PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

PERIYAR MANIAMMAI
INSTITUTE OF SCIENCE & TECHNOLOGY
(Deemed to be University)
Established Under Sec. 3 of UGC Act, 1956 • NAAC Accredited
think • innovate • transform

Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.3	Average percentage of courses having focus on employability/ entrepreneurship/ skill Development offered by the Biotechnology

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS COPY OF THE COURSES HIGHLIGHTING THE FOCUS ON EMPLOYABILITY/ ENTREPRENEURSHIP/ SKILL DEVELOPMENT

1. List of courses for the programmes in order of

S. No.	Programme Name
i.	Bachelor of Technology(Biotechnology)(Full Time)

2. Syllabus of the courses as per the list.

Legend : Words highlighted with **Blue Color** - Entrepreneurship
Words highlighted with **Red Color** - Employability
Words highlighted with **Green Color** - Skill Development

Name of the Course	Course Code	Year of Introduction	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
B.Tech. Biotechnology (Full Time)			
2022-23 ACADEMIC YEAR			
Calculus and Linear Algebra	XMA101	2018-19	Skill development
Programming for Problem Solving	XCP102	2013-14	Skill development
Speech Communication	XGS105	2021-22	Skill development
Programming for Problem Solving Laboratory	XCP107	2013-14	Skill development
Applied Physics for Engineers Laboratory	XAP108	2018-19	Skill development
Calculus, Ordinary Differential Equations and Complex Variable	XMA201	2018-19	Skill development
Electrical and Electronic Engineering Systems	XBE202	2018-19	Skill development
Technical Communication	XGS204	2021-22	Skill development
Workshop Practices	XWP205	2018-19	Skill development
Chemical Engineering Thermodynamics	XBT206	2014-15	Employability Skill
Electrical and Electronic Engineering Systems Laboratory	XBE207	2018-19	Skill development
Applied Chemistry for Engineers Laboratory	XAC208	2018-19	Skill development
Probability and statistics	XPS301	2018-19	Skill development
Biochemistry	XBT302	2021-22	Employability Skill
Microbiology	XBT303	2021-22	Employability Skill
Material and Energy Balances	XBT304	2019-20	Employability Skill
Entrepreneurship Development	XUM306	2016-17	Employability Skill, Entrepreneurship
Biochemistry Laboratory	XBT308	2021-22	Skill development
Microbiology Laboratory	XBT309	2021-22	Skill development
In-plant Training - I	XBT310	2014-15	Employability Skill

Basic Transport Processes	XBT401	2021-22	Employability Skill
Cell Biology	XBT403	2021-22	Employability Skill
Immunology	XBT404	2021-22	Employability Skill
Economics for Engineers	XUM405	2016-17	Entrepreneurship
Basic Transport Processes Laboratory	XBT407	2021-22	Skill development
Cell Biology Laboratory	XBT408	2021-22	Skill development
Immunology Laboratory	XBT409	2021-22	Skill development
Bioinstrumentation	XBT501	2018-19	Employability Skill, Skill development
Molecular Biology	XBT502	2016-17	Employability Skill
Bioprocess Engineering	XBT503	2018-19	Employability Skill, Skill development
Plant biotechnology	XBT504A	2016-17	Employability Skill
Food technology	XBT504B	2016-17	Employability Skill
Chemical reaction engineering	XBT504C	2016-17	Employability Skill
Employability Skill And Report Writing	XUM506	2016-17	Employability Skill
In-Plant training-II	XBT508	2014-15	Employability Skill
Economics for Engineers	XUM601	2016-17	Entrepreneurship
Bioreactor Design	XBT602	2016-17	Employability Skill, Skill development
Recombinant DNA technology	XBT603	2016-17	Employability Skill, Skill development
Immunology	XBT604	2016-17	Employability Skill
Animal biotechnology	XBT605A	2016-17	Employability Skill
Nanobiotechnology	XBT605B	2016-17	Employability Skill
Heat transfer	XBT605C	2016-17	Employability Skill
Protein engineering	XBT701A	2016-17	Employability Skill
Pharmaceutical biotechnology	XBT701B	2016-17	Employability Skill
Bioinformatics and Computational Biology	XBT702	2016-17	Employability Skill, Skill development
Downstream processing	XBT703	2016-17	Employability Skill, Skill development
Cancer biology	XBT704A	2016-17	Employability Skill
Stem cell biotechnology	XBT704B	2016-17	Employability Skill

Metabolic engineering	XBT704C	2016-17	Employability Skill
In-plant Training – III	XBT707	2014-15	Employability Skill
Project Work (Phase-II)	XBT804	2018-19	Employability Skill, Entrepreneurship

SYLLABUS FOR B.TECH Biotechnology (FT)

ACADEMIC YEAR 2022-23

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**		**4**	**1**	**0**	**5**

PREREQUISITE: Differentiation and Integration

COURSE OUTCOMES:

Course outcomes:		**Domain**	**Level**
CO1	**Apply** the orthogonal transformation to reduce quadratic form to canonical forms.	Cognitive	Applying
CO2	**Apply** power series to tests the convergence of the Sequences and series and Half range Fourier sine and cosine series.	Cognitive Psychomotor	Applying Guided Response
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian	Cognitive	Applying
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	Understanding Receiving
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.	Cognitive	Applying

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

Course Code	:	XCP102	L	T	P	C
Course Name	:	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3
Prerequisite	:	Basic Understanding Skills	L	T	P	H
C	P	A	3	0	0	3
3	0	0				

Course Objectives

- To learn programming language basics and syntax
- To ignite logical thinking
- To understand structured programming approach
- To deal with user defined data types
- To know about data storage in secondary memory

Course Outcome: After the completion of the course, students will be able to		**Domain**	**Level**
CO1	***Define*** programming fundamentals and ***Solve*** simple programs using I/O statements	Cognitive	Apply
CO2	***Explain simple programs*** using control structures and arrays	Cognitive	Understand
CO3	***Explain the simple programs*** using functions and pointers	Cognitive	Understand
CO4	***Explain simple programs*** using structures and unions	Cognitive	Understand
CO5	***Explain simple programs*** using files and ***Build*** simple projects	Cognitive	Understand

COURSE CONTENT

UNIT-I	**PROGRAMMING FUNDAMENTALS AND I/O STATEMENTS**	**9**

Introduction to components of a computer system, Program–Flowchart –Pseudo code– Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, and Operators – sample program structure -Header files – Data Types- Variables - Output statements –Input statements.

UNIT -II	**CONTROL STRUCTURE AND ARRAYS**	**9**

ControlStructures–ConditionalControlstatements:Branching,Looping-Unconditional control structures:switch,break,continue,gotostatements–Arrays:OneDimensionalArray–Declaration –Initialization–AccessingArrayElements–Searching–Sorting–TwoDimensionalarrays-Declaration– Initialization–MatrixOperations–MultiDimensionalArrays-Declaration–Initialization.Storage classes: auto –extern–static. Strings: Basic operation son strings.

UNIT -III	**FUNCTIONS AND POINTERS**	**9**

Functions: Built-in functions–User Defined Functions-Parameter passing methods-Passing arrays to functions–Recursion-Programs using arrays and functions. Pointers-Pointer declaration Address operator-Pointer expressions & pointer arithmetic-Pointers and function-CallbyvalueCall by Reference-Pointer to arrays-Use of Pointers itself-referential structures-Notion of linked list

UNIT -IV	**STRUCTURES AND UNIONS**	**9**

Structures and Unions-Giving values to members-Initializing structure-Functions and structures -Passing structure to elements to functions-Passing entire function of unction's-Arrays of structure-

Structure with in a structure and Union.			
UNIT -V	**FILES**		**9**
File management in C-File operation function sin C-Defining and opening a file-Closing a file-The get and put functions-The print & scan functions-seek function–Files and Structures.			
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, Programming in ANSIC, Tata McGraw-Hill, 7th edition 2017.
2. Brian W.Kernighan and Dennis M.Ritchie,"TheCProgrammingLanguage",Pearson EducationInc.2005
3. Johnson baugh R. and KalinM.,“ApplicationsProgrammingin ANSIC”, III Edition, 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 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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		**Domain**	**Level**
After completion of the course, students will be able to			
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 PushpLata.*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 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSECODE			XCP107	L	T	P	C
COURSENAME			Programming For Problem Solving Laboratory	0	0	1	1
PREREQUISITES			Basic Understanding Skills	L	T	P	H
C	P	A		0	0	2	3
0.75	1	0.25					

LEARNING OBJECTIVES

- To learn programming language basics and syntax
- To ignite logical thinking
- To understand structured programming approach
- To deal with user defined data types
- To know about data storage in secondary memory

COURSEOUTCOMES		DOMAIN	LEVEL
CO1	***Solve*** simple programs using I/O statements	Cognitive Psycomotor	Apply Respond
CO2	***Solve*** programs using control structures and arrays	Cognitive Psycomotor	Apply Respond
CO3	***Solve*** programs using functions and pointers	Cognitive Psycomotor	Apply Respond
CO4	***Solve*** programs using structures	Cognitive Psycomotor	Apply Respond
CO5	***Solve*** programs using files	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 3numbers using Branching Statements	CO2
4	Programtodisplaydivisiblenumbersbetweenn1andn2usinglooping Statement	CO2
5	Program to search an array elementinanarray.	CO2
6	Program to find largest/smallest elementinanarray.	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 mark sheet 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 an other file.	CO5
15	Program using files to store and display student mark list 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
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	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 □ 1, 6 – 10 □ 2, 11 – 15 □ 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	Applying
CO2	**Solve** first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	Cognitive	Applying
CO3	**Solve** Second order ordinary differential equations with variable coefficients using various methods.	Cognitive	Applying
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 Psychomotor	Applying 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	Applying Receiving
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	Cognitive	Understand

	characteristics of basic semiconductor devices.		
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, 6thed , 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. NagendraKrishnapura, 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 □ 1, 6 – 10 □ 2, 11 – 15 □ 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** the nature 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

		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	Understanding Guided response
CO2:	***Defining*** metal casting process, moulding methods and **relates** Casting and Smithy applications.	Cognitive Psychomotor	Remembering Perception
CO3:	***Plan*** basic carpentry and fitting operation and ***Practice*** carpentry and fitting operations.	Cognitive Psychomotor	Applying Guided response
CO4:	***Summarize*** metal joining operation and ***Practice*** welding operation.	Cognitive Psychomotor	Understanding Guided response
CO5:	***Illustrate*** the, electrical and electronics basics and ***Makes*** appropriate electrical connections**.**	Cognitive Psychomotor	Understanding Remembering 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, DhanpatRai and Co., New Delhi.
4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

E RESOURCEShttp://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 □ 1, 6 – 10 □ 2, 11 – 15 □ 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
CO6	**Calculate** required free energy, equilibrium rate constant and conversion.		Apply

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
CO6	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		0	0	3	3
1.5 : 1 : 0.5					

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. Staircase Wiring
5. Forward and Reverse bias characteristics of PN junction diode.
6. Forward and Reverse bias characteristics of zener diode.
7. Input and Output Characteristics of NPN transistor.
8. Construction and verification of simple logic gates.
9. Construction and verification of adders and subtractors

	PRACTICAL = 30	**TOTAL =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 : 1. Determination of chloride ion present in the water sample by Argentometric method. 2. Determination of total, temporary and permanent hardness of water sample by EDTA method. 3. Determination of cell constant and conductance of solutions. 4. Potentiometry - determination of redox potentials and emfs. 5. Determination of surface tension and viscosity. 6. Adsorption of acetic acid by charcoal. 7. Determination of the rate constant of a reaction. 8. Estimation of iron by colorimetric method. 9. Synthesis of a polymer/drug. 10. Saponification/acid value of oil.	**CO1** **CO1** **CO2** **CO2** **CO3** **CO3** **CO4** **CO4** **CO5** **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														

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

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	Understanding
CO2	**Find** distribution function, Marginal density function, conditional density function, **Define** density function of conditional distribution functions normal, exponential and gamma distributions.	Cognitive	Remembering
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	Remembering
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	Understanding
CO5	**Explain** small sample test for single mean, difference of mean and correlation coefficients, variance test, chi-square test with simple Problems.	Cognitive	Understanding

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	-	45

TEXTBOOKS

1.VeerarajanT.,"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

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

XBT302			BIOCHEMISTRY	L	T	P	C
				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	***Explain*** about the structure and properties of water, amino acids and proteins	Cognitive	Understand
CO2	***Illustrates*** the functions of proteins and enzymes.	Cognitive	Understand
CO3	***Identify*** the types of carbohydrates and its role in biological functions	Cognitive	Remember
CO4	***Find*** the characteristics of different types Nucleotides and Nucleic acids	Cognitive	Apply
CO5	**Evaluate** the types of transport can be applicable for different types of biomolecules across the cell membrane	Cognitive	Evaluate
CO6	**Demonstrate** the lipds, carbohydrates and proteins for cellular level functions.	Cognitive	Apply

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

		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
CO4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
CO 6	1	1	1	1	2	1	1	1	1		1	1	1	1
Total	**6**	**6**	**11**	**1**	**7**	**1**	**1**	**6**	**6**	**5**	**6**	**8**	**9**	**7**
ScaledValue	**2**	**2**	**3**	**1**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**2**	**2**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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	***Explain*** the fundamental concepts in the structure and functioning of a prokaryotic cell	Cognitive	Understand
CO2	***Illustrate*** microbial taxonomy and microbial classification methods	Cognitive	Understand
CO3	***Analyze*** microbial ecosystem and their interactions in different environments	Cognitive	Analyze
CO4	***Apply*** the bacterial growth, growth curve and microbial nutritional requirements,	Cognitive	Apply
CO5	**Demonstrate** the mechanisms of various antimicrobial drugs against pathogens applications of microorganisms,	Cognitive	Apply
CO6	**Summarize** the preferable method for microbial production	Cognitive	Understand

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 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	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
CO 6	1	2	1	2	1	2					1	1	1	1
Total	**16**	**14**	**9**	**10**	**6**	**8**	**8**	**2**	**5**	**4**	**6**	**6**	**5**	**5**
ScaledValue	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**1**	**1**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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 composition of unit process	Cognitive	Understand
CO2	***Compute*** the material balances across different unit operations	Cognitive	Apply
CO3	**Compute** the material balances across chemical reactors	Cognitive	Apply
CO4	***Explain*** the energy balance calculations for systems with and without chemical reactions	Cognitive	Understand
CO5	***Describe*** the Biotechnology stoichiometry system	Cognitive	Understand
CO6	***Calculate*** the theoretical oxygen demand	Cognitive	Apply

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, 4th Edition, 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

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO2	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO3	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO4	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO5	3	3	2	3	2	0	2	0	0	0	0	0	2	2
CO 6	2	2	1	2	1		1						1	2
Total	**17**	**17**	**11**	**17**	**11**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**11**	**11**
ScaledValue	**3**	**3**	**3**	**3**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**2**	**3**	**3**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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	0	2
Prerequisite			NIL					

Course Objectives Through this course the students will

- Understand the Entrepreneurial motivation and inclination
- Idea about the market assessment
- To get familiar in government 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

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**	**PSO 1**	**PS O2**
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
Scaled Value	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														

COURSECODE			XBT308	L	T	P	C
COURSE NAME			Biochemistry Laboratory	0	0	2	2
PREREQUISITE							
C	P	A		L	T	P	H
0.5	2	0.5		0	0	2	6

COURSE OBJECTIVES The course will provide
Hands on experience in using Biochemistry Lab
Practice on handling chemicals, Will help to make understanding on research.

	COURSE OUTCOMES	DOMAIN	LEVEL
CO1	**Prepare** a buffer and Calculate the molar extinction coefficient	Cognitive, Psychomotor, Affective	Apply Mechanism, Respond
CO2	**Practice** on the Thin Layer Chromatography by separating the amino acids.	Cognitive, Psychomotor, Affective	Apply Mechanism, Respond
CO3	**Perform** the qualitative/qualitative analysis of proteins, Carbohydrates and serum cholesterol.	Cognitive, Psychomotor, Affective	Apply Mechanism, Respond
CO4	**Estimate** the purity of DNA and Saponification Value of Fats/Oils.	Cognitive, Psychomotor, Affective	Apply Mechanism, Respond
CO5	**Determine** the β-carotene, Flavonoid	Cognitive, Psychomotor, Affective	Apply Mechanism, Respond
CO6	**Plot** the titration curves of amino acids.	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

		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
CO4	1	1	2	0	1	0	0	1	1	1	1	0	1	0
CO5	1	1	2	0	1	0	0	1	1	1	1	2	0	0
CO 6	1	2	2		1	1	2					2	2	1
Total	**6**	**7**	**12**	**0**	**6**	**1**	**2**	**5**	**5**	**5**	**5**	**9**	**9**	**7**
ScaledValue	**2**	**2**	**3**	**0**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	**XBT 309**	**L**	**T**	**P**	**C**
COURSE NAME	**Microbiology 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 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	***Demonstrate*** media preparation and sterilization techniques	Cognitive, Psychomoto, Affective	Apply Mechanism Respond
CO2	***Perform*** staining techniques, antimicrobial and cell counting assays	Cognitive, Psychomoto, Affective	Apply Mechanism Respond
CO3	***Practice*** the different culturing techniques	Cognitive, Psychomoto, Affective	Apply Mechanism Respond
CO4	***Determine*** the characteristics of bacteria	Cognitive, Psychomoto, Affective	Apply Mechanism Respond
CO5	***Experiment*** on isolation of microbes for metabolites production	Cognitive, Psychomoto, Affective	Apply Mechanism Respond
CO 6	***Apply*** the preferable method for microbial application	Cognitive, Psychomoto, Affective	Apply Mechanism Respond

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

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
CO 6	1	2	1	2	1	2					1	1	1	1
Total	16	14	9	10	6	8	8	2	5	4	6	6	5	5
ScaledValue	3	3	2	2	2	2	2	1	1	1	2	2	1	1
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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
CO6: *Display* the experience on practical skills obtained during the IPT	Cognitive	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
CO6	1		1		1		1	1	1		1	1	1	1
Total	2	1	3	4	4	0	2	4	4	4	5	1	7	7
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

IV Semester

XBT401			**Basic Transport Processes**	**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	***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:

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2
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**	**PO10**	**PO11**	**PO12**	**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

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*** the fundamental and metabolism pathways	Cognitive	Understand
CO2	***Identify*** the mechanism offatty acid and cholesterol Synthesis in *in-vivo*	Cognitive	Remember
CO3	***Explain*** oxidative phosphorylation and photophosphorylation	Cognitive	Understand
CO4	***Illustrate*** biosynthesis of amino acids and nucleotides	Cognitive	Understand
CO5	***Infer*** about the metabolic disorder anddisease	Cognitive	Analyze
CO6	***Summarize*** the oxidation process of fatty acids	Cognitive	Understand

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 photophosphorylation	**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

		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	1	3	2
CO2	1	1	2	0	1	0	0	1	1	1	1	2	2	3
CO3	1	1	2	0	1	0	0	1	1	1	1	3	1	2
CO4	1	1	2	0	1	0	0	1	1	1	1	2	1	1
CO5	1	1	2	0	1	0	0	1	1	1	1	1	1	1
CO 6	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total	**6**	**6**	**11**	**1**	**6**	**1**	**1**	**6**	**6**	**6**	**6**	**10**	**9**	**10**
ScaledValue	2	2	3	1	2	1	1	2	2	2	2	2	2	2
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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	***Explain*** the origin of eukaryotic cells and cells specialization	Cognitive	Understand
CO2	***Recall*** the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive	Remember
CO3	***Analyze*** the transport of proteins between intracellular compartments	Cognitive	Analyze
CO4	***Describe*** the types of cell division and its importance	Cognitive	Understand
CO5	***Describe*** cellular signaling and types of signaling receptors	Cognitive	Understand
CO6	***Explain*** the types of ionic pumps and its role in cellular functions	Cognitive	Understand

I – Cells and Tissues	**7**
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	**11**
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	**11**
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	**7**
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:

2. Sadava, D. E. *Cell biology: organelle structure and function*. Jones & Bartlett Learning, 1993.
3. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. *Essential cell biology*. Garland Science, 2013.
4. 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

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

XBT 404			**IMMUNOLOGY**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**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	***Write*** the general concepts of immune system	Cognitive	Remember
CO2	***Explain*** the properties of antigens and antibodies and their interactions via various tests.	Cognitive	Understand
CO3	***Describe*** various mechanisms of antigen presentation and MHC.	Cognitive	Understand
CO4	***Compare*** the different types of hypersensitive reactions	Cognitive	Understand
CO5	***Summarize various*** types vaccines and immunization techniques	Cognitive	Understand
CO6	***Explain*** the autoimmune diseases.	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:

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

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO 1**	**PS O2**
CO1	3	2	2	1	1	1	1	0	1	0	1	1	3	3
CO2	3	2	2	1		1	1	0	1	0	1	1	2	2
CO3	2	1	1		1	1		0		0	1		2	1
CO4	2	2	1				1	0	1	0	1	1	1	2
CO5	2	2	2	1	1	1	1	0		0	1	1	1	1
CO 6	1	1	1	1	1	2		0	1	0	1	1	2	1
Total	**13**	**9**	**8**	**4**	**4**	**5**	**3**	0	**4**	0	**6**	**5**	**11**	**10**
Scaled Value	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**2**	**1**	**3**	**2**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

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	**2.64:0.24:0.12**	**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 Psychomotor	Understand Perception
CO2	***Calculate and Explain*** the Break-even point and marginal costing	Cognitive Psychomotor	Understand &Apply Perception
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 IIBREAK-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&ElinM.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	**XBT407**	**L**	**T**	**P**	**C**
COURSE NAME	**BASIC TRANSPORT PROCESSES LABORATORY**	**0**	**0**	**1**	**1**
PREREQUISITES	**-**	**L**	**T**	**P**	**H**
C:P:A	**0:0.5:0.5**	**0**	**0**	**1**	**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	**Calculate** the co efficient of discharge the various flow meters.	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO2	**Perform** the characteristics curve of the pumps	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO3	**Calculate** the minimum area required for thickener process and power calculation by mixing process	Cognitive Psychomotor	Apply Mechanism Respond
CO4	**Determine** the thermal conductivity and heat transfer coefficient by heat transfer equipments.	Cognitive Psychomotor	Apply Mechanism Respond
CO5	**Plot** the adsorption isotherm equilibria and identify the suitable solvent for solvent extraction process	Cognitive Psychomotor Affective	Apply Mechanism Respond
CO6	**Illustrate** Process control system and of MATLAB in Unit operation.	Cognitive Psychomotor	Apply Mechanism

		Affective	Respond
S.No	**List of Experiments**		**(30 hours)**
1	I. Experiment on fluid flow meters (U tube manometer, Orifice meter, Venturi meter, Pitot tube meter). II. Centrifugal and Reciprocating pumps characteristics		CO1 &CO2
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]		CO3
3	I. Heat Transfer by Conduction, Convection II. Heat Exchanger		CO4
4	I. Simple Extraction II. Batch Adsorption		CO5
5	I. Introduction to MATLAB		CO6

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

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

COURSECODE			**XBT408**	**L**	**T**	**P**	**C**
COURSE NAME			**Cell Biology Laboratory**	**0**	**0**	**2**	**2**
PREREQUISITE							
C	**P**	**A**		**L**	**T**	**P**	**H**
0	1	1		**0**	**0**	**2**	**8**

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	***Perform*** the staining technique to identify the type of cells	Cognitive Psychomotor Affective	Understand Mechanism, Respond
CO2	***Identify*** the cell viability by preferable staining method	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO3	***Practice*** the feasible staining technique for acquire the knowledge about the stages of mitotic division	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO4	***Apply*** the mechanism of SDS –PAGE electrophoresis technique by separate the proteins	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO5	***Apply*** the feasible method to separate the lipds and proteins from tissues	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO6	Study the different stages of cells	Cognitive Psychomotor Affective	Understand Mechanism, Respond

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

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

CO4	2	1	0	1	1	1	0	0	1	1	1	1	0	0
CO5	3	1	0	1	1	1	0	0	1	1	1	1	0	0
CO 6	1	1	1	1			0	0			1	1		
Total	**15**	**5**	**1**	**4**	**5**	**3**	**0**	**0**	**3**	**3**	**5**	**5**	**0**	**0**
ScaledValue	**3**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**
1 – 5 □ 1, 6 – 10 □ 2, 11 – 15 □ 3														
0-NoRelation,1-Low Relation,2-MediumRelation,3-HighRelation														

COURSE CODE	**XBT 409**	**L**	**T**	**P**	**C**
COURSE NAME	**IMMUNOLOGY LABORATORY**	**0**	**0**	**1**	**1**
PREREQUISITES		**L**	**T**	**P**	**H**
C:P:A = 0:1:1		**0**	**0**	**1**	**4**

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 Psychomotor Affective	Apply Mechanism, Respond
CO2	***Practice*** the counting of blood cells	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO3	***Demonstrate*** the ABO blood grouping system and blood group.	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO4	***Carry out*** the coupling technique to label the Antibody with Enzyme HRP.	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO5	***Demonstrate*** qualitative and quantitative assays for identifying the reaction pattern, similarity pattern, unknown concentration, separation of desired antigen.	Cognitive Psychomotor Affective	Apply Mechanism, Respond
CO6	***Interpret*** the agglutination reaction	Cognitive Psychomotor Affective	Apply Mechanism, Respond

S.No	**List of Experiments**
1	Collection of Serum from Blood
2	Isolation of lymphocytes from whole blood
3	Differential Leukocyte count
4	Total Leukocyte count
5	Total and differential count of RBC
6	Blood Grouping Experiment

7	Antibody Labelling with HRP
8	Ouchterlony double diffusion
9	Single radial immunodifussion
10	Immunoelectrophoresis
11.	DIRECT Elisa
12.	Widal test
13.	Latex Agglutination

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

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

V Semester

XBT 501			**BIOINSTRUMENTATION**	**L**	**T**	**P**	**C**
				3	**0**	**1**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**3**	**0**	**2**	**5**

Prerequisite: Physics, Applied Physics

Learning Objectives:

Upon completion of this course, the students

- Will be able to identify the different techniques used in the experiments in biotechnology.
- Will be able to distinguish various techniques involved in the processing of various biological systems

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 Affective	Understanding Respond

		psychomotor	Guided response
CO2	***Describe*** the spectrophotometric methods and ***perform***the experiments related to spectroscopy.	Cognitive Affective psychomotor	Understanding Respond Guided response
CO3	***Understand*** the electrochemical techniques and ***apply***it in various applications in biotechnology.	Cognitive Affective psychomotor	Understanding Respond Guided response
CO4	***Know*** the principle of instrumentation and ***applications*** of various imaging techniques in biological field.	Cognitive Affective psychomotor	Understanding Respond Guided response
CO5	***Distinguish*** the various separation and sequencing techniques	Cognitive Affective psychomotor	Understanding Respond Guided response

Course content	**Hours**
I – Introduction	**9+6**
Classification of instrumental methods; Concepts of accuracy, precision and limits of detection (LOD); Types of errors: random and systematic; Calibration of instrumental methods: Comparison with standards, external and internal standard addition methods; Introduction and significance of signal to noise ratio	
II – Spectroscopic Techniques	**9+6**
Regions and properties of electromagnetic radiation, Absorption, transmittance and their relationship, Beer lamberts law and its limitations, Deviations (Real, chemical and instrumental; Principle, Instrumentation and applications of UV-Visible, IR & FTIR and Circular Dichroism Spectroscopy. Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique).	
III – Electrochemical	**9+6**
Basic concept of indicators, Principle of pH meter- hydrogen electrode and glass electrode, Ion selective electrodes – Conductometry-Electrochemical cells and batteries. Standard electrodes. Three-electrode cell. Case study of blood glucose meter.	
IV – Bioimaging	**9+6**
Mass spectrometry and MALDI – TOF Analysis – Crystalline structure analysis using XRD and NMR, Scanning Electron Microscope, Transmission Electron Microscope.	
V – Separation and Sequencing Techniques	**9+6**
Importance and challenge of separations. Mass spectrometry. Affinity-based separations. Chromatography. Gas chromatography (GC). High-performance liquid chromatography (HPLC). Thin-layer chromatography (TLC). Electrophoresis. Electroosmotic flow. DNA sequencing. Sanger sequencing.	
Bioinstrumentation Lab	
List of Practical Experiments: 1. Precision, accuracy and validation in an experiment using absorption spectroscopy 2. Analysis of sample size and surface through SEM and AFM analysis. (Demonstration with instrument). 3. Isolation of pigments from leaf extract through column chromatography. 4. Absorption spectra for $KMnO_4$ 5. UV spectra of nucleic acids, protein. 6. Estimation of chloride using conductivity meter.	

7. Extraction of caffeine using HPLC and analysis of chromatogram.
8. Analysis of amino acids using TLC.
9. Analysis of amino acids using ethanol using GC.
10. Compositional analysis of by XRD

Lecture	Tutorial	Practical	Total
45	0	30	75

Text Books:

1. Willard, H.H., Merritt. I.I., Dean J.a., and Settle, F.A.,"Instrumental methods of analysis", Sixth edition, CBS publishers, 1986.
2. Skoog D.A. and West D.M., "Fundamentals of Analytical Chemistry", Saunders college Publishing, 1982.

Reference Books:

1. A.I.Vogel., "Qualitative Inorganic analysis ", V.Edition, Prentice-Hall of India (P) Ltd., New Delhi, 1991.
2. Sharma, B.K., "Instrumental Methods of Analysis ", Goel publishing House, 1995.
3. Parikh V.M., "Absorption spectroscopy of organic molecules ", Addison – Wesley Publishing Company, 1974.

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	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

	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

XBT 502			MOLECULAR BIOLOGY	L	T	P	C
				2	1	0	3
C	P	A		L	T	P	H
3	0	0		2	1	0	3

Prerequisite: Biochemistry, Genetics.

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	Remember, Understanding
CO2	***Explain*** and ***Apply***and its replication and repair	Cognitive	Understanding, Applying
CO3	***Classify*** and ***Develop*** transcription and post transcriptional modifications	Cognitive & Affective	Analyzing Receiving
CO4	***Classify***and ***Dissect*** translation and post translational processing	Cognitive	Understanding Analyze
CO5	***List*** and respond gene regulations	Cognitive & Affective	Remember (Respond)

Course content	Hours
I – Introduction to Molecular Biology - DNA and RNA	**6+3**
Scope and History. Structure of DNA-Nucleoside, Nucleotide, Base pairing, Base stacking, Double Helix, features of Watson and Crick model, major and minor groove, Supercoiling- twist, writhe and linking number. Forms of DNA- A, B, Z. Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA.	
II – Replication and Repair	**6+3**
Types and functions of DNA polymerases in Prokaryote and Eukaryote. Replication in prokaryote and Eukaryote. Proof reading activity, 5'Æ 3' exonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair.	
III – Transcription and Post Transcriptional Modifications	**6+3**
Fine structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing.	
IV – Translation and Post Translational Processing	**6+3**
Genetic code and Wobble hypothesis. Translation in prokaryote and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.	

V – Gene Regulation	6+3
Principles of gene regulation- Transcriptional and post transcriptional gene regulation-activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-lac operon, trp operon, ara operon and gal operon.	

Lecture	Tutorial	Practical	Total
30	15	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	3	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	1	2	2
CO 4	1	1	2	0	1	0	0	1	1	13	1	1	1	2
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**	**9**	**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	**5**	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**8**	**9**	**11**
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	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 503			**BIOPROCESS ENGINEERING**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**3**	**1**	**2**	**6**

Prerequisite: Microbiology, Biochemistry, Bioenergetics and Metabolism

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 study the rheological properties of media.
- 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 Psychomotor	Remembering Understanding
CO2	***Identify,reproduce,*** and ***demonstrate*** the different media components involved in a fermentation process.	Cognitive Affective Psychomotor	Remembering Valuing Applying
CO3	I***nterpret***, ***describe*** and ***differentiate*** various control systems involved in bioreactor.	Cognitive Affective Psychomotor	Understanding Receiving Phenomena Perception
CO4	***Recognize, discuss*** and ***measure*** the various transport phenomena involved in bioprocesses.	Cognitive Affective Psychomotor	Understanding Mechanism
CO5	***understand***the scale up procedure of mixing ,aeration and know the applications to ***develop*** a bio product.	Cognitive Affective Psychomotor	Understanding Creating
I – Introduction to Bioprocesses			**9+3+6**

Introduction and need for bioprocess Engineering- Biologist and Engineers differ in their approach of research- general requirements of fermentation processes – basic configuration of fermenter and

ancillaries, main parameters to be monitored and controlled – operation of fermentation processes.

II – Media Formulation and Fermentation Process Design	**9+3+6**

Sterilization of media, Composition of medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods - factorial designs, Plackett- Burmann screening designs. Process Optimization experiments: Response surface methodology – concepts & methods, design considerations, central composite designs and Box-Behnken response surface design.

III – Bioreactor Instrumentation and Control	**9+3+6**

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. Bioreactor controlling probes-manual control and automatic control system- Exhaust gas analysis and computation of oxygen transfer rate and carbon dioxide production rates-Online, offline and real time monitoring of process parameters.

IV – Transport Phenomena in Bioreactors	**9+3+6**

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	**9+3+6**

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 on Applications of Bioprocess Engineering.

Bioprocess Engineering Lab

List of Practical Experiments

1. Study of Fermenter.
2. Determination of thermal death rate constant for a fermentation process.
3. Comparison of bioprocess efficiencies in synthetic and complex industrial media.
4. Medium formulation and optimization studies.
5. Estimation of biomass concentration for microbial production.
6. Determination of oxygen mass transfer coefficient by Sulphite oxidation method.
7. Determination of oxygen mass transfer coefficient by Dynamic Gassing out method
8. Residence time distribution studies.
9. Production of Single cell proteins.
10. Various product assay techniques.

Lecture	**Tutorial**	**Practical**	**Total**
45	**15**	**30**	**90**

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
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

XBT 504A			PLANT 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: 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 tissue culture and ***knows***various media for tissue culture.	Cognitive	Remembering Understand
CO2	***Compare*** the various gene transfer methods in plants and ***relate***each other with its pros and cons.	Cognitive Affective	Organizing Responds to Phenomena
CO3	***Explain*** the various tissue culture techniques and ***describes*** the protoplast isolation techniques	Cognitive	Remembering Understanding
CO4	***Relate*** and ***analyze*** various plant breeding and related techniques	Cognitive	Understanding Analyzing
CO5	***Choose*** and **apply** the plant genetics to develop commercially important products.	Cognitive	Understanding Applying

Course content	Hours
I – Introduction to Plant Tissue Culture	**6+3**
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 hormones – Physiochemical conditions for tissue culture – Measurement of growth and viability in the tissue culture.	
II – *In vitro* Propagation	**6+3**
Types of plant tissue culture - 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 and regeneration of protoplast – Germplasm conservation and cryopreservation.	
III – Plant Breeding Techniques	**6+3**
Simple and complex inheritance - back cross - 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.	
IV – Genetic Transformation of Plants	**6+3**
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.	

V – Applications of Plant Biotechnology	6+3

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
30	15	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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
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 504B			FOOD TECHNOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

Prerequisite: Microbiology, Biochemistry, Bioprocess Engineering

Learning Objectives:

Upon completion of this course, the students

- Would be able to describe to modify foods using biotechnology
- Would be able to know the role of bacteria, yeast and mould in food processing and fermentation of foods
- Would be able to explain the role of functional foods and nutraceuticals in the promotion of human health and nutrition.
- Would be able to know packaging materials, their need according to different foods and to food quality parameters and their maintenance during storage.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Outline***the scope and importance of food biotechnology and ***describe***the biotechnological approaches to modify the foods	Cognitive	Analyzing Understanding
CO2	***Discuss*** on the fermentation strategies for different fermented foods and their microbiology aspects	Cognitive	Analyzing Understanding
CO3	***Explain*** different biotechnological approaches to produce genetically modified foods	Cognitive	Analyzing Understanding
CO4	***Describe*** the techniques adapted to preserve different kinds of foods	Cognitive	Analyzing Understanding
CO5	***Discuss*** the guidelines and regulations given for food safety and analysis	Cognitive	Analyzing Understanding

Course content	Hours
I- Introduction	9
Introduction to Food Technology: Conventional and nonconventional foods, Biotechnological approaches to improve nutritional quality and shelf life of foods, Scope and importance of food biotechnology, Future Foods	
II- Microbiology of Fermented Foods	**9**
Microbes associated with food products – Yeasts, bacteria, moulds – Fermented Foods: Yoghurt, Cheese, Soysauce, Vinegar, Wine, Beer – Cocoa, tea and coffee fermentation.	
III- Functional Foods and Genetically Modified Foods	**9**
Functional foods: categories of functional foods, role of biotechnology in functional foods, Nutrition related diseases and relevant functional foods: cardiovascular disease, cancer, obesity. Genetically modified foods: Faster maturation- Coho Salmon, Modification of poultry and egg.	
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 food- packaging materials -atmosphere in the package –Vaccum packaging, Controlled atmosphere packaging, Modified atmosphere packaging	
V- Food Quality and Safety Analysis	**9**
Food Quality and maintenance: Food quality, different factors inside and outside the food, Analytical instruments used in food analysis, Biosensors for food quality assessment. Food Regulations: Hazard Analysis Critical Control Points (HACCP), Food Safety and Standards Authority of India (FSSAI)	

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

Text Books:

1. Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., *Food Biotechnology*, CRC press, 2005.
2. M. ShafiurRahman, Handbook of food preservation, 2nd edition, CRC Press, Taylor & Francis Group, NW. 2007.
3. Richard Coles, Derek McDowell and Mark J. Kirwan, Food Packaging Technology, CRC Press, Blackwell publishing ltd. 2004.

References:

1. Jean-Richard Neeser, and J. Bruce German, eds. *Bioprocesses and biotechnology for functional foods and nutraceuticals*. CRC Press, 2004.
2. Fortin ND. 2008. Food Regulation: Law, Science, Policy and Practice. Wiley, USA. ISBN: 978-0470409695.
3. Food Safety and Standards Act and Regulations by FSSAI.
4. Byong H. Lee, *Fundamentals of Food Biotechnology*, 2nd Edition, WileyBlackwell. 2014

E - References:

1. https://nptel.ac.in/courses/103103029/34
2. https://nptel.ac.in/courses/126105015/

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

	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**	**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 504C			**CHEMICAL REACTION ENGINEERING**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have understood the concepts of reaction kinetics, the types of reactors and their performance equations

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Recall*** and ***explain*** the kinetics of a chemical reaction	Cognitive	Remembering Understanding
CO2	***Interpret*** and ***modify*** the batch reactor data	Cognitive	Understanding, analyzing
CO3	***Compare*** and ***evaluate*** the performance of batch, PFR and CSTR reactors.	Cognitive	Remembering, Understanding
CO4	***Identify*** and ***discuss*** the designs for single and multiple reactions.	Cognitive	Understanding Analyzing
CO5	**Describe** characteristics of RTD curves.	Cognitive	Remembering, Applying

Course content	**Hours**
I – Reaction Kinetics	**9**
Kinetics of Homogeneous Reactions. Elementary, non-elementary reactions – intermediates, reaction mechanism, definition of reaction rate, rate law. Temperature-dependency of a rate - Arrhenius theory-collision theory and transition state theory Concentration dependency of rate- power law model.	
II – Interpretation of Batch Reactor Data	**9**
Integral and differential methods of analysis – Half-life method – Zero-order reaction – Empirical rate equation of nth order – Irreversible first and second order reactions for variable and constant volume systems.	
III – Design of reactors	**9**

Ideal Reactors – Batch reactor, plug flow reactor, mixed flow reactor– Space time, space velocity -- Performance equations and their graphical representation.	
IV – Design of reactor for single & multiple reactions	**9**
Single reactions – Size comparison of single reactors – Auto catalytic reactions – Multiple reactions – Irreversible reactions in series and parallel.	
V – RTD Studies	**9**
General characteristics- Residence time distribution Function-Measurement of the RTD –pulse input experiment- step tracer experiment –Characteristics of the RTD –RTD in ideal Reactors – E the age distribution of fluid in RTD- Relationship between the F and E curves.	

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

Text Books:

1. Gavhane K. A. Chemical Reaction Engineering – I NiraliPrakashan, Educational Publishers, 13th Edition 2013.
2. Scott Fogler, H., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India, 2006.
3. Levenspiel, O. Chemical Reaction Engineering, 3rd Edition, 3/e, John Wiley & Sons, New York, 1999.

Reference Books:

1. Smith, J. M. *Chemical Engineering Kinetics*,3/e, McGraw-Hill International, New York, 1981.
2. S.D.Dawande, "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.
3. Richardson, J.F. and Peacock, D.G., "Coulson Richardson's Chemical Engineering." Vol III, 3rd Edition, Asian Books (P) Ltd, 2000.

E-References:

1. http://nptel.ac.in/courses/103101001/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3										1	3	1	1
CO 2	2	3		1					1			2	1	1
CO 3		1	3									3	1	1
CO 4		1	2									2	1	1
CO 5	1	2	3	1								1	1	1
	6	**7**	**8**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**11**	**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	PO 10	PO 11	PO 12	PSO 1	PSO 2
Original Value	**6**	**7**	**8**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**11**	**5**	**5**
Scaled Value	2	2	2	1	0	0	0	0	1	0	1	3	1	1

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XUM506			EMPLOYABILITY SKILL AND REPORT WRITING	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
0.5	1	1.5		3	0	0	3

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learnt to convert learning process into employability.
- Would able to write scientific article, research and review papers.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	Prepare how to face an interview and to learn how to prepare for an interview	Cognitive	Understand
CO2	Knowledge on a career related communication and learning the different formats of CV	Affective	Response
CO3	Communicates with the group of people in discussion	Affective	Value
CO4	Learn to search research papers, prepare seminars.	Psychomotor	Perception set
CO5	Execute the learning by writing scientific papers	Cognitive	Evaluate

Course content	Hours
I – Technical Skills	**9**
Interview skills; tips for various types of interviews. Types of questions asked; body language, etiquette and dress code in interview, interview mistakes, telephonic interview, frequently asked questions. Planning for the interview.	
II – CV Writing	**9**
CV Writing; difference between resume and CV; characteristics of resume and CV; basic elements of CV and resume, use of graphics in resume and CV; forms and functions of Cover Letters.	
III – Workshop	**9**
Mock interviews - workshop on CV writing – Group Discussion	
IV –Writing and Reading Activity Topics	**9**
Scientific internet search and presentation; Entrepreneurship and Project Preparation	
V – Report Writing	**9**
Article writing, review, research paper and book chapter writing.	

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Business Correspondence & Report Writing by R.C. Sharma and K. Mohan, TMH

2. How to prepare for Group Discussion & Interview (With Audio Cassette) by Prasad, TMH
3. Mary Ellen Guffey, Dana Loewy Essentials of Business Communication,Cengage Learning, 2012
4. Michael Spiropoulos, Interview Skills that win the job: Simple techniques for answering all the tough questions, Allen &Unwin, 2005

Reference Books:

1. Paul McGee, How To Write a CV That Really Works: A Concise, Clear and Comprehensive Guide to Writing an Effective CV, Hachette UK, 2014
2. William L. Fleisher,Effective Interviewing and Interrogation Techniques, Nathan J. Gordon, Academic Press, 2010.

E-References:

1. https://nptel.ac.in/noc/individual_course.php?id=noc18-hs29
2. https://nptel.ac.in/courses/109104031/
3. https://nptel.ac.in/courses/109106094/26
4. https://www.coursera.org/browse/personal-development
5. https://nptel.ac.in/courses/110105034/SM_Web/Ch14%20revised.pdf
6. http://www.utsa.edu/careercenter/PDFs/Interviewing/Types%20of%20Interviews.pdf
7. http://www.amu.apus.edu/career-services/interviewing/types.htm
8. http://www.careerthinker.com/interviewing/types-of-interview/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	0	0	0	0	0	0	0	0	0	0	0	2	0
CO 2	0	0	0	0	0	0	1	3	0	0	1	0	0	0
CO 3	0	0	0	0	0	0	0	0	3	1	3	1	0	0
CO 4	0	1	2	1	3	0	0	0	0	0	0	3	0	0
CO 5	0	0	0	3	0	0	0	0	0	3	0	1	0	0
	2	1	2	4	3	0	1	3	3	4	4	5	2	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	PO 10	PO 11	PO 12	PSO 1	PSO 2
Original Value	2	1	2	4	3	0	1	3	3	4	4	5	2	0

Scaled Value	1	1	1	1	1	0	1	1	1	1	1	1	1	0

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XBT 508			INPLANT TRAINING - II	L	T	P	C
				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

Mapping COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2													
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

COURSE CODE	XUM601	L	T	P	C
COURSE NAME	ECONOMICS FOR ENGINEERS	3	0	0	3
PREREQUISITES		L	T	P	H
C:P:A	2.64:0.24:0.12	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 Psychomotor	Understand Perception
CO2	***Calculate and Explain***the Break-even point and marginal costing	Cognitive Psychomotor	Understand &Apply Perception
CO3	***Summarize***and***Use***value engineering procedure for cost analysis	Cognitive Affective	Understand Receive
CO4	***Estimate*** replacement problem	Cognitive	Understand

UNIT I INTRODUCTION TO ECONOMICS	**08**
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 IIBREAK-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	**07**
Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.	
UNIT V DEPRECIATION	**08**
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	TUTORIAL	TOTAL
HOURS	45	0	45

REFERENCES

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&ElinM.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.

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

Table 1 : Mapping of CO's with POs

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO1	**1**	**2**	**0**	**1**	**0**	**0**	**1**	**1**	**1**	**2**	**2**	**3**
CO2	**2**	**2**	**1**	**2**	**0**	**0**	**2**	**1**	**1**	**2**	**3**	**3**
CO3	**2**	**2**	**1**	**3**	**0**	**0**	**2**	**2**	**1**	**2**	**2**	**3**
CO4	**1**	**2**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**	**2**	**3**
CO5	**1**	**2**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**1**	**2**	**3**
Scaled	**1**	**2**	**1**	**2**	**0**	**0**	**1**	**1**	**1**	**2**	**2**	**3**

0 – No relation 1- Low relation 2- Medium relation 3 – High relation

XBT 602			**BIOREACTOR DESIGN**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**3**	**1**	**2**	**6**

Prerequisite: Bioenergetics and Metabolism, Bioreactor Design Lab, Chemical Engineering Thermodynamics, Bioprocess Engneering.

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 enzyme catalyzed reaction and its kinetics.	Cognitive Affective Psychomotor	Remembering Receiving Phenomena
CO2	***Outline*** the cell kinetics and ***choose*** an appropriate method For finding the parameters for growth.	Cognitive Psychomotor	Understanding Perception
CO3	***Recognize***, ***perform*** and ***detect*** various immobilization techniques for a biochemical process.	Cognitive Psychomotor	Understanding Perception
CO4	***Identify*** and ***select*** a kinetic model and design a bioreactor according to a biochemical process	Cognitive Affective Psychomotor	Understanding Responds to Phenomena Perception

CO5	***Identify,select*** and ***follow***a bioreactor for a particular process.	Cognitive Affective Psychomotor	Understanding Receiving Phenomena

Course content	**Hours**
I – Enzymes Production and Its Kinetics	**9+3+6**
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.	
II – Cell Kinetics	**9+3+6**
Microbial, animal and plant cell cultivation –growth kinetics – factors affecting the growth – 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	
III – Immobilized Systems	**9+3+6**
Application of hydrolytic enzymes-Immobilized microbial cells, carrier binding, Entrapping, Cross linking, Advantages and disadvantages of immobilized cells, -methods and effect of mass transfer – Immobilization of microbial cells for the production of bioproducts–Immobilized cell reactor experiments-Experimental reactor systems Various immobilization Technology Case Study: Ethanol fermentation. – immobilized biocatalysts and its applications – free cell and immobilized cell reactors. Case study on immobilized cell reactor using Saccharomyces cerevisiae.	
IV – Design Considerations	**9+3+6**
Choosing the cultivation method, modifying batch and continuous reactors, Bioreactor consideration for plant and animal cell cultures, Scale up, cosiderations on aeration, agitation and heat transfer, scale down	
V – Bioreactors	**9+3+6**
Ideal Bioreactors-Type of bioreactor-Airlift bioreactors-Airlift pressure cycle bioreactors—Fluidized bed reactors-trickle bed reactors-loop reactor-Stirred tank reactors-Bubble column fermeter -Heat transfer-Monod model for a chemostat- Temperature effect on rate constant.	

List of Practical Experiments

1. Study of M-M kinetics and determination of M-M constants.
2. Extraction of enzyme from fruits and vegetable.
3. Effect of temperature on Enzyme Activity.
4. Effect of pH on Enzyme Activity.
5. Effect of substrate concentration on Enzyme Activity.
6. Enzyme immobilization by physical adsorption.
7. Enzyme immobilization by Gel Entrapment.
8. Study of Production of growth and/or non-growth associated products.
9. Study of Microbial Growth kinetics and estimation of Monod parameters.
10. Estimation of alcohol concentration in wine production.

Lecture	Tutorial	Practical	Total
45	**15**	**30**	**90**

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 603			**RECOMBINANT DNA TECHNOLOGY**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**1**	**0.5**		**3**	**1**	**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	***Recall*** the basic concepts of gene cloning and various Restriction and modification enzymes	Cognitive	Remembering
CO2	***Explain*** and ***distinguish***various vector systems	Cognitive Psychomotor	Understanding Perception
CO3	***Describes, Compares***and ***Identifies*** various techniques	Cognitive	Remembering

	involved.	Psychomotor	Analyzing Perception
CO4	***Discusses, Manipulates*** and ***Describes*** various screening and selection methods.	Cognitive Affective Psychomotor	Applying Resp. Phen. Perception
CO5	***Explain*** and ***Apply*** the applications of rDNA technology under Biosafety guidelines.	Cognitive	Remember Applying

Course content	**Hours**
I – Basic Concepts Of Gene Cloning	**9+3**
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+3+6**
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+3+12**
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).	
IV – Screening and Selection of Transformants	**9+3+12**
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+3**
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.	
Recombinant DNA Technology Lab	
List of Practical Experiments 1. Isolation of Plasmid and Genomic DNA. . 2. Restriction enzyme digestion. 3. Agarose gel Electrophoresis. 4. Southern blotting 5. SDS PAGE. 6. Western blotting. 7. Purification of digested DNA. 8. Ligation of restricted vector and genomic DNA 9. Competent cell preparation- calcium chloride method 10. creening and selection of recombinants	

Lecture	**Tutorial**	**Practical**	**Total**
45	**15**	**30**	**90**

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**
CO1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO2	3	0	3	2	2	1	0	0	0	0	1	0	0	0
CO3	3	0	3	1	3	0	0	1	0	2	0	0	0	0
CO4	3	0	3	1	3	0	0	2	0	1	0	0	0	0
CO5	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

XBT 604			IMMUNOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
1.5	1	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	Remembering Evaluating
CO2	***Explains*** the properties of antigens and antibodies and ***identify*** their interactions via various tests.	Cognitive Psychomotor	Understanding Perception
CO3	***Describe*** various mechanisms of antigen presentation and ***discuss*** the role of MHC in Ag Presentation.	Cognitive Affective	Remembering Responds to Phenomena
CO4	***Compares*** the different types of hypersensitive reactions and ***explain*** the autoimmune diseases.	Cognitive	Analyzing Understanding
CO5	***Comprehend*** the types, mechanism of vaccines and ***respond***to the various immunization techniques	Cognitive Psychomotor	Understanding Guid. Resp.

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, 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 – Monoclonal antibodies – Antigen-antibody interactions: 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**
Complement System: Functions, Components, Activation and Regulation of complement system – Allergy and hypersensitivity: Types of hypersensitivity – Autoimmunity, Auto immune disorders	

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
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 605 A			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: Cell biology, Genetic engineering

Learning Objective:

Upon completion of this course, the students

- Would have learnt animal cell culturing techniques.
- 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	Understanding
CO2: ***Describe*** various gene transfer methods in animal cells.	Cognitive	Evaluating
CO3:*Analyze* various micromanipulation techniques and **reproduce** them in fertilization technology.	Cognitive Affective	Applying Resp. phen.
CO4:*Distinguish* various methods and techniques for production of transgenic animals and cloning.	Cognitive	Understanding
CO5: ***Describe*** manipulation strategies to improve livestock production including meat and milk production	Cognitive	Evaluating

I- Cell Culture Techniques	**9**
Types and composition of media – Culture vessels and substrates used for cell culture - Primary and secondary cell lines – Monolayer culture – Suspension culture – 3D cell culture (spheroids) - Types, establishment and characterization of cell lines; Differentiation and Scaling up of animal cell culture- Measurement of cell death, viability and cytotoxicity; Immobilized cultures.	
II- Gene Transfer Techniques	**9**
Types of Gene transfer methods - Micromanipulation technology; Biology and Construction of viral vectors like SV40, adenovirus, and adeno associated virus,Transfection methods; stable and transient methods – Cloning techniques and strategies, gene therapy for animal diseases.	
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.	
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.	
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

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

Subject Versus 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	8	10	9	12	5	4	5	6	9	8	12	8	9
Scaled to 0,1,2,3 scale	3	2	2	2	3	1	1	1	2	2	2	3	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 605B			NANOBIOTECHNOLOGY	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: 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 Affective	Remembering Understanding
CO2:*Construct* microfluidic devices and ***relate*** its advantages.	Cognitive	Creating Understanding
CO3:*Design* and ***Develop*** theranostics nanoparticles	Cognitive	Creating
CO4:*Outlines* the environmental applications of nanoparticles	Cognitive	Understanding
CO5:*Understands* the Fundamentals of Nanocarriers and ***design*** a drug delivery system.	Cognitive Affective	Receiving Phenomena Creating

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.	
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.	
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.	
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.

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**	**PO 5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**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

Mapping of Subject Vs Pos

	PO 1	**PO 2**	**P O 3**	**PO 4**	**P O 5**	**PO 6**	**P O 7**	**P O 8**	**P O 9**	**PO1 0**	**P O 11**	**PO1 2**	**PSO 1**	**PSO 2**
Origina l value	8	12	7	5	12	10	7	2			5	12	8	9

Scaled to 0,1,2,3 scale	2	3	2	1	3	2	2	1			1	3	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 605C			**HEAT TRANSFER**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Pre-requisites : Nil

Learning Objectives:

Upon completion of this course, the students

- To facilitate the learners understand the basic concepts and principles of heat transfer and their applications.

Course Outcomes: After the completion of the course, students will be able to	**Domain**	**Level**
CO1: Calculate the thermal resistance and compute the conduction heat transfer rates in any system.	Cognitive	Understand and Analysing
CO2: Compute the heat transfer rate in any convection system.	Cognitive	Understand and Analysing
CO3:understanding of heat exchangers equipments and applications	Cognitive	Understand and Analysing
CO4: Calculate the heat transfer coefficients and heat transfer rates for a given radiation-system	Cognitive	Understand and Analysing
CO5: Compute the key parameters for any single effect evaporator.	Cognitive	Understand and Analysing

I- Conduction	**9 hrs**
Heat Transfer Fundamentals: Modes of heat transfer, thermal diffusivity and heat transfer coefficient, heat conduction through series and parallel resistances. Analogy between flow of heat flow of electricity and thermal conductivity; effect of temperature on thermal conductivity, conduction through extended surfaces-rectangular fin and pin-fin.	
II- Convection	**9 hrs**
Convective heat transfer - natural and forced convection; Dimensional analysis; Thermal boundary layer; Analogies and Correlations.	
III- Heat Exchangers	**9 hrs**
Types of heat exchangers; parallel & counter-flow heat exchangers; - double pipe heat exchanger, shell and tube heat exchanger -concept of LMTD - Fouling factors and Wilson's plot, heat transfer area calculation.	
IV- Radiation	**9 hrs**
Concepts of thermal radiation, absorptivity, reflectivity, transmissivity.Concept of black body and gray body, Stefan-Boltzmann's law, Kirchoff's law- the effect of radiation on temperature measurement.	

V- Evaporation			9 hrs
Types of evaporators; single-effect evaporator - capacity; economy, the effect of boiling-point elevation; Duhring's rule. Material & energy balance in single-effect evaporator.			
Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**0**	**45**
Text Books:			
1. Holman JP "Heat Transfer (SI units)" 9th Edition, McGraw Hill companies, 2010. 2. Gavhane K A "Heat Transfer (SI units)" 10th Edition NiraliPrakashan , 2010. 3. Frank Kreith Mark S.Bohn "Principles of Heat Transfer" 6th Edition, Cengage Learning india private limited, 2009.			
References:			
1. McCabe, W. L., J.C. Smith and P. Harriott, *Unit Operations of Chemical Engineering*, 7/e, McGraw-Hill International Edition, 2005. 2. Nag P K Heat Transfer Tata McGraw-Hill Edition, New Delhi, 2002. 3. Donald Q.Kern Process Heat Transfer 20th Edition, Tata McGraw-Hill Edition, New Delhi ,1997			

Mapping of COs with 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

Mapping of Subject VsPos

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
Original value	14	13	5	11	8	5	8	5	5	0	8	11	11	11
Scaled to 0,1,2,3 scale	3	3	1	2	2	1	2	1	1	0	2	3	3	3

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 701 A			PROTEIN ENGINEERING	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: Biochemistry, Molecular Biology

Learning Objective:

Upon completion of this course, the students

- Would learn to make up of proteins, structure and function.
- Would able to give mechanism of protein build up and function.
- Would learn the strategy to engineer proteins for benefits of human beings.

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Explain* and understand the aminoacid characteristics and primary structure of proteins	Cognitive	Understanding
CO2:*Explain* and ***analyze*** the secondary and super secondary structural features	Cognitive	Understanding Analyzing
CO3:*Describe* and ***compare*** the different level of protein structure and their folding mechanism.	Cognitive	Remembering Analyzing
CO4:*Explain* the protein structure its function al relationship and ***relate*** that in various examples.	Cognitive Affective	Applying Organization
CO5:*Explain* the protein engineering concepts and ***assist*** that in various engineered protein production.	Cognitive	Applying Responds to phenomena

I- Structure and Functional Aspects of Amino acids	**9 + 3**
Acid–base properties of amino acids - Stereochemical representations of amino acids - Peptide bonds - chemical and physical properties of amino acids - Detection, identification and quantification of amino acids and proteins – Stereoisomerism - Non-standard amino acids – Primary structure of proteins – peptide mapping and peptide sequencing – Edman degradation method.	
II- Protein Architecture	**9 + 3**
Ramachandran plot – Tertiary structure – Interactions that stabilize the tertiary structure – Organization of Domains – Quaternary structure – Importance of quaternary structures in globin family – haemoglobin and allosteric regulation – Methods to determine the three-dimensional structure of proteins.	
III- Protein Folding and Assembly	**9 + 3**
Protein folding: Molten globule state – Role of hydrophobic residues in folding – Single and multiple protein folding pathway – Role of disulphide bonds in protein folding – Invivo protein folding: Structure of Molecular chaperones and their role in protein folding – osmolyte assisted protein folding - Amide exchange and measurement of protein folding – Membrane protein folding – Protein misfolding and the diseased state: amyloidosis.	
IV - Protein Structure and Function Relationship	**9 + 3**
Helix turn helix motif in DNA binding proteins - Role in prokaryotic and eukaryotic transcription factors - Trp repressor - Zn fingers &Leucine zippers - Membrane proteins and receptors :	

bacteriorhodopsin – Structure function relationship in Immunoglobulin – Enzymes: Serine proteases mechanism of action.	
V- Protein Engineering	**9 + 3**
Strategies for protein engineering: Effect of Disulfide bridges, Dipoles of α helices - Random and site-directed mutagenesis in protein engineering - Role of low-fidelity enzymes in protein engineering – SNP –Production of Peptide Vaccines – Protein microarray and its role on disease diagnosis.	

Lecture	Tutorial	Practical	Total
45	**15**	**0**	**60**

Text Books:

1. Voet D., Voet G. Biochemistry, 4th edition, John Wiley & Sons, 2010.
2. Branden, C. and Tooze, R., Introduction of Protein structure, Garland, 2nd Edition, 1999.
3. Alan Fersht. Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding. 3rd revised edition, W.H.Freeman& Co Ltd, 1999.

References:

1. Creighton T.E. Proteins: Structure and Molecular Properties, , 2nd Edition, Freeman, WH, 1992.
2. Creighton T.E. Protein Structure: A Practical Approach, 2nd Edition, Oxford University Press, 1997.
3. Lilia Alberghina. Protein Engineering in Industrial Biotechnology, CRC press, Harwood Academic Publishers, 2003.

E- References:

1. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2763986/
2. www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijbt/ijbt2k6/ijbt_july06.asp
3. http://books.google.co.in/books?id=x0UyTLIhWSAC&pg=PA227&source=gbs_toc_r&cad=3#v=onepage&q&f=false

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PO12
CO 1	1	1	0	1	2	2	1	1	0	2	2	3	1	1	3
CO 2	2	3	2	2	2	1	1	0	1	0	0	2	1	1	2
CO 3	3	1	2	1	2	0	0	0	1	1	1	3	2	3	3
CO 4	1	3	2	3	2	1	2	1	1	2	1	2	2	2	2
CO 5	3	2	3	3	3	2	2	2	3	2	2	3	3	3	3
	10	10	9	10	11	6	6	4	5	7	6	13	9	10	13

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
Original value	10	10	9	10	11	6	6	4	5	7	6	13	9	10
Scaled to 0,1,2,3 scale	2	2	2	2	3	2	2	1	1	2	2	3	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 701B			**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***the scope and applications of biotechnology in pharmacy	Cognitive	Analyzing Understanding
CO2	***Outline***thepharmacodynamics, pharmacokinetics of drugs	Cognitive	Analyzing Understanding
CO3	***Describe*** various adverse effects of drugs	Cognitive	Analyzing Understanding
CO4	***Explain*** the manufacturing process for various therapeutical products including vaccines, enzymes, interleukins, hormones	Cognitive	Analyzing Understanding
CO5	***Comprehend*** the methods applied to test the quality of drugs and other biopharmaceuticals	Cognitive	Analyzing Understanding

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:

5. Crommelin.D.J.A, Robert D. Sindela, Bernd Meibohm "Pharmaceutical Biotechnology: fundamentals and applications", Informa Healthcare, 2008.
6. Pharmaceutical biotechnology:drug discovery and clinical applications by Kayser,Wiley publishers, 1st edition 2007
7. 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

	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	**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

XBT 702			**BIOINFORMATICS AND COMPUTATIONAL BIOLOGY**	**L**	**T**	**P**	**C**
				1	**0**	**2**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**2**	**0**	**2**	**4**

Prerequisite: Computer programming, biochemistry

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	Understanding Perception
CO2	**Understands** the significance of sequence analysis and **performs** sequence alignment.	Cognitive Psychomotor	Applying 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	Receiving phenomena

I- Introduction to Bioinformatics	**9+6**
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	**9+6**
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	**9+6**
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	**9+3+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	**9+3+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

1. Accession and retrieval of data from various biological databases.
2. Unix/Linux – basic operations and working with terminal.
3. Perl programming - Simple programs using Operators, Control Structures, Subroutines, Hash, Creating a static HTML file by a Perl Program.
4. Heuristic methods (BLAST, FASTA) of searching for homologous sequences
5. Pair-wise (Needleman – Wunch Algorithm & Smith waterman Algoritghm)and Multiple sequence alignment.
6. Gene prediction methods (ORF Finder).
7. Phylogenetic tree building using Phylip.
8. Protein Secondary structure prediction.
9. Homology Modeling.
10. Molecular Visualization and 3D structural studies using Rasmol - Commands, Domain identification.
11. Molecular Visualization and 3D structural studies using Chimera.
12. Small molecule building, using ISIS Draw and CHEM SKETCH – Tutorial

Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**30**	**75**

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

Mapping of Subject Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
Original value	2	9	10	3	13	0	0	0	4	0	0
Scaled to 0,1,2,3 scale	1	2	2	1	3	0	0	0	1	0	0

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 703			**DOWNSTREAM PROCESSING**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**4**	**1**	**2**	**6**

Prerequisite:Microbiology, Bioprocess Engineering, Biochemical Engineering

Learning Objectives:

Upon completion of this course, the students

- Will be able understand the principle behind the different processes involved in the downstream processing.

Course Outcomes:

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Recall*** and ***describe*** the basics of bioseparation process.	Cognitive Affective	Remembering Receiving Phenomena
CO2	***Outline*** and ***differentiate*** the different methods of downstream processing.	Cognitive Affective Psychomotor	Understanding Valuing Perception
CO3	***Identify***, ***locate*** and ***select*** a specific method for a production process.	Cognitive Affective	Understanding

		Psychomotor	Receiving Phenomena Perception
CO4	***Recognize***, ***perform*** and ***detect*** various separation technique for a bioproduct development	Cognitive Affective Psychomotor	Understanding Responding phenomena Perception
CO5	***Identify,choose*** and ***follow***the different methods for the purification of a particular product.	Cognitive Affective Psychomotor	Understanding Receiving Phenomena Guided response

I- Introduction to Downstream Processing Processes	**9+3+3**
Scope and overview-Economics, strategies for initiation of project, Process Design Criteria cost reduction strategies, upstream and downstream processing in biotechnology, various biotechnology products and their biological properties, fundamentals of bioseparation. Separation process design criteria-Characteristics of biological mixtures, Morphological features of the cell, Concentration of product of interest and impurities, physical and rheological characteristics.	
II- Downstream Processing Methods	**9+3+3**
Cell disruption Techniques, types of cells, location of products inside the cells and products , cell distruption Methods, Mechanical and Non mechanical methods- Filtration, types of filtration equipments, filter media and filter aids, basic theory of filtration, principle of rotary drum filter-centrifugation-principle of sedimentation , types of centrifuges, flocculation and sedimentation.	
III- Product Identification Techniques	**9+3+3**
Characterization of product- Electrophoresis, Principle and methods-Analysis of product purity-Chromatography,Enzyme Linked Immuno Sorbent Assay (ELISA),Ion exchange chromatography, Reverse phase chromatography, Affinity Ligand Technology HPLC Radial Flow Chromatography. Experiment No 4: Extraction of pigments from spinach and estimation by thin layer chromatography.	
IV- Product Separation Techniques	**9+3+3**
Distillation- Principle and types, Extractive distillation, Steam Distillation, Vaccum Distillation-Extraction-Solvent extraction principles, Extraction methods, modes of aqueous two-phase extraction, Super critical fluid extraction -Adsorption, principle, Isotherms, different types of adsorption-Evaporation, principle, factors influencing rate of evaporation, types of evaporators.	
V- Product Purification and Resolution	**9+3+3**
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-Application of ultrafiltration- Application of microfiltration - Crystallization, theory of crystallization- Freeze drying- Principle, process and application of freeze drying integrated bio-processing- product polishing stages **List of Experiments:** 1: Yeast cell disruption studies by sonication. 2: Design of thickener for batch sedimentation using yeast by Kynch's theory.	

3: Determine the specific cake resistance of a media by filtration.
4: Centrifugation studies during the settling of E.coli cells.
5: Determination of partition coefficient and yield of yeast cells using aqueous two phase extraction.
6: High-resolution purification preparative liquid chromatographic techniques.
7: Ammonium Sulfate precipitation of protein using yeast cell suspension.
8: Crystallization of a product.
9. Determination of drying time for the given sample in vacuum tray drier.
10:Lyophillization

Lecture	Tutorial	Practical	Total
45	15	15	75

Text Books:

1. Nooralabettu Krishna Prasad,Downstream Process Technology, A New Horizon in Biotechnology,PHIPvt 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 Vs POs

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

Mapping of Subject Vs POs

	PO 1	PO2	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	11	9	11	7	0	4	5	0	5	0	2			

value												5	7	8
Scaled to 0,1,2,3 scale	3	2	3	2	0	1	1	0	1	0	1	1	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 704 A			**CANCER BIOLOGY**	**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: 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	Understanding
CO2:*Explain* and ***compare*** various types of carcinogenesis and its metabolism	Cognitive	Understanding Analyzing
CO3:*Illustrate* the role of activation of kinases, ***identification*** of oncogenes, and ***conforms*** the role of telomere.	Cognitive Affective	Understanding Analyzing Responds to Phenomena
CO4:*Explain* metastasis and its significant clinical markers for invasion and metastasis	Cognitive	Understanding
CO5:*Describe* and ***compiles*** molecular tool for early diagnosis of cancer, different forms of cancer therapy.	Cognitive Affective	Understanding 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	**9**
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	**9**
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**
45	0	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. DeVitaJr, 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	8	7

Mapping of Subject Vs POs

	PO 1	PO2	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	8	7
Scaled to 0,1,2,3 scale	3	2	2	3	3	2	1	1	1	1	1	2	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 704 B			**STEM CELL 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, 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	Remembering Understanding
CO2: ***Explain*** and **develop** the embryonic stem cell culturing.	Cognitive	Understanding Applying
CO3:*Discuss*and***analyze***the differentiation of stem cells	Cognitive	Understanding Analyzing
CO4:*Explain* *and* ***evaluate*** thevarious techniques involved in stem cell assay.	Cognitive	Understanding Evaluating

CO5: ***Discuss and apply*** the various applications of stem cells.	Cognitive	Understanding
I- Basics of Stem Cell		**9**
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		**8**
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		**7**
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		**9**
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		**12**
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**
45	**0**	**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	8	7

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	8	7
Scaled to 0,1,2,3 scale	3	2	2	3	3	2	0	0	0	0	0	2	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 704 C			**METABOLIC ENGINEERING**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Prerequisite: Enzyme engineering, Biochemistry

Learning Objective:

Upon completion of this course, the students

- Would have learn about regulation of various metabolic processes.
- Would have learn about Metabolic Flux Analysis and Its Application.

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1: ***State*** and ***understands*** the role of transport processes in metabolic pathways and material balance	Cognitive	Remembering Understanding
CO2: ***Analyze*** the regulation of enzymes involved in metabolic pathways	Cognitive	Analyzing
CO3: ***Build*** algorithms for biosynthesis pathways	Cognitive	Applying
CO4: ***Explain*** metabolic flux analysis and its role in manipulation of metabolite production.	Cognitive	Understanding
CO5: ***Explain*** and ***compiles*** various strategies to manipulate the production of industrially important Metabolites	Cognitive	Responds to Phenomena

I- Introduction	**9**
Importance Of Metabolic Engineering – Overview Of Cellular Metabolism – Various Types Of Reactions – Stoichiometry Of Cellular Reactions – Dynamic Mass Balance – Yield Coefficient And Linear Rate Equation: Metabolic Model Of *PenicilliumChrysogenum* – Black Box Model – Elemental And Heat Balance Using Black Box Model.	
Ii- Regulation of Metabolic Pathways	**9**

Regulation of enzyme activity: Overview of enzyme kinetics and inhibition – Feed back inhibition and Activation: Feed back control architecture in aspartate pathway – Allosteric enzyme regulation - Regulation of enzyme concentration: Control of transcription and translation – Genetic regulatory network: cholesterol synthesis and elimination - Regulation of at the whole cell level - Regulation of metabolic networks – Regulation of eukaryotes versus prokaryotes.

III- Synthesis of Metabolic Pathways	**9**

Metabolic pathway synthesis algorithm - Overview of the algorithm - Pathway for synthesis of alanine and serine - Case study: Lysine biosynthesis

IV- Metabolic Flux Analysis and Its Application	**9**

Metabolic flux analysis - Overdetermined systems - Underdetermined systems; Linear Programming - Sensitivity analysis – Introduction to experimental determination of metabolic fluxes by isotope labeling: Distribution of TCA cycle Metabolite isotopomers from labeled pyruvate - Applications of metabolic flux analysis; Metabolic fluxes in mammalian cell culture – Determination, validation and application.

V- Applications of Metabolic Engineering	**9**

Enhancement of Product yield and Productivity: Amino acids – Metabolic engineering of pentose metabolism for ethanol production – Extension of product spectrum by metabolic engineering : Antibiotics , vitamins, biopolymers – Improvement of cellular properties: Alteration of substrate uptake and maintenance of genetic stability – Xenobiotic degradation

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

Text Books:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou., Metabolic engineering: Principles and Methodologies, Jens Nielsen Academic Press, 1st Edition, 1998.
2. Christina D. Smolke., The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, New York, London, 1st Edition, 2010.

References:

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons, 1980.
2. Stanbury P.F and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.
3. Cortassa S., Aon M.A., Iglesias A.A and LioydDAn Introduction to Metabolic and Cellular Engineering, World Scientific Publishing Co., Singapore, 1st Edition, 2002.

E References:

1. https://gcep.stanford.edu/pdfs/energy_workshops_04_04/biomass_shanmugam.pdf

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	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
Total	13	10	8	11	11	6	4	2	5	5	5	9	8	7

Mapping of Subject Vs POs

	PO 1	PO 2	PO 3	P	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	8	7
Scaled to 0,1,2,3 scale	3	2	2	3	3	2	1	1	1	1	1	2	2	2

Scale: 3- high, 2 – Medium, 1 - Low, 0 – not related

XBT 707			**INPLANT TRAINING - III**	**L**	**T**	**P**	**C**
				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

	obtained during the programme.		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	PO 10	PO 11	PO 12	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	0	6	6
Scaled	1	1	2	1	1	0	1	1	1	1	1	1	2	2

XBT 801			**PROJECT WORK**	**L**	**T**	**P**	**C**
				0	**0**	**12**	**12**
C	**P**	**A**		**L**	**T**	**P**	**H**
6	**3**	**3**		**0**	**0**	**24**	**24**

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	10
PO2	3	2	1	2	1	10
PO3	-	-	1	3	1	5

PO4	-	1	2	3	1	11
PO5	-	-	2	3	1	6
PO6	1	-	1	1	-	10
PO7	1		1	1	-	4
PO8	1	-	1	1	-	6
PO9	-	-	-	-	2	6
PO10	-	-	-	-	3	9
PO11	-				2	6
PO12	1				3	8
PSO1	1	1	1	1	1	6
PSO2	1	1	1	1	1	6

1 - Low, 2 – Medium, 3 – High