trees, Phylogenetic Tree Construction Methods: Distance based methods- NJ, UPGMA, Character based methods –Maximum Parsimony, Phylogenetic programs, Bootstrapping.

IV- Protein Structure, Modelling and Simulations	**3**

Protein structure basics, Protein structural visualization and comparison, Secondary structure prediction-Chau-Fasman, GOR, Neural networks, Protein tertiary structure prediction Homology modeling, Threading and Fold recognition.

V- Role of Bioinformatics in Drug Discovery	**3**

Drug designing- objectives- Rational drug design- Computer assisted drug design and drug development-Molecular docking and its applications- QSAR, In Silico drug design- role of structural bioinformatics in drug design and development- Pharmacogenomics- prospects and uses.

List of Experiments	**(30 hrs)**

9. Accession and retrieval of data from various biological databases.Unix/Linux – basic operations

and working with terminal.
10. Perl programs - Simple programs using Operators, Control Structures, Subroutines, Hash, Creating a static HTML file by a Perl Program.
11. Heuristic methods (BLAST, FASTA) of searching for homologous sequences
12. Pair-wise (Needleman – Wunch Algorithm & Smith waterman Algoritghm)and Multiple sequence alignment.Gene prediction methods (ORF Finder).
13. Phylogenetic tree building using Phylip.
14. Protein Secondary structure prediction.Homology Modeling.Molecular Visualization and 3D structural studies using Rasmol - Commands, Domain identification.
15. Molecular Visualization and 3D structural studies using Chimera.
16. Small molecule building, using ISIS Draw and CHEM SKETCH – Tutorial

Lecture	Tutorial	Practical	Total
15	0	30	45

Text Books:
4. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004
5. Ghosh, Zhumur, and Bibekanand Mallick. Bioinformatics: Principles and Applications. Oxford University Press, 2008.
6. S. Harisha , "Fundamentals of Bioinformatics", I. K. International Pvt Ltd, 2010

References:
4. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008
5. T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005
6. Stephen A. Krawetz, David D. Womble, Introduction To Bioinformatics A Theoretical and Practical Approach, Humana Press, 2003

E-References:
3. http://nptel.ac.in/courses/102103044/40
4. vlab.amrita.edu/?sub=3&brch=273

Mapping of Cos Vs PO s

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1			1		2				2					
CO 2		2	2	1	3									1
CO 3		2	1	1	2							3	3	1
CO 4	1	3	3	1	3						3	1	2	3
CO 5	1	2	3		3						2	1	1	1
	2	9	10	3	13				2		5	4	7	5

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	2	9	10	3	13	0	0	0	2	0	5	4	7	5
Scaled Value	3	1	3	2	3	1	1	2	1	0	1	1	1	1

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related, 0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT 708			PROJECT WORK PHASE-I	L	T	P	C
				0	0	2	2
C	P	A		L	T	P	H
1.5	0.5	0.5		0	0	6	6

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes		Domain	Level
On the successful completion of the course, students will be able to			
CO1	*Identify* the engineering problem relevant to the domain interest.	Cog	Analyze
CO2	*Interpret* and infer literature survey for its worthiness.	Cog	Analyze Apply
CO3	*Analyse* and *identify* an appropriate technique for solve the problem.	Cog	Analyze Apply
CO4	*Perform* experimentation /Simulation/Programming/Fabrication, *Collect* and *interpret* data.	Phy Cog	Comp. Overt Resp., Create, Apply
CO5	*Record* and report the technical findings as a document.	Cog	Remember, Understand

Mapping of COs with POs

	CO1	CO2	CO3	CO4	CO5	Total
PO1	3	2	1	2	1	9
PO2	3	2	1	2	1	9
PO3	-	-	1	3	1	5
PO4	-	1	2	3	1	6
PO5	-	-	2	3	1	6
PO6	1	-	1	1	-	3
PO7	1		1	1	-	3
PO8	1	-	1	1	-	3
PO9	-	-	-	-	2	2
PO10	-	-	-	-	3	3
PO12	-	-	-	-	2	2
PO12	1	-	-	-	3	4
PSO1	1	1	1	1	1	5
PSO2	1	1	1	1	1	5

1 – Low, 2 – Medium, 3 – High

			L	T	P	C
XBT 709			**0**	**0**	**2**	**2**
C	**P**	**A**	**L**	**T**	**P**	**H**
1.33	**1.33**	**1.33**	**0**	**0**	**2**	**2**

INPLANT TRAINING - III

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes		Domain	Level
On the successful completion of the course, students will be able to			
CO1	*Relate* classroom theory with workplace practice	Cog	Understand
CO2	*Comply* with factory discipline, management and business practices.	Aff	Response
CO3	*Demonstrates* teamwork and time management.	Aff	Value
CO4	*Describe* and *display* hands-on experience on practical skills obtained during the programme.	Phy	Perception Set
CO5	*Summarize* the tasks and activities done by technical documents and oral presentations.	Cog	Evaluate

Mapping COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2							1	3			1		1	1
CO3									3	1	3		3	3
CO4		1	2	1	3								1	1
CO5				3						3			1	1
Total	2	1	2	4	3	0	1	3	3	4	4	0	6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

VIII Semester

					L	T	P	C
XBT801A			**INTRODUCTION TO QUANTUM BIOLOGY, ARTIFICIAL INTELLIGENCE (AI) AND DATA SCIENCE**		**2**	**1**	**0**	**3**
C	**P**	**A**			**L**	**T**	**P**	**H**
3	**0**	**0**			**2**	**1**	**0**	**3**

Objectives: Students able to inspire on Quantum biology, AI and Data Science to contribute in emerging technology.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	*Interprets* and *Realize* Quantum mechanics in biology.	Cognitive	Understand Remember
CO2	*Interprets* and *Realize* Quantum Biology Applications.	Cognitive	Understand Remember
CO3	*Interprets* and *Realize* Artificial Intelligence in Engineering.	Cognitive	Understand Remember
CO4	*Interprets* and *Realize* Data Science in Engineering.	Cognitive	Understand Remember
CO5	*Outlines* the Resources for AI and Data Science, etc.	Cognitive	Understand Remember

Course content		Hours
Unit-I	**Introduction to Quantum Biology**	**6**

General introduction on quantum mechanics – How plant use quantum mechanics – quantum mechanics in respiration – nucleotides separation by 0.3 nm deal with UV photons – transfer of electrons and protons in cells.

Unit-II	**Quantum Biology Applications**	**6**

Photosynthesis – DNA mutation – Quantum vision implications – Enzyme activity as quantum biochemistry – Antibodies surface proteins on microorganisms.

Unit-III	**Introduction to Artificial Intelligence**	**6+3**

Introduction to AI concept – History of AI - Concept of AI in Drugs and Vaccination – Health Care Data Analysis – Plant Genome Studies – Gene Editing – Enzyme Compositions.

Unit-IV	**Introduction to Data Science**	**6+6**

Application of Data Science – Requirements for Data Science – Introduction to R Program and R-Studio.

Unit-V	**Resources**	**6+6**

Relationship between AI, Data Science, Machine Learning and Deep Learning – Open Resources.

Lecture	Tutorial	Practical	Total
30	**15**	**-**	**45**

Text Books:

4. Graham R Fleming, Gregory D.Scholes "Quantum Effects in Biology" Cambridge University Press 2014.
5. Stuart J. Russell and Peter Norvig – "Artificial Intelligence – A Modern Approach" 3rd Edition, Pearson Publisher, 2015.
6. R.Ragunathan and N. Shankar, "Data Science for Engineers"

Reference Books:

Davy Cielen, Arno D.B. Meysman, and Mohamed Ali, "Introducing Data Science" Manning Publications, 2016.

E-References:

https://doi.org/10.1017/CBO9780511863189.003
https://royalsocietypublishing.org/doi/10.1098/rsif.2018.0640
https://nptel.ac.in/courses/106/102/106102220/
https://nptel.ac.in/courses/106/106/106106179/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	2	2	2	0	0	0	1	3	0	0
CO 2	3	3	2	2	1	2	2	0	0	0	2	2	1	1
CO 3	3	3	2	3	1	2	2	0	0	0	2	3	2	3
CO 4	3	3	2	3	1	2	2	0	0	0	2	2	2	2
CO 5	3	3	2	3	1	2	2	0	0	0	2	3	3	3
	15	15	9	12	6	10	10	0	0	0	9	13	8	9

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	15	15	9	12	6	10	10	0	0	0	9	13	8	9
Scaled Value	3	3	2	3	2	2	2	0	0	0	2	3	2	2

$1 – 5 \rightarrow 1$,　　　　$6 – 10 \rightarrow 2$,　　　　$11 – 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT801B			ENZYME ENGINEERING		L	T	P	C
					2	1	0	3
C	P	A			L	T	P	H
3	0	0			2	1	0	3

Prerequisites : -

Objectives:
- To enhance the student's ability of employability through study the core enzyme characteristics and products.

Course Outcomes: At the end of this course, the students should be able to		Domain	Level
CO1	*Explain* the enzyme principles and *Study* the properties.	Cognitive	Understand
CO2	*Describe* the extraction and *Interpret* the properties with the bioprocesses.	Cognitive	Understand
CO3	*Recognize* the Immobilization types and *Describe* the techniques.	Cognitive	Understand
CO4	*Discuss* the kinetic properties and *Interpret* with the techniques.	Cognitive	Understand
CO5	*Describe* the salient features of industrial applications of enzyme.	Cognitive	Understand

Course Content		Hours
Unit-I	**Introduction**	6+3
Enzyme catalysis principles – Enzyme catalysis – Enzyme kinetics – Impact of pH and Temperature – Immobilization types.		
Unit-II	**Enzyme Extraction**	6+3
Extraction of crude enzyme from plant, animal and sources of microbials – Purification – Characterization – Enzyme activity – Development of enzyme assay.		
Unit-III	**Immobilization Techniques**	6+3
Enzyme Adsorption – Matrix Entrapment – Encapsulation – Cross Linking – Covalent binding and their examples – Advantage and disadvantage of immobilization techniques.		
Unit-IV	**Kinetic Properties of Enzymes**	6+3
Structure and stability of immobilized enzymes – Effect of partition – Effect of diffusion – Mass balance – Stoichiometry measurement – Role of effector molecules in enzyme kinetics.		
Unit-V	**Applications**	6+3
Overview of applications of immobilized enzyme system - Concise overview on large scale enzyme production – Enzyme products.		

Lecture	Tutorial	Practical's	Total
30	15	0	45

Text Books

1.Nicolas C. price and Lewis stevens, "Fundamentals of enzymology", Oxford University Press
2.Stanbury.Peter.F, Allan Whitaker, Stephen J. Hall, "Principles of Fermentation Technology", Third Edition, ELSIVER, 2017.

References

3.Chaplin and Bucke, "Enzyme technology", Cambridge Univerity Press.

4.James Bailey, David Ollis, "Biochemical Engineering Fundamentals", 2nd Ed., McGraw Hill Education, 2017.

E-References

1.https://nptel.ac.in/courses/102/102/102102033/

Mapping of COs Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 2	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 3	3	3	1	3	2	1	2	1	1	0	2	2	3	3
CO 4	2	1	1	1	1	1	1	1	1	0	1	1	1	1
CO 5	3	3	1	1	1	1	1	1	1	0	1	1	1	1
	14	**13**	**5**	**11**	**8**	**5**	**8**	**5**	**5**	**0**	**8**	**8**	**11**	**11**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	14	13	5	11	8	5	8	5	5	0	8	8	11	11
Scaled Value	3	3	0	3	2	0	2	0	0	0	2	2	9	3

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBT801C	WASTE MANAGEMENT AND BY-PRODUCTS UTILIZATION	L	T	P	C
		2	1	0	3
C	**P**	**A**		L	T	P	H
3	**0**	**0**		2	1	0	3

PREREQUISITE: Nil

Learning Objectives: Upon completion of this course, the students
- Will be able to understand the origin and type of waste and by products, waste identification, classification and composition.
- Will be able to describe the need for treatment and utilization of waste
- Will be able to know the legal and statutory requirements for waste handling, treatment and disposal

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Acquire*the knowledge of waste generation and the factors for waste accumulation and ***Differentiates*** the waste disposal vs waste management	Cognitive	Remember
CO2:*Characterize* the type and categories of several wastes	Cognitive	Remember
CO3:*Outlines* the methods for waste management and disposal	Cognitive	Analyze
CO4:*Discuss* and *compiles* the various methods of waste and by-products utilization from different sources	Cognitive	Analyze Understand
CO5:*Describe* the importance of safety and regulations regarding waste management	Cognitive	Remember

Unit-I	**Introduction**	**6+3**
Definition of waste – Waste handling – Factors affecting waste generation – Waste disposal vs Waste management – Rural waste vs Urban waste – Waste vs Pollution.		
Unit-II	**Waste Characterization**	**6+3**
Types of waste – Categories of solid wastes (Domestic waste, Market waste, Food waste, Agricultural waste, e-Waste, Industrial inert waste, Industrial hazardous waste, Biomedical waste, Radioactive waste, Plastic waste – Next Generation Waste.		
Unit-III	**Waste management**	**6+3**
Direct combustion of solid waste – Effluent treatment and disposal – Biowaste management (Sources, Categories, Impacts on health, Steps involved in Biomedical waste management)		
Unit-IV	**Waste and By-products utilization**	**6+3**
Introduction to by-products and waste generation in agricultural production and processing – Utilization of waste from fruit and vegetable processing – Fish, Meat and Poultry industry's waste utilization – Utilization of by-products from wheat, rice, corn and dal mills – Utilization of by-products from oil mills – Utilization of by-products from dairy industry.		
Unit-V	**Safety and regulations**	**6+3**
Legal aspects: Biomedical waste management and handling rules, CPCB (Central pollution control board) guidelines, Safe disposal of radioactive waste rules, guideline of BARC (Baba Atomic Research Centre), International Scenario: World Health Organization (WHO) guidelines on management of wastes.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
30	**15**	**0**	**45**

TEXT BOOKS:

1. Pichtel, J. (2005). *Waste management practices: municipal, hazardous, and industrial*. CRC press.
2. Arvanitoyannis, I. S. (2010). *Waste management for the food industries*. Academic Press.

REFERENCE BOOKS:

4. Sayler, G. S., Fox, R., & Blackburn, J. (Eds.). (2013). *Environmental biotechnology for waste treatment* (Vol. 41). Springer Science & Business Media.
5. Nigam, P. S. N., & Pandey, A. (Eds.). (2009). *Biotechnology for agro-industrial residues* utilisation: utilisation of *agro-residues*. Springer Science & Business Media.
6. Dhillon, G. S., & Kaur, S. (Eds.). (2016). *Agro-industrial wastes as feedstock for enzyme production: apply and exploit the emerging and valuable use options of waste biomass*. Academic Press.

E- REFERENCES

1. https://nptel.ac.in/courses/120/108/120108005/
2. https://nptel.ac.in/courses/105/106/105106056/
3. http://ecoursesonline.iasri.res.in/course/view.php?id=518

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	0	0	2	0	1	2	0	3	0	0	1	1	0	0
CO 2	0	0	2	0	1	2	0	3	0	0	1	1	0	0
CO 3	3	3	1	2	1	0	3	1	2	1	1	1	0	3
CO 4	3	3	1	3	1	0	3	1	2	1	1	1	3	3
CO 5	0	0	2	0	1	3	0	3	2	1	1	1	0	0
	6	**6**	**8**	**5**	**5**	**7**	**6**	**11**	**6**	**3**	**5**	**5**	**3**	**6**

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	6	6	8	5	5	7	6	11	6	3	5	5	3	6
Scaled Value	3	1	0	1	1	1	0	0	1	1	1	1	0	0

1-5 →1, 6-10→2, 11-15→3

No relation, 1-Low Relation, 2- Medium Relation, 3-High Relation

XBT 804			PROJECT WORK PHASE-II	L	T	P	C
				0	0	9	9
C	**P**	**A**		**L**	**T**	**P**	**H**
6	**3**	**3**		**0**	**0**	**9**	**18**

PREREQUISITE: - Nil

COURSE OUTCOMES:

Course Outcomes		Domain	Level
On the successful completion of the course, students will be able to			
CO1	Identify the Engineering Problem relevant to the domain interest.	Cog	Analyze
CO2	Interpret and Infer Literature survey for its worthiness.	Cog	Analyze Apply
CO3	Analyse and identify an appropriate technique for solve the problem.	Cog	Analyze Apply
CO4	Perform experimentation /Simulation/Programming/Fabrication, Collect and interpret data.	Phy Cog	Comp. Overt Resp., Create, Apply
CO5	Record and Report the technical findings as a document.	Cog	Remember, Understand

Mapping of COs with Pos

	CO1	CO2	CO3	CO4	CO5	Total
PO1	3	2	1	2	1	9
PO2	3	2	1	2	1	9
PO3	-	-	1	3	1	5
PO4	-	1	2	3	1	7
PO5	-	-	2	3	1	6
PO6	1	-	1	1	-	3
PO7	1		1	1	-	3
PO8	1	-	1	1	-	3
PO9	-	-	-	-	2	2
PO10	-	-	-	-	3	3
PO11	-				2	2
PO12	1				3	4
PSO1	1	1	1	1	1	5
PSO2	1	1	1	1	1	5

1 - Low, 2 – Medium, 3 – High

Open Electives

XBTOE1			INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students

- Would have understood the various types of IPR.
- Would have learnt to search the database, drafting the patent and filing process.
- Would have understood about the IPR audit and related disputes.
- Would have earned knowledge on IPR and earned certificates from WIPO, NPTEL and other portals.
- Would able to identify new GI, protect copyright, design and filing a patent

Course Outcomes		Domain	Level
CO1	***Understand***the significance of IPR and ***identify*** various types of IPR.	Cognitive	Understand
CO2	***Understand*** the process of *registration and* ***infer*** *the valuation of IP*.	Cognitive	Understand
CO3	***Understand*** the legal framework and ***infer*** legislative process in India, selected countries and WIPO	Cognitive	Understand
CO4	***Understand*** the international commitment and ***imply*** suitable market for the registered IP.	Cognitive	Understand
CO5	***Apply*** your understandingand***create***a new GI, filing patent, novel design or copyright and recognition or commercialization of the IPR	Cognitive	Understand

I - Introduction to IPR	9

Creativity, Invention, Innovations; Importance of Intellectual Property; Types of Intellectual Property; History and development of IPR in India – Initiatives by Indian Government towards& WIPO IPR – advancement in S&T, traditional knowledge and biodiversity resources. WIPO distance learning courses in WIPO.

Distance Learning Courses in WIPO (Any three courses; all are free of cost)

21. DL-General Course on Intellectual Property (version 2) [DL101E20S4]
22. e-Tutorial on using Patent Information (DL-177) [DL177E20S2]
23. IP Panorama [DLIPP PanoramaE21]
24. DL-001 Primer on Intellectual Property [DL001E20]
25. DL-301 Patents (Open) [DL301OE19S2]
26. DL-201 Copyright and Related Rights (Open) [DL201OE19]
    Study material inIPR -India (Need to submit a page report)
27. https://ipindia.gov.in/index.htm
28. https://ipindiaonline.gov.in/trademarkefiling/user/frmloginNew.aspxOptional Courses

(registration cost is required)	
29. https://e-learning.iptse.com/	
II- Types, Registration and Valuation of IPR (India/Pct)	**9**

Patents – Copyrights and related rights – Trade Marks – Industrial Designs – Protection of Integrated Circuits and Layout Design – Geographical Indications of Goods – Biological Diversity – Plant Varieties and Farmers Rights – Trade Secrets / undisclosed information.

Distance Learning Course in WIPO and study material in IPR-India

30. DL302 Trademarks, Industrial Designs and Geographical Indications (Open) [DL3020E19]
    GATE way in IPR-India
31. https://ipindia.gov.in/designs.htm
    Patent Search (Practice and submit a two pages report)
32. https://ipindiaservices.gov.in/publicsearch

III- Legal and Legislation Framework in India	**9**

IPR Laws – Owner's Rights – Negotiation of International Treaties – Traditional Knowledge Digital Library (TKDL) – Commercialization of IPR – Enforcement and Adjudication – Human Capital Development.
Study material to learn TKDL, Patent Act 1970 (Need to submit a page report)

33. http://tkdl.res.in/tkdl/langdefault/common/Abouttkdl.asp?GL=Eng
34. https://www.indiacode.nic.in/bitstream/123456789/1392/3/a1970-39.pdf

IV- International Conventions and Treaties	**9**

WTO - International conventions – Establishment of WIPO – General Agreement on Trade and Tariff (GATT) – TRIPS – PCT.

35. DL101PCT Distance Learning Course: Introduction to the Patent Cooperation Treaty [PCT101E19]
    Optional: students who are interested can carry out the following course and earn certificate (which is signed from WHO, WIPO and WTO).
36. DL701 Promoting Access to Medical Technologies and Innovation – WHO, WIPO, WTO Executive Course on the intersections between public health, intellectual property and trade [DL7011ENT19S2]

V - IPR Management	**9**

Drafting patent specification – Claims- IPR audit-IP asset management – IP Litigations – Transfer of Rights – IP training and education – IP valuation – Agreement Drafting.
Reading the material and submission of a page note; Optional: earning certificate from NPTEL and WIPO.

37. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-hs14/
38. https://www.wipo.int/sme/en/ip_audit/
39. https://www.wipo.int/ipadvantage/en/
40. http://164.100.236.140/e-gateways.htm#comprehensive-e-filing
    Optional: Identify a GI need to be registered in your place; Filing patent of your innovation; Novel Design need to protected; Copyright of your work registered

Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**0**	**45**
Text Books			

| 2. | SubbaramN.R."Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998. |

E-References

5. Neeraj Pandey, KhushdeepDharni, Intellectual Property Rights, PHI Private Limited, Delhi, 2014.
6. Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com].
7. Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. [www.ipmatters.net/features/000707_gibbs.html.

E Resources

6. http://www.wipo.int/patentscope/en/
7. http://www.ipindia.nic.in/
8. http://www.uspto.gov/
9. https://www.epo.org/index.html
10. https://www.jpo.go.jp/

Mapping Of Cos and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

$1 - 5 \rightarrow 1,$ $6 - 10 \rightarrow 2,$ $11 - 15 \rightarrow 3$

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBTOE2			BIOSAFETY MANAGEMENT	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students

- Would have understood the various types of safety aspects.
- Would have learnt to behave with precautions.
- Would have understood about the Biosafety requirements in all areas.
- Would have earned knowledge on Biosafety system to set in their working place to avoid the risks.

Course Outcomes		Domain	Level
CO1	*Understand* the significance of Safety and *identify* Various types of Safety.	Cognitive	Understand
CO2	*Understand* the Biosafety and *infer* with the Management.	Cognitive	Understand
CO3	*Understand* the Guidelines of Biosafety and *infer* with the Various Safety Committee.	Cognitive	Understand
CO4	*Understand* the Hazards and *imply* the Analysis System.	Cognitive	Understand
CO5	*Understand* the risk and *Imply* the various safety Risk Analysis.	Cognitive	Understand

Course Content	Hours
Unit-I Introduction to Safety	9
Phenomena of safety –Types of Hazards: Physical, Chemical, Biological, Ergonomics and noise hazards – Concept of Industrial safety apply over Biosafety.	
Unit-II Introduction to Biosafety	9
Historical Background of Biological Safety – Primary Contaminants for Biological Safety – Introduction to Microorganisms – Biosafety Level of Specific Microorganisms - Emerging of Biosafety in global – Level of Infectious Agents and Infectious Animals	
Unit-III Guidelines of Biosafety	9
Guidelines from Goverment of India – Definitions of GMOs & LMOs – Roles of Institutional Biosafety Committee, RCGM, GEAC – Roles of GMO in Food, Agricultural and Environmental Sectors.	
Unit-IV Hazard Analysis	9
Hazard identification and control – HAZOP, job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Safety Survey – Plant inspection – Past accident analysis.	
Unit-V Risk Analysis	9
Risk Assesment, Management and Communication –Overview of National Regulations and Relevant International Agreements Including Cartagena Protocol – Safety Procedures: Handling and Storage of Chemicals, Fire Chemistry and its Control – Personal Protections.	

Lecture	Tutorial	Practical	Total
45	**0**	**0**	**45**

Text Books

1. Fleming and Hunt, "Biological Safety, Principles and Practices" 5th edition, ASM Press, 2017.
2. Deshmukh, L.M., "Industrial Safety Management (Hazard identification and risk control)", TATA McGraw Hill, 2008.

References

1. Raghavan, K.V. and Khan, A.A., "Methodologies in Hazard Identification and Risk
2. **https://www.who.int/publications-detail-redirect/9241546506 (Manual from WHO)**

E Resources

1. http://www.geacindia.gov.in/resource-documents/13_2-Regulatory_Framework_for_GE_Plants_in_India.pdf
2. https://ibkp.dbtindia.gov.in/Content/Commitee?AspxAutoDetectCookieSupport=1

Mapping Of Cos and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

XBTOE3			DIGITAL HEALTH	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0					
				3	0	0	3

Prerequisite: -

Learning Objectives:

Upon completion of this course, the students
- Students will get aware of Digital Health
- Students will learn analytical skill on digital data
- Students can develop employability opportunity

Course Outcomes		Domain	Level
CO1	*Understand* the significance of Digital health and *identify* Various types employability from digital health..	Cognitive	Understand
CO2	*Understand* the functions and goals and *infer* with the Digital Health Management.	Cognitive	Understand
CO3	*Understand* the products of digital health and *infer* with the services.	Cognitive	Understand
CO4	*Understand* the Digital Health Applications and *imply* the Analysis System.	Cognitive	Understand
CO5	*Understand* the innovations and *Imply* the Entrepreneurship from digital health.	Cognitive	Understand

Course Content		Hours
Unit-I	**Fundamentals of Digital Health**	**9**
Introduction to Healthcare; Application of Technology in Medicine; Information Technology for Health Informatics; Software development for improving healthcare; Public policy for Health Informatics; Current trends in Health Informatics.		
Unit-II	**Function and Goals of Digital Health**	**9**
The objectives of digital health products and services- strategy to improve the quality of outcomes of digital health products and services; population health; patient experience and health disparities.		
Unit-III	**Digital Health Products and Services**	**9**
Remote sensing and wearables, Telemedicine, health information exchange, Data analytics and intelligence- Artificial Intelligence and Business Intelligence, predictive modeling, Health and wellness behavior modification tools, Bioinformatics tools(-omics), Medical social media, Digitized health record platforms, Patient -physician-patient portals, Decision support systems, Imaging, Personalized and Precision Medicine.		
Unit-IV	**Applications of Digital Health**	**9**
Diagnosis, Treatment, Prevention and Wellness, Rehabilitation, Behavioral Health, Disease Management, Public Health.		

Unit-V	Innovation and Entrepreneurship in Digital Health	9

Intellectual Property Protection, Regulatory Issues, Business Models, Financing Digital Health Startup Ventures, Leading High-Performance digital Health Teams, Product and Customer Development, Startup Methodologies, Clinical Validation and Translational Research, Data Security and Confidentiality.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books

1. Ronquillo Y., Meyers A., and Korvek S.J., "Digital Health" Statpearls Pulishing, Treasure Island (FL), 2021.

References

1. Rivas H., "Digital Health: Scaling Healthcare to the world (Health Informatics)", Springer Publisher, 2018.

E Resources

1.https://www.coursera.org/learn/introduction-to-digital-health
2.https://www.who.int/docs/default-
3.source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf

Mapping Of Cos and POs

	Program Outcomes													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO2	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO3	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO4	2	0	2	0	2	3	1	3	3	0	2	3	0	0
CO5	2	0	2	0	2	3	1	3	3	0	2	3	0	0
	10	0	10	0	10	15	5	15	15	0	10	15	0	0

0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	10	0	10	0	10	15	5	15	15	0	10	15	0	0
Scaled Value	2	0	2	0	2	3	0	3	3	0	2	3	0	0

$1 - 5 \rightarrow 1$, $6 - 10 \rightarrow 2$, $11 - 15 \rightarrow 3$
0 - No Relation, 1 - Low Relation, 2- Medium Relation, 3- High Relation

Value Added Course

8thBoard of Studies for the programme B.Tech Biotechnology was conducted on 19.Aug.2021. The following new value added courses were introduced and recommended for ACM approval.

1. R Program and R Studio for Biotechnologist

S.No	Topic	Hrs
	Course Description	
11.	R and Rstudio Installation and Operation	3
12.	Variables and Data Types	3
13.	Data Frames	3
14.	Recasting and Joining of Data Frames	3
15.	Arithmetic, Logical and Matrix Operation in R and Rstudio	3
16.	R Functions	6
17.	Control Structures	3
18.	Basic Data Visualization	3
19.	Introduction to apply on Biotechnology Domain	3
20.	Report Submission	-
	TOTAL	**30**

References:
R.Ragunathan and N. Shankar, "Data Science for Engineers" NPTEL, CSE, IIT Madras.

2. Python for Biotechnologist

S.No	Topic	Hrs
	Course Description	
12.	Python Installation and Operation	3
13.	Fundamentals of the Program – An Introduction	3
14.	Variables and Expressions	3
15.	Math Module	3
16.	Statements and Type	3
17.	Functions	3
18.	Code organizations	3
19.	Conditionals and Exercise	3
20.	Introduction to Biopython	3
21.	Installation of Biopython and Guide to do program in Online	3
22.	Report Submission	-
	TOTAL	**30**

References:
https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1004867
http://biopython.org/DIST/docs/tutorial/Tutorial.html

3. Training on Hospital's Clinical Research Lab

Course Description		
S.No	Topic	Days
1.	Clinical Data Management	3
2.	Clinical Research	3
3.	Pharmacovigilance	3
4.	Anatomy and Physiology	3
5.	Infectious Diseases	3
6.	Bacterial Infection Treatment	3
7.	Viral Infection Treatment	3
8.	Fungai Infection Treatment	3
9.	Basic Training on Hospital Equipments for Diagnosis	3
	Combine with Deepam Hospitals – Tambaram (West) Chennai	
	TOTAL	**27**

References:

Materials Provides by Trainers

4. Downstream Manufacturing (Microbial)

Course Description		
S.No	Topic	Hrs
1.	Basic Requirements	3
2.	Initiating	3
3.	Microbial Medium preparations	3
4.	Conditions Maintenance	3
5.	Loading and Operating	3
6.	Trouble Shooting	3
7.	Product Yielding	3
8.	Purification	3
9.	Quality and Quantity Analysis	3
10.	Operating Test and Report Writing	3
	Exclusive training on Labscale fermenter Imported from Boengineering Swizerland	
	TOTAL	**30**

References:

Bioengineering Fermenter Manual Book.

Biotechnology specialization course curriculum and syllabus

B.Tech (Hons) Biotechnology (*Specialization in Computer Science and Biology*)

Curriculum and Syllabus

Computer Science and Biology is the combined application of the Maths, Statistics and computer programming to solve Biology based problems and applications. All the below computer programming will be thought and trained in appropriate Biological applications emerging in current requirements in Bio-Industries.

S.No	Course Code	Semester	Courses	Credits				Hours			
				L	T	P	C	L	T	P	Total
1.	XBTHC1	III	C and Java	1	0	2	3	3	0	2	5
2.	XBTHC2	IV	Python	1	0	2	3	3	0	2	5
3.	XBTHC3	IV	Biostatistics	2	1	0	3	3	2	0	5
4.	XBTHC4	V	R program and R studio	1	0	2	3	3	0	2	5
5	XBTHC5	VI	MAT Lab	1	0	2	3	3	0	2	5
6	XBTHC6	VII	Mini Project	0	0	5	5	0	0	10	10
			Total	**6**	**1**	**13**	**20**	**15**	**2**	**18**	**35**

Total Credit = 20

Semester III

XBTC01			C and JAVA		`L	T	P	C
C	P	A			1	0	2	3
					L	T	P	H
3	0	0			2	0	3	5

COURSE CONTENT		Hours
UNIT I	**Introduction Computing**	**3**
	Computing systems, Computing environments, Computer languages, Creating and running programmes, Program Development.	
UNIT II	**Introduction to the C Language**	**10**
	Background, C Programs, Identifiers, Types Variables, Constants, Input/ Output Operators – Arithmetic, Relational, Logical, Bitwise, etc. Statements, Switch statements, Repetition statements, Arrays, Strings, Structures, Apply for simple biological application using C programme.	
UNIT III	**Introduction to JAVA**	**8**
	What is Java? And Java Installation, Java program structure and Java data types, Java variables.	
UNIT IV	**Operators in JAVA**	**12**
	Java Control Flow:- Decision Making and Loop Statements, Java Numbers and Strings, Java array and array list, Apply for simple biological application using Java.	
UNIT V	**Introduction to React JS**	**12**
	Java script library, React components and JSX, props, state.	
Total Hours		**45**

TEXT BOOKS/REFERENCE BOOKS

1. C to All, S.Thamarai Selvi, R. Murugesan, Anuradha Publications.
2. Programming in C, Ajay Mittal, Pearson.
3. JAVA A Beginner's Guide, Herbert Schildt,
4. Learning React : A Hands - On Guide – to building web applications using React and Redux, Kirupa Chinnathambi.

Semester IV

XBTC02			Python	`L	T	P	C
C	P	A		1	0	2	3
3	0	0		L	T	P	H
				2	0	3	5

COURSE CONTENT		Hours
UNIT I	**Introduction to Python Language**	**3**
	History of Python, Basic installation, Sources of downloads.	
UNIT II	**Operation of Python**	**12**
	Language Syntax, Keywords Identifiers, Python Comments, Python Data Types, Python Operators.	
UNIT III	**Python Control Flow Decision Making**	**15**
	Looping, Branching, Numbers, Strings, Lists, Tuples, Sets, Arrays, File Handling	
UNIT IV	**Applications**	**15**
	Apply on various applications – Mathematical equations – Data Science – Biological systems.	
Total Hours		**45**

TEXT BOOKS/REFERENCE BOOKS

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
3. Karl Beecher, "Computational Thinking: A Beginner & 39;s Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.
4. G Venkatesh and MadhavanMukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
5. John V Guttag, " Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press 2021 GE3151 Notes PROBLEM SOLVING AND PYTHON PROGRAMMING
6. Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", Starch Press 2nd Edition,
7.https://www.python.org/
8. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

XBT 501	BIOSTATISTICS	L	T	P	C
		2	1	0	3
C **P** **A**		L	T	P	H
3 **0** **0**		2	1	0	3

Course content	Hours
INTRODUCTION TO STATISTIC	**10**
Introduction, graphical representation of data. Measures of central tendency, dispersion. Significance of statistics to biological problems, experimental studies; randomized controlled studies, historically controlled studies, factorial design, cluster design,; completely randomized block design, analysis and interpretation.	
DESCRIPTIVE STATISTICS AND OBSERVATIONAL STUDY DESIGN	**12**
Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, case control studies, outcomes, odd ratio and relative risks. Principles of statistical inference: Parameter estimation, hypothesis testing. Variables; categorical data, binomial distribution, Normal distribution	
COMPARISON OF MEANS	**12**
Test statistics; t-test, F distribution, independent and dependent sample comparison, Wilcoxon Signed Rank Test, Wilcoxon Mann-Whitney Test, ANOVA. Correlation and simple linear regression: Introduction, Karl Pearson correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, regression model fit, Multiple linear regression and linear models: Introduction, Multiple linear regression model, ANOVA table for multiple linear regression model, assessing model fit, polynomials and interactions. Oneway and Two-way ANOVA tables, F-tests.	
DESIGN AND ANALYSIS OF EXPERIMENTS	**11**
Random block design, multiple sources of variation, correlated data and random effects regression, model fitting. Completely randomized design, stratified design. Biological study designs. Optimization strategies with case studies.	
	Total:45

Text Books:

1. Biostatistics Alvin E. Lewis McGraw-Hill Professional Publishing 2013
2. Statistics and Numerical Methods in BASIC for Biologists J.D. Lee and T.D. Lee Van Nostr and Reinhold Company 1982
3. Statistical Analysis of Gene Expression Microarray Data T.P. Chapman CRC 2003
4. SAS Essentials: Mastering SAS for Data Analytics Alan C. Elliott , Wayne A. Woodward John Wiley & Sons 2nd Edition, 2015
5. Numerical Methods of Statistics (Cambridge Series in Statistical and Probabilistic Mathematics) John F. Monahan Cambridge University Press 2011
6. Numerical Methods for Engineers and Scientists Joe D. Hoffman CRC Press 2ndEdition, 2001
7. Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health) Warren J. Ewens Gregory Grant Springer 2005

XBTC03			R Programme and R Studio	`L	T	P	C
C	P	A		1	0	2	3
3	0	0		L	T	P	H
				2	0	3	5

COURSE CONTENT		Hours
UNIT I	**Introduction**	5
	Introduction to R Program and R Studio, Difference between R Program and R Studio, Downloads sources, Installation and updating.	
UNIT II	**R Language**	9
	Overview, Data types, Operators, decision making.	
UNIT III	**Operation**	9
	Loop Control, Array, String, Function, Vector, Lists, Matrices.	
UNIT IV	**Data Operation**	10
	Factors, Data Frames, Data and File Management, Charts and Graphs.	
UNIT V	**Applications**	12
	Running R studio – Biological applications on R Program and R Studio	
Total Hours		45

TEXT BOOKS/REFERENCE BOOKS

1. Hadley Wickham, R for Data Science, 1st edition, O'Reilly,2017
2. Tilman M. Davies, The Book of R, 1st edition, 2016.
3. Data Science for Engineers, RagunathanRengasamy, Shankar Narasimhan, IIT Madras, NPTEL.
4. François Chollet with J. J. Allaire, Deep Learning with R, Second Edition , 2018.

Semester VI

XBTC04			MATLAB	`L	T	P	C
C	P	A		1	0	2	3
3	0	0		L	T	P	H
				2	0	3	5

COURSE CONTENT	Hours
UNIT I **Introduction**	5
Installation, Overview on Mathworks, Online operation source, Tools.	
UNIT II **Running Files**	9
Variables, Data Types, Script Files, Function files	
UNIT III **Operation**	9
Matrix, ODE, Integration, Input and Output Statements, Conditional Statements, Loops, Arrays, Array Function.	
UNIT IV **Data Operation**	10
Factors, Data Frames, Data and File Management, Charts and Graphs.	
UNIT V **Applications**	12
Numerical methods, Image processing, Simulink, AI, Data Science - Introduction	
Total Hours	45

TEXT BOOKS/REFERENCE BOOKS

1. Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers, by RudraPratap,OUP USA,2005.
2. Programming and Engineering Computing with MATLAB 2018 by Huei-Huang Lee, SDC Publications, 2018
3. Holly Moore, " MATLAB for Engineers" Third Edition – Pearson Publications.
4. Stephen J. Chapman, "MATLAB Programming for Engineers" Fourth Edition –Thomson learning