PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY • PMIST •

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

Criterion 1 – Curricular Aspects

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

DEPARTMENT OF BIOTECHNOLOGY

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

1. List of courses for the programmes in order of

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

2. Syllabus of the courses as per the list.

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

1. List of courses

Name of the Course	Course Code	Year of introduction	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
2020-21			
Calculus and Linear Algebra	XMA101	**2008-09**	*****
Environmental Sciences	XES102	**2008-09**	Employability Skill- Role Play,Stage presentation
Electrical and Electronics Engineering System	XBE103	**2008-09**	*****
Applied Physics for Engineers	XAP104	**2008-09**	*****
Engineering Graphics	XEG105	**2008-09**	Employability Skill- Assignment, Design Practice, Tutorial on applications
Calculus, Ordinary Differential Equations and Complex Variable	XMA201	**2008-09**	*****
Programming for Problem Solving	XCP202	**2013-14**	Employability Skill -Assignment, Programming tests, Small program submission for applications.
English	XGS203	**2008-09**	Employability Skill - Presentation, Coherence, Interpersonal & Technical Communication, Body Language
Applied Chemistry for Engineers	XAC204	**2008-09**	*****
Workshop Practices	XWP205	**2008-09**	Employability Skill-Cutting Practices, Carpentery model frame Assignment
Probability and Statistics	XPS301	**2008-09**	*****
Material and Energy Balance	XBT302	**2018-19**	*****
Biochemistry	XBT303	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Microbiology	XBT304	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Entrepreneurship Development	XUM305	**2015-16**	Entrepreneurship-Business plan preparation, Chart work, Assignment, Case study
Unit Operations	XBT305	**2013-14**	****
Human Ethics	XUM306	**2008-09**	****
Material Science	XES401	**2013-14**	****

Genetics	XBT402	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Cell Biology	XBT403	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Bioenergetics and Metabolism	XBT404	**2018-19**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Chemical Engineering Thermodynamics	XBT405	**2013-14**	****
Constitution of India	XUM406	**2018-19**	****
Entrepreneurship Development	XEP407	**2008-09**	Employability Skill- Consumer need analysis, Group Discussion **Entrepreneurship Skill-** Generating Business Ideas
Plant Biotechnology	XBT501	**2008-09**	Employability Skill- **Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion**
Chemical Reaction Engineering	XBT502	**2015-16**	*****
Recombinant DNA Technology	XBT503	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Bioprocess Engineering	XBT504	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Food Biotechnology	XBT505B	**2012-13**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Total Quality Management	XTQ506	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Business Communication	XGS507	**2008-09**	Employability Skill- Creating business presentation,Minutes, Data sheet preparation
In-Plant Training II	XBT508	**2008-09**	Employability Skill – Report making on, Industrial/Laboratory Process, Correlate the curriculum/Syllabus to Industrial process Techniques followed
Open Elective I	XBT601	**2011-12**	*****
Animal Biotechnology	XBT602	**2011-12**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Immunology	XBT603	**2008-09**	Employability Skill- **Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion**

Biochemical Engineering	XBT604	**2011-12**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Protein Engineering	XBT605	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Drug Discovery and Development	XBT606A	**2015-16**	*****
Environmental Studies	XBT607	**2008-09**	*****
Academic Writing	XGS608	**2015-16**	Employability Skill- Presentation, Coherence, Interpersonal & Technical Communication, Body Language
Open Elective II	XOE701	**2011-12**	*****
Bioinformatics and Computational Biology	XBT702	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Computation Practice
Downstream Processing	XBT703	**2008-09**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Cancer Biology	XBT704A	**2013-14**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Industrial Waste Water Management	XBT705B	**2015-16**	*****
Cyber Security	XUM706	**2015-16**	*****
Project Phase I	XBT707	**2008-09**	Employability Skill- Literature Survey, Objective fixing, Priliminary setup, Viva - Voce
Carrer Development Skills	XGS708	**2015-16**	Employability Skill- &Entrepreneurship Skill- Practicing Insurance concept and sales
Inplant Training III	XBT709	**2008-09**	Employability Skill- Report making on, Industrial/Laboratory Process, Correlate the curriculum/Syllabus to Industrial process Techniques followed
Open Elective III	XOE801	**2011-12**	****
Advanced Microbiology	XBT802A	**2015-16**	Employability Skill- Assignment, Quiz/Oral Presentation,Seminar, Group Discussion
Tissue Engineering	XBT803A	**2013-14**	Employability Skill- Assignment, Quiz/Oral, Presentation,Seminar, Group Discussion
Project Phase II	XBT804	**2008-09**	Employability Skill- Optimization, Advancement (Depth view) Viva -Voce

SYLLABUS FOR COURSES

XES 102			ENVIRONMENTAL SCIENCES	L	T	P	C
				3	0	0	0
C	P	A		L	T	P	H
1.4	0.3	0.3		3	0	0	3

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- would have learn about natural energy resources.
- Would have learn about the pollution sources and control.

Course Outcomes		Domain	Level
After the completion of the course, students will be able to			
CO1	***Describe*** the significance of natural resources and ***explain*** anthropogenic impacts.	Cognitive	Remember Understand
CO2	***Illustrate*** the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive	Understand
CO3	***Identify*** the facts, consequences, preventive measures of major pollutions and ***recognize*** the disaster phenomenon	Cognitive Affective	Remember Receive
CO4	***Explain*** the socio-economic, policy dynamics and***practice*** the control measures of global issues for sustainable development.	Cognitive	Understand Apply
CO5	***Recognize*** the impact of population and the concept of various welfare programs, and ***apply*** themodern technology towards environmental protection.	Cognitive	Understand Analysis

I – Introduction to Environmental Studies and Energy	**12**
Definition, Scope And Importance – Need For Public Awareness – Forest Resources: Use, Deforestation, Case Studies. – Water Resources: Use And Over-Utilization Of Surface And Ground Water, Dams-Benefits And Problems – Mineral Resources: Uses, Environmental Effects Of Mining, Case Studies-Iron Mining(Goa), Bauxite Mining(Odisha) – Food Resources: Effects Of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, Salinity, Case Studies – Energy Resources: Growing Energy Needs, Renewable And Non-Renewable Energy Sources, Use Of Alternate Energy Sources, Case Studies – Land Resources: Land As A Resource, Land Degradation – Role Of An Individual In Conservation Of Natural Resources – Equitable Use Of Resources For Sustainable Lifestyles.	
II – Ecosystems and Biodiversity	**7**
Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Biogeochemical cycles – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
III – Environmental Pollution	**10**
Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management– Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.	
IV – Social Issues and the Environment	**10**

Rain water harvesting – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Public awareness.

V – Human Population and the Environment	**6**

Population growth, variation among nations – Population explosion– Environment and human health – HIV / AIDS– Role of Information Technology in Environment and human health.

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

Text Books:

1. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co, USA, 2000.
2. Townsend C., Harper J and Michael Begon, Essentials of Ecology, Blackwell Science, UK, 2003
3. Trivedi R.K and P.K.Goel, Introduction to Air pollution, Techno Science Publications, India, 2003.
4. Disaster mitigation, Preparedness, Recovery and Response, SBS Publishers & Distributors Pvt. Ltd, New Delhi, 2006.
5. Introduction to International disaster management, Butterworth Heinemann, 2006.
6. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, New Delhi, 2004.

Reference Books:

1. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media, India, 2009.
2. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
3. S.K.Dhameja, Environmental Engineering and Management, S.K.Kataria and Sons, New Delhi, 2012.
4. Sahni, Disaster Risk Reduction in South Asia, PHI Learning, New Delhi, 2003.
5. Sundar, Disaster Management, Sarup& Sons, New Delhi, 2007.
6. G.K.Ghosh, Disaster Management, A.P.H.Publishers, New Delhi, 2006.

E-References:

1. http://www.e-booksdirectory.com/details.php?ebook=10526
2. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Science
3. https://www.free-ebooks.net/ebook/What-is-Biodiversity
4. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
5. http://bookboon.com/en/pollution-prevention-and-control-ebook
6. http://www.e-booksdirectory.com/details.php?ebook=8557
7. http://www.e-booksdirectory.com/details.php?ebook=6804
8. http://bookboon.com/en/atmospheric-pollution-ebook
9. http://www.e-booksdirectory.com/details.php?ebook=3749
10. http://www.e-booksdirectory.com/details.php?ebook=2604
11. http://www.e-booksdirectory.com/details.php?ebook=2116
12. http://www.e-booksdirectory.com/details.php?ebook=1026
13. http://www.faadooengineers.com/threads/7894-Environmental-Science

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	1	1	0	0	1	1	1	0	0	0

CO 2	3	3	1	1	1	1	0	0	1	1	1	0	0	0
CO 3	2	2	2	1	2	2	1	1	1	1	1	0	0	0
CO 4	2	2	1	1	1	1	1	1	1	1	1	0	0	0
CO 5	2	2	1	1	1	1	1	1	1	1	1	0	0	0
	12	12	6	5	6	6	3	3	5	5	5	0	0	0

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

XEG 105			**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
				0	**0**	**3**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learn to use engineering graphics to design and project things in 2D.
- Would have learn to draw to design structures**.**

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Apply*** the national and international standards, ***construct*** and ***practice*** various curves	Cognitive, Psychomotor and Affective	Applying, Guided response and Responds to Phenomena
CO2	***Interpret***, ***construct*** and ***practice*** orthographic projections of points, straight lines and planes.	Cognitive, Psychomotor and Affective	Understanding, Mechanism and Responds to Phenomena
CO3	***ConstructSketch*** and ***Practice*** projection of solids in various positions and true shape of sectioned solids.	Cognitive, Psychomotor and Affective	Applying, Complex Overt Response and Responds to Phenomena
CO4	***Interpret***, ***Sketch*** and ***Practice*** the development of lateral surfaces of simple and truncated solids, intersection of solids.	Cognitive, Psychomotor and Affective	Understanding, Complex Overt Response and Responds to Phenomena
CO5	***Constructsketch*** and ***practice*** isometric and perspective views of simple and truncated solids.	Cognitive, Psychomotor and Affective	Applying, Complex Overt Response and Responds to Phenomena
I – Introduction, Free Hand Sketching of Engg Objects and Construction of Plane Curve			**6+6**
Importance of graphics in engineering applications – use of drafting instruments – BIS specifications			

and conventions as per SP 46-2003.

Pictorial representation of engineering objects – representation of three dimensional objects in two dimensional media – need for multiple views – developing visualization skills through free hand sketching of three dimensional objects.

Polygons & curves used in engineering practice – methods of construction – construction of ellipse, parabola and hyperbola by eccentricity method – cycloidal and involute curves – construction – drawing of tangents to the above curves.

II – Projection of Points, Lines and Plane Surfaces	**6+6**

General principles of orthographic projection – first angle projection – layout of views – projections of points, straight lines located in the first quadrant – determination of true lengths of lines and their inclinations to the planes of projection – traces – projection of polygonal surfaces and circular lamina inclined to both the planes of projection.

III- Projection of Solids and Sections of Solids	**6+6**

Projection of simple solids like prism, pyramid, cylinder and cone when the axis is inclined to one plane of projection – change of position & auxiliary projection methods – sectioning of above solids in simple vertical positions by cutting plane inclined to one reference plane and perpendicular to the other and above solids in inclined position with cutting planes parallel to one reference plane – true shapes of sections.

IV- Development of Surfaces and Intersection of Solids	**6+6**

Need for development of surfaces – development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones – development of lateral surfaces of the above solids with square and circular cutouts perpendicular to their axes – intersection of solids and curves of intersection –prism with cylinder, cylinder & cylinder, cone & cylinder with normal intersection of axes and with no offset.

V – Isometric and Perspective Projections	**6+6**

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones – principles of perspective projections – projection of prisms, pyramids and cylinders by visual ray and vanishing point methods.

Lecture	**Tutorial**	**Practical**	**Total**
30	**0**	**30**	**60**

Text Books:

1. Bhatt,N.D, “Engineering Drawing”, Charotar Publishing House, 46th Edition-2003.
2. Natarajan,K.V, “ A Textbook of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2006.
3. Dr. P.K. Srividhya, P. Pandiyaraj, “Engineering Graphics”, PMU Publications, Vallam, 2013

Reference Books:

1. Luzadder and Duff, “Fundamentals of Engineering Drawing” Prentice Hall of India PvtLtd, XI Edition - 2001.
2. Venugopal,K. and Prabhu Raja, V., “Engineering Graphics”, New Age International(P) Ltd., 2008.
3. Gopalakrishnan.K.R,. “Engineering Drawing I & II”, Subhas Publications, 1998.
4. Shah,M.B and Rana,B.C.,”Engineering Drawing”, Pearson Education,2005.

E-References:

1. http://periyarnet/Econtent
2. http://nptel.ac.in/courses/112103019/

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	2	3	2	3	1	1	2	3	3	3	-
CO 2	3	3	3	1	3	1	3	1	1	1	2	3	3	-
CO 3	3	3	3	1	3	1	3	1	1	1	2	3	3	-
CO 4	3	3	3	1	3	1	3	1	1	1	2	3	3	-
CO 5	3	3	3	1	3	1	3	1	1	1	2	3	3	-
	15	15	15	6	15	6	15	5	5	6	11	3	3	-

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

XCP 202			**PROGRAMMINGFOR PROBLEMSOLVING**	**L**	**T**	**P**	**C**
				3	**0**	**2**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
				3	**0**	**2**	**5**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learn to Solvesimpleprograms.
- Would have learn to write simple programs.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Define***programmingfundamentalsand***Solve***simpleprograms usingI/O statements	Cognitive Psychomotor	Remember Understand Apply
CO2	***Define***syntaxand ***writesimpleprograms***using control structures and arrays	Cognitive Psychomotor	Remember Understand, Apply
CO3	***Explain***and ***writesimpleprograms***usingfunctionsand pointers	Cognitive Psychomotor	Understand Apply
CO4	***Explain***and ***writesimpleprograms***usingstructures and unions	Cognitive Psychomotor	Understand Apply, Analyze
CO5	***Explain***and ***writesimpleprograms***usingfiles and ***Build***simple projects	Cognitive Psychomotor	Remember Understand Create

I – Programming Fundamentals and Input/ OutputStatements	**9+6**
Introductiontocomponentsofacomputersystem,Program–Flowchart– Pseudocode–Software– IntroductiontoClanguage–Character set–Tokens: Identifiers,Keywords,Constants,andOperators–	

sampleprogramstructure-Header files – Data Types-Variables- Output statements –Input statements.	
II – ControlStructure andArrays	**9+6**
ControlStructures–ConditionalControlstatements:Branching,Looping-Unconditionalcontrolstructures:switch,break,continue,gotostatements– Arrays:OneDimensionalArray–Declaration–Initialization–Accessing ArrayElements–Searching–Sorting–TwoDimensionalarrays-Declaration –Initialization– Matrix Operations – MultiDimensional Arrays-Declaration–Initialization.Storageclasses:auto–extern–static.Strings:Basicoperations on strings.	
III – Functions andPointers	**9+6**
Functions:Builtinfunctions–UserDefinedFunctions-Parameterpassing methods-Passingarraystofunctions–Recursion-Programsusingarraysand functions.Pointers-Pointerdeclaration-Addressoperator-Pointer expressions&pointerarithmetic-Pointersandfunction-Callbyvalue-Call byReference-Pointertoarrays-UseofPointersinself-referentialstructures-Notion of linked list(no implementation).	
IV – Structures andUnions	**9+6**
Structures andUnions -Givingvalues to members-Initializingstructure-Functions and structures-Passingstructure to elements to functions- Passing entire function to functions- Arrays of structure - Structurewithin a structure and Union.	
V – Files	**9+6**
FilemanagementinC-FileoperationfunctionsinC-Definingandopeninga file-Closingafile-Thegetwandputwfunctions-Thefprintf&fscanf functions - fseek function– Files andStructures.	

Practical:

1. Program to displayasimple pictureusingdots.
2. Program for addition of two numbers
3. Program to swap two numbers
4. Program to solve anymathematical formula.
5. Program to find greatest of 3 numbers using BranchingStatements
6. Program to displaydivisible numbers between n1and n2 usinglooping Statement
7. Program to remove duplicate element in an array.
8. Program to perform stringoperations.
9. Performingbasic sorting algorithms.
10. Program to find factorial of a given number using four function types.
11. Programs usingRecursion such asFindingFactorial, Fibonacci series, Ackermanfunction etc.Quick sort orMerge sort
12. Programs usingPointers.
13. Program to readand displaystudent mark sheet Structureswith variables
14. Program to readand displaystudent marks of a class usingStructures with arrays
15. Program to create linkedlist usingStructures with pointers.
16. Program for copying contents of one file to another file.
17. Program usingfiles usingstructure with pointer.

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

Text Books:

1. ByronGottfried,"ProgrammingwithC",IIIEdition,(IndianAdaptedEdition),TMHpublications, 2010
2. YeshwantKanethker,“Let us C”, BPBPublications, 2008
3. Brian W. Kernighan and Dennis M. Ritchie,"The C Programming Language", Pearson EducationInc. 2005

Reference Books:

1. Behrouz A.Forouzanand Richard. F. Gilberg,"A Structured ProgrammingApproach UsingC",II Edition, Brooks–Cole ThomsonLearningPublications, 2001
2. Johnson baugh R. and Kalin M., “ApplicationsProgrammingin ANSIC”,IIIEdition, Pearson

EducationIndia, 2003 E. Balaguruswamy, Programmingin ANSIC,Tata McGraw-Hill
E-References:
1. http://www.digimat.in/nptel/courses/video/106105171/L01.html

Mapping of COs with POs

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

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

XGS 203			**ENGLISH**	**L**	**T**	**P**	**C**
				2	**0**	**1**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.6	**0.4**	**0**		**2**	**0**	**2**	**4**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learn to use good vocabulary for speaking and writing.
- Would have learn to find grammatical errors while writing.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
CO1	***Ability*** to recall the meaning for proper usage	Cognitive	Remember
CO2	***Apply*** the techniques in sentence patterns	Cognitive	Apply
CO3	***Identify***the common errors in sentences	Cognitive	Remember
CO4	***Construct*** the Nature and Style of sensible Writing	Cognitive	Create
CO5	***Practicing***thewriting skills.	Psychomotor	Guided Response
CO6	***Grasping*** the techniques in learning sounds and etiquettes	Psychomotor	Adapting

I – Vocabulary Building	**9**
1.1 The concept of Word Formation 1.2 Root words from foreign languages and their use in English 1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. 1.4 Synonyms, antonyms, and standard abbreviations.	
II – Basic Writing Skills	**9**
2.1 Sentence Structures 2.2 Use of phrases and clauses in sentences 2.3 Importance of proper punctuation	

2.4 Creating coherence 2.5 Organizing principles of paragraphs in documents 2.6 Techniques for writing precisely	
III – Identifying Common Errors in Writing	**9**
3.1 Subject-verb agreement 3.2 Noun-pronoun agreement 3.3 Misplaced modifiers 3.4 Articles 3.5 Prepositions 3.6 Redundancies 3.7 Clichés	
IV – Nature and Style of sensible Writing	**9**
4.1 Describing 4.2 Defining 4.3 Classifying 4.4 Providing examples or evidence 4.5 Writing introduction and conclusion	
V – Writing Practices	**9**
5.1 Comprehension 5.2 Précis Writing 5.3 Essay Writing	
VI – Oral Communication Lab	
(This unit involves interactive practice sessions in Language Lab) □ Listening Comprehension □ Pronunciation, Intonation, Stress and Rhythm □ Common Everyday Situations: Conversations and Dialogues □ Communication at Workplace □ Interviews □ Formal Presentations	

Lecture	Tutorial	Practical	Total
30	0	15	45

Text Books:

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011
2. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Reference Books:

1. Practical English Usage. Michael Swan. OUP. 1995
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006

E-References:

Mapping of COs with POs

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

CO 4	2	0	0	0	0	0	1	0	1	0	0	0	0	0
CO 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**4**	**0**	**0**	**0**	**0**	**0**

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

XWP 205			**WORKSHOP PRACTICES**	**L**	**T**	**P**	**C**
				1	**0**	**2**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**3**	**0**		**2**	**0**	**4**	**6**

Prerequisite: Nil

Learning Objectives:

Upon completion of this course, the students

- Would have learn to cast and mould things.
- Would have learn the use of various tools of carpentry.

Course Outcomes		**Domain**	**Level**
After the completion of the course, students will be able to			
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 connections**.**	Cognitive Psychomotor	Understanding Origination

I – **6+12**

1. Introduction to Machining Process
2. Plain Turining Using Lathe Operation
3. Introduction to Cnc
4. Demonstration of Plain Turning Using Cnc

II – **6+9**

1. Study Of Metal Casting Operation
2. Demonstration Of Moulding Process
3. Study Of Smithy Operation

III – **6+18**

1. Study of carpentry tools
2. Half lap joint – Carpentry
3. Mortise and Tenon joint – Carpentry
4. Study of fitting tools
5. Square fitting
6. Triangular fitting

IV – **6+9**

1. Study Of Welding Tools
2. Square butt joint – welding
3. Tee joint – Welding

V –	6+12

1. Introduction to house wiring
2. One lamp controlled by one switch
3. Two lamps controlled by single switch
4. Staircase wiring

Lecture	Tutorial	Practical	Total
30	0	60	90

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 ByManchanda Vol. I,II,III India Publishing House, Jalandhar.

Reference Books:

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

E-References:

1. http://nptel.ac.in/courses/112107145/

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	2	1	2	2	1	0	0	1	1	0	1	2	0	0
CO 2	2	1	2	2	1	0	0	1	1	0	1	2	0	0
CO 3	2	1	2	2	1	0	0	1	1	0	1	2	0	0
CO 4	2	1	2	2	1	0	0	1	1	0	1	2	0	0
CO 5	2	1	2	2	1	0	0	1	1	0	1	2	0	0
	10	**5**	**10**	**10**	**5**	**0**	**0**	**5**	**5**	**0**	**5**	**10**	**0**	**0**

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

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

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

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	CO1
2. Preparation of slants /plates and aseptic transfer of microbial cultures	CO1
3. Staining and identification of microbes using simple and differential staining	CO1
4. Biochemical characterization of microbes	CO2
5. Isolation of microbes using spread plate method	CO3
6. Isolation of microbes using streak plate method	CO3
7. Isolation of microbes using pour plate method	CO3
8. Microbial growth control using Kirby-Bauer method	CO4
9. Cell counting	CO4
10. Screening of microorganisms for enzyme production	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

	PO1	PO2	PO3	PO4	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

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'sLewin'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

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 Between Intracellular 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

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

XUM406			ENTREPRENEURSHIP DEVELOPMENT	L	T	P		C
				2	0	0		2
C	P	A		L	T	P	SS	H
2.7	0	0.3		2	0	0	1	3

PREREQUISITE: Nil

COURSE OUTCOMES:

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.	Affective Cognitive	Receiving Understanding
CO2	***Determine*** the new venture ideas and ***analyse***the feasibility report.	Cognitive	Understanding Analysing
CO3	***Develop*** the business plan and ***analyse*** the plan as an individual or in team.	Affective Cognitive	Receiving Analysing
CO4	***Describe*** various parameters to be taken into consideration for launching and managing small business.	Cognitive	Understanding
CO5	***Explain the*** technological management and Intellectual Property Rights	Cognitive	Understanding

I	**ENTREPRENEURIAL TRAITS AND FUNCTIONS**	**9**
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 startup 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. Hisrich, 2016, *Entrepreneurship*, Tata McGraw Hill, New Delhi.
2. S.S.Khanka, 2013, *Entrepreneurial Development*, S.Chand and Company Limited, New Delhi.

REFERENCES:

1. Mathew Manimala, 2005, *Entrepreneurship Theory at the Crossroads, Paradigms & Praxis,*

Biztrantra, 2nd Edition.
2. Prasanna Chandra, 2009, *Projects – Planning, Analysis, Selection, Implementation and Reviews*, Tata McGraw-Hill.
3. P.Saravanavel, 1997, *Entrepreneurial Development*, Ess Pee kay Publishing House, Chennai.Arya Kumar,2012, *Entrepreneurship: Creating and Leading an Entrepreneurial Organisation*, Pearson Education India. Donald F Kuratko, T.V Rao, 2012, *Entrepreneurship: A South Asian perspective*, Cengage Learning India.
4. Dinesh Awasthi, Raman Jaggi, V.Padmanand, *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

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/

Table 1: Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	0	0	0	1	2	0	1	1	1	1	2	1	0	0
CO 2	0	0	0	0	0	2	0	1	0	1	1	1	0	0
CO 3	0	0	2	0	0	3	2	1	3	3	3	3	0	1
CO 4	1	0	1	3	0	0	0	0	0	1	2	0	0	0
CO 5	1	1	1	3	0	0	0	0	0	2	2	1	0	0
Total	2	1	4	7	2	5	3	3	4	8	10	6	0	0
Scaled to 0,1,2, 3	1	1	1	2	1	1	1	1	1	2	2	2	0	1

1-5 →1, 6-10 →2, 11-15 →3

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

XBT 501			**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.	Cognitive	Remembering Understand

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

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/

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

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

XBT 503			**RECOMBINANT DNA TECHNOLOGY**	**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: Genetics and Molecular biology.

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, distinguish* and ***Isolate*** various vector systems	Cognitive Psychomotor	Understanding Perception
CO3:*Describes, Compares* and *Manipulates* various techniques involved.	Cognitive Psychomotor	Remembering Analyzing Mechanism
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

I	**INTRODUCTION RECOMBINANT DNA TECHNOLOGY**	9

Basic concepts of gene cloning- 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	BIOLOGY OF VECTORS	9+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.

Experiment No 1: Genomic DNA extraction
Experiment No 2: Restriction enzyme digestion of vector

III	MOLECULAR TECHNIQUES	9+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).

Experiment No 3: Western blotting.
Experiment No 4: DNA finger printing
Experiment No 5: SDS PAGE.
Experiment No 6: Agarose gel Electrophoresis.

IV	SCREENING AND SELECTION OF TRANSFORMANTS	9+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.
Experiment No 7: Partial digestion of genomic DNA
Experiment No 8: ligation of restricted vector and genomic DNA
Experiment No 9: Competent cell preparation- calcium chloride method
Experiment No 10: Screening and selection of recombinants

V	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY	9

Production of recombinant- insulin, human growth factor, vaccine and gene therapy- gene silencing using RNAi. Human genome project and its application. Biosafety guidelines and ethical issues of recombinant DNA techniques.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45		30	75

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.

REFERENCES:

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/

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

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

XBT 504			**BIOPROCESS ENGINEERING**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**1**	**0.5**		**3**	**2**	**2**	**7**

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 basicparts of a fermented and its operations.	Cognitive Psychomotor	Remembering Understanding
CO2: ***Identify,reproduce,*** and ***demonstrate***the different media components involved in a fermentation process.	Cognitive Affective Psychomotor	Remembering Valuing Applying
CO3: I***nterpret***, ***describe*** and ***differentiate*** various control systems involved in bioreactor.	Cognitive Affective Psychomotor	Understanding Receiving Phenomena Perception
CO4: ***Recognize, discuss*** and ***measure*** the various transport phenomena involved in bioprocesses.	Cognitive Affective Psychomotor	Understanding Mechanism
CO5: ***Explain*** and ***follow*** the scale up procedure and ***develop*** a bio product.	Cognitive Affective Psychomotor	Understanding Creating

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.

Experiment no 1: Study of Fermenter.

Experiment no 2: Determination of thermal death rate constant for the given microbial sample.

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.

Experiment no 3: Comparison of bioprocess efficiencies in synthetic and complex industrial media.
Experiment no 4: Medium formulation and optimization studies.

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, FIA, flow cytometry, florescence activated cell sorting (FACS)- Use of molecular methods in the monitoring of cellular parameters-Biosensors.
Experiment no 5: Estimation of biomass concentration for microbial production.

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.
Experiment no 6: Determination of oxygen mass transfer coefficient by Sulphite oxidation method.
Experiment no 7: Determination of oxygen mass transfer coefficient by Dynamic Gassing out method
Experiment no 8: Residence time distribution studies.

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.

Experiment no 9: Production of Single cell proteins.
Experiment no 10:Various product assay techniques.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	15	15	75

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,

AdityaBook 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

Cos Vs POs

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

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

XBT 505 B			**FOOD BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2	**0**	**0.25**		**3**	**0**	**0**	**3**

PREREQUISITE: Microbiology, Basic industrial basic biotechnology, Bioprocess engineering.

COURSE OUTCOMES:

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1:*Know* the principles and ***defines*** the concepts of food biotechnology.	Cognitive	Remembering
CO2:*Describe* the role of microbes associated with food products.	Cognitive	Understanding
CO3:*Outlines* the methods for Genetically modified food production.	Cognitive	Analyzing
CO4:*Discuss* and ***compiles*** the various methods of food preservation and packaging	Cognitive Affective	Understanding Receiving Phenomena
CO5:*Describe* the importance of food quality and regulations	Cognitive	Evaluating

I	**INTRODUCTION TO FOOD BIOTECHNOLOGY**	**9**
Introduction – principles, scope and importance of food biotechnology. Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables. Functional foods: Concept of Prebiotics, Probiotics and Neutraceuticals.		
II	**UTILIZATION OF MICROORGANISMS IN FOOD INDUSTRIES**	**9**

Microbes normally associated with food products –yeast- alcoholic beverages, bread and related products. Genetic manipulations- rennet, Penicillium- wine- lactic acid bacteria- single cell protein- Origin, scope and development of fermented food products - Natto- Miso-Sufu. microbes based products- Mushrooms- Cocoa, tea and coffee fermentation		
III	**GENETICALLY MODIFIED FOOD PRODUCTS**	**9**
Herbicide tolerance- soybean, Insect resistance- corn, Altered fatty acid composition- canola, Virus resistance- Plum, Vitamin enrichment- Golden rice, Faster maturation- Coho Salmon. Future aspects- Benefits for astronauts from GMF.		
IV	**FOOD PRESERVATION AND PACKAGING**	9
Principles and methods of food preservation- Food preservation by low-temp: Refrigeration, freezing and freeze-drying. Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization, extrusion cooking. Non-thermal preservation: Hydrostatic pressure, dielectric heating, microwave processing, hurdle technology, membrane technology, irradiation. Packaging of food- packaging materials-atmosphere in the package- Vaccum packaging, Controlled atmosphere packaging, Modified atmosphere packaging. Food spoilage- Food Analysis and Diagnostics –ELISA - Biosensor for food quality assessment		
V	**FOOD SAFETY AND REGULATIONS**	**9**
International aspects of quality and safety assessment of food derived by modern biotechnology, Safety of fermented foods. Approval process for food additives, nutritional labeling, dietary supplements, quality assurance/control department- Concept of codex almentarious, Hazard Analysis Critical Control Points (HACCP).		

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

TEXT BOOKS:

1. ZekiBerk., Food process engineering and technology. Academic press, Second Edition 2013.

2. Prescott M., Harley J.P. and Klein D.A., "Microbiology", Seventh Edition, Tata McGraw Hill, 2007.

REFERENCES:

1. Byong H. Lee., Fundamentals of food biotechnology. John Wiley & Sons, 2014.
2. Ray B., "Fundamental Food Microbiology", Third Edition, CRC Press LLC, 2003.
3. Shetty, Kalidas, et al., eds. Food biotechnology. CRC Taylor & Francis, 2006.

E- REFERENCES

1. http://nptel.ac.in/courses/103107088/
2. http://nptel.ac.in/courses/103103029/34

Cos Vs Pos

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

CO 5	2		3		3	3					
	10	3	12	9	12	9					5

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

XTQ 506			**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
2.5	**0**	**0.5**		**3**	**0**	**0**	**3**

COURSE OUTCOMES:

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1:*List* and ***explain*** the basic concepts of total quality concepts and its limitations.	Cognitive	Remembering Understanding
CO2:*Analyze* and ***explain*** the customer satisfaction, employee involvement, supplier selection and appraise the performance by TQM principle.	Cognitive	Comprehension
CO3:*Explain* and ***apply*** the statistical process control tools.	Cognitive	Understanding Appling
CO4:*Select* and ***explain***the different TQM tools and their significance.	Cognitive	Remembering Understanding
CO5:*Explain* the importance aspects of different quality systems.	Cognitive	Understanding

I	**INTRODUCTION**	**9**
Definition of quality – Dimensions of quality – Quality planning – Quality costs – Analysis techniques for quality costs – Basic concepts of Total Quality Management – Historical review – Principles of TQM – Leadership – Concepts – Role of senior management – Quality Council – Quality statements – Strategic planning – Deming philosophy – Barriers to TQM implementation		
II	**TQM PRINCIPLES**	**9**
Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation, empowerment, teams, recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy – PDSA cycle – 5S – Kaizen – Supplier partnership – Partnering – Sourcing – Supplier selection – Supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure.		
III	**STATISTICAL PROCESS CONTROL (SPC)**	**9**
The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.		
IV	**TQM TOOLS**	**9**
Benchmarking – Reasons to benchmark – Benchmarking process – Quality Function Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.		

V	QUALITY SYSTEMS	9

Need for ISO 9000 and other quality systems – ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 – Concept, requirements and benefits.

L-45 hrs Total -45 hrs

TEXT BOOKS

1. Dale H. Besterfiled, et. Al. "Total Quality Management", New Delhi, Pearson Education, Inc,2007.
2. James R. Evans and William M. Lidsay, "The Management and Control of Quality", 5th Edition, South-Western, 2002.

REFERENCES

1. Feigenbaum, A.V., "Total Quality Management", McGraw Hill, 1991.
2. Oakland, J.S., "Total Quality Management", Butterworth Heineman, 1989.
3. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International, 1996.
4. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

E REFERENCE

1. http://nptel.ac.in/faq/110101010/Prof.IndrajitMukherjee,IIT,Bombayand Prof.TapanP.Bagchi, IIT, Kharagpur.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1
CO1	0	0	1	0	0	0	0	0	1	0	0	0
CO2	0	0	0	0	0	1	2	0	0	0	0	0
CO3	0	0	0	0	0	1	1	2	0	0	0	0
CO4	1	1	0	0	1	1	2	1	1	0	0	1
CO5	1	0	0	2	0	2	3	2	3	0	0	1
	2	1	1	2	1	5	8	5	5	0	0	2

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

XGS 507			BUSINESS COMMUNICATION	L	T	P	C
				1	0	0	1
C	P	A		L	T	P	H
3	0	0		1	0	2*	3

PREREQUISITE: Communication Skill and Basic Grammar Knowledge

COURSE OUTCOMES:

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1: ***Define*** and ***Identify*** different styles to various forms of business communication.	Cognitive	Remember
CO2: ***Identify*** the proper tone of language required in writing and speaking in business communication.	Cognitive	Remember
CO3: ***Display*** knowledge on grammar and other linguistic features in writing various forms of business communication.	Cognitive	Understand
CO4: ***Distinguish*** between letters and memos and various forms of Business Communication.	Cognitive	Analyse
CO5: ***Prepare*** business reports, minutes, proposals.	Cognitive	Apply

I	**INTRODUCTION TO BUSINESS COMMUNICATION**	**10**
Introduction to business communication; modern developments in the style of writing letters memos and reports: block letters, semi block letters, full block letters, simplified letters etc.,		
II	**USE OF LANGUAGE**	**10**
The language used in memos/minutes/telephone memos/ letters/ assignments art of writing E-mail etc. Advantages of written and spoken communication.		
III	**GRAMMAR**	**10**
The use of active and passive voice; the use of grammar, propriety,accuracy , exactness , the tone & other elements of language used in these writings.		
IV	**TYPES OF REPORTS**	**5**
The format of various types of Reports/ projects etc.,		
V	**BUSINESS WRITING**	**10**
Writing Business reports, proposals and minutes.		

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

TEXT BOOKS

1. John Sealy, Writing and Speaking Author:, Oxford University Press, New Delhi Third Edition 2009.
2. Williams K S, Communicating in Business (8th Edition) Engage Learning India Pvt. Ltd.; 2012.

E REFERENCE

1.https://is.muni.cz/el/1456/jaro2014/MPV_COMA/um/E-book_Business-Communication.pdf
2.http://communication-revolution.biz/wp-content/uploads/2013/12/The-Business-Communication-Revolution.pdf

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1
CO1	0	0	1	0	0	0	0	0	1	0	0	0
CO2	0	0	0	0	0	1	2	0	0	0	0	0

CO3	0	0	0	0	0	1	1	2	0	0	0	0
CO4	1	1	0	0	1	1	2	1	1	0	0	1
CO5	1	0	0	2	0	2	3	2	3	0	0	1
	2	1	1	2	1	5	8	5	5	0	0	2

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

XBT 508			**INPLANT TRAINING - II**	**L**	**T**	**P**	**C**
				0	**0**	**0**	**1**
C	**P**	**A**		**L**	**T**	**P**	**H**
0.66	**0.66**	**0.66**		**0**	**0**	**0**	**0**

PREREQUISITE:- Nil

COURSE OUTCOMES:

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

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**
CO1	2											
CO2							1	3			1	
CO3									3	1	3	1
CO4		1	2	1	3							3
CO5				3						3		1
Total	2	1	2	4	3		1	3	3	4	4	5

1 - Low, 2 – Medium, 3 – High

Semester-VI

XBT 602			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

COURSE OUTCOMES:

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 – Types, establishment and characterization of cell lines; Differentiation and Scaling up of animal cell culture- Measurement of cell death, viability and cytotoxicity; Immobilized cultures; Hybridoma technology.

II	GENE TRANSFER TECHNIQUES	9

Types of Gene transfer methods - Micromanipulation technology; Biology and Construction of viral vectors like SV40, adenovirus, lentivirus, vaccinia virus, herpes virus, and adeno associated virus, baculovirus ,Transfection methods; stable and transient methods – Cloning techniques and strategies.

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 – Ethical concerns regarding transgenesis.

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
CO 1	3	2	1	2	2	0	1	1	2	1	1
CO 2	3	1	2	1	2	0	0	1	0	2	1
CO 3	3	1	2	3	3	2	2	1	2	2	2
CO 4	3	2	2	2	3	1	1	1	1	2	2
CO 5	3	2	3	1	2	2	1	1	1	2	2
	15	8	10	9	12	5	4	5	6	9	8

1 - Low, 2 – Medium, 3 – High

XBT 603			**IMMUNOLOGY**	**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: Cell biology and Microbiology

COURSE OUTCOMES:

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1: ***Outline*** the general concepts of immune system and ***describe*** the cells and organs of the immune system	Cognitive	Remembering Evaluating
CO2:*Explains* the properties of antigens and antibodies and ***identify*** their interactions via various tests.	Cognitive Psychomotor	Understanding Perception
CO3:*Describe* various mechanisms of antigen presentation and ***discuss*** the role of MHC in Ag Presentation.	Cognitive Affective	Remembering Responds to Phenomena
CO4:*Compares* the different types of hypersensitive reactions and ***explain*** the autoimmune disesases.	Cognitive	Analyzing Understanding
CO5:*Comprehend* the types, mechanism of vaccines and ***respond***to the various immunization techniques	Cognitive Psychomotor	Understanding Guid. Resp.
I	**IMMUNE SYSTEM**	**9+3**
Introduction – types of immune system: Innate and adaptive – Antigen presenting cells -		

Lymphocytes their origin, activation and differentiation – Hematopoiesis - Cells of the immune system - Organs of the immune system: primary and secondary lymphoid organs.

Experiment No 1: Blood grouping – An immunological view.
Experiment No 2: Identification of leucocytes by Giemsa staining

II	ANTIGEN - ANTIBODY INTERACTIONS	9+3

Antigens: Immunogenicity, Antigenicity, Epitope, haptens and Adjuvants – Antibody: Structure, Classes and Biological Activities – Monoclonal antibodies - Multigene Organization of Ig Genes - Variable Region Gene Rearrangements - Generation of Antibody Diversity - Antigen-Antibody Interactions: Cross-Reactivity, Precipitation and Agglutination Reactions, Immunotechniques: ELISA, RIA, Flow cytometry etc.,

Experiment No 3: Ouchterlony Double diffusion test.
Experiment No 4: Single radial diffusion test
Experiment No 5: Enzyme Linked Immuno Sorbent Assay

III	MHC AND ANTIGEN PRESENTATION	9+3

MHC Moleules: Structure, Organization, Inheritance and Cellular Distribution. Ag presentation: Self-MHC Restriction of T Cells, Endogenous Antigens: The Cytosolic Pathway, Exogenous Antigens: The Endocytic Pathway, Presentation of Nonpeptide Antigens.

Experiment No 6: Immunoelectrophoresis
Experiment No 7: Rocket immunoelectrophoresis

VI	IMMUNE RESPONSES	9+3

Cytokines and their role in immune response – properties and receptors, Complement: Functions, components and activation, Hypersensitive reactions and their types. Autoimmune diseases: organ specific and systemic – Immunological basis of graft rejection – Immunosuppressive drugs and clinical transplantations

Experiment No 8 : Widal Test
Experiment No 9 : Latex agglutinization test

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.

Experiment No10: Demonstration of Selection of animals, Preparation of antigens, immunization and method of bleeding, Serum separation and storage.
Experiment No 11 : Western blotting

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	15	60

TEXT BOOKS:

1. JanesKuby., 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

Cos Vs PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	1	1	0	1	2	2	1	1	0	2	2
CO 2	2	3	2	2	2	1	1	0	1	0	0
CO 3	3	1	2	1	2	0	0	0	1	1	1
CO 4	1	3	2	3	2	1	2	1	1	2	1
CO 5	3	2	3	3	3	2	2	2	3	2	2
	10	10	9	10	11	6	6	4	5	7	6

1 - Low, 2 – Medium, 3 – High

XBT604			**BIOCHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
				3	**1**	**1**	**5**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**1**	**0.5**		**3**	**2**	**2**	**7**

PREREQUISITE: 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 biochemical process.	Cognitive Affective	Remembering Receiving Phenomena
CO2:*Outline* and ***differentiate*** the enzymes and its kinetics	Cognitive Psychomotor	Understanding Perception
CO3:*Identify* and ***select*** a kinetic model for a biochemical process	Cognitive Psychomotor	Understanding Perception
CO4:*Recognize*, ***perform*** and ***detect*** various immobilization techniques for a biochemical process.	Cognitive Affective Psychomotor	Understanding Responds to Phenomena Perception
CO5:*Identify,choose* and ***follow***a design for a bioreactor.	Cognitive Affective Psychomotor	Understanding Receiving Phenomena Guided response

I	**INTRODUCTION TO BIOCHEMICAL ENGINEERING**	**9+3+3**

An overview of industrial biochemical processes with case studies – comparing chemical and biochemical processes – development and scope of biochemical engineering - Industrially important microbial strains – classification, structure – molecular genetics and control systems.		
II	**ENZYMES AND ITS KINETICS**	**9+3+3**
Enzymes and their classifications – mechanism of enzyme reactions – M-M kinetics – enzyme inhibition – enzyme stability- factors affecting reaction rates – industrial production process- Industrial applications of enzymes. Experiment No 1: Study of M-M kinetics and determination of M-M constants. Experiment No 2: Effect of physical parameters such as temperature and pH on Enzyme Activity.		
III	**BIOCHEMICAL SYSTEMS**	**9+3+3**
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 in an immobilized cell reactor using *Saccharomyces cerevisiae* Experiment No 3:Enzyme immobilization by physical adsorption. Experiment No 4:Enzyme immobilization by Gel Entrapment.		
IV	**BIOCHEMICAL REACTION KINETICS**	**9+3+3**
Microbial, animal and plant cell cultivation – growth measurements – growth kinetics – factors affecting the growth – Monod Model – modeling of batch and continuous cell growth – immobilized whole cells and characteristics – free cell and immobilized cell reactors. Experiment No 5: Study of Production of growth and/or non-growth associated products. Experiment No 6: Study of Microbial Growth kinetics and estimation of Monod parameters.		
V	**BIOREACTORS DESIGN**	**9+3+3**
Bioreactors-Type of bioreactor-Airlift bioreactors-Airlift pressure cycle bioreactors-loop reactor-Stirred tank reactors-Bubble column fermeter -Heat transfer-Monod model for a chemostat-Temperature effect on rate constant. Experiment No 7: Comparative Study of Batch, fed batch and/or continuous cultures. Experiment No 8: Production of Enzymes.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**15**	**15**	**75**

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.

REFERENCES:

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.

3. http://www.novozymes.com/en/about-us/our-business/what-areenzymes/Pages/default.aspx
E REFERENCES:
1. http://nptel.ac.in/courses/103105054/

COs VsPOs

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

1 - Low, 2 – Medium, 3 – High

XBT 605			**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	Cognitive	Understanding
CO2:*Explain* and ***analyze*** the secondary and super secondary structural features	Cognitive	Understanding Analyzing
CO3:*Describe* and ***compare*** the different level of protein structure and their folding mechanism.	Cognitive	Remembering Analyzing
CO4:*Explain* the protein structure its function al relationship and ***relate*** that in various examples.	Cognitive Affective	Applying Organization
CO5:*Explain* the protein engineering concepts and ***assist*** that in various engineered protein production.	Cognitive	Applying Responds to phenomena

I	**STRUCTURE AND FUNCTIONAL ASPECTS OF AMINOACIDS**	**9 + 3**
Amino acids found in proteins - 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**
Secondary structure of proteins – α helix, β strands, turns and additional secondary structure – 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

Cos Vs POs

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

CO 4	1	3	2	3	2	1	2	1	1	2	1
CO 5	3	2	3	3	3	2	2	2	3	2	2
	10	10	9	10	11	6	6	4	5	7	6

1 - Low, 2 – Medium, 3 – High

XGS608			**ACADEMIC WRITING**	**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	Objective of this course to provide training on academic writing over research and field report.	COG	Understand Response Value Perception Set Evaluate
CO2		AFF	
CO3		AFF	
CO4		PHY	
CO5		COG	

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**
CO1	2											
CO2							1	3			1	
CO3									3	1	3	1
CO4		1	2	1	3							3
CO5				3						3		1
Total	2	1	2	4	3		1	3	3	4	4	5

1 - Low, 2 – Medium, 3 – High

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.	Cognitive Psychomotor	Understanding Perception
CO2:*Understands* the significance of sequence analysis and ***performs*** sequence alignment.	Cognitive Psychomotor	Applying Guided response
CO3:*Explain* and ***Construct*** phylogenetic trees to study phylogenetic relationships	Cognitive Psychomotor	Understand Guided response
CO4:*Predict* and ***Analysis*** the protein structure and molecular docking	Cognitive Psychomotor	Create mechanism
CO5:*Understand* the steps involved in drug discovery process.	Affective	Receiving phenomena

I	**INTRODUCTION TO BIOINFORMATICS**	**9+6**

Important contributions - aims and tasks of Bioinformatics - applications of Bioinformatics - challenges and opportunities – Biological databases- Classification of biological databases- Primary and Secondary databases, Sequence and structure databases, Specialized databases- retrieval system- Entrez- SRS.

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

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.

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)

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.

Experiment No 7: Phylogenetic tree building using Phylip

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 modeling, Threading and Fold recognition.

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		
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. **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

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008
2. T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005
3. Stephen A. Krawetz, David D. Womble, Introduction To Bioinformatics A Theoretical and Practical Approach, Humana Press, 2003

E- REFERENCES:

1. http://nptel.ac.in/courses/102103044/40
2. vlab.amrita.edu/?sub=3&brch=273

Cos Vs PO s

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

1 - Low, 2 – Medium, 3 – High

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

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

I	**INTRODUCTION TO DOWNSTREAM PROCESSING PROCESSES**	**9+3+3**

Scope and overview-Economics, strategies for initiation of project, Process Design Criteria cost reduction strategies, upstream and downstream processing in biotechnology, various biotechnology products and their biological properties, fundamentals of bioseparation. Separation process design criteria-Characteristics of biological mixtures, Morphological features of the cell, Concentration of product of interest and impurities, physical and rheological characteristics

II	**DOWNSTREAM PROCESSING METHODS**	**9+3+3**

Cell disruption Techniques, types of cells, location of products inside the cells and products , cell distruption Methods, Mechanical and Non mechanical methods- Filtration, types of filtration equipments, filter media and filter aids, basic theory of filtration, principle of rotary drum filter-centrifugation-principle of sedimentation , types of centrifuges, flocculation and sedimentation.
Experiment No 1:Cell disruption studies by sonication
Experiment No 2: Sedimentation
Experiment No 3: Filtration

III	**PRODUCT IDENTIFICATION TECHNIQUES**	**9+3+3**

Characterization of product- Electrophoresis, Principle and methods-Analysis of product purity-Chromatography,Enzyme Linked Immuno Sorbent Assay (ELISA),Ion exchange chromatography, Reverse phase chromatography, Affinity Ligand Technology HPLC Radial Flow Chromatography.

Experiment No 4: 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. Experiment No 5: Extraction Studies. Experiment No 6: High-resolution purification preparative liquid chromatographic techniques		
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 Experiment No 7: Ammonium Sulphate precipitation Experiment No 8: Crystallization Experiment No 9:Drying Experiment No 10:Lyophillization		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**15**	**15**	**75**

TEXT BOOKS:

1. Nooralabettu Krishna Prasad,Downstream Process Technology, A New Horizon in Biotechnology,PHIPvt Ltd,2nd Edition, 2012.
2. Sivasankar, B. Biosperations: Principles and Techniques. PHI Learning Pvt. Ltd., 2005.

REFERENCES:

1. Hatti-Kaul, Rajni, and Bo Mattiasson. "Downstream processing in biotechnology." Basic biotechnology. Cambridge University Press, Cambridge ,2001.
2. Belter, Paul A., Edward Lansing Cussler, and W. Hu. "Bioseparations: downstream processing for biotechnology" 1987.
3. Asenjo J.M. Separation processes in Biotechnology, 1993

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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

Cos Vs POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	3		2	1		1	1		1		
CO 2	2	3	2	1		1			1		

CO 3	2	3	1	2					1		
CO 4	2	1	3	2			3		1		
CO 5	2	2	3	1		2	1		1		2
	11	9	11	7		4	5		5		2

1 - Low, 2 – Medium, 3 – High

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

COURSE OUTCOMES:

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1:*Outline* and 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 ***understands*** 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	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	IAGNOSIS AND THERAPY	9
Diagnosis: Detection using biochemical assays, tumor markers - Molecular tools for early diagnosis of cancer, Disease staging - FISH, Karyotyping, DNA microarrays, SNPs, CGH and imaging techniques. Treatment: Chemotherapy – Classification of drugs – Topoisomerase inhibitors – Radiotherapy – Gene therapy – Immuno therapy – Antigen specific and Adaptive therapy – Stem cell therapy - Use of signal targets towards therapy of cancer - Gene therapy		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS:

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

REFERENCES:

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

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

COs Vs POs

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1	3	2	2	1	2	1			2	2	2
CO 2	2	2	2	2	3	3	2	1			
CO 3	3	3	2	2	2				1	1	2
CO 4	2			3	2						

CO 5	3	3	2	3	2	2	2	1	2	2	1
	13	10	8	11	11	6	4	2	5	5	5

1 - Low, 2 – Medium, 3 – High

XBT 707			**PROJECT PHASE-I**	**L**	**T**	**P**	**C**
				0	**0**	**2**	**2**
C	**P**	**A**		**L**	**T**	**P**	**H**
1.5	**0.5**	**0.5**		**0**	**0**	**2**	**4**

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

Mapping of COs with POs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**	**CO7**	**Total**
PO1	3	2	1	2	1	-	1	10
PO2	3	2	1	2	1	-	1	10
PO3	-	-	1	3	1	-	-	5
PO4	-	1	2	3	1	2	2	11
PO5	-	-	2	3	1	-	-	6
PO6	1	-	1	1	-	3	3	10
PO7	1		1	1	-	1		4
PO8	1	-	1	1	-	3	-	6
PO9	-	-	-	-	2	3	1	6
PO10	-	-	-	-	3	3	3	9
PO12	-				2	2	2	6
PO12	1				3	3	1	8

1 – Low, 2 – Medium, 3 – High

XGS 708			CAREER DEVELOPMENT SKILLS	L	T	P	C
				0	0	0	0
C	P	A		L	T	P	H
1.8	0.8	0.4		0	0	0	1

PREREQUISITE:- Nil

COURSE OUTCOMES:

Course Outcomes		Domain	Level
On the successful completion of the course, students will be able to			
CO1	Knowledge on a career related communication and learning the different formats of CV	COG	Response
CO2	Prepare how to face an interview and to learn how to prepare for an interview	PSY	Set
CO3	Communicates with the group of people in discussion	AFF	Response

COURSE CONTENT

I	**CV WRITING**	**10 hrs**
	CV Writing; difference between resume and CV; characteristics of resume and CV; basic elements of CV and resume, use of graphics in resume and CV; forms and functions of Cover Letters.	
II	**TECHNICAL SKILLS**	**10 hrs**
	Interview skills; tips for various types of interviews. Types of questions asked ; body language, etiquette and dress code in interview, interview mistakes, telephonic interview , frequently asked questions. Planning for the interview.	
III	**WORKSHOP**	**10hrs**
	Mock interviews - workshop on CV writing – Group Discussion	

L-20 hrs Workshop - 10 hrs Total = 30 hrs

Text books

1. Paul McGee, How To Write a CV That Really Works: A Concise, Clear and Comprehensive Guide to Writing an Effective CV, Hachette UK, 2014
2. Mary Ellen Guffey, Dana Loewy Essentials of Business Communication,Cengage Learning, 2012
3. Michael Spiropoulos, Interview Skills that win the job: Simple techniques for answering all the tough questions, Allen &Unwin, 2005
4. William L. Fleisher,Effective Interviewing and Interrogation Techniques, Nathan J. Gordon, Academic Press, 2010.

E-references

1. http://www.utsa.edu/careercenter/PDFs/Interviewing/Types%20of%20Interviews.pdf
2. http://www.amu.apus.edu/career-services/interviewing/types.htm
3. http://www.careerthinker.com/interviewing/types-of-interview/

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1			1		2				2		
CO 2		2	2	1	3						
CO 3		2	1	1	2						

CO 4	1	3	3	1	3						
CO 5	1	2	3		3						2
	2	9	10	3	13				2		

1 – Low, 2 – Medium, 3 – High

XBT 709			**INPLANT TRAINING - III**	**L**	**T**	**P**	**C**
				0	**0**	**0**	**2**
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

Mapping of CO's with PO's

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**
CO1	2											
CO2							1	3			1	
CO3									3	1	3	1
CO4		1	2	1	3							3
CO5				3						3		1
	2	1	2	4	3		1	3	3	4	4	5

1 - Low, 2 – Medium, 3 – High

XBT 802 A			ADVANCED MICROBIOLOGY	L	T	P	C
				3	0	0	3
C	P	A		L	T	P	H
3	0	0		3	0	0	3

PREREQUISITE: Microbiology, cell biology

COURSE OUTCOMES:

Course Outcomes	Domain	Level
After the completion of the course, students will be able to		
CO1:*Explain* about the various classes and diversity of microorganism.	Cognitive	Understanding
CO2:*Identification* andthe ***applications*** of microorganisms in renewable energy production.	Cognitive	Analyzing
CO3:*Describe* about the microbial interaction with the environment.	Cognitive	Understanding
CO4:*Explain* the importance and disadvantages of aquatic microbes.	Cognitive	Understanding
CO5:*Summarize* the various microorganisms in soil and their applications.	Cognitive	Understanding

I	DIVERSITY OF THE MICROBIAL WORLD	9

Microbial Evolution and diversity – Microbial taxonomy: various characteristics used for taxonomy – classification of archaea – Types and applications of proteobacteria – Structure, nutrition, metabolism and reproduction of fungi and viruses – **Algae: distribution, characterization and nutrition.**

II	MICROORGANISMS AS A SOURCE OF RENEWABLE ENERGY	9

Scope and importance Renewable sources - Energy from waste materials: Production of nonconventional fuels - methane (biogas) and hydrogen - Use of microorganisms in petroleum augmentation and recovery - bio-diesel from microbial sources - Microbial fuel cells – biodegradable plastics from microbes.

III	MICROBES AND THE ENVIRONMENT	9

Microbial ecology – Interactions among microorganisms: plant – microbe, animal – microbe and human-microbe interactions – Microenvironment: biofilms and microbial mats – microorganism and ecosystem - Degradation of xenobiotic compounds – Bioremediation - Microbial leaching.

IV	AQUATIC MICROBES	9

Aquatic environment and microorganism: gases, nutrients and nutrient cycle – Microbial community: marine microorganism – carbon cycling in ocean environment – fresh water microorganism – water borne pathogens, diseases and their control – sanitary analysis of water – important microbes in waste water treatment.

V	ERRESTRIAL MICROBES	9

Soil as an environment for microbes – Important Nutrients and composition of soil - Microbes at tropical, temperate, cold mist area and dessert soils – Soil microorganisms in various association

with vascular plants – subsurface biosphere – soil microorganism and human diseases – beneficial microorganisms from soil: biofertilizers.			
LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
45	**0**	**0**	**45**

TEXT BOOKS:

1. Michael J. Pelczar , E.C.S. Chan, Microbiology (An Application Based Approach) Tata McGraw Hill; 1st edition, 2010.
2. Tortora, G.J., Funke, B.R. and Case, C.L., Microbiology: An Introduction, Benjamin Cummings, 10th Edition, 2009.

REFERENCES:

1. Young, M.Y., Comprehensive Biotechnology, Vol 1-4, Pergamon Press, Oxford, 1st Edition, 1985.
2. Rittman, B and McCarty, P.L., Environmental Biotechnology: Principles and Applications, McGraw- Hill, 2nd Edition, 2000.
3. Glazer, A.N. and Nikaido, Microbial Biotechnology, Freeman and company, 2nd Edition, 2007.

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1. http://www.austincc.edu/rohde/noteref.htm
2. http://www.microrao.com/mypgnotes.htm

COs Vs Pos

	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO 1	2			1	2	1					1
CO 2	2		2	2	1	3	2	1	1	2	1
CO 3	2			1	1	3	2			1	
CO 4	1			2		2	1			1	1
CO 5	2			1	1	2	2			1	
	9	0	2	7	5	11	7	1	1	5	3

1 - Low, 2 – Medium, 3 – High

XBT 803 A			**TISSUE ENGINEERING**	**L**	**T**	**P**	**C**
				3	**0**	**0**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
3	**0**	**0**		**3**	**0**	**0**	**3**

PREREQUISITE: Basics in Cell biology

COURSE OUTCOMES:

Course Outcomes	**Domain**	**Level**
After the completion of the course, students will be able to		
CO1:*Recall* and ***Explain*** the scope, design principles and applications of tissue engineering	Cognitive	Remembering, Understanding
CO2:*Recall* and ***Outline*** the cell signalling, cellular junctions,	Cognitive	Understanding,

sources of cells, cell culture process for the tissue engineering		Remembering
CO3:*Define* and ***Summarize*** the need of biomaterials for tissue engineering, their mechanical properties, compatibility, degradation, and classification	Cognitive	Remembering, Understanding
CO4:*Recall* and ***Outline*** the bioreactor design and its various types based on application	Cognitive	Understanding, Remembering
CO5:*Tell* the conceptrelated to tissue fabrication technology including Scaffold based methods and Scaffold free methods of fabrication	Cognitive	Understanding, Remembering

I	**INTRODUCTION**	**8**

Basic definition – Scope of tissue engineering – Design principles for tissue engineering – Building blocks of tissue engineering – Structural and organization of tissues: Tissue Components, Tissue types – Tissue Dynamics – Tissue repair.

II	**CELLS IN TISSUE ENGINEERING**	**10**

Cells and tissue engineering – Cell signalling: Endocrine signalling, Paracrine signalling, Autocrine signalling and Direct cell-to-cell signalling – Cellular junctions: Tight junctions, Adherens junctions, Desmosome junctions and Gap junctions – Cell sourcing: Animal derived, Human derived, Cell lines derived and Stem cells derived – Cell culture process: Cell isolation, Cell attachment and Sub-passing of cells.

III	**BIOMATERIALS FOR TISSUE ENGINEERING**	**9**

Definition – Tensile properties – Biomaterials degradation – Biomaterials biocompatibility: Immune response – Biomimetic biomaterials: Natural polymers, RGD linked synthetic polymers – Classification of biomaterials: Natural vs synthetic, Degradable vs non-degradable, Metals vs ceramics vs polymers – Idealized biomaterials.

IV	**BIOREACTORS FOR TISSUE ENGINEERING**	**9**

Definition – Classification: Bioreactors for cell culture and cell expansion, Bioreactors for scaffold fabrication, Bioreactors for scaffold cellularization, Bioreactors for stretch, Bioreactors for perfusion and Bioreactors for electric stimulation – Bioreactors design considerations.

V	**TISSUE FABRICATION TECHNOLOGY**	**9**

Introduction – Scaffold free methods – Cell patterning techniques – Scaffold based methods – Rapid prototyping technology – Printing technology – Organ-on-a-chip model.

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

TEXT BOOKS:

1. Robert Lanza, Robert Langer, Joseph P. Vacanti. Principles of Tissue Engineering. Academic Press, 2013.
2. Birla, R. Introduction to tissue engineering: applications and challenges. John Wiley & Sons, 2014.

REFERENCES:

1. Lanza, R., Langer, R., &Vacanti, J. P. (Eds.). Principles of tissue engineering. Academic press, 2011.
2. Ikada, Y. Tissue engineering: fundamentals and applications (Vol. 8). Academic Press, 2011.
3. Micou, M. K., and Kilkenny, D. A Laboratory Course in Tissue Engineering. CRC Press,

2012.
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1. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/lecture-notes/ 2. http://nptel.ac.in/courses/113108071/ 3. http://nptel.ac.in/courses/113104009/

Cos VsPos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 1	3										
CO 2	3				1						
CO 3	3	2		1	1		2		1		1
CO 4	3	2		1	1		2		1		1
CO 5	3	3	3	3			3		2		1
	15	**7**	**3**	**5**	**3**	**0**	**7**	**0**	**4**	**0**	**3**

1 - Low, 2 – Medium, 3 – High

XBT 804			**PROJECT PHASE-II**	**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

Mapping of COs with Pos

	CO1	CO2	CO3	CO4	CO5	CO6	CO7	Total
PO1	3	2	1	2	1	-	1	10
PO2	3	2	1	2	1	-	1	10
PO3	-	-	1	3	1	-	-	5
PO4	-	1	2	3	1	2	2	11
PO5	-	-	2	3	1	-	-	6
PO6	1	-	1	1	-	3	3	10
PO7	1		1	1	-	1		4
PO8	1	-	1	1	-	3	-	6
PO9	-	-	-	-	2	3	1	6
PO10	-	-	-	-	3	3	3	9
PO11	-				2	2	2	6
PO12	1				3	3	1	8

1 - Low, 2 – Medium, 3 – High