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 department

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)

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 **Purple Color** - Skill Development

List of the courses

Name of the Course	Course Code	Year of Introduction	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
Calculus and Linear Algebra	XMA101	2018-19	Skill development- Tutorials and Assignment
Programming for Problem Solving	XCP102	2013-14	Skill Development- Assignment, Programming tests, Small program submission for applications.
Speech Communication	XGS105	2021-22	Skill Development-Assignment, Oral Presentation, Debate, Group Discussion
Constitution of India *#	XUM106	2017-18	Skill Development-Assignment, Seminar, Technical Report
Programming for Problem Solving Laboratory	XCP107	2013-14	Skill Development – Lab experiment, miniproject
Applied Physics for Engineers Laboratory	XAP108	2018-19	SkillDevelopment-Lab experiment, miniproject
Calculus, Ordinary Differential Equations and Complex Variable	XMA201	2018-19	Skill development- Tutorials and Assignment
Electrical and Electronic Engineering Systems	XBE202	2018-19	Skill development- Seminars and laboratory experiment
Technical Communication	XGS204	2021-22	Skill Development-Assignment, Seminar, Technical Report
Workshop Practices	XWP205	2018-19	Skill Development - -Cutting Practices, Carpentery model frame Assignment
Electrical and Electronic Engineering Systems Laboratory	XBE207	2018-19	Skill development- Seminars and laboratory experiment
Applied Chemistry for Engineers Laboratory	XAC208	2018-19	SkillDevelopment-Lab experiment, miniproject
Probability and Statistics	XPS301	2018-19	Skill development- Tutorials and Assignment
Material and Energy Balance	XBT302	2019-20	Employability Skill- • design of unit operations, Assignment
Biochemistry	XBT303	2019-20	Employability Skill- • Assignment, Quiz/Oral, Group Discussion
Microbiology	XBT304	2019-20	Employability Skill- • Assignment, Quiz/Oral,

Unit operations	XBT305	2019-20	Employability Skill- • Assignment, Quiz/Oral, problem solving skill
Human Ethics	XUM306	2019-20	Employability Skill- • Assignment, Seminar, Group Discussion
In-Plant training-I	XBT307	2014-15	Employability Skill - Report making on, Industrial/Laboratory Process, Correlate the curriculum/Syllabus to Industrial process
Genetics	XBT402	2019-20	Employability Skill- • Assignment, Quiz/Oral, Group Discussion
Cell Biology	XBT403	2019-20	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Bioenergetics and Metabolism	XBT404	2019-20	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Chemical Engineering Thermodynamics	XBT405	2014-15	Employability Skill- Quiz/Oral, problem solving skills.
Entrepreneurship Development	XUM406	2016-17	Employability Skill-Consumer need analysis, Group Discussion Entrepreneurship Skill- Generating Business Ideas
Constitution of India	XUM407	2017-18	Skill Development-Assignment, Seminar, Technical Report
Bioinstrumentation	XBT501	2020-21	Employability Skill-•Quiz/Oral Presentation, Seminar, Group Discussion
Molecular Biology	XBT502	2020-21	Employability Skill- • Assignment, Quiz/Oral,
Bioprocess Engineering	XBT503	2018-19	Employability Skill- Assignment, Quiz/Oral
Plant biotechnology	XBT504A	2020-21	Employability Skill- Quiz/Oral, Presentation,Seminar, Group Discussion
Food Technology	XBT504B	2020-21	Employability Skill- Quiz/Oral, Seminar, Group Discussion
Chemical Reaction Engineering	XBT504C	2020-21	Employability Skill- Presentation,Seminar, Test

In-Plant training-II	XBT508	2014-15	Employability Skill - Report making on, Industrial/Laboratory Process, Correlate the curriculum/Syllabus to Industrial process
Economics for Engineers	XUM601	2016-17	Entrepreneurship,Casevstudy
Bioreactor Design	XBT602	2020-21	Employability Skill- Assignment, Quiz/Oral Presentation, Seminar, Group Discussion, Design practice
Recombinant DNA Technology	XBT603	2020-21	Employability Skill- • Assignment, Quiz/Oral, Group Discussion
Immunology	XBT604	2020-21	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Animal biotechnology	XBT605A	2020-21	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Nanobiotechnology	XBT605B	2020-21	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Heat Transfer	XBT605C	2020-21	Skill development- Tutorials and Assignment, design of heat transfer equipments
Protein Engineering	XBT701A	2018-19	Employability Skill- Assignment, Quiz/Oral Presentation, Seminar, Group Discussion
Pharmaceutical Biotechnology	XBT701B	2020-21	Employability Skill- Assignment, Quiz/Oral Presentation, Seminar, Group Discussion
Mass Transfer Fundamentals	XBT701C	2021-22	Employability Skill- Assignment, seminar.
Bioinformatics and Computational Biology	XBT702	2021-22	Employability Skill- Quiz/Oral, Lab experiment
Downstream processing	XBT703	2018-19	Employability Skill- Quiz/Oral, problem solving skills.
Cancer Biology	XBT704A	2021-22	Employability Skill- Assignment, Seminar,case study

Stem cell biotechnology	XBT704B	2021-22	Employability Skill- Assignment, Quiz/Oral, poster presentation
Metabolic Engineering	XBT704C	2021-22	Employability Skill- Assignment, mini project
In-Plant training-III	XBT707	2014-15	Employability Skill - Report making on, Industrial/Laboratory Process, Correlate the curriculum/Syllabus to Industrial process
Project work	XBT801	2021-22	Employability Skill- Optimization, Advancement (Depth view) Viva -voce

2. Syllabus of the courses as per the above list

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

PREREQUISITE: Differentiation and Integration

COURSE OUTCOMES:

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

UNIT -I	**Matrices**	12

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

UNIT -II	**Sequences and series**	12

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

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

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

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

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

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

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

LECTURE	TUTORIAL	TOTAL
45	15	60

Text Books:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015**. (Unit-1, Unit-3 and Unit-4).**

2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi **Publications**, Reprint, 2014. **(Unit-2).**
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2010. **(Unit-5).**

Reference Books:

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

Cos versus GA mapping

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

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

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

CourseOutcome:Afterthecompletionofthecourse,studentswillbe able to		**Domain**	**Level**
CO1	***Define*** programming fundamentals and ***Solve*** simpleprogramsusingI/O statements	Cognitive	Apply
CO2	***Explain simple programs*** using controlstructuresandarrays	Cognitive	Understand
CO3	***Explain the simple programs*** using functions andpointers	Cognitive	Understand
CO4	***Explain simple programs*** using structures andunions	Cognitive	Understand
CO5	***Explain simpleprograms*** usingfiles and ***Build*** simpleprojects	Cognitive	Understand

COURSECONTENT

UNIT-I	**PROGRAMMINGFUNDAMENTALSANDI/OSTATEMENTS**	**9**

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

UNIT -II	**CONTROLSTRUCTURE ANDARRAYS**	**9**

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

UNIT -III	**FUNCTIONS ANDPOINTERS**	**9**

Functions:Builtinfunctions–UserDefinedFunctions-Parameterpassingmethods-Passingarraystofunctions–Recursion-Programsusingarraysandfunctions.Pointers-Pointerdeclaration
- Addressoperator-Pointerexpressions&pointerarithmetic-Pointersandfunction-Callbyvalue - CallbyReference-Pointertoarrays-UseofPointersinself-referentialstructures-Notionoflinkedlist

UNIT -IV	**STRUCTURESANDUNIONS**	**9**

StructuresandUnions-Givingvaluestomembers-Initializingstructure-Functionsandstructures -Passingstructuretoelementstofunctions-Passingentirefunctiontofunctions-Arraysofstructure-Structurewithin a structureandUnion.

UNIT -V	**FILES**	**9**

FilemanagementinC-FileoperationfunctionsinC-Definingandopeningafile-Closingafile - Thegetandputfunctions-Theprint&scanfunctions-seekfunction–FilesandStructures.

L	**T**	**P**	**Total**
45	**0**	**0**	**45**

TEXTBOOKS

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

REFERENCEBOOKS

1. E.Balaguruswamy,ProgramminginANSIC,TataMcGraw-Hill,7th edition2017.
2. BrianW.Kernighanand DennisM.Ritchie,"TheCProgrammingLanguage",PearsonEducationInc. 2005
3. JohnsonbaughR.andKalinM.,“ApplicationsProgramminginANSIC”, IIIEdition,Pearson EducationIndia,2003

E-REFERENCES

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

Mapping of CO’s with PO:

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

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 Pushp Lata. *Communication Skills*. Oxford University Press. 2011

Mapping Of Course Outcomes with Program Outcomes

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

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

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

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

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

REFERENCES:

1. W.H.Morris Shores- Government and politics of India, NewDelhi, B.1.Publishers, 1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House, 1977.
3. R.Thanker- The Government and politics of India, London:Macmillon, 1995.
4. A.C.Kapur- Select Constitutions S,Chand& Co.,NewDelhi, 1995
5. V.D.Mahajan- Select Modern Governments,S,Chand&Co, NewDelhi,1995.
6. B.C.Rout- Democractic Constitution of India.
7. Gopal K.Puri- Constitution of India, India 2005.

Mapping Of Course Outcomes with Program Outcomes

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

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

COURSECODE			XCP107	L	T	P	C
COURSENAME			PROGRAMMING FOR PROBLEMSOLVINGLAB	0	0	1	1
PREREQUISITES			BasicUnderstandingSkills	L	T	P	H
C	P	A		0	0	2	2
0.75	0	0.25					

LEARNINGOBJECTIVES

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

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

S.No.	ListofExperiments	COs
1	ProgramtodisplayaLeave Letterasperproperformat	CO1
2	i. Programforaddition oftwonumbers ii. Programtosolveanymathematicalformula.	CO1
3	Programtofindgreatestof3numbersusingBranchingStatements	CO2
4	Programtodisplaydivisiblenumbersbetweenn1andn2usinglooping Statement	CO2
5	Programtosearchanarrayelementinanarray.	CO2
6	Programtofindlargest/smallestelementinanarray.	CO2
7	Programtoperformstringoperations.	CO3
8	Programtofind areaof a rectangle ofagiven numberuse fourfunction types.	CO3
9	Programstopassandreceivearrayandpointersusingfourfunction types	CO3
10	ProgramsusingRecursion forfindingfactorial ofanumber	CO3
11	Programtoreadanddisplaystudentmarksheetofastudentstructures withvariables	CO4

12	Programtoreadanddisplaystudentmarksofaclassusingstructures witharrays			CO4
13	Programtocreatelinked listusingstructureswithpointers			CO4
14	Programforcopyingcontents ofonefileto anotherfile.			CO5
15	Programusingfilestostoreanddisplaystudentmarklistofaclassusing structureswith array			CO5
HOURS		**TUTORIAL**	**PRACTICAL**	**TOTAL**
		0	**30**	**30**

MappingofCOwithPO's

		PROGRAM OUTCOMES												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	3	2	0	0	3	0	0	0	0	0	2	3	2	0
CO2	3	2	0	0	2	0	0	0	0	0	2	3	2	0
CO3	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO4	2	2	1	2	2	0	0	0	0	0	2	2	2	0
CO5	2	2	1	0	2	0	0	1	0	2	2	2	2	0
Total	12	10	3	4	11	0	0	1	0	2	10	12	10	0
ScaledValue	3	2	1	1	3	0	0	1	0	1	2	3	2	0
1 – 5 → 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 LAB	0	0	2	2
C:P:A	0:2:0	L	T	P	H
PREREQUISITE:	Basic Physics in HSC level	0	0	2	2

COURSE OUTCOMES		Domain	Level
CO1	***Determine*** the significance of elasticity in engineering systems and technological advances.	Psychomotor:	Mechanism
CO2	***Locate*** basic applications of electromagnetic induction to technology.	Psychomotor:	Mechanism
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	15

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														

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 **Apply** Greens, Gauss divergence and Stokes theorem	Cognitive	Apply
CO2	**Solve** first order differential equations of different types Which are solvable for p, y, x and Clairaut's type.	Cognitive	Apply
CO3	**Solve** Second order ordinary differential equations with Variable coefficients using various methods.	Cognitive	Apply
CO4	**Use** CR equations to verify analytic functions and to find Harmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	Cognitive	Apply
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	Apply
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 → 1, 6 – 10 → 2, 11 – 15 → 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	1	0	4
3:0:0					

Course Outcomes		Domain	Level
CO1	**Relate** the fundamentals of electrical parameters and **build** and **explain** AC, DC circuits by Using measuring devices	Cognitive	Understand
CO2	**Explain** the operation of DC and AC machines.	Cognitive	Understand
CO3	**Illustrate** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.	Cognitive	Understand
CO4	**Explain the** number systems and logic gates. **Construc**t the different digital circuit.	Cognitive	Understand
CO5	**Outline the** different types of microprocessors and their applications.	Cognitive	Understand

UNIT-I: FUNDAMENTALS OF DC AND AC CIRCUITS, MEASUREMENTS	**9+3**
Fundamentals of DC– Ohm's Law – Kirchhoff's Laws - Sources - Voltage and Current Relations – Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities - Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).	
UNIT -II: ELECTRICAL MACHINES	**9 + 3**
Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single-Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single-Phase Transformer, Three phase transformers, Auto transformer.	
UNIT- III: SEMICONDUCTOR DEVICES	**9 + 3**
Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications.	
UNIT- IV: DIGITAL ELECTRONICS	**9 + 3**
Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subtractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.	
UNIT- V: MICROPROCESSORS	**9+ 3**
Architecture, 8085, pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, Instruction types, classification of instructions, addressing modes, Interfacing Basics: Data transfer concepts – Simple Programming concepts.	

LECTURE	TUTORIAL	TOTAL
45	15	60

TEXT BOOKS

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

REFERENCE BOOKS

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

E-REFERENCES

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

Mapping of COs with Pos

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	1	1			1	1	1		3	**3**
CO2	3	3	1	1	1	1			1	1	1		3	**3**
CO3	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**		**3**	**3**
CO4	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**3**	**3**
CO5	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**3**	**3**
Total	**12**	**12**	**6**	**5**	**6**	**6**	**3**	**3**	**5**	**5**	**5**		**15**	**15**
ScaledValue	**3**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**		**5**	**5**
1 – 5 → 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	**Ability** to understand the basic principles	Cognitive	Remember
CO2	**Apply** the techniques in writing	Cognitive	Apply
CO3	**Identify** communicative styles	Cognitive	Remember
CO4	**Construct** the nature of writing	Cognitive	Create

Course Content		Hours
UNIT-I	**Basic Principles**	**9**
1.1 – Basic Principles of Technical Writing 1.2 – Styles used in Technical Writing 1.3 – Language and Tone		
UNIT –II	**Techniques**	**9**
2.1 – Special Techniques used in writing 2.2 – Definition & Description of mechanism 2.3 – Description- Classification-Interpretation		
UNIT-III	**Communication**	**9**
3.1 – Modern development in style of writing 3.2 - New letter writing formats		
UNIT-IV	**Report writing**	**9**
4.1 – Types of Report writing 4.2 – Project writing formats		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
2	**0**	**9**	**36**

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	4	5

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, Dhanpat Rai and Co., New Delhi. 4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.
E RESOURCES http://nptel.ac.in/courses/112107145/

Mapping of CO's with PO'S:

		PROGRAM OUTCOMES												
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO2	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO3	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO4	2	1	1	1	1	1	-	1	1	-	1	2	0	0
CO5	2	1	1	1	1	1	-	1	1	-	1	2	0	0
Total	**10**	**5**	**5**	**5**	**5**	**5**	**-**	**5**	**5**	**-**	**5**	**10**	**0**	**0**
ScaledValue	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**-**	**1**	**2**	**0**	**0**
1 – 5 → 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**	**2**	**2**
1.5 : 1 : 0.5					

COURSE OBJECTIVES:

The course helps to Learn the basic concepts of electrical and electronics components.

a. Understand the basic wiring methods and connection.
b. Study the characteristics of diodes, Zener diodes, NPN transistors.
c. Verify the working of simple logic gates, adders and subtractors.

Course Outcomes:		Domain	Level
CO1	**Apply** the fundamental electrical concepts and **differentiate** the various electronic components.	Cognitive Psychomotor Affective	Understand Set Valuing
CO2	**Implement** and **execute** the different types of wiring connections.	Cognitive Psychomotor Affective	Understand Set Valuing

CO3	**Demonstrate** the Fluorescent lamp connection with choke.	Cognitive Psychomotor Affective	Understand Set Valuing
CO4	**Characterize** and **display** the basic knowledge on the working of PN junction and Zener diode.	Cognitive Psychomotor Affective	Understand Set Valuing
CO5	**Implement** and **execute** the various digital electronic circuits such as Adders and Subtractors.	Cognitive Psychomotor Affective	Understand Set Valuing

List of Experiments:

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

PRACTICAL	**TOTAL**
30	**30**

Cos versus GA mapping

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

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

Laboratory Part **30 hrs**

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

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														

XPS 301			PROBABILITY AND STATISTICS	L	T	P	C
				3	1	0	4
C	P	A		L	T	P	H
3.5	0.25	0.25		3	1	0	4

Learning Objectives:

Upon completion of this course, the students

- Would appreciate the importance of probability and statistics in computing and research.
- Would develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries and to use appropriate statistical method in the analysis of simple datasets.
- Would interpret and clearly present output from statistical analyses in a clear concise and understandable manner.
- Would gain the knowledge in 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		Domain	Level
After the completion of the course, students will be able to			
CO1	***Explain***conditional probability, independent events; **find** expected values and Moments of Discrete random variables with properties.	Cognitive	Understanding Remembering
CO2	***Find***distribution function, Marginal density function, conditional density function, ***Define*** density function of	Cognitive	Remembering

	conditional distribution functions normal, exponential and gamma distributions.		
CO3	***Find*** measures of central tendency, statistical parameters of Binomial, Poisson and Normal, correlation, regression. Rank Correlation coefficient of two variables.	Cognitive Psychomotor	Remembering Guided Response
CO4	***Explain*** large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviations with simple problems.	Cognitive	Understanding
CO5	***Explain***small sample test for single mean, difference of mean and correlation coefficients, variance test, chi-square test with simple Problems.	Cognitive Affective	Understanding Receiving

I – Basic Probability	**12**
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.	
II – Continuous Probability Distributions & Bivariate Distributions	**12**
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.	
III – Basic Statistics	**12**
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.	
IV – Applied Statistics	**12**
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.	
V – Small Samples	**12**
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	Practical	Total
45	**15**	**0**	**60**

Text Books:

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

Reference Books:

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, 3rdEd.,Wiley, 1968.
5. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2010.

E-References:

1. Probability And Statistics By Prof.Someshkumar, Department Of Mathematics, Iit Kharagpur (Http://Nptel.Ac.In/Noc/Noc_Courselist.Php)

Mapping of COs with GAs

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
CO 1	3	2	1						1	1		1
CO 2	3	2	1						1	1		1
CO 3	3	2	1	1					1	1		1
CO 4	3	2	1	1	1	1			1	1	1	1
CO 5	3	2	1	1	1	1	1		1	1	1	1
	15	**10**	**5**	**3**	**2**	**2**	**1**		**5**	**5**	**2**	**5**

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

Mapping of Subjects with GAs

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
Original Value	**15**	**10**	**5**	**3**	**2**	**2**	**1**	**0**	**5**	**5**	**2**	**5**
Scaled Value	3	2	1	1	1	1	1	0	1	1	1	1

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

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

XBT302			**MATERIAL AND ENERGY BALANCE**	**L**	**T**	**P**	**C**
				2	**1**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**0.5**	**0.5**		**2**	**1**	**0**	**3**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have understood the material and energy balance for process engineering.
- Would have understood the methods of calculations for reactive and chemical systems.
- Would apply their knowledge of principles of material and energy balance for engineering applications.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Interpret*** different unit systems and***Express***the composition gas liquid and solid systems	Cognitive	Understanding Remembering
CO2	***Compute*** the material balances across different unit operations	Cognitive	Understanding Analysing
CO3	**Compute** the material balances across chemical reactors	Cognitive	Understanding Analysing
CO4	***Explain*** the energy balance calculations for systems with and without chemical reactions	Cognitive	Understanding

CO5	***Describe*** the humidification operations	Cognitive	Understanding Receiving

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.	
II – Material Balances for Unit Operations	**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	
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	
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	
V – Energy Balances for Chemical Systems	**6+3**
Energy balances with chemical reaction: Heat of reaction, Heat of combustion - Evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction.	

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.

E-References:

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

Mapping of COs with POs

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

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

Mapping of Subjects with POs

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

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XBT 303			**BIOCHEMISTRY**	**L**	**T**	**P**	**C**
				3	**1**	**0**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**1.75**	**0.25**		**3**	**1**	**0**	**4**

Prerequisite: Applied Physics, Applied Chemistry, Biology

Learning Objectives:

Upon completion of this course, the students

- Would have learn the fundamentals of biomolecules.
- Would have learn the functions of proteins and biosignalling.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Recognize*** and ***Understand*** about role of water and amino acids.	Cognitive Psychomotor	Remembering Recieving
CO2	***Recognize*** and ***Understand*** proteins and their structures. Also, will learn about enzymes.	Cognitive Psychomotor	Recalling Origination
CO3	***Recognize*** and ***Understand*** about carbohydrate and glycobiology.	Cognitive Psychomotor	Create Guided Response
CO4	***Recognize*** and ***Understand*** about Nucleotides and Nucleic acids.	Cognitive Psychomotor	Create Guided response
CO5	***Recognize*** and ***Understand*** lipids and biosignalling.	Cognitive Psychomotor	Create Guided response

I – Water, Amino acids and Proteins	**9+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	**11+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	**10+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	**9+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
45	**15**	**0**	**60**

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

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

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

Mapping of Subjects with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**5**	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**7**	**8**	**6**
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	2

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

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

XBT 304			**MICROBIOLOGY**	**L**	**T**	**P**	**C**
				3	**0**	**2**	**4**
C	**P**	**A**		**L**	**T**	**P**	**H**
2	**0.5**	**0.5**		**3**	**0**	**2**	**5**

Prerequisite: Biology, Chemistry

Learning Objectives:

Upon completion of this course, the students

- Would have understand the existence of microbial world through the study of the characteristics of microorganisms, multiplication, growth in different media and their control.
- Would apply their knowledge of microbiology to demonstrate aseptic microbiological techniques in the laboratory.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Comprehend*** knowledgeabout historical perspective of microbiology and its developments. ***Recognize*** the fundamental concepts in the structure and functioning of a prokaryotic cell. ***Perform*** staining techniques to observe microorganisms	Cognitive Psychomotor	Understanding Remembering Applying Guided response
CO2	***Acquire*** knowledge about microbial taxonomy and microbial classification methods.	Cognitive Psychomotor	Understanding Remembering Applying Guided response
CO3	***Demonstrate*** the microbial nutritional requirements. ***Perform*** culturing techniques to isolate microorganisms	Cognitive Psychomotor	Understanding Remembering Guided response
CO4	***Choose*** the appropriate media for the cultivation of microorganisms and ***Acquire*** knowledge on the bacterial growth, growth curve and control of microorganisms.	Cognitive Psychomotor	Understanding Remembering Guided response

CO5	***Demonstrate*** the various industrial applications of microorganisms.	Cognitive	Understanding Remembering
I- Introduction to Microbiology			**7 + 3 + 9**
History and Scope of Microbiology – Study of microbial structure: Microscopy (light, dark-field, phase contrast, electron), Specimen preparation, Staining techniques (simple and differential) – Overview of Prokaryotic cell structure: Cell membrane, Cytoplasmic matrix, Cell wall, Flagella, Capsule.			
II- Classification of Microorganisms			**9 + 3 + 3**
Taxonomy: Binomial Nomenclature – Five Kingdom classification system: Monera, Protista, Fungi, Plantae, Animalia – Three Domain classification: Bacteria, Archea, Eukarya – Classification of viruses – Methods of Classification: Morphological characteristics, Physiological and metabolic characteristics, Biochemical characteristics, Ecological characteristics, Molecular characteristics.			
III- Microbial Nutrition and Culturing Techniques			**11 + 3 + 12**
Nutritional types of microorganisms: Autotrophs, Heterotrophs, Phototrophs, Chemotrophs, Lithotrophs, Organotrophs – Culture media: defined, complex – Culture techniques: spread plate, streak plate, pour plate) – Preservation of microbial cultures – Microbe-microbe interaction: Mutualism, Parasitism, Commensalism			
IV- Microbial Growth and Control			**11 + 3+ 6**
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 Control: Use of physical methods (moist heat, dry heat, radiation), Use of chemical agents (phenols, alcohols, gases).			
V- Industrial Microbiology			**7 + 3**
Microbial products: Antibiotics, Amino acids, Organic acids, Biopolymers, Biosurfactants, Biocatalysts, Vaccines – Biofuel production – Wastewater treatment – Microbial fuel cells – Biodegradation and Bioremediation			
Microbiology Lab			
List of Practical 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. Biochemical characterization of microbes 5. Isolation of microbes using spread plate method 6. Isolation of microbes using streak plate method 7. Isolation of microbes using pour plate method 8. Microbial growth control using Kirby-Bauer method 9. Cell counting 10. Screening of microorganisms for enzyme production			CO1 CO1 CO1 CO2 CO3 CO3 CO3 CO4 CO4 CO5

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

Text Books:

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

Reference Books:		
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		

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	1	0	1	0	1	1	1	1	0	0
CO 2	3	3	1	1	1	2	2	1	1	1	1	1	0	0
CO 3	3	1	2	3	1	2	1	0	1	1	1	1	2	0
CO 4	3	3	2	0	1	0	2	0	1	1	1	1	0	2
CO 5	3	2	2	3	1	2	2	1	1	0	1	1	2	2
	15	**12**	**8**	**8**	**5**	**6**	**8**	**2**	**5**	**4**	**5**	**5**	**4**	**2**

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

Mapping of Subjects with POs

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

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

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

XBT 305			UNIT OPERATIONS	L	T	P	C
				3	1	2	5
C	P	A		L	T	P	H
3	1	1		3	2	2	7

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have understood the existence of unit operations through the study of the characteristics of fluid mechanics, particle mechanics, heat transfer and mass transfer.
- Would have understood the phenomena and function of basic sciences for the engineering principles.
- Would apply their knowledge of principles techniques in the laboratory.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Interprets*** and ***Analyze*** the dimensional homogeneity of unit operations	Cognitive	Understanding Remembering Applying Guided response
CO2	***Distinguishes*** types of fluids and fluid flow, ***Explain*** the energy balances across fluid moving systems	Cognitive Psychomotor	Understanding Remembering Applying Guided response
CO3	***Demonstrates*** the Particles, Size reduction, agitation, mixing, centrifugation and filtration operations	Cognitive Affective	Understanding Remembering Guided response
CO4	***Analyse*** the mechanism of conduction and convection mode of heat transfer	Cognitive Psychomotor	Understanding Remembering Guided response
CO5	***Outlines*** the modes of mass transfer operations and ***Describes*** the basic principles in distillation, extraction and drying	Cognitive Affective	Understanding Remembering

Course content	Hours
I – Dimensional Analysis	**8+6+6**
Units and Dimensions, dimensional homogeneity and dimensionless numbers and similitude	
II – Fluid Mechanics	**10+6+6**
Definition and classification, types of fluids, types of flow. Equations for flow, Continuity equation, Bernoulli equation, Hagen-Poiseuille equation. Fluid flow measuring devices, valves, pumps, energy calculations and characteristic of pumps.	
III – Mechanical Operations	**9+6+6**
Characterization of particles shape and size, Size reduction, settling and sedimentation. Agitation and Mixing - power consumption in mixing. Fluid solid interactions, Centrifugation, membrane filtration and filtration equipment's.	

IV – Heat Transfer	**9+6+6**
Heat conduction, conduction through single and multi-layers walls, insulations. Convective heat transfer, forced and natural convection, condensation. Type of heat exchangers.	
V – Mass Transfer	**9+6+6**
Basics, modes of mass transfer, Fick's law of Diffusion, mass transfer correlations. Mass transfer operations: Distillation, extraction and drying.	
Unit Operations Lab	
List of Practical Experiments 1. Identification of fluid types and flow 2. Flow measurements by flow meters 3. Centrifugal and Reciprocating pump characteristics 4. Settling and sedimentation 5. Centrifugation 6. Rotary drum filter 7. Mixing power consumption 8. Heat transfer by Conduction 9. Heat transfer by Convection 10. Heat exchangers	

Lecture	**Tutorial**	**Practical**	**Total**
45	**30**	**30**	**105**

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. http://ce-iitb.vlabs.ac.in/List%20of%20experiments.html?domain=Chemical%20Engineering
2. http://uorepc-nitk.vlabs.ac.in/#
3. http://iitg.vlab.co.in/?sub=58

Mapping of COs with POs

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

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

	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	**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

XUM 306			HUMAN ETHICS	L	T	P	C
				2	1	0	0
C	P	A		L	T	P	H
1	0	0		2	1	0	3

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learn about ethics of human relationships.
- Would have learn about gender equality, women issues and empowerment.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Relate*** and ***Interpret*** the human ethics and human relationships	Cognitive	Remember, Understanding
CO2	***Explain*** and ***Apply*** gender issues, equality and violence against women	Cognitive	Understanding, Applying
CO3	***Classify*** and ***Develop*** the identify of women issues and challenges	Cognitive Affective	Analyzing Receiving
CO4	***Classify***and ***Dissect*** human rights and report on violations.	Cognitive	Understanding, Analyze
CO5	***List*** and ***respond***to family values, universal brotherhood, fight against corruption by common man and good governance.	Cognitive Affective	Remember, (Respond)

Course content	Hours
I – Human Ethics and Values	**4+3**
Human Ethics and values - Understanding of oneself and others- motives and needs- Social service, Social Justice, Dignity and worth, Harmony in human relationship: Family and Society, Integrity and Competence, Caring and Sharing, Honesty and Courage, WHO's holistic development - Valuing Time, Co-operation, Commitment, Sympathy and Empathy, Self-respect, Self-Confidence, character building and Personality.	
II – Gender Equality	**6+3**
Gender Equality - Gender Vs Sex, Concepts, definition, Gender equity, equality, and empowerment. Status of Women in India Social, Economical, Education, Health, Employment, HDI, GDI, GEM. Contributions of Dr.B.R. Ambethkar, Thanthai Periyar and Phule to Women Empowerment.	
III – Women Issues and Challenges	**6+3**
Women Issues and Challenges- Female Infanticide, Female feticide, Violence against women, Domestic violence, Sexual Harassment, Trafficking, Access to education, Marriage. Remedial Measures – Acts related to women: Political Right, Property Rights, and Rights to Education, Medical Termination of Pregnancy Act, and Dowry Prohibition Act.	
IV – Human Rights	**6+3**
Human Rights Movement in India – The preamble to the Constitution of India, Human Rights and Duties, Universal Declaration of Human Rights (UDHR), Civil, Political, Economical, Social and Cultural Rights, Rights against torture, Discrimination and forced Labour, Rights and protection of	

children and elderly. National Human Rights Commission and other statutory Commissions, Creation of Human Rights Literacy and Awareness. - Intellectual Property Rights (IPR). National Policy on occupational safety, occupational health and working environment.

V – Good Governance and Addressing Social Issues	**8+3**

Good Governance - Democracy, People's Participation, Transparency in governance and audit, Corruption, Impact of corruption on society, whom to make corruption complaints, fight against corruption and related issues, Fairness in criminal justice administration, Government system of Redressal. Creation of People friendly environment and universal brotherhood.

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

Text Books:

1. Aftab A, (Ed.), Human Rights in India: Issues and Challenges, (New Delhi: Raj Publications, 2012).
2. Bajwa, G.S. and Bajwa, D.K. Human Rights in India: Implementation and Violations (New Delhi: D.K. Publications, 1996).
3. Chatrath, K. J. S., (ed.), Education for Human Rights and Democracy (Shimala: Indian Institute of Advanced Studies, 1998).

Reference Books:

1. Jagadeesan. P. Marriage and Social legislations in Tamil Nadu, Chennai: Elachiapen Publications, 1990).
2. Kaushal, Rachna, Women and Human Rights in India (New Delhi: Kaveri Books, 2000)
3. Mani. V. S., Human Rights in India: An Overview (New Delhi: Institute for the World Congress on Human Rights, 1998).
4. Singh, B. P. Sehgal, (ed) Human Rights in India: Problems and Perspectives (New Delhi: Deep and Deep, 1999).
5. Veeramani, K. (ed) Periyar on Women Right, (Chennai: Emerald Publishers, 1996).
6. Veeramani, K. (ed) Periyar Feminism, (Periyar Maniammai University, Vallam, Thanjavur: 2010).
7. Planning Commission report on Occupational Health and Safety http://planningcommission.nic.in/aboutus/committee/wrkgrp12/wg_occup_safety.p
8. Central Vigilance Commission (Gov. of India) website: http://cvc.nic.in/welcome.html.
9. Weblink of Transparency International: https://www.transparency.org/

Mapping of COs with POs

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

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	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**15**	**15**	**15**	**0**	**0**	**0**	**0**
Scaled Value	0	0	0	0	0	0	0	3	3	3	0	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 307			**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	Cog	Understanding
CO2:*Comply with* Factory discipline, management and business practices.	Aff	Responding
CO3:*Demonstrates teamwork* and time management	Aff	Value
CO4:*Describe* and ***Display*** hands-on experience on practical skills obtained during the programme.	Psy	Perception Set
CO5:*Summarize* the tasks and activities done by technical documents and oral presentations.	Cog	Evaluating

XBT 402			GENETICS	L	T	P	C
				3	1	0	4
C	P	A		L	T	P	H
3	0	1		3	1	0	4

Prerequisite: Biochemistry and Microbiology

Learning Objectives:

Upon completion of this course, the students

- Would have learnt the fundamentals of genetics
- Would have learnt the gene mutations

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

Course content	Hours
I – Reproduction as Basis of Heredity	**7+3**
The relationship between genes and traits, the branches of genetics, relationship of genetics to other areas of biology, genetics and society. The cell as the unit of life, overview of chromosomes, cell division, gametogenesis, the life cycles of some genetically important organisms.	
II – Mendelian Principles of Genetics and Gene Interactions	**8+3**
The principles of dominance and segregation, the principle of independent assortment, applications of Mendelian principles. Gene interactions that produce new phenotypes, epistasis.	
III – Quantitative Inheritance	**8+3**
Quantitative traits, polygenic inheritance, heritability, Extranuclear genomes and inheritance: Organization of extranuclear genomes, role of extranuclear inheritance, examples of extranuclear inheritance, maternal effect, genomic imprinting.	
IV – Chromosomal Basis of Inheritance and Linkage	**8+3**
Experimental evidence linking the inheritance of genes to chromosomes, chromosomes as arrays of genes, non-disjunction as proof of the chromosome theory, the chromosomal basis of Mendelian principles.	
V – Construction of Genetics and Physical Maps and Gene Mutations and Chromosomal Changes	**14+3**
Linkage and crossing over, genetic mapping in eukaryotes, genetic transfer and mapping in bacteria, intragenic mapping in bacteriophages. DNA Replication in prokaryote and eukaryotes,	

enzymes and accessory proteins, telomere replication. DNA repair, Transcription process in prokaryote & eukaryotes, regulation of transcription. RNA processing, nuclear export and stability of RNA, Translation in prokaryote and eukaryotes translation, translational control , co and post translational modification of proteins, Regulation of Gene expression in prokaryotes &eukaryotes.Occurrence and causes of DNA mutations, spontaneous and induced mutations, DNA repair, Types of chromosomal mutations, variations in chromosome structure, variations in chromosome number, chromosome rearrangements, consequences of mutations and Transposable elements.

Lecture	Tutorial	Practical	Total
45	15	0	60

Text Books:

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

Reference Books:

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

E-References:

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

Mapping of COs with POs

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

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

Mapping of Subjects with POs

	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	**5**	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**8**	**8**	**9**
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	2

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XBT 403			**CELL BIOLOGY**	**L**	**T**	**P**	**C**
				3	**1**	**2**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
2	**0.5**	**0.5**		**3**	**1**	**2**	**6**

Prerequisite: Biology, Chemistry, Microbiology, Biochemistry

Learning Objectives:

Upon completion of this course, the students

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

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Study*** and ***understand*** the origin of eukaryotic cells and cells specialization	Cognitive	Understanding Remembering Applying
CO2	***Recognize*** the fundamental concepts in the structure and functioning of a eukaryotic cell.	Cognitive	Understanding Remembering Applying
CO3	***Acquire*** knowledge on the transport of proteins between intracellular compartments	Cognitive	Understanding Remembering
CO4	***Acquire*** knowledge about cell cycles mitosis and meiosis	Cognitive Psychomotor	Understanding Remembering Guided response
CO5	***Describe*** cellular signalling and types of signaling receptors	Cognitive	Understanding Remembering
I – Cells and Tissues			**7+3+6**
Unity and Diversity of Cells – Origin of Eukaryotic cells – Plant cells – Viruses – Cell			

specialization: Epithelia, Connective tissue, Nervous tissue, Muscle – Cells as experimental models	
II – Cellular Organization and Membrane Transport	**11+3+6**
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+3+6**
Transport to and from the Nucleus – Transport Across Membranes – Vesicular Trafficking BetweenIntracellular Compartments	
IV – Cell Division and Control	**9+3+6**
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+3+6**
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.	
Cell Biology Lab	
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	

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

Text Books:

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

References:

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

E-References:

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

Mapping of COs with POs

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

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

Mapping of Subjects with POs

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

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XBT 404			**BIOENERGETICS AND METABOLISM**	**L**	**T**	**P**	**C**
				3	**1**	**2**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0.5**	**0.15**		**3**	**1**	**2**	**6**

Prerequisite: Biochemistry, Applied Physics, Applied Chemistry,Microbiology.

Learning Objectives:

Upon completion of this course, the students

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

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

Course content	Hours
I – Bioeneregetics and Glycolytic pathways	**9+3+6**
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	**9+3+6**
Biosynthesis of fatty acids, Oxidation of fatty acid – beta oxidation and omega oxidation, Ketone Bodies, Biosynthesis of Cholesterol, Biosynthesis of phospholipids and glycolipids, Metabolic Fates of Amino Groups, Pathways of Amino Acid Degradation.	
III – Oxidative phosphorylation and photophoshorylation	**9+3+6**
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	**9+3+6**
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	**9+3+6**
Qualitative and quantitative analysis of metabolism involving in disease and disorders. Report writing on metabolic disorders or diseases.	
Bioenergetics and Metabolism Lab	
List of Practical Experiments 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 Estimation of Saponification Value of Fats/Oils	

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

Text Books:

1. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, W. H. Freeman; 6th edition edition (13 February 2013), 1158 pages ISBN-10: 1464109621, ISBN-13: 978-1464109621.
2. Biochemistry, Donald Voet, Judith G. Voet 4th Edition, 2011, 1520 pages ISBN: 978-0-470-91410-6.
3. Branden C. and Tooze J., "Introduction to Protein Structured, Second Edition", Garland Publishing, NY, USA, 1999.

Reference Books:

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

E-References:

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

Mapping of COs with POs

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

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

Mapping of Subjects with POs

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

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

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

<table>
<tr><td colspan="3">XBT 405</td><td rowspan="3">CHEMICAL ENGINEERING THERMODYNAMICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="3"></td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="3"></td><td colspan="4"></td></tr>
<tr><td>C</td><td>P</td><td>A</td><td></td><td>L</td><td>T</td><td>P</td><td>H</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td></td><td>3</td><td>2</td><td>0</td><td>5</td></tr>
<tr><td colspan="8">Prerequisite: Engineering chemistry</td></tr>
<tr><td colspan="8">Learning Objectives:</td></tr>
<tr><td colspan="8">Upon completion of this course, the students
• Would have gained knowledge about the laws of thermodynamics
• Would have understood the thermodynamic properties on engineering aspects</td></tr>
<tr><td colspan="5">Course Outcomes</td><td colspan="2">Domain</td><td>Level</td></tr>
<tr><td colspan="8">After the completion of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="4">State the basic laws of thermodynamics and explain the fundamentals of thermodynamics.</td><td colspan="2">Cognitive</td><td>Remembering Understanding</td></tr>
<tr><td>CO2</td><td colspan="4">Interpret and analyze the PVT relationship for various systems.</td><td colspan="2">Cognitive</td><td>Interpretation, analyzing</td></tr>
<tr><td>CO3</td><td colspan="4">Know the thermodynamic relations and estimate the thermodynamic properties.</td><td colspan="2">Cognitive</td><td>Remembering, Understanding</td></tr>
<tr><td>CO4</td><td colspan="4">Analyze and evaluate the phase equilibrium in various systems like miscible and immiscible systems.</td><td colspan="2">Cognitive</td><td>Analyzing, evaluating</td></tr>
<tr><td>CO5</td><td colspan="4">Knows the chemical equilibrium for industrial reactions and will calculate required free energy, equilibrium rate constant and conversion.</td><td colspan="2">Cognitive</td><td>Remembering, Applying</td></tr>
<tr><td colspan="7">Course content</td><td>Hours</td></tr>
<tr><td colspan="7">I – Fundamentals of Thermodynamics</td><td>9+3</td></tr>
<tr><td colspan="8">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, Zeroth Law of Thermodynamics, Reversible and Irreversible processes, General Statement of First law of thermodynamics</td></tr>
<tr><td colspan="7">II – PVT Relationships for Gases and Liquids</td><td>9+3</td></tr>
<tr><td colspan="8">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 - General Statement of Second and Third laws of thermodynamics – application of the law of thermodynamics.</td></tr>
<tr><td colspan="7">III – Thermodynamic Properties of Pure Fluids</td><td>9+3</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="7">IV – Phase Equilibria</td><td>9+3</td></tr>
<tr><td colspan="8">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.</td></tr>
</table>

V – Chemical Equilibria			9+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 – Heterogeneous reaction equilibria.			
Lecture	**Tutorial**	**Practical**	**Total**
45	**15**	**0**	**60**

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

Reference Books:

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.

E-References:

1. Thermodynamics of Biomolecular Systems: http://ocw.mit.edu/courses/biologicalengineering/20-110j-thermodynamics-of-biomolecular-systems-fall-2005/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2									2	2		2
CO 2	3	3	2	2	1		2				2	2	3	2
CO 3	3	3	2	2	1		2				2	2	3	2
CO 4	3	3	2	3	1	1	2				2	2	2	2
CO 5	3	3	3	3	1	1	2	1	1		2	3	3	3
	15	**14**	**9**	**10**	**4**	**2**	**8**	**1**	**1**		**10**	**11**	**11**	**11**

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

Mapping of Subjects with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	**15**	**14**	**9**	**10**	**4**	**2**	**8**	**1**	**1**	**0**	**10**	**11**	**11**	**11**
Scaled Value	3	3	2	2	1	1	2	1	1	0	2	3	3	3

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XUM 406			ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
1.5	0.5	1		3	0	0	3

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learned about the qualities of an entrepreneur.
- Would have learned how to start and grow a business.
- Would have learned the risk and safety involved in entrepreneurship.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Recognise*** and ***describe*** the personal traits of an entrepreneur.	Cognitive	Remember, Understanding
CO2	***Determine*** the new venture ideas and ***analyse*** the feasibility report.	Cognitive	Understanding, Applying
CO3	***Develop*** the business plan and ***analyse*** the plan as an individual or in team.	Cognitive Affective	Analyzing Receiving
CO4	***Describe*** various parameters to be taken into consideration for launching and managing small business.	Cognitive	Understanding, Analyze
CO5	***Describe*** Technological management and Intellectual Property Rights	Cognitive Affective	Remember, (Respond)

Course content	Hours
I – Entrepreneurial Traits and Functions	
Definition of Entrepreneurship; competencies and traits of an entrepreneur; factors affecting Entrepreneurship Development; Role of Family and Society; Achievement Motivation; Entrepreneurship as a career and national development.	
II – New Product Development and Venture Creation	**9**
Ideation to Concept development; Sources and Criteria for Selection of Product; market assessment; Feasibility Report; Project Profile; processes involved in starting a new venture; legal formalities; Ownership; Case Study.	
III – Entrepreneurial Finance	**9**
Financial forecasting for a new venture; Finance mobilization; Business plan preparation; Sources of Financing, Angel Investors and Venture Capital; Government support in start-up promotion.	
IV – Launching of Small Business and Its Mangement	**9**
Operations Planning - Market And Channel Selection - Growth Strategies - Product Launching – Incubation, Monitoring And Evaluation Of Business - Preventing Sickness And Rehabilitation Of Business Units.	
V – Technology Management, IPR Portfolio for New Product Venture	**9**
Technology management; Impact of technology on society and business; Role of Government in supporting Technology Development and IPR protection; Entrepreneurship Development	

Training and Other Support Services.

Lecture	Tutorial	Practical	Total
45	0	0	45

Text Books:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, ***Entrepreneurship***, Tata McGraw Hill, 6th Edition, 2011.
2. S.S.Khanka, ***Entrepreneurial Development***, S.Chand and Company Limited, 2013.

Reference Books:

1. Mathew Manimala,, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition, 2005.
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 2009.
3. Saravanavel P., Entrepreneurial Development, Ess Pee kay Publishing House, 1997.
4. Arya Kumar, Entrepreneurship: Creating and Leading an Entrepreneurial Organization, Pearson Education 2012.
5. Donald F.K., Rao T.V, Entrepreneurship: A South Asian perspective, Cengage Learning India, 2012.

E-References:

1. Jeff Hawkins, "Characteristics of a successful entrepreneur", ALISON Online entrepreneurship courses, "https://alison.com/learn/entrepreneurial-skills
2. Jeff Cornwall, "Entrepreneurship -- From Idea to Launch", Udemy online Education, https://www.udemy.com/entrepreneurship-from-idea-to-launch/
3. Dinesh A., Raman J., Padmanand V., Suggested Reading / Reference Material for Entrepreneurship Development Programmes (EDP/WEDP/TEDP), EDI Publication, Entrepreneurship Development Institute of India, Ahmedabad. Available from: http://www.ediindia.org/doc/EDP-TEDP.pdf

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	3	3	3	1	2	2	3	2	3	3	1	1
CO 2	1	1	3	2	2	1	2	2	3	2	3	2	1	1
CO 3	1	1	2	3	2	1	2	2	3	2	3	2	1	1
CO 4	1	1	3	3	2	1	2	2	3	2	3	2	1	1
CO 5	1	1	3	2	3	1	2	2	3	2	3	2	1	1
	5	**5**	**14**	**13**	**12**	**5**	**10**	**10**	**15**	**10**	**15**	**11**	**5**	**5**

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original Value	**5**	**5**	**14**	**13**	**12**	**5**	**10**	**10**	**15**	**10**	**15**	**11**	**5**	**5**
Scaled Value	1	1	3	3	3	1	2	2	3	2	3	3	1	1

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XUM407			CONSTITUTION OF INDIA	L	T	P	C
				3	0	0	0
C	P	A		L	T	P	H
3	0	0					
Prequisite: Nil				3	0	0	3

Learning Objectives:

Upon completion of this course, the students

- Would have gained knowledge about the constitution and its history.
- Would have learn about the functioning of law in the country.

Course Outcomes		Domain	Level
CO1	***Understand*** the Constitutional History	Cognitive	Understanding
CO2	***Understand*** the Powers and Functions	Cognitive	Understanding
CO3	***Understand*** the Legislature	Affective	Remembering
CO4	***Understand*** the Judiciary	Affective	Remembering
CO5	***Understand*** the Centre State relations	Cognitive	Understanding

I - Constitutional History- The Constitutional Rights- Preamble- Fundamental Rights- Fundamental Duties- Directive principles of State Policy.	**08**
II - The Union Executive- The President of India (powers and functions)- Vice-President of India-The Council of Ministers-Prime Minister- Powers and Functions.	**09**
III - Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committes of Lok Sabha- Speaker of the Lok Sabha.	**10**
IV - The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction- Appelete jurisdictions- Advisory Jurisdiction- Judicial review.	**09**
V- Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-Legislative Assembly- State Judiciary- Powers and Functions of the High Courts.	**09**

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

REFERENCES

1. W.H.Morris Shores- Government and politics of India, NewDelhi,B.1.Publishers,1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House, 1977.
3. R.Thanker- The Government and politics of India, London:Macmillon, 1995.
4. A.C.Kapur- Select Constitutions S,Chand& Co.,NewDelhi, 1995
5. V.D.Mahajan- Select Modern Governments,S,Chand&Co, NewDelhi,1995.
6. B.C.Rout- Democractic Constitution of India.
7. Gopal K.Puri- Constitution of India, India 2005.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	2	0	0	1	0	0	0	0	0
CO 2	2	0	0	1	0	0	0	0	0
CO 3	2	0	0	1	0	0	0		1
CO 4	2	0	0	1	0	0	0	1	1
CO 5	2	2	0	1	0	0	0	1	1
Total	10	2	0	5	0	0	0	2	3
Scaled to 0,1,2,3	2	1	0	1	0	0	0	1	1

1-5 →1, 6-10 →2, 11-15 →3

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

XBT 501			**BIOINSTRUMENTATION**	**L**	**T**	**P**	**C**
				3	**0**	**2**	**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 Remembering
CO2	***Describe*** the spectrophotometric methods and ***perform***the experiments related to spectroscopy.	Cognitive Affective	Understanding Remembering
CO3	***Understand*** the electrochemical techniques and ***apply***it in various applications in biotechnology.	Cognitive	Understanding Remembering Guided response
CO4	***Know*** the principle of instrumentation and ***applications*** of various imaging techniques in biological field.	Cognitive	Understanding Remembering

			Guided response
CO5	***Distinguish*** the various separation and sequencing techniques	Cognitive	Understanding Remembering

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l Value	**14**	**12**	**11**	**7**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**4**	**0**	**5**
Scaled Value	3	3	3	2	0	0	2	0	0	0	0	2	0	2

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original Value	**5**	**5**	**10**	**0**	**5**	**0**	**0**	**5**	**5**	**5**	**5**	**8**	**9**	**11**
Scaled Value	1	1	2	0	1	0	0	1	1	1	1	2	2	3

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 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**
1.5	**1**	**0.5**		**3**	**1**	**2**	**6**

PREREQUISITE: Basic Industrial Biotechnology, Microbiology

COURSE OUTCOMES:

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: ***Recall*** and ***identify*** the basic parts of a fermented and its operations.	CogPsy	Remembering Perception
CO2: ***Identify, organise,*** and ***perform*** the different media components involved in a fermentation process.	CogAffPsy	Remembering Valuing Applying
CO3: I***nterpret***, ***compare*** and ***describe*** various control systems involved in bioreactor.	CogAffPsy	Understanding Receiving Phenomena Perception
CO4: ***Recognize, choose*** and ***follow*** the various transport phenomena involved in bioprocesses.	CogAffPsy	Understanding Receiving Phenomena Guided Resp.
CO5: ***Explain*** and ***follow*** the scale up procedure and ***design*** a bio product.	CogAffPsy	Understanding Responding Guided Resp.

I	**INTRODUCTION TO BIOPROCESSS**	**9+3+3**
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 – sterilization of media.

II	MEDIA FORMULATION AND FERMENTATION PROCESS DESIGN	9+3+3

Criteria for good 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+3

Instrumentation, measurement and control of the bioprocess parameter such as temperature, pressure, pH, dissolved oxygen, redox, microbial biomass, flow measurement-Agitation and aeration-Detection and prevention of foam. 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+3

Flow properties of Fermentation Broths, Factors affecting broth viscosity. Mixing in a Bioreactor – Flow regimes - Power Requirements for Mixing, Ungassed 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	BIOPROCESS SCALE UP CONSIDERATIONS & APPLICATIONS	9+3+3

Scale up procedure of bioreactors: scale up for constant K_La, scale up based on shear forces, mixing time-Bioprocess considerations in using Animal and Plant cell cultures. Case studies on Single Cell protein Production- 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.

Various product assay techniques

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	15	30	90

TEXT BOOKS:

1. Najafpour, Ghasem. Biochemical engineering and biotechnology. Elsevier, 2015.
2. 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. Schuler and Kargi, Bioprocess engineering. Prentice Hall
4. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001.
5. Lee J.M, Biochemical Engineering 2nd ed, Prentice Hall, 2000.

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

XBT 504A			PLANT BIOTECHNOLOGY	L	T	P	C
				2	1	0	3
C	P	A		L	T	P	H
2.5	0	0.5		2	2	0	4

PREREQUISITE: Cell biology , Genetics and Molecular biology .

COURSE OUTCOMES:

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

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	**INVITRO 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 of proteins – Bioreactor engineering for recombinant protein production using plant suspension culture - Plant vaccines, custom-made antibodies - *Arabidopsis* genome sequencing project technology and its applications - Mechanism of insecticidal crystal protein of *Bacillus thuringiensis*, strategy to generate BT cotton transgenic plants; their problems and solutions – Role of RNAi technology in plant biotechnology.		

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.

REFERENCES:

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/

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	**4+3**
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	**7+3**
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	**7+3**
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	**8+3**
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	**4+3**
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**
30	**15**	**0**	**45**

Text Books:

1. Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., *Food Biotechnology,* CRC press, 2005.
2. M. Shafiur Rahman, 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 → 1, 6 – 10 → 2, 11 – 15 → 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 Nirali Prakashan, 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	PO1 0	PO1 1	PO1 2	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

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

COURSE CODE	XBT 601	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& Elin M.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.
REFERENCES	
1.	Luke M Froeb / Brian T Mccann, "Managerial Economics – A problem solving approach" Thomson learning 2007
2.	Truett&Truett, "Managerial economics- Analysis, problems & cases "Wiley India 8th edition 2004.
3.	Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4.	Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

Mapping of CO with PO

CO Vs PO	CO1	CO2	CO3	CO4	CO5	Total	Scaled to 0,1,2 and 3
PO_1	1	2	2	1	2	8	2
PO_2	1	2	2	1	3	9	2
PO_3	1	1	2	1	2	7	2
PO_4	1	1	2	0	1	5	1
PO_5	1	2	2	1	2	8	2
PO_6	1	2	2	1	3	9	2
PO_7	1	1	2	1	2	7	2
PO_8	1	1	2	0	1	5	1
PO_9	1	2	2	1	2	8	2
PO_{10}	1	2	2	1	3	9	2
PO_{11}	1	1	2	1	2	7	2
PO_{12}	1	1	2	0	1	5	1
PSO_1	1	2	2	1	2	8	2
PSO_2	1	2	2	1	3	9	2
TOTAL	14	22	28	11	29	-	-

1-5 → 1, 6-10 → 2, 11-15 → 3

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

XBT 602			BIOREACTOR DESIGN	L	T	P	C
				3	1	2	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.

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 → 1, 6 – 10 → 2, 11 – 15 → 3

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

XBT 603			**RECOMBINANT DNA TECHNOLOGY**	**L**	**T**	**P**	**C**
				3	**1**	**2**	**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 involved.	Cognitive Psychomotor	Remembering 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 Screening 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**
CO 1	1	1	2	1	1	1	0	0	1	0	1	0	0	0
CO 2	3	0	3	2	2	1	0	0	0	0	1	0	0	0

CO 3	3	0	3	1	3	0	0	1	0	2	0	0	0	0
CO 4	3	0	3	1	3	0	0	2	0	1	0	0	0	0
CO 5	3	0	3	2	3	2	3	3	0	1	2	0	0	0
	13	**1**	**14**	**7**	**12**	**4**	**3**	**6**	**1**	**4**	**4**	0	0	0

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

Mapping of Subjects with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
Original Value	**13**	**1**	**14**	**7**	**12**	**4**	**3**	**6**	**1**	**4**	**4**	0	0	0
Scaled Value	3	1	3	2	3	1	1	2	1	1	1	0	0	0

1 – 5 → 1, 6 – 10 → 2, 11 – 15 → 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	Cognitive	Analyzing

	and ***explain*** the autoimmune diseases.		Understanding
CO5	***Comprehend*** the types, mechanism of vaccines and ***respond***to the various immunization techniques	Cognitive Psychomotor	Understanding Guid. Resp.

I- Immune System	**9 + 6**
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 + 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 + 6**
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 + 6**
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 + 3**
Vaccines: Active and Passive Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA and Multivalent Subunit Vaccines. Tumors of the Immune System - Tumor Antigens - Immune Response to Tumors – Cancer immunotheraphy.	

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

Text Books:

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

References:

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

E - References:

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

Mapping of COs with POs

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

Mapping of Subjects with POs

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

XBT 604 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 604B			**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		**12**
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

	PO1	PO2	PO 3	PO4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO12	PSO1	PSO2
Original 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 604C			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 Vs Pos

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Origina l value	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 701A	**PROTEIN ENGINEERING**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

C	**P**	**A**		**L**	**T**	**P**	**H**
2.5	**0**	**0.5**		**3**	**2**	**0**	**5**

PREREQUISITE: Biochemistry, Molecular Biology

COURSE OUTCOMES:

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	Cog	Understanding
CO2:*Explain* and ***analyze*** the secondary and super secondary structural features	Cog	Understanding Analyzing
CO3:*Describe* and ***compare*** the different level of protein structure and their folding mechanism.	Cog	Remembering Analyzing
CO4:*Explain* the protein structure its function al relationship and ***relate*** that in various examples.	Cog Aff	Applying Organization
CO5:*Explain* the protein engineering concepts and ***assist*** that in various engineered protein production.	Cog	Applying Responds to phenomena

I	STRUCTURE AND FUNCTIONAL ASPECTS OF AMINOACIDS	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 ARCHITECHTURE**	**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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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
CO3	3	1	2	1	2	0	0	0	1	1	1	3	2	3	3
CO4	1	3	2	3	2	1	2	1	1	2	1	2	2	2	2
CO5	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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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:

1. Crommelin.D.J.A, Robert D. Sindela, Bernd Meibohm "Pharmaceutical Biotechnology: fundamentals and applications", Informa Healthcare, 2008.

2. Pharmaceutical biotechnology:drug discovery and clinical applications by Kayser,Wiley publishers, 1st edition 2007
3. Katzung B.G. Basic and Clinical Pharmacology,(6th Ed) Prentice Hall of Intl., 1995

E- References:

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

Mapping Of COs and POs

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

Mapping of Subject Vs POs

	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 701 C			**MASS TRANSFER FUNDAMENTALS**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

Prerequisites : Nil

Objectives:

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

Course Outcomes: At the end of this course, the students should be able to		**Domain**	**Level**
CO1	Explain the basic principles in diffusional mass transfer and calculate the rate of the mass transfer under one dimensional steady state diffusion	Cognitive	Understand Analysing
CO2	Describe the operations of Distillation and absorption and	Cognitive	Understand

	calculate number trays for distillation and absorption tower		Analysing
CO3	List situations where liquid–liquid extraction might be preferred to distillation	Cognitive	Understand Analysing
CO4	Discuss the salient features of Separation by adsorption, chromatographic separation process and Explain the concept of breakthrough in fixed-bed adsorption.	Cognitive	Understand Analysing
CO5	Describe the salient features and mechanism involved in Drying and Design cooling towers.	Cognitive	Understand Analysing

I- Mass Transfer and Diffusion **9 hrs**

Steady state molecular diffusion in fluids and solids. One dimensional steady state and unsteady state molecular diffusion through stationary media – molecular diffusion in laminar flow – diffusivity measurements – mass transfer analogies – inter phase mass transfer, models of mass transfer at fluid – fluid interface – two film theory and overall mass transfer coefficients – Diffusion in multi component gaseous mixtures – Diffusion in solids.

II- Distillation **9 hrs**

Vapour liquid equilibrium – methods of distillation – simple, steam, flash distillation, azeotropic, Extractive and molecular distillation – Continuous distillation – McCabe - Thiele method, ponchonsavarit method

III - Extraction and Leaching **9 hrs**

L-L equilibrium – staged and continuous extraction concepts, Equipments for extraction – general design considerations. Solid – liquid equilibria, leaching principles – Equipments for leaching – equilibrium stage model for leaching and washing - simple problems.

IV- Absorption and Adsorption **9 hrs**

Theory of absorption – Factors affecting gas absorption-Equilibrium and operating line concept in absorption stage determination – Pressure drop and limiting flow rates – weeping; coning; entrainment; flooding; channellingAdsorption and its types -sorbents – equilibrium consideration-kinetic and transport considerations – sorption systems.

V - Humidification and Drying **9 hrs**

Basic terminologies in humidification – psychrometric chart, construction and use. Methods of humidification and dehumidification – equipments – spray chamber– cooling tower principles, types and operation – process design of cooling tower.

Theory and mechanism of drying – drying characteristics of materials -batch and continuous drying – drying equipment – design and performance of various drying equipments.

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

Text Books

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

References

1. Dutta, B. K., " *Principles of mass transfer and separation processes"*, Prentice Hall of India, Delhi, 2007

2. Coulson and Richardson, "Chemical Engineering" Vol. I & II, Asian Books Pvt.ltd., 1998.
3. McCabe, W.L., J.C. Smith and P. Harriott, "*Unit Operations of Chemical Engineering"*, 7/e, McGraw-Hill International Edition, 2005.

Mapping of COs Vs Pos

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

Mapping of Subject Vs Pos

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
Original value	14	13	5	11	8	5	8	5	5		8	8	11	11
Scaled to 0,1,2,3 scale	3	3	0	3	2	0	2	0	0	0	2	2	3	3

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

XBT 702	**BIOINFORMATICS AND COMPUTATIONAL BIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**1**	**4**

C	**P**	**A**	**L**	**T**	**P**	**H**
1.5	**1**	**0.5**	**3**	**0**	**2**	**5**

PREREQUISITE: Computer programming, biochemistry

COURSE OUTCOMES:

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.	Cog Psy	Understanding Perception
CO2:*Understands* the significance of sequence analysis and ***performs*** sequence alignment.	Cog Psy	Applying Guided response
CO3: *Explain* and ***reproduce*** phylogenetic trees to study phylogenetic relationships	Cog Psy	Understand Guided

		response
CO4:*Predict* and ***construct*** the protein structure and molecular docking	Cog Psy	Create mechanism
CO5:*Understand* and ***choose*** the steps involved in drug discovery process.	Cog Aff	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+6**

Protein structure basics, Protein structural visualization and comparison, Secondary structure prediction- Chau-Fasman, GOR, Neural networks, Protein tertiary structure prediction Homology 86odelling, Threading and Fold recognition.

V	**ROLE OF BIOINFORMATICS IN DRUG DISCOVERY**	**9+6**

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

Experiment No 1: Accession and retrieval of data from various biological databases.

Experiment No 2: Unix/Linux – basic operations and working with terminal

Experiment No 3: Perl programming – Simple programs using Operators, Control Structures, Subroutines, Hash, Creating a static HTML file by a Perl Program

Experiment No 4: Heuristic methods (BLAST, FASTA) of searching for homologous sequences

Experiment No 5: Pair-wise (Needleman – Wunch Algorithm & Smith waterman Algoritghm)and Multiple sequence alignment

Experiment No 6: Gene prediction methods (ORF Finder)

Experiment No 7: Phylogenetic tree building using Phylip

Experiment No 8: Protein Secondary structure prediction

Experiment No 9: Homology Modeling

Experiment No 10: Molecular Visualization and 3D structural studies using Rasmol– Commands, Domain identification
Experiment No 11: Molecular Visualization and 3D structural studies using Chimera
Experiment No 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.

REFERENCES

3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008
4. T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005
5. 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	

XBT 703			DOWNSTREAM PROCESSING	L	T	P	C
				3	1	1	5
C	P	A		L	T	P	H
1	1	1		3	2	2	7

PREREQUISITE: Microbiology, Basic industrial biotechnology, Bioprocess Engineering

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.	CogAff	Remembering Receiving Phenomena
CO2:*Outline*, ***differentiate*** and ***relates*** the different methods of downstream processing.	Cog Aff Psy	Understanding Valuing Perception
CO3:*Identify*, ***locate*** and ***select*** a specific method for a production process.	Cog Aff Psy	Understanding Receiving Phenomena Perception
CO4:*Recognize*, ***perform*** and ***detect*** various separation technique for a bioproduct development	Cog Aff Psy	Understanding Responding phenomena Perception
CO5:*Identify,choose* and ***follow***the different methods for the purification of a particular product.	Cog Aff Psy	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.

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,PHI Pvt Ltd,2nd Edition, 2012.
2. Sivasankar, B. Biosperations: Principles and Techniques. PHI Learning Pvt. Ltd., 2005.

REFERENCES:

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

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	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	11	9	11	7	0	4	5	0	5	0	2	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. DeVita Jr, V.T., Lawrence, T.S., Rosenberg, S.A., DePinho, R.A. and Weinberg, R.A., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Lippincott Williams & Wilkins Philadelphia, PA, 9th Edition, 2011.
2. Ian F.Tannock, Richard P. Hill, Robert G. Bristow and Lea Harrington., The Basic Sciences of Oncology, 4th Edition, The McGraw-Hill Companies, Inc. New Jersey,2005.
3. PelengarisA.,and M. Khan (Eds)., The Molecular Biology of Cancer, Wiley - Blackwell Publishing, USA. 2006.
4. Gareth Thomas.,Medicinal Chemistry – An Introduction, 1st Edition, John Wiley and Sons, USA, 2004.
5. Benjamin Lewin., Genes VIII, International Edition, Pearson Prentice Hall, New Delhi. 2004.

E References:

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

Mapping of Cos Vs POs

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Original value	13	10	8	11	11	6	4	2	5	5	5	9	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
2.5	0	0.5		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 *Penicillium Chrysogenum* – 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

	PO1	PO2	PO3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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 relate

XBT 707			**INPLANT TRAINING - III**	**L**	**T**	**P**	**C**
				0	**0**	**0**	**1**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.33	**1.33**	**1.33**		**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

XBT 801			PROJECT WORK	L	T	P	C
				0	0	12	12
C	P	A		L	T	P	H
6	3	3		0	0	12	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
CO6	Devote oneself as a responsible member and display as a leader in a team to manage projects.	Aff Cog	Value, Organization, Create
CO7	Responding of project findings among the technocrats.	Aff	Responding