Curriculum and Syllabi

B.Tech. BIOTECHNOLOGY

SEMESTERS I to VIII

Regulations 2022

Programme: B.Tech. Biotechnology

2022 Regulations

(2022 Batch onwards)

Curriculum for Semesters I to VIII

SEMESTER I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22HS101	English for Communication	3	0	2	5	4	60 / 40	HS
2.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
3.	22CS101	Problem Solving Techniques I	3	0	2	5	4	60 / 40	ES
4.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES
Theory Courses									
5.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
6.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
7.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
8.	22BT101	Biomolecules	3	0	0	3	3	60 / 40	PC
Mandatory Course									
9.		Student Induction Programme							MC

SEMESTER II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES
2.	22BT201	Bio-organic Chemistry	3	0	2	5	4	60 / 40	BS
3.	22BT202	Microbiology	3	0	2	5	4	60 / 40	PC
Theory Courses									
4.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
5.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC
6.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
7.	22HS203	Universal Human Values	2	0	0	2	2	0 / 100	HS
Practical Course									
8.	22BT203	Bio Chemistry Laboratory	0	0	4	4	2	40 / 60	ES

SEMESTER III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22BT301	Cell Biology	3	0	2	5	4	60 / 40	PC
2.	22BT302	Molecular biology	3	0	2	5	4	60 / 40	PC
3.	22CS302	Problem Solving Techniques III	3	0	2	5	4	60 / 40	ES
Theory Courses									
4.	22MA303	Probability and Statistics	3	1	0	4	4	60 / 40	BS
5.	22BT303	Basic	3	0	0	3	3	60 / 40	PC

		Industrial Biotechnology							
Practical Course									
6.	22EEC301	Industrial Training / Internship - I	0	0	0	2 Weeks	1	0/100	EEC

SEMESTER IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22BT401	Bio process Technology	3	0	2	5	4	60 / 40	PC
2.	22BT402	Bioanalytical techniques	3	0	2	5	4	60 / 40	ES
Theory Courses									
3.	22BT403	Biostatistics	3	1	0	4	4	60 / 40	BS
4.	22BT404	Immunology	3	0	0	3	3	60 / 40	PC
Elective Courses									
5.		Open Elective - I					3	60 / 40	OE
6.		Open Elective - II					3	60 / 40	OE
Mandatory Course									
7.	22MC403	History of Science & Technology in India					-	0/100	MC

SEMESTER V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22BT501	Genetic engineering	3	0	2	5	4	60 / 40	PC
2.	22BT502	Plant Biotechnology	3	0	2	5	4	60 / 40	PC
Elective Courses									
3.		Professional					3	60/40	PE

		Elective – I							
4.		Professional Elective – II					3	60/40	PE
5.		Open Elective - III					3	60/40	OE
Practical Course									
6.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0 / 100	EEC
7.	22EEC503	Mini Project	0	0	4	4	2	40 / 60	EEC

SEMESTER VI

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22BT601	Bioinformatics	3	0	2	5	4	60/40	PC
2.	22BT602	Downstream Processing	3	0	2	5	4	60/40	PC
Theory Course									
3.	22HS601	Environmental Science and Engineering	3	0	0	3	3	60/40	HS
Elective Courses									
4.		Professional Elective – III					3	60/40	PE
5.		Professional Elective – IV					3	60/40	PE
6.		Open Elective - V					3	60/40	OE
7.		Open Elective - VI					3	60/40	OE
Mandatory Course									
8.	22MC601	Well being with traditional practices (Yoga, Ayurveda and Siddha)					-	0/100	MC

SEMESTER VII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22BT701	Protein Engineering	3	0	2	5	4	60/40	PC
Theory Courses									
2.	22HS701	IPR, Biosafety and Ethics	3	0	0	3	3	60/40	HS
3.	22BT702	Enzyme Engineering and Technology	3	0	0	3	3	60/40	PC
4.	22BT703	Genomics	3	0	0	3	3	60/40	PC
Elective Courses									
5.		Professional Elective - V					3	60/40	PE
6.		Professional Elective - VI					3	60/40	PE
Practical Course									
7.	22EEC701	Project Work – Phase I	0	0	4	4	2	0 / 100	EEC

SEMESTER VIII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Courses									
1.	22BT801	Clinical trials & Health care policies in Biotechnology	3	0	0	3	3	60/40	PC
Elective Course									
2.		Professional Elective – VII					3	60/40	PE
Practical Course									
3.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

Total Credits : 166

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SUMMARY

S.No	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS	4	2				3	3		12
2	BS	8	8	4	4					24
3	ES	6	6	4	4					20
4	PC	3	4	11	7	8	8	10	3	54
5	PE					6	6	6	3	21
6	OE				6	3	6			15
7	EEC	1	1	1		3		2	10	18
8	AC	1	1							2
	Total	23	22	20	21	20	23	21	16	166
9	MC (Non Credit)	~			~		~			

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22HS101	English for Communication	3	0	2	5	4	60 / 40	HS
2.	22HS203	Universal Human Values	2	0	0	2	2	0 / 100	HS
3.	22HS601	Environmental Science and Engineering	3	0	0	3	3	60/40	HS
4.	22HS701	IPR, Biosafety and Ethics	3	0	0	3	3	60/40	HS

BASIC SCIENCES (BS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
2.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
3.	22BT201	Bio-organic Chemistry	3	0	2	5	4	60 / 40	BS
4.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
5.	22MA303	Probability and Statistics	3	1	0	4	4	60 / 40	BS
6.	22BT403	Biostatistics	3	1	0	4	4	60 / 40	BS

ENGINEERING SCIENCES (ES)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22CS101	Problem Solving Techniques I	3	0	2	5	4	60 / 40	ES
2.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES

3.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES
4.	22BT203	Bio Chemistry Laboratory	0	0	4	4	2	40 / 60	ES
5.	22CS302	Problem Solving Techniques III	3	0	2	5	4	60 / 40	ES
6.	22BT402	Bioanalytical techniques	3	0	2	5	4	60 / 40	ES

PROFESSIONAL CORE (PC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22BT101	Biomolecules	3	0	0	3	3	60 / 40	PC
2.	22BT202	Microbiology	3	0	2	5	4	60 / 40	PC
3.	22BT301	Cell Biology	3	0	2	5	4	60 / 40	PC
4.	22BT302	Molecular biology	3	0	2	5	4	60 / 40	PC
5.	22BT303	Basic Industrial Biotechnology	3	0	0	3	3	60 / 40	PC
6.	22BT401	Bio process Technology	3	0	2	5	4	60 / 40	PC
7.	22BT404	Immunology	3	0	0	3	3	60 / 40	PC
8.	22BT501	Genetic engineering	3	0	2	5	4	60 / 40	PC
9.	22BT502	Plant Biotechnology	3	0	2	5	4	60 / 40	PC
10.	22BT601	Bioinformatics	3	0	2	5	4	60/40	PC
11.	22BT602	Downstream Processing	3	0	2	5	4	60/40	PC
12.	22BT701	Protein Engineering	3	0	2	5	4	60/40	PC
13.	22BT702	Enzyme Engineering and Technology	3	0	0	3	3	60/40	PC
14.	22BT703	Genomics	3	0	0	3	3	60/40	PC
15.	22BT801	Clinical trials & Health care	3	0	0	3	3	60/40	PC

		policies in Biotechnology							

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
2.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
3.	22EEC301	Industrial Training / Internship - I	0	0	0	2 Weeks	1	0/100	EEC
4.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0 / 100	EEC
5.	22EEC503	Mini Project	0	0	4	4	2	40 / 60	EEC
6.	22EEC701	Project Work – Phase I	0	0	4	4	2	0 / 100	EEC
7.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

AUDIT COURSES (AC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
2.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC

NON CREDIT MANDATORY COURSES (NCMC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.		Student Induction							MC

		Programme							
2.	22MC403	History of Science & Technology in India					-	0/100	MC
3.	22MC601	Well being with traditional practices (Yoga, Ayurveda and Siddha)					-	0/100	MC

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Professional Electives

Professional Elective I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT01	Agriculture and food Biotechnology	3	0	0	3	3	60/40	PE
2.	22PBT02	Biopolymer and its application	3	0	0	3	3	60/40	PE
3.	22PBT03	Microscopy	3	0	0	3	3	60/40	PE
4.	22PBT04	Animal Biotechnology	3	0	0	3	3	60/40	PE
5.	22PBT05	Bioprocess Modelling and Simulation	3	0	0	3	3	60/40	PE

Professional Elective II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT06	Nano Biotechnology	3	0	0	3	3	60/40	PE
2.	22PBT07	Vaccine Technology	3	0	0	3	3	60/40	PE
3.	22PBT08	Stem cell Technology	3	0	0	3	3	60/40	PE
4.	22PBT09	Tissue Engineering	3	0	0	3	3	60/40	PE
5.	22PBT10	Computational Biology	3	0	0	3	3	60/40	PE

Professional Elective III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT11	Molecular forensics	3	0	0	3	3	60/40	PE
2.	22PBT12	Molecular diagnostics	3	0	0	3	3	60/40	PE
3.	22PBT13	Drug design and discovery	3	0	0	3	3	60/40	PE
4.	22PBT14	Solid waste management	3	0	0	3	3	60/40	PE
5.	22PBT15	Genomics and proteomics	3	0	0	3	3	60/40	PE

Professional Elective IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT16	Metabolic Engineering	3	0	0	3	3	60/40	PE
2.	22PBT17	Structural Biology	3	0	0	3	3	60/40	PE
3.	22PBT18	Proteomics	3	0	0	3	3	60/40	PE
4.	22PBT19	Biofuels	3	0	0	3	3	60/40	PE
5.	22PBT20	Fundamentals of Nanoscience	3	0	0	3	3	60/40	PE

Professional Elective V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT21	Environmental Biotechnology	3	0	0	3	3	60/40	PE
2.	22PBT22	Industrial Microbiology	3	0	0	3	3	60/40	PE
3.	22PBT23	Marine Biotechnology	3	0	0	3	3	60/40	PE
4.	22PBT24	Sustainable Bioprocess	3	0	0	3	3	60/40	PE

		Development							
5.	22PBT25	Industrial Safety	3	0	0	3	3	60/40	PE

Professional Elective VI

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PCS16	Big Data Analytics	2	0	2	4	3	60/40	PE
2.	22PBT26	Industrial Enzymology	3	0	0	3	3	60/40	PE
3.	22PBT27	Immuno technology	3	0	0	3	3	60/40	PE
4.	22PBT28	Entrepreneurship & Management	3	0	0	3	3	60/40	PE
5.	22PBT29	Industrial Waste Management	3	0	0	3	3	60/40	PE

Professional Elective VII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT30	Cancer Biology	3	0	0	3	3	60/40	PE
2.	22PBT31	Cancer Management Techniques	3	0	0	3	3	60/40	PE
3.	22PBT32	Microbial Biotechnology	3	0	0	3	3	60/40	PE
4.	22PBT33	Transport Phenomena	3	0	0	3	3	60/40	PE
5.	22PBT34	Biopharmaceutical Technology	3	0	0	3	3	60/40	PE

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Open Electives

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22OHS01	Advanced Engineering Chemistry	3	0	0	3	3	60 / 40	OE
2.	22OAG01	Agricultural Finance, Banking and Co-Operatives	3	0	0	3	3	60 / 40	OE
3.	22OME03	Air pollution and control engineering	3	0	0	3	3	60 / 40	OE
4.	22OME04	Automotive Systems	3	0	0	3	3	60 / 40	OE
5.	22OBM04	Biomedical Instrumentation	3	0	0	3	3	60 / 40	OE
6.	22OAG03	Climate Change and Adaptation	3	0	0	3	3	60 / 40	OE
7.	22OCS03	Cloud Computing	3	0	0	3	3	60 / 40	OE
8.	22OEC02	Control Systems Engineering	3	0	0	3	3	60 / 40	OE
9.	22OCS13	Data Structures	3	0	0	3	3	60 / 40	OE
10.	22OCS14	Database Management Systems	3	0	0	3	3	60 / 40	OE
11.	22OME07	Design of Experiments	3	0	0	3	3	60 / 40	OE
12.	22OAG05	Energy Conservation and Management	3	0	0	3	3	60 / 40	OE
13.	22OAG07	Environment & Agriculture	3	0	0	3	3	60 / 40	OE
14.	22OBT02	Food Processing and Preservation	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
15.	22OBT03	Fuel Cell Chemistry	3	0	0	3	3	60 / 40	OE
16.	22OAG09	Geographic Information System	3	0	0	3	3	60 / 40	OE
17.	22OAG10	Green Building Design	3	0	0	3	3	60 / 40	OE
18.	22OBM11	Hospital Waste Management	3	0	0	3	3	60 / 40	OE
19.	22OBT05	Industrial Chemistry	3	0	0	3	3	60 / 40	OE
20.	22OME14	Industrial Robotics	3	0	0	3	3	60 / 40	OE
21.	22OAG11	Integrated Water Resources Management	3	0	0	3	3	60 / 40	OE
22.	22OBT06	Introduction to Bioenergy and Biofuels	3	0	0	3	3	60 / 40	OE
23.	22OHS04	Medical physics	3	0	0	3	3	60 / 40	OE
24.	22OAG14	Participatory Water Resources Management	3	0	0	3	3	60 / 40	OE
25.	22OBT08	Principles of Food Preservation	3	0	0	3	3	60 / 40	OE
26.	22OBT09	Principles of Food Processing	3	0	0	3	3	60 / 40	OE
27.	22OME25	Product Design and Development	3	0	0	3	3	60 / 40	OE
28.	22OME27	Production Technology of Agricultural machinery	3	0	0	3	3	60 / 40	OE
29.	22OME30	Renewable Energy Resources	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
30.	22OEC21	Sensors and Actuators	3	0	0	3	3	60 / 40	OE
31.	22OCS27	Software Engineering	3	0	0	3	3	60 / 40	OE
32.	22OME33	Supply Chain Management	3	0	0	3	3	60 / 40	OE

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Verticals

Vertical I : Bioprocess Technology

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT35	Bioprocess Control and Instrumentation	3	0	0	3	3	60/40	PE
2.	22PBT36	Fermentation Technology	3	0	0	3	3	60/40	PE
3.	22PBT37	Food Processing and Technology	3	0	0	3	3	60/40	PE
4.	22PBT38	Bioreactor Design and Scale up process	3	0	0	3	3	60/40	PE
5.	22PBT05	Bioprocess Modelling and Simulation	3	0	0	3	3	60/40	PE
6.	22PBT39	Bioreactor Consideration for Recombinant Products	3	0	0	3	3	60/40	PE

Vertical II : Biosciences

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT40	Biosensors	3	0	0	3	3	60/40	PE
2.	22PBT41	Bio-Nanotechnology	3	0	0	3	3	60/40	PE
3.	22PBT08	Stem Cell Technology	3	0	0	3	3	60/40	PE
4.	22PBM23	Biomaterials	3	0	0	3	3	60/40	PE

5.	22PBT42	Protein Engineering	3	0	0	3	3	60/40	PE
6.	22PBT43	Modern Bio analytical Techniques	3	0	0	3	3	60/40	PE

Vertical III : Medical Biotechnology

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT44	Human Genetics	3	0	0	3	3	60/40	PE
2.	22PBT30	Cancer Biology	3	0	0	3	3	60/40	PE
3.	22PBT45	Biopharmaceuticals and Biosimilars	3	0	0	3	3	60/40	PE
4.	22PBT09	Tissue Engineering	3	0	0	3	3	60/40	PE
5.	22PBT46	Molecular Therapeutics and Diagnostics	3	0	0	3	3	60/40	PE
6.	22PBT47	Biomedical Engineering	3	0	0	3	3	60/40	PE

Vertical IV : Bio Chemical Engineering

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT48	Mass Transfer Operations	3	0	0	3	3	60/40	PE
2.	22PBT49	Transport Phenomena in Biological System	3	0	0	3	3	60/40	PE
3.	22PBT50	Bioenergy and Biofuels	3	0	0	3	3	60/40	PE
4.	22PBT21	Environmental Biotechnology	3	0	0	3	3	60/40	PE
5.	22PBT51	Applied Chemical Reaction Engineering	3	0	0	3	3	60/40	PE

6.	22PBT52	Petroleum Biotechnology	3	0	0	3	3	60/40	PE

Vertical V : Animal Biotechnology

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT53	Fundamentals of Animal Biotechnology	3	0	0	3	3	60/40	PE
2.	22PBT54	Animal Health and Nutrition	3	0	0	3	3	60/40	PE
3.	22PBT55	Animal Physiology and Metabolism	3	0	0	3	3	60/40	PE
4.	22PBT56	Animal Cell Culture Technology	3	0	0	3	3	60/40	PE
5.	22PBT57	Advances in Animal Biotechnology	3	0	0	3	3	60/40	PE
6.	22PBT58	Biotechniques in Animal Breeding	3	0	0	3	3	60/40	PE

Vertical VI : Computational Biotechnology

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT59	Programming for Bioinformatics Applications	3	0	0	3	3	60/40	PE
2.	22PBT60	Fundamentals of Algorithms for Bioinformatics	3	0	0	3	3	60/40	PE
3.	22PBT61	Molecular Modelling	2	1	0	3	3	60/40	PE

4.	22PBT62	Computer Aided Drug Design	3	0	0	3	3	60/40	PE
5.	22PBT63	Metabolomics and Metabolic Engineering	3	0	0	3	3	60/40	PE
6.	22PBT64	Data Mining And Machine Learning Techniques For Bioinformatics	3	0	0	3	3	60/40	PE

Vertical VII : Quality and Regulatory Affairs

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT65	Clinical Trials and Health care policies in Biotechnology	3	0	0	3	3	60/40	PE
2.	22PBT66	Biotechnological products and its validation	3	0	0	3	3	60/40	PE
3.	22PBT67	Quality assurance and quality control in Biotechnology	3	0	0	3	3	60/40	PE
4.	22PBT68	Entrepreneurship and patent design	3	0	0	3	3	60/40	PE
5.	22PBT69	Intellectual property rights in Biotechnology	3	0	0	3	3	60/40	PE
6.	22PBT70	Biosafety and Hazard Management	3	0	0	3	3	60/40	PE

Vertical VIII : Agro Biotechnology

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBT71	Plant anatomy	3	0	0	3	3	60/40	PE
2.	22PBT72	Therapeutic application of phytochemicals	3	0	0	3	3	60/40	PE
3.	22PBT73	Bio-fertilizer production & mushroom cultivation	3	0	0	3	3	60/40	PE
4.	22PBT74	Biotechnological approach in crop improvement	3	0	0	3	3	60/40	PE
5.	22PBT75	Advance techniques in agro forestry	3	0	0	3	3	60/40	PE
6.	22PBT76	Plant tissue culture & transformation techniques	3	0	0	3	3	60/40	PE

SEMESTER I

22HS101	**ENGLISH FOR COMMUNICATION**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
4. To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
5. To use language efficiently in expressing their opinions via various media.

Course Content:

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 15

Listening - for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages;
Listening and filling a form.

Speaking - Self Introduction; Introducing a friend; Conversation - politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a form.

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails.

Writing - Writing emails / letters introducing oneself.

Grammar - Present Tense (simple and progressive); Question types: Wh / Yes or No / and Tags.

Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 15

Listening - Listening to podcast, anecdotes / stories / event narration; documentaries and interviews with celebrities.

Speaking - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarising of documentaries / podcasts/ interviews.

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs.

Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.)

Grammar - Past tense (simple); Subject-Verb Agreement; and Prepositions.

Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 15

Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about a product.

Speaking - Picture description; Giving instruction to use the product; Presenting a product; and Summarising a lecture.

Reading - Reading advertisements, gadget reviews; user manuals.

Writing - Writing definitions; instructions; and Product /Process description.

Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses.

Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers(connectives & sequence words)

UNIT IV CLASSIFICATION ND RECOMMENDATIONS 12

Listening - Listening to TED Talks; Scientific lectures; and educational videos.
Speaking - Small Talk; Mini presentations and making recommendations.
Reading - Newspaper articles; Journal reports-and Non Verbal Communication (tables, pie charts etc.,)
Writing - Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from nonverbal (chart, graph etc., to verbal mode)
Grammar - Articles; Pronouns - Possessive & Relative pronouns.
Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION 15

Listening - Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.
Speaking - group discussions, Debates, and Expressing opinions through Simulations & Role-play.
Reading - Reading editorials; and Opinion Blogs;
Writing - Essay Writing (Descriptive or narrative).
Grammar - Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences.
Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

Expected Course Outcome:

1. To listen and comprehend complex academic texts.
2. To read and infer the denotative and connotative meanings of technical texts.
3. To write definitions, descriptions, narrations and essays on various topics.
4. To speak fluently and accurately in formal and informal communicative contexts.
5. To express their opinions effectively in both oral and written medium of communication.

Text Book(s):

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

Reference Books:

1. Technical Communication – Principles And Practices, Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN: 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

22PH101	ENGINEERING PHYSICS	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To make the students effectively achieve an understanding of mechanics and properties of matter.
2. To enable the students to gain knowledge of electromagnetic waves.
3. To introduce the basics of solid-state physics.
4. Equipping the students to successfully understand the importance of optics and Laser.
5. To motivate the students towards the applications of quantum mechanics.
6. To learn problem solving skills related to physics principles and interpretation of experimental data.
7. To determine error in experimental measurements and techniques used to minimize such error.

Course Content:

UNIT I MECHANICS AND PROPERTIES OF MATTER 9

Mechanics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy-moment of inertia and its theorem- gyroscope - torsional pendulum.

Elasticity: Elastic modules – Poisson's ratio – relation between them – determination of Young's modulus by uniform and non-uniform bending- I section girders.

UNIT II ELECTROMAGNETIC WAVES 9

Maxwell's equations (Basics) - Charged particles in uniform and constant electric field – Charged particles in an alternating electric field- polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.

UNIT III SOLID STATE PHYSICS 9

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation.

UNIT IV OPTICS & LASER 9

Classification of optical materials – carrier generation and recombination processes - insulators and semiconductors (concepts only) - photo current in a P-N diode – solar cell - LED– Laser diodes – Optical data storage techniques.

Laser (Basics)– Einstein's coefficient- Types of Laser- He- Ne Laser - CO_2 laser, Nd-YAG laser, semiconductor laser – MASER Introduction - Holography: Principle and construction -Reconstruction of Holography.

UNIT V QUANTUM MECHANICS & NANODEVICES 9

Compton effect - The Schrodinger equation (Time dependent and time independent forms)- particle in an infinite potential well: 1D,2D and 3D Boxes.

NanoDevices: Introduction - quantum confinement – quantum structures: quantum wells, wires and dots –– band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - resonant- tunneling diode – single electron transistor – quantum cellular automata - Quantum system for information processing.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:
1. Understand the importance of mechanics and properties of matter
2. Express their knowledge in electromagnetic waves.
3. Demonstrate a strong foundational knowledge in solid state physics.
4. Gain the knowledge in optics and Laser.
5. Understand the importance of quantum physics and Nanodevices.
6. Understand the functioning of various physics laboratory equipment.
7. Use graphical models to analyze laboratory data.
8. Use mathematical models as a medium for quantitative reasoning and describing physical reality.

Text Book(s):
1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. Brijlal and N. Subramaniam "Properties of Matter", Eurasia Publishing House Limited, 1993.
3. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ. Press.
4. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGrawHill (Indian Edition), 2017.
5. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

Reference Books:
1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physics – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson Education (Indian Edition) 2009.

Web Links:
1. https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf
2. https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf
3. https://safehandsakola.org/downloads/Physics/Concepts%20of%20Modern%20Physics%20-Arthur%20Beiser.pdf
4. https://web.pdx.edu/~pmoeck/books/Tipler_Llewellyn.pdf
5. https://farside.ph.utexas.edu/teaching/qmech/qmech.pdf
6. https://web.pdx.edu/~pmoeck/phy381/workbook%20nanoscience.pdf

List of Experiments:
1. Torsional pendulum - Determination of rigidity modulus of wire and **3**

moment of inertia of regular and irregular objects.

2.	Uniform bending – Determination of Young’s modulus.	**3**
3.	Laser- Determination of the wavelength of the laser using grating.	**3**
4.	Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.	**3**
5.	Melde’s string experiment	**3**
6.	Simple harmonic oscillations of cantilever.	
7.	Non-uniform bending - Determination of Young’s modulus.	
8.	Laser-Determination of particle size and acceptance angle of the laser.	
9.	Determination of wavelength of mercury spectrum – spectrometer grating.	
10.	Determination of thickness of a thin wire – Air wedge method.	
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

22CS101	**PROBLEM SOLVING TECHNIQUES I**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

Course Content:

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments;

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension;

UNIT V FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages;

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Write simple Python programs using conditionals and loops for solving problems.
4. Decompose a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries etc.
6. Read and write data from/to files in Python programs.

Text Book(s):

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

Reference Books:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

Web Links:

1. https://www.python.org/

List of Experiments:

1.	Exchange the values of two variables	**3**
2.	Circulate the values of n variables, distance between two points.	**3**
3.	Square root, gcd, Exponentiation.	**3**
4.	Linear search, binary search.	**3**
5.	Simple sorting, histogram, Students marks statement.	**3**
6.	Retail bill preparation.	**3**
7.	Word count, copy file.	**3**
8.	Voter’s age validation, Marks range validation (0-100).	**3**
9.	Mini Project – 1	**3**
10.	Mini Project – 2	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

22ES101	**INNOVATION AND DESIGN THINKING**	**L**	**T**	**P**	**C**
		1	**0**	**2**	**2**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To explain the concept of design thinking for product and service development
2. To explain the fundamental concept of innovation and design thinking
3. To discuss the methods of implementing design thinking in the real world.

Course Content:

UNIT I PROCESS OF DESIGN **3**

Understanding Design thinking - Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

UNIT II TOOLS OF DESIGN THINKING **3**

Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design.

UNIT III DESIGN THINKING IN IT **3**

Design Thinking to Business Process modelling, Finding pain points.

UNIT IV DT FOR STRATEGIC INNOVATIONS **3**

Growth – Story telling representation – Strategic Foresight - Change – Sense Making - experience design - Standardization – Humanization - Creative Culture.

UNIT V DESIGN THINKING WORKSHOP **3**

Design Thinking Workshop Empathize, Design, Ideate, Prototype and Test.

TOTAL LECTURE CUM PRACTICAL HPERIODS **15 Periods**

Expected Course Outcome:

1. To immerse students into the world of innovation as a systematic process of tackling relevant business and/or social problems.
2. To provide a social and thinking space for the recognition of innovation challenges and the design of creative.
3. To expose the student with state-of-the-art perspectives, ideas, concepts, and solutions related to the design and execution of innovation driven projects using design thinking principles.
4. To develop an advance innovation and growth mindset form of problem identification and reframing, foresight, hindsight and insight generation.

Text Book(s):

1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design",Cengage learning (International edition) Second Edition, 2013.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
3. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand –

Improve – Apply", Springer, 2011.
4. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Reference Books:

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", CengageLearning, Second Edition, 2011.
2. Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).

22MA101	**MATRICES AND CALCULUS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables. This is needed in many branches of engineering.
4. To make the students understand various techniques of integration.
5. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

Course Content:

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS 12

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules (sum, product, quotient, chain rules) – Implicit differentiation – Logarithmic differentiation – Applications: Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 12

Definite and Indefinite integrals – Substitution rule – Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction– Improper integrals – Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS **12**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.

TOTAL LECTURE CUM TUTORIAL PERIODS 60 Periods

Expected Course Outcome:

1. At the end of the course the students will be able to Use the matrix algebra methods for solving practical problems.
2. Apply differential calculus tools in solving various application problems.
3. Able to use differential calculus ideas on several variable functions.
4. Apply different methods of integration in solving practical problems.
5. Apply multiple integral ideas in solving areas, volumes and other practical problems.

Text Book(s):

1. Kreyszig. E, “Advanced Engineering Mathematics”, John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, “Calculus: Early Transcendentals”, Cengage Learning, 8th Edition, New Delhi, 2015.

Reference Books:

1. Anton. H, Bivens. I and Davis. S, “Calculus”, Wiley, 10th Edition, 2016.
2. Bali. N., Goyal. M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., “Calculus” Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., “Higher Engineering Mathematics”, McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, “Engineering Mathematics” Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, “Thomas Calculus”, 14th Edition, Pearson India, 2018.

Web Links:

1. https://www.pdfdrive.com/higher-engineering-mathematics-d18621876.html
2. https://www.pdfdrive.com/advanced-engineering-mathematics-d166759888.html
3. https://theswissbay.ch/pdf/Gentoomen%20Library/Maths/Calculus/Calculus%20-%20Early%20Transcendentals%206e.pdf

22AC101	HERITAGE OF TAMIL	L	T	P	C
		1	0	0	1

Pre-requisite Nil **Syllabus Version** V 0.1

Course Content:

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II NARRATION AND SUMMATION 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV CLASSIFICATION ND RECOMMENDATIONS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V EXPRESSION 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL LECTURE PERIODS 15 Periods

Text cum Reference Book(s):

1. தமிழக வரலொறு – மக்களும் பண் பொடும் – கக.கக. பிள்ளள (தவளியீடு: தமிழ்நொடு பொடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முளனவர்இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – ளவளக நதிக்களரயில் சங்ககொல நகர நொகரிகம் (ததொல்லியல் துளற தவளியீடு)
4. தபொருளந – ஆற்றங்களர நொகரிகம். (ததொல்லியல் துளற தவளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: 38 Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22EEC101	**APTITUDE AND SOFT SKILLS**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To enhance students' cognitive prowess and mental potential.
2. To improve students' mental aptitude relevant to their academic choices, vocational preferences, job profiles and their ability to succeed.
3. To measure a range of skills such as language comprehension, logical thinking and numerical ability.
4. To get familiar with the method of solving aptitude and multi-choice questions.

Course Content:

UNIT I FUNDAMENTALS OF APTITUDE 2

English diagnostic test - EDT - Logical Reasoning-Puzzles - Factors influencing positive mind set-Importance of self-confidence and self-esteem.

UNIT II SPEAKING SKILLS 3

Effective communication – Barriers & Strategies – Day to Day conversation -Improving responding capacity – Extempore speech practice – Speech assessment. Arithmetic aptitude – Simplification.

UNIT III READING SKILLS 2

Reading Op-Ed columns and commentary – skimming and scamming methods -speed reading. Logical Reasoning-verbal analogies.

UNIT IV GREETINGS 2

Greetings and expressions- expressing gratitude and apologies -*expressions* of courtesy. Arithmetic aptitude – Percentages.

UNIT V ETIQUETTE 3

Etiquette- Respect, Consideration & Honesty-oral presentation-role of audio/video visual aids. Logical Reasoning – Non-verbal - Arithmetic aptitude – Introduction to numbers.

TOTAL LECTURE PERIODS 12 Periods

Expected Course Outcome:

1. Students will be able to understand what he is good at and what they can be good at.
2. The vast scope and dynamics of aptitude classes ensured a streamlined process for the students to make career choices, academic pursuits, and professional growth.
3. The soft skills classes make the students scalable and standardized and help the students to

outperform a large number of applicants in the market.
4. The soft skills classes help students to identify their leadership styles and work effectively as a team.

Text Book(s):

1. English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press pvt,Ltd.
2. New International Business English by Leo Jones and Richard Alexander. Cambridge University Press pvt,Ltd.
3. Quantitative Aptitude for Competitive Examinations by R S Aggarwal, S. CHAND Publishers.
4. A Modern Approach To Logical Reasoning by R S Aggarwal, S. CHAND Publishers.

Reference Books:

1. A New Approach to REASONING Verbal & Non-Verbal Paperback – 1 January 2014 by B.S. Sijwalii & Indu Sijwali.
2. How to prepare for quantitative aptitude for the CAT 6th edition by Arun sharma published on May, 2014 by Mcgraw Hill Education publishers.
3. Magical Book on Quicker Maths by M Tyra and K Kundan.
4. Shortcuts in Reasoning (Verbal, Non-Verbal, Analytical & Critical) for Competitive Exams 3rd Edition by Disha Experts.
5. Everyday Etiquette: How to Navigate 101 Common and Uncommon Social Situations. Published by St. Martin's Griffin; First edition.

		L	T	P	C
22BT101	**BIOMOLECULES**	**3**	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To gain knowledge on structure, composition, bonding and function of various biomolecules.
2. To illustrate the basic nature and properties of biomolecules which are involved in the metabolic pathways.
3. To articulate the significance of these biomolecules and to apply these fundamentals in biotechnology.

Expected Course Outcome:

1. Recall the chemical bonding and properties of biomolecules.
2. Understand the biochemistry at the atomic level, and to draw the basic structures of biomolecules.
3. Recognize the significance of biomolecules in the proper functioning of living cells.
4. Illustrate the structure and functions of conjugated biomolecules – proteoglycans, glycoproteins and glycolipids.
5. Discuss the applications of biomolecules in biotechnology industries.
6. Analyze the clinical and biological significance of biomolecules.

Course Content:

UNIT I CARBOHYDRATES 9

Classification, structure, properties and functions of carbohydrates: Monosaccharides – classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides- examples; Polysaccharide – classes, examples; complex and conjugated carbohydrates- proteoglycan, glycoprotein, glycolipid. Industrial and clinical significance of carbohydrates- a review.

UNIT II LIPIDS AND FATTY ACIDS 9

Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – cholesterol. Review on industrial and clinical significance of fatty acids and lipids.

UNIT III AMINO ACIDS AND PROTEINS 9

Amino acids- basic structure, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides. Review on industrial and clinical significance of amino acids, peptides and proteins.

UNIT IV NUCLEIC ACIDS 9

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, RNA types, structure and functions, properties of nucleic acids.

UNIT V SIGNIFICANCE OF VITAMINS, MINERALS AND NUTRACEUTICALS 9

Classification of Vitamins; biological functions of Vitamins – roles in metabolism and regulatory pathways, anti-oxidant roles; clinical symptoms of Vitamin deficiency; Biological significance of minerals; Vitamin and mineral supplementations-nutraceuticals.

TOTAL LECTURE PERIODS 45 Periods

Text Book(s):

1. Lehninger, A.L, Nelson D.L and Cox, M.M, “Principles of Biochemistry”, Freeman Publishers, New York, 7th edition, 2017. BIOTECHNOLOGY 11.17.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.

Reference Books:

1. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
2. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain “Biochemistry”, Chand publication, 4th edition, 2008.

SEMESTER II

22CS201	**PROBLEM SOLVING TECHNIQES - II**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the constructs of C Language.
2. To develop C Programs using basic programming constructs
3. To develop C programs using arrays and strings
4. To develop modular applications in C using functions
5. To develop applications in C using pointers and structures
6. To do input/output and file handling in C

Course Content:

UNIT I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process.

UNIT II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binary search.

UNIT III FUNCTIONS AND POINTERS 9

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference.

UNIT IV STRUCTURES AND UNION 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility.

UNIT V FILE PROCESSING 9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Demonstrate knowledge on C Programming constructs
2. Develop simple applications in C using basic constructs
3. Design and implement applications using arrays and strings
4. Develop and implement modular applications in C using functions.
5. Develop applications in C using structures and pointers.
6. Design applications using sequential and random-access file processing.

Text Book(s):

1. Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie, D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.

Reference Books:

1. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996.

List of Experiments:

1.	Write a C program to calculate and display the area of a rectangle using the input values entered by the user.	**3**
2.	Write a C program to sort an array of integers using selection sort technique.	**3**
3.	Write a C program to concatenate two strings entered by the user and display the resultant string.	**3**
4.	Write a C program to find the factorial of a number using recursion.	**3**
5.	Write a C program to swap two numbers using call by value and call by reference.	**3**
6.	Write a C program to create a structure named student with the fields roll no, name, and marks in three subjects. Initialize the structure with the values entered by the user and display the details.	**3**
7.	Write a C program to read data from a text file and display it on the screen.	**3**
8.	Write a C program to implement a singly linked list and display its elements.	**3**
9.	Write a C program to open a binary file, write data to it, and read data from it.	**3**
10.	Write a C program to implement a stack using an array and perform push, pop, and display operations.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipment: (for batch of 30 students)

1.	Standalone Computer	30 nos
2.	TURBO C	1 nos

22BT201	BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To know in detail about the elements of atom, charges and their bonding rule.
2. To understand the various kinetic properties and types of reaction mechanisms.
3. To understand the possible bio-organic reactions involved in biosynthesis.

Course Content:

UNIT I BONDING AND STEREOCHEMISTRY 9

Atoms Electrons and orbitals - Covalent Bonds - Octet rule - Polar covalent Bonds - Electronegativity- formal charge - Resonance Acids and Bases - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria - SP3 hybridization - Conformations analysis ethane, butane and cyclohexane - Cis- trans isomerism. Stereochem activity around the tetrahedral carbon – optical activity - Conformation of the peptide bond.

UNIT II MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS 9

SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester- hydrolysis of amides. Ester enolates - claisen. condensation – Michael condensation.

UNIT III KINETICS AND MECHANISM 9

Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation Eyring equation - ΔG, ΔS, ΔH, Thermodynamics of coupled reactions.

UNIT IV CATALYSIS 9

Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation

UNIT V BIOORGANIC REACTIONS 9

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer Terpene biosynthesis – Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To learn the basics principles of chemical Bonding, Stereochemistry of Bio-organic molecules.
2. To be aware about Kinetics, mechanisms of reactions and catalysis of biomolecules.
3. To know about possible bio-organic reactions involved in biosynthesis
4. To gain the knowledge about mechanism of substitution and addition reactions
5. To gain the knowledge about proton transfer and bond formation.

Text Book(s):

1. Carey, Francis A.” Organic Chemistry”. VIIth Edition, Tata MCGraw Hill, 2009.
2. Page, M.I. and Andrew Williams “Organic and Bio-organic Mechanisms”. Pearson, 2010.

Reference Books:

1. Dugas, Hermann “Bioorganic Chemistry: A Chemical Approach to Enzyme Action” 3rd Edition, Springer, 2003

List of Experiments:

1.	Synthesis of aspirin	**3**
2.	Hydrolysis of sucrose	**3**
3.	Preparation of pyruvic acid from tartaric acid	**3**
4.	Preparation of oleic acid from tartaric acid	**3**
5.	Preparation of alpha D- glucopyranosepentaacetate	**3**
6.	Preparation of 1,2,5,6 dicyclohexylnoine alpha d glucofuranose	**3**
7.	Isolation of lycopene from tomato paste	**3**
8.	Preparation of L-proline	**3**
9.	Preparation of L-cysteine from hair	**3**
10.	Preparation of S-ethylhydroxylbutonate from methyl acetoacetate using yeast	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

22BT202	MICROBIOLOGY	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To highlight the functions and characteristics of microorganisms
2. To study the growth of microorganisms and the impact of environment on their growth
3. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms.
4. To enable the students to understand the basic principles involved in the isolation of different kinds of microorganisms and gain accurate handling of microorganisms
5. Students will be taught about the different parts of microscopes and their functions
6. The students will learn to identify the microorganisms using various staining techniques and biochemical tests

Course Content:

UNIT I INTRODUCTION TO MICROBIOLOGY 9

An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM)- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining, spore staining

UNIT II MICROBIAL STRUCTURE AND MULTIPLICATION 9

Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells, Multiplication of bacteria, viruses, algae, protozoa, fungi, yeast with appropriate examples, Life history of actinomycetes and bacteriophage

UNIT III MICROBIAL NUTRITON AND METABOLISM 9

Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth, Mathematics of growth generation time and growth rate constant, factors affecting growth. Aerobic and Anaerobic respiration, Microbial metabolism-Entner–Doudoroff and Phosphoketolase pathway

UNIT IV CONTROL OF MICROORGANISMS 9

Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents; Chemotherapy and antibiotics- antibacterial, antifungal agents, anti-viral agents

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 9

Primary metabolites; secondary metabolites and their applications; preservation of food;production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Acquire basic knowledge on the history and development of microbiology
2. Recognize the fundamental concepts in the structure and functions of microbes
3. Understand the classification and nomenclature of microorganism, microscopic, staining and sterilization techniques
4. Identify the appropriate physical and chemical methods to control the growth of microbes
5. Culture, identify, and explain different kinds of microorganisms present in environmental samples

Text Book(s):

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi,
   India.2007
2. Prasad B.N., "A Text Book of Biotechnology", Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal. 2003.

Reference Books:

1. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C. BrownPublishers, 2001.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
3. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.

List of Experiments:

1.	Lab safety method and Regulations, Principles and methods of sterilization and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow	**3**
2.	Media preparation and Culturing of microorganisms–	**3**
3.	Estimation of copper content of the given solution by Iodometry.	**3**
4.	Enumeration of microorganisms from Soil	**3**
5.	Enumeration of microorganisms from Water.	**3**
6.	Staining Techniques -Simple, Gram staining and spore staining	**3**
7.	Staining of fungus – Lacto phenol cotton blue staining	**3**
8.	Motility test by Hanging drop method and soft agar inoculation	**3**
9.	Biochemical Characterization of Bacteria: IMViC test, Catalase, Casein and Starch Hydrolysis.	**3**
10.	Antibiotic sensitivity assay – Disc and Well diffusion method	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	pH meter	5 no
2.	Auto Clave	1 no
3.	Petridish	30 nos
4.	Incubator	1 no

22MA201	NUMERICAL METHODS	L	T	P	C
		3	1	0	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the basic concepts of solving algebraic and transcendental equations.
2. To introduce the numerical techniques of interpolation in various intervals in real life situations.
3. To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
4. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
5. To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

Course Content:

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - Fixed point iteration method– Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method - Two point and three-point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Finite difference methods for solving second order two - point linear boundary value problems - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Understand the basic concepts and techniques of solving algebraic and transcendental equations.
2. Appreciate the numerical techniques of interpolation and error approximationsin various intervals in real life situations.
3. Apply the numerical techniques of differentiation and integration forengineering problems.
4. Understand the knowledge of various techniques and methods for solving firstand second order ordinary differential equations.
5. Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

Text Book(s):

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science",Khanna Publishers, 10th Edition, New Delhi, 2015.

Reference Books:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia,6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5thEdition, 2015.

22AC201 **TAMILS AND TECHNOLOGY**

L	T	P	C
1	0	0	1

Pre-requisite Nil **Syllabus Version** V 0.1

Course Content:

UNIT I WEAVING AND CERAMIC TECHNOLOGY **3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY **3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY **3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY **3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING **3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL LECTURE PERIODS **15 Periods**

Text cum Reference Books:

1. 1. தமிழக வரலாறு- மக்களும் பண்பாடும்- க.க.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி- வைகை நதிக்கரையில் நகர நாகரிகம் (தொல்லியல் வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute ofTamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by:International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: InternationalInstitute of Tamil Studies.)
9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: TheAuthor)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book andEducational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22HS203	**UNIVERSAL HUMAN VALUES**	**L T P C** **2 0 0 2**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Understand the importance of "VALUES" and "SKILLS" working together to ensure long-term happiness and prosperity.
2. Developing a holistic view on life, careers, happiness, and prosperity based on an accurateunderstanding of human reality and the rest of existence.
3. Attention to realistic ramifications of such a holistic view in terms of moral behaviour, reliable andgratifying human relationship with nature, and ethical human conduct.

Course Content:

UNIT I COURSE INTRODUCTION – AND VALUE EDUCATION 6

Introduction to human virtues, recognizing the need, fundamental guidelines, Content and Process on Value Education. Self-exploration-Wealth vs Prosperity, Understanding Needs of Self and Body.

UNIT II COURSE INTRODUCTION – AND VALUE EDUCATION 6

Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in theSelf, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

UNIT III FAMILY AND SOCIETY HARMONY AND HUMAN RELATIONSHIP 6

The basic unit of human interaction, "trust" - the core value of Relations, "respect" - understood as correct evaluation, different emotions, justice in relationships, harmony in society, a vision of Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family! - PracticeExercises and Case Studies will be taken up in Practice Sessions.

UNIT IV WHOLE EXISTENCE AS CO-EXISTENCE AND CONCORD OF NATURE 6

Concord in nature, link, self-monitoring, understanding of mutual fulfilment in the four orders of nature,recognizing existence as coexistence on all levels, holistic awareness of happiness in existence.

UNIT V HOLISTIC UNDERSTANDING OF HAPPINESS OF UNIVERSAL HUMAN VALUES 6

Inference of the above holistic understanding of happiness of universal human values. Accepting human values naturally. Finality of ethical human behavior. A Humanistic Constitution and a Humanistic World Order. Ability in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical, Strategies for Transition.

TOTAL LECTURE PERIODS 30 Periods

Expected Course Outcome:

Upon successful completion of the course, students should be able to:

1. The big picture of life
2. Socially Responsible Behavior
3. Environmentally friendly work
4. Ethical Human Behavior
5. Have the ability and skills to maintain good health and hygiene
6. Recognize and pursue excellence (merit) and appreciate everyone

Reference Books:

1. Vivekananda - Romain Rolland (English).
2. Gandhi - Romain Rolland (English).
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991 15. Donella
4. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club ofRome’s report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.

Reference Links:

1.https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

2. https://fdp-si.aicte-india.org/8dayUHV_download.php

3. https://www.youtube.com/watch?v=8ovkLRYXIjE

4.https://www.youtube.com/watch?v=OgdNx0X923I

5.https://www.youtube.com/watch?v=nGRcbRpvGoU

6.https://www.youtube.com/watch?v=sDxGXOgYEKM

22BT203	**BIO CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Pre-requisite **Syllabus Version** V 0.1

List of Experiments:

1.	Accuracy, precision, sensitivity and specificity (theory)	**4**
2.	Preparation of buffer –titration of a weak acid and a weak base.	**4**
3.	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.	**4**
4.	Quantitative method for amino acid estimation using ninhydrin distinguishing amino from imino acid.	**4**
5.	Protein estimation by Biuret and Lowry's methods.	**4**
6.	Protein estimation by Bradford and spectroscopic methods.	**4**
7.	Extraction of lipids and analysis by TLC.	**4**
8.	Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo).	**4**
9.	Enzymatic assay: phosphatase from potato.	**4**
10.	Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method.	**4**

TOTAL PRACTICAL PERIODS **40 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1. Analyze current biochemical and molecular techniques to plan and carry outexperiments.
2. Perform good biochemical laboratory practices.
3. Adapt methods for biochemical analysis.
4. Carry out experiments in biomolecular separations.
5. Understand the applicability of biochemical methods to realistic solution.

Reference Books:

1. Harpers Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange ,Stanford , Conneticut.
2. Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publisher

List of Equipments: (for batch of 30 students)

1.	Test tubes	120 nos
2.	UV spectrometer	1 no
3.	Colorimeter	1 no
4.	pH meter	5 nos
5.	TLC slate	30 nos

SEMESTER III

22BT301	**CELL BIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To acquaint students with the concepts in Cell Biology.
2. To understand structure and function of the organelles of cells
3. To learn the cell-cell interactions, transport mechanism and signaling pathways of cell
4. To acquaint the students with basic laboratory techniques involved in cell

Course Content:

UNIT I FEATURES OF CELL AND ITS ORGANELLES 9

Brief history of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella.

UNIT II CELL CYCLE AND THEIR SOCIAL CONTEXT 9

Cell cycle and molecules that control cell cycle, Regulation of cell cycle, Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell- cell communication:Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

UNIT III CELL TRANSPORT AND TRAFFIC 9

Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell.

UNIT IV SIGNALING MOLECULES AND THEIR RECEPTORS 9

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling

UNIT V SIGNAL TRANSDUCTION 9

Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP3) in signal transduction, calcium ion flux and its role in cell signaling.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to
1. Acquire knowledge on the structure and function of cellular organelles and components
2. Analyze the behavior of cells in their microenvironment in multicellular organisms with emphasis on cell-cell interactions, cell-extra cellular matrixinteractions.
3. Illustrate specific process and proteins involved in membrane transport.
4. The students learn about the cells of the immune system and their functions
5. Understand the regulatory pathways of cells

Text Book(s):

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, MolecularBiology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference Books:

1. De Robertis & De Robertis, Cell Biology, 4th Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

List of Experiments:

1.	Microscopically Identification of Cells in Permanent Fixed Slides	**3**
2.	Staining for Various Stages of Mitosis in Allium cepa (Onion)	**3**
3.	Osmosis and Tonicity Studies Using Red Blood Corpuscles	**3**
4.	Differentiation of Blood Cells Using Giemsa Staining	**3**
5.	Separation of Peripheral Blood Mononuclear Cells and Trypan Blue Assay for Live Cell	**3**
6.	Blood Grouping and Rh typing	**3**
7.	Preparation of Plasma and Serum	**3**
8.	Single Radial Immunodiffusion	**3**
9.	Double Immunodiffusion – Ouchterlony Method	**3**
10.	Immuno electrophoresis	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	pH meter	15 nos
2.	Autoclave	1 nos
3.	Centrifuge	1 nos
4.	Electrophoresis Kit	5no

22MA303	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

	Nil	**Syllabus Version**	V 0.1

Pre-requisite

Course Objectives:

1. This course aims at providing the required skill to apply the statistical tools in engineering problems.
2. To introduce the basic concepts of probability and random variables.
3. To introduce the basic concepts of two dimensional random variables.
4. To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
5. To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

Course Content:

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Probability – Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 9+3

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit..

UNIT IV DESIGN OF EXPERIMENTS 9+3

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design.

UNIT V STATISTICAL QUALITY CONTROL 9+3

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome: On completion of the course, the student is expected to
1. Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.

2. . Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

3. Apply the concept of testing of hypothesis for small and large samples in real life problems.

4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.

5. Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

Text Book(s):

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

Reference Books:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‘s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

22CS302	PROBLEM SOLVING TECHNIQUES-III	L	T	P	C
		3	0	2	4

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. To understand Object Oriented Programming concepts and basics of Java programming language
2. To know the principles of packages, inheritance and interfaces
3. To develop a java application with threads and generics classes
4. To define exceptions and use I/O streams
5. To design and build Graphical User Interface Application using JAVAFX.

Course Content:

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object-Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors- Methods -Access specifiers - Static members- Java Doc comments

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT IV I/O, GENERICS, STRING HANDLING 9

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

UNIT V	**JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS**	**9**

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu Menu bars – MenuItem

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply the concepts of classes and objects to solve simple problems
2. Develop programs using inheritance, packages and interfaces
3. Make use of exception handling mechanisms and multithreaded model to solve real world problems
4. Build Java applications with I/O packages, string classes, Collections and generics concepts
5. Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications

Text Book(s):

1. Herbert Schildt, "Java: The Complete Reference", 11 th Edition, McGraw Hill Education, New Delhi,2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1 st Edition, McGraw Hill Education, NewDelhi, 2015

Reference Books:

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11 th Edition, Prentice Hall, 2018.

List of Experiments:

1.	Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion).	**3**
2.	Develop stack and queue data structures using classes and objects.	**3**
3.	Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.	**3**

4.	Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.	**3**
5.	Solve the above problem using an interface	**3**
6.	Implement exception handling and creation of user defined exceptions	**3**
7.	Write a java program that implements a multi-threaded application that has three threads. Firstthread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print thevalue of the cube of the number.	**3**
8.	Write a program to perform file operations.	**3**
9.	Develop applications using JavaFX controls, layouts and menus	**3**
10.	Develop a mini project for any application using Java concepts.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	Operating Systems: Linux / Windows	30 nos
2.	Front End Tools: Eclipse IDE / Netbeans IDE	-

22BT302 **MOLECULAR BIOLOGY**

L	T	P	C
3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression
4. The objective of the course the student will learn various basic techniques in molecular biology and genetic engineering.
5. The student will learn how to isolate DNA from various sources.

Course Content:

UNIT I CHROMOSOME ORGANIZATION 9

Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments: Grifith, Hershey and chase; Avery McLeod & McCarty. Bacterial Recombination: Transformation, Transduction, Sexduction and Conjugation. Lytic and lysogeny

UNIT II DNA REPLICATION AND MUTATIONS 9

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes, D-loop and rolling circle mode of replication, regulation of replication, replication of linear viral DNA, Replication in eukaryotes and telomere replication. Mutation: types, DNA repair - methylation, mismatch, SOS, recombination.

UNIT III TRANSCRIPTION 9

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing and RNA editing. Transcription in virus: RNA replicase, Reverse transcriptase.

UNIT IV TRANSLATION 9

Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Posttranslational modifications, Inhibitors

UNIT V REGULATION OF GENE EXPRESSION 9

Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin in gene regulation.

Expected Course Outcome:

1. On completion of the course, the student is expected to
2. Understand the fundamental concepts of the organization of genome and central dogma
3. Summarize the fundamental mechanism on the process of replication, transcription and translation
4. Recognize common mutations, their natural repair systems and the natural geneexpression regulation
5. The student knows how to carry out qualitative and quantitative measurements onnucleic acids.
6. The student knows how to manipulate DNA using restriction and ligation techniques.
7. The student knows how to transfer DNA into bacteria by the transformation technique.

Text Book(s):

1.David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference Books:

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
3. Gardner, Simmons and Snustad, "Principles of Genetics", John Wiley, 8th edition, 2000.

List of Experiments:

1.	Isolation of genomic DNA from plant tissue	**3**
2.	Isolation of genomic DNA from animal liver	**3**
3.	Isolation of genomic DNA from microorganism (E-coli)	**3**
4.	Isolation of plasmid DNA from microorganism	**3**
5.	Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer	**3**
6.	Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation	**3**
7.	Extraction of proteins from plant or animal tissue and confirmation with qualitative tests	**3**
8.	Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain	**3**
9.	Restriction enzyme digestion of DNA samples confirmation through	**3**

agarose gel electrophoresis

10. Transformation of DNA into competent cells **3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	pH meter	15 nos
2.	Centrifuge	1 no
3.	Electrophoresis kit	5 nos
4.	Sonicator	1 no
5.	UV Transilluminator	1 no

22BT303	BASIC INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
2. To gain knowledge about bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures

Course Content:

UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 9

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

UNIT II PRODUCTION OF PRIMARY METABOLITES 9

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

UNIT III PRODUCTION OF SECONDARY METABOLITES 9

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Bio preservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.

UNIT V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 9

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To explain the steps involved in the production of bio products and methods to improve modern biotechnology.
2. To apply basic biotechnological principles, methods and models to solve biotechnological tasks.
3. To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology.
4. To design and deliver useful modern biotechnology products to the Society.
5. Recognize the concepts of industrial biotechnology and iotechnological concept and principles in bioprocesses.

Text Book(s):

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" IInd Edition. Affiliated East West Press Pvt.Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" IInd Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd., 2006.68

Reference Books:

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.
3. Cruger, Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology", IInd Edition, Panima Publishing, 2000.
4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004.
5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", IInd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
6. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
7. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications

SEMESTER IV

22BT401	**BIOPROCESS TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

The student should be made to,

1. To provide the students with the basics of bioreactor engineering.
2. To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONFIGURATION OF BIOREACTORS 9

Ideal reactors and its characteristics Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors.

UNIT II BIOREACTOR SCALE – UP 9

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT III BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 9

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors.

UNIT IV MODELLING AND SIMULATION OF BIOPROCESSES 9

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

UNIT V RECOMBINANT CELL CULTIVATION 9

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris/ Saccharomyces cereviseae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactorconsiderations in the above system

TOTAL LECTURE PERIODS: 45 PERIODS

EXPECTED COURSE OUTCOME:

Upon completion of this course the student will be able to

1. Describe various bioreactor configurations and operation modes.
2. Apply the knowledge of bioreactor scale up on the basis of rule of thumbs.
3. Define kinetic parameters and apply the bioreactor considerations for immobilized enzyme systems.
4. Utilize modelling approaches and simulation concepts for bioprocess estimations.
5. Apply bioreactor considerations for the development of recombinant products.

TEXT BOOKS:

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa,. Bioprocess Engineering, 3rd Edition, Prentice Hal, 2017
2. Pauline Doran, Bioprocess Engineering Calculation, 2nd Edition, Blackwell Scientific Publications, 2012

List of Experiments:

1.	Batch Sterilization kinetics	3
2.	Batch cultivation with exhaust gas analysis	3
3.	Estimation of kLa – Dynamic Gassing-out method	3
4.	Estimation of kLa – Sulphite Oxidation Method	3
5.	Estimation of kLa – Power Correlation Method	3
6.	Fed batch cultivation and Total cell retention cultivation	3
7.	Photobioreactor	3
8.	Residence time distribution	3
9.	Estimation of Overall Heat Transfer Coefficient	3
10.	Estimation of Mixing Time in reactor	3

TOTAL PRACTICAL PERIODS 30 periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 periods

Equipment Needed for 30 Students

1.	Electrophoresis Kit	1 no
2.	Reactors	6 no
3.	Incubators	2 no
4.	Light Microscopes	1 no
5.	Incubator Shaker	1 no
6.	Spectrophotometer	2 no
7.	Laminar Flow Chamber	1 no
8.	Glassware, Chemicals, Media as required	

References:

1. Anton Moser, Bioprocess Technology, Kinetics and Reactors, , Springer Verlag.
2. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
3. James M. Lee, Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Decker Inc.

22BT402	**BIOANALYTICAL TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

OBJECTIVES:

1. To study the various analytical techniques used in Biotechnology
2. To gain knowledge about diffraction techniques

UNIT I SPECTROSCOPY STUDY OF CHEMICAL COMPOUNDS AND BIO-MOLECULES 9

Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantization of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, Beer Lambert's law, deviation of Beer-Lambert's equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy.

UNIT II DIFFRACTION TECHNIQUE 9

Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).

UNIT III CHROMATOGRAPHY 9

Classification of chromatographic techniques and their principles, Theory of chromatography,band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes,sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.

UNIT IV MICROSCOPY 9

Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron, diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.

UNIT V ELECTROPHORETIC TECHNIQUES 9

Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. The students will be capable of handling different instruments in the laboratory.
2. They would be able to compare different separation techniques and use them effectively inresearch work
3. They will be able to perform electrophoresis
4. Students will be able to handle different types of microscopes
5. They will also be able to perform different chromatographic techniques.

TEXTBOOKS:

1. D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series.

2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009) 2. R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012).

3. R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York, 2011).

4. D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and conceptsfrom cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).

5. R. L. Switzer, Experimental biochemistry (W. H. Freeman and Co, New York, 3rd ed., 1999).

6. Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.

REFERENCE:

R. F. Boyer, Modern experimental biochemistry (Benjamin Cummings, San Francisco, 3rded., 2000).

J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006;

B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin ; New York, 2nd ed., 2002).

D. B. Williams, C. B. Carter, Transmission electron microscopy a textbook for materials science (Springer, New York, 2009.

TOTAL LECTURE PERIODS 45 Periods

LIST OF EXPERIMENTS:

1. Precision and validity in an experiment using absorption spectroscopy 3
2. Validating Lambert-Beer's law using $KMnO_4$ 3
3. Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry 3
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy. 3
5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxolate. 3
7. Estimation of SO^{4--} by nephelometry. 3
8. Estimation of Al^{3+} by Flourimetry. 3
9. Limits of detection using aluminium alizarin complex. 3
10. Chromatography analysis using TLC.

TOTAL PRACTICAL PERIODS 30 periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 periods

REFERENCES:

1. Skoog, D.A. et al. "Principles of Instrumental Analysis", Vth Edition, Thomson / Brooks –Cole,1998.

2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.

3. Willard, H.H. et al. "Instrumental Methods of Analysis", VIth Edition, CBS, 1986.

4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", Vth Edition, McGraw-Hill, 1985.

22BT403	BIOSTATISTICS	L	T	P	C
		3	1	0	4

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. This course is designed to provide a solid foundation on topics in statistics that can be useful for the biotechnologists to conduct research on different types of data arising in public health and clinical studies.
2. It is framed to address the issues in biotechnology usingthe concepts on probability, regression, sampling, estimation theory, testing of hypothesis and design an analysis of experiments.

Course content

UNIT I RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 9

Discrete random variable – Probability mass function – Properties – Continuous random variable – Probability density function – Properties – Moments : Mean and variance with properties –Special distributions : Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal – Properties - Simple Problems.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION THEORY 9

Random sampling – Sample mean and variance – Standard error – Simple problems – Estimator: Unbiasedness – Maximum likelihood estimation – Method of moments – Curve fitting by the method of least squares : Fitting curves of the form *y ax b*, *y ax* 2 *bxc*, *y abx* and *y ax b* - Multiple regression lines.

UNIT III TESTING OF HYPOTHESIS 9

Sampling distributions – Type I and Type II errors – Tests based on Normal, t,2 and F distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances – Independence of attributes (r x c contingency table) - Goodness of fit**.**

UNIT IV NON-PARAMETRIC STATISTICS 9

One sample sign test–Sign test for paired samples – Signed rank test – Ranksumtest : The U-test – Rank-sum test : The H-test – Test based on runs.

UNIT V DESIGN OF EXPERIMENTS 9

Completely random design–Randomized complete block design – Analysis of variance: One - way and Two - way classifications – Latin square design - 22 factorial design.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

Upon completion of the course, students will be able to

1. Basic probability axioms and rules and the moments of discrete and continuous random variables.
2. Distributions and their properties, Least squares, correlation, regression, consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem. Sampling and use statistical tests in testing hypotheses on data.
3. List the guidelines for designing experiments, recognize the key historical figures in Designof Experiments, conduct statistical tests and analyze the results.
4. Analyze the experiments by applying suitable non-parametric tests
5. The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES :

1. Devore, J.L., “Probability and Statistics for Engineering and Sciences”, 8th Edition,Cengage Learning Pvt. Ltd., New Delhi, 2014.

2. Freund, J.E., “Mathematical Statistics”, 5th Edition, Prentice Hall of India, 2001.

3. Gupta, S.C. and Kapoor, V. K, “Fundamentals of Mathematical Statistics”, Sultan Chandand Sons, 14th Edition, 2016.

4. Johnson, R.A and Gupta C. B., “Miller and Freund’s Probability and Statistics forEngineers”, Pearson Education Int., Asia, 8th Edition, 2011.

5. Libschutz, S. “Probability and Statistics”, 4th Edition, McGraw Hill, New Delhi, 2010.

6. Miller, I. and Miller, “Mathematical Statistics”, 7th Edition, Pearson Education Inc.(10th impression), 2012.

22BT404	IMMUNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives

1. To discuss the structure, functions and integration of immune system.
2. To explain the immune response and protective mechanism against various pathogens.

UNIT I INTRODUCTION TO IMMUNE SYSTEM **9**

Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex

UNIT II HUMORAL AND CELLULAR IMMUNITY **9**

Development, maturation, activation, regulation, differentiation and classification of T-cells and Bcells, antigen processing and presentation, theory of clonal selection, TCR; antibodies:structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions

UNIT III IMMUNITY AGAINST PATHOGENS AND TUMORS **9**

Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy

UNIT IV IMMUNE TOLERANCE AND HYPERSENSITIVITY **9**

Immune tolerance, Immuno deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, auto immune disorders and diagnosis

UNIT V APPLIED IMMUNOLOGY **9**

Monoclonal antibodies, engineering of antibodies; T- Cell cloning - Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immuno diffusion ELISA, FACS), immune modulatory drugs.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

Upon completion of the course, students will be able to

1. Understand the structure, functions and integration of immune system.
2. Understand the antigen-antibody interactions that offers defence mechanism.
3. Understand the importance of various techniques of therapeutically significant monoclonal and engineered antibodies production
4. Aware of the concepts and mechanism behind tumour development, allergy and

hypersensitivity reactions.

5. Gain knowledge in Immunotherapeutic development for Clinical Applications

TEXT BOOKS:

1. Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts EssentialImmunology, 13th Edition, Wiley –Blackwell, 2016.

2. Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan International, 7th Edition, 2012

3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.

REFERENCES:

1. Coico, Richard "Immunology: A Short Course" VIth Edition. John Wiley, 2008.
2. Khan, Fahim Halim "Elements of Immunology" Pearson Education, 2009.

3. Robert R Rich, Thomas A Fleisher, William T Shearer, Harry Schroeder, Anthony J Frew, and Cornelia M Weyand, Clinical Immunology – Principles and Practive, Elsevier, 4th Edition,2013.

4. https://www.inspirenignite.com/anna-university/bioprocess-laboratory-ii-biotech-6th-sem-syllabus-for-b-tech-2017-regulation-anna-univ/

22MC403	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P	C
		3	0	0	0

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives

1. This course aims at providing the knowledge about history of science and technology in India.
2. To understand historiography of India.
3. To introduce the basic concepts of Science in Ancient India, colonial India and Post Independent India.

UNIT-I CONCEPTS AND PERSPECTIVES 9

Meaning of History: Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment inhistory, Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA 9

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S.Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 9

Technology in pre-historic period, Beginning of agriculture and its impact on technology Science and Technology during Vedic and Later Vedic timesScience and technology from 1st century AD to C-1200.

UNIT-IV SCIENCE AND TECHNOLOGY IN COLONIAL INDIA 9

Science and the Empire, Indian response to Western Science Growth of techno-scientific institutions

UNIT-V SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA 9

Science, Technology and Development discourse, Shaping of the Science and Technology Policy Developments in the field of Science and Technology Science and technology in globalizing India. Social implications of new technologies like the Information Technology and Biotechnology

TOTAL LECTURE PERIODS 45 periods

Expected Course Outcome:

After completing the course, the students will be able to:

1. Learn the importance of concepts and perspectives of science & technology.
2. Gain confidence about the knowledge about history of science & technology.
3. Learn about Science & technology in ancient India.
4. Understand the importance of Science & technology in colonial India.
5. Gain complete knowledge about Science & technology in a Post- Independent India.

REFERENCES

1. http://www.indianscience.org/index.html
2. https://prepp.in/news/e-492-science-and-technology-in-ancient-india-ancient-india-history-notes
3. https://academic.oup.com/crawlprevention/governor?content=%2fbook%2f4022%2fchapter%2f145664825
4. https://www.pgurus.com/a-very-brief-history-of-indian-science/
5. https://www.sciencedirect.com/science/article/abs/pii/S0160791X97000158

SEMESTER V

22BT501	GENETIC ENGINEERING	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To understand the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
2. To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
3. To understand comparative genomics and proteomics.

UNIT I CLONING WITH SPECIALIST-PURPOSE VECTORS 9

M13 based vectors, production of RNA probes and interfering RNA - controllable promoters for maximal expression of cloned gene – λPL, trc, T7 and pBAD - factors affecting the expression of cloned genes - purification tags for purification of cloned gene product – vectors for solubilization of expressed proteins - gateway system of transferring DNA fragments to vectors

UNIT II cDNA LIBRARY CONSTRUCTION 9

Oligo dT priming, self-priming and its limitations. Full length cDNA cloning – Capture method and Oligo capping. Screening strategies – Hybridization, PCR, Immunoscreening, South-western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR.

UNIT III MUTAGENESIS AND ALTERED PROTEIN SYNTHESIS 9

Random mutagenesis - Error-prone PCR, Rolling circle error-prone PCR, use of mutator strains, temporary mutator strains, Insertion mutagenesis, ethyl methane sulfonate, DNA Shuffling, signature tagged mutagenesis and transposon mutagenesis. Incorporation of unnatural amino acids into proteins – Phage and cell-surface display for selection of mutant peptides

UNIT IV GENOME ENGINEERING 9

DNA damage – sources and types - DNA double stranded break repair mechanisms - Engineered nucleases in genome engineering – mega nucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering – targeted gene mutation, creating chromosome rearrangement, studying gene function with stem cells, transgenic animals, endogenous gene labelling and targeted transgene addition genome engineering -prospects and limitations.

UNIT V GENETIC MANIPULATION OF CELLS AND ANIMALS 9

Overview - principle of gene transfer - methods of gene transfer to animal cell culture - selectable markers for animal cells - Isolation and manipulation of mammalian embryonic stem cells - Using gene transfer to study gene expression and function - creating disease models using gene transfer and gene targeting technology - potential of animal for modelling human disease.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

The students after completing this course would be aware of clone methods ofcommercially important genes.

1. The students would be aware of producing the commercially important recombinant proteins.
2. The students would be aware of gene and genome sequencing techniques.
3. The students would be aware of microarrays, Analysis of Gene expression andproteomics.
4. The students would be aware of genetic manipulation of cells.
5. The students would be aware of gene engineering.

REFERENCES

1. Benjamin Lewin, “Gene IX”, Oxford University Press, Cambridge, U.K. 2011.
2. Brown, T.A., “Gene cloning and DNA analysis: An introduction”, 6th Edition, WileyBlackwell, 2010.
3. Glick, B.R. and Pasternak J.J., “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 3rd Edition, ASM Press, 2003.
4. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL,2001.
5. Primrose, S.B., and Twyman., “Principles of Gene Manipulation and Genomics”, 7th Edition, Blackwell Science, 2006.
6. Winnacker, E.L., “Frome Genes to Clones: Introduction to Gene Technology”, WileyBlackwell, 2006.
7. Yamamoto, Takashi (Ed.). “Targeted Genome Editing Using Site-Specific Nucleases”,Springer, Japan, 2015

TOTAL LECTURE PERIODS 45 Periods

LIST OF EXPERIMENTS:

1. Isolation of DNA	**3**
2. Electroporation to Yeast	**3**
3. Isolation of RNA	**3**
4. cDNA synthesis	**3**
5. Primer designing	**3**
6. Real-time PCR	**3**
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.	**3**
8. Confirmation of the presence of insert by colony PCR	**3**
9. Induction and expression of recombinant protein	**3**
10. Western blot with ECL detection	**3**

TOTAL PRATICAL PERIODS 30 periods

TOTAL LECTURE CUM PRATICAL PERIODS 75 periods

REFERENCES

1. Sambrook, J. and Russsel, D.W., “Molecular cloning – A laboratory manual”, Third edition,Cold Spring Harbor Laboratory Press, Cold Spring harbor, New York, USA, 2001

Required Equipments:

1.	Microscopes,	10
2.	PCR, purification columns,	5
3.	microplate reader, UV spectrometer,	5
4.	PAGE apparatus,	3
5.	Western blot apparatus (dry/semi-dry/wet),	5
6.	Southern blot apparatus,	5
7.	Centrifuge,	5
8.	Haemocytometer,	2
9.	required stains,	
10.	Chemicals, enzymes & consumables	

22BT502	PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	2	4

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:
1. Plant genetic materials and molecular biology techniques
2. Plant metabolic engineering and its importance
3. Plant transformation techniques and GM crops

Course Content:

UNIT I INTRODUCTION TO PLANT MOLECULAR BIOLOGY 9

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

UNIT II CHLOROPLAST AND MITOCHONDRIA 9

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 9

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

UNIT IV AGROBACTERIUM MEDIATED GENE TRANSFER 9

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –TDNA, importance in genetic engineering

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 9

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products, RNA i, Transgene silencing,ethical issues; case studies on successful transgenics including drought management.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to
1. Understand the plant genome and its molecular mechanisms
2. Get familiarized about additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites
4. Gain knowledge on Agrobacterium mediated gene transfer techniques
5. Develop knowledge on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Text Book(s):

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008

Reference Books:

1. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed., Blackie,1988

TOTAL PRACTICAL PERIODS 30 periods
TOTAL LECTURE CUM PRACTICAL PERIODS 75 periods

List of Experiments

1. Preparation of Tissue Culture Media
2. Plant Tissue Culture - Direct and Indirect Organogenesis
3. Isolation of Plant Genomic DNA
4. Extraction of Total RNA Using Trizol Reagent
5. Transformation of Binary Vector to Agrobacterium
6. Extraction and Detection of Plant Secondary Metabolites
7. Isolation of Protoplasts
8. Cell Suspension Culture
9. Somatic Embryogenesis
10. Particle Bombardment Mediated Gene Transformation In Plants

SEMESTER VI

			L	T	P	C
22BT601	**BIOINFORMATICS**					
			3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To improve the programming skills of the student
2. To let the students know the recent evolution in biological science.

Course Content:

UNIT I INTRODUCTION 9

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genomespecific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

UNIT II SEQUENCE ALIGNMENT 9

Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms

UNIT III PHYLOGENETIC METHODS 9

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultra metric trees, Parsimonious trees, Neighbor joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV PROTEIN STRUCTURE ANALYSIS 9

Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

UNIT V PERL PROGRAMMING 9

Basics of PERL programming for Bioinformatics: Data types: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Develop bioinformatics tools with programming skills.
2. Apply computational based solutions for biological perspectives.
3. Pursue higher education in this field.
4. Practice life-long learning of applied biological science
5. Know about the recent evolution in biological science

Text Book(s):

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy,A.Krogh, G.Mitchison.
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O ReilleyMedia

Reference Books:

2. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

List of Experiments:

1.	Exploration of the resources available in NCBI and PUBMED	**3**
2.	Retrieval of a Gen Bank entry using an accession number	**3**
3.	Retrieval and analysis of a gene sequence “AF375082” in FASTA format	**3**
4.	Finding the official symbol, Alias name, chromosome number and ID for gene using NCBI	**3**
5.	Retrieval and analysis of Protein sequence from protein database	**3**
6.	Primary structure analysis of a Protein	**3**
7.	Secondary structure analysis of a protein	**3**
8.	Tertiary Protein structure analysis using RASMOL	**3**
9.	Pair-wise sequence alignment and multiple sequence alignment using CLUSTAL-W10. Pair wise and multiple sequence alignment using BLAST.	**3**
10.	Retrieval of a Gen Bank entry using an accession number	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

22BT602	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the methods to obtain pure proteins, enzymes and in general about product development R & D.
2. To have depth knowledge and hands on experience on Downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion.

Course Content:

UNIT I INTRODUCTION **9**

Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilisation of bio-products

UNIT II PHYSICAL METHODS OF SEPARATION **9**

Unit operations for solid-liquid separation - filtration and centrifugation.

UNIT III ISOLATION OF PRODUCTS **9**

Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

UNIT IV PRODUCT PURIFICATION **9**

Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic technique

UNIT V FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS **9**

Crystallization, drying and lyophilization in final product

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Define the fundamentals of downstream processing for product recovery
2. Understand the requirements for successful operations of downstream processing
3. Describe the components of downstream equipment and explain the purpose of each
4. Apply principles of various unit operations used in downstream processing and enhance problem solving technique
5. Understand the different parameters required for production.

Text Book(s):

1. Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing forBiotechnology", John Wiley, 1988.
2. Nooralabettu Krishna Prasad., Downstream Process Technology: A New Horizon in Biotechnology, Prentice Hall India,2010.
3. Sivasankar, B. "Bioseparations: Principles and Techniques". PHI, 2006.

Reference Books:

1. Raja Ghosh "Principles of Bioseparations Engineering". World Scientific, 2006
2. Michael R.Ladisch Bio separations Engineering: Principles, practice and Economics, WileyInterscience,1st Edition,2001.
3. Product Recovery in Bioprocess Technology". (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

List of Experiments:

1.	Solid liquid separation – centrifugation	**3**
2.	Solid liquid separation – microfiltration	**3**
3.	Cell disruption techniques – ultrasonication or French pressure cell or Dynomill	**3**
4.	Precipitation – ammonium sulphite precipitation	**3**
5.	Ultra filtration separation	**3**
6.	Aqueous two-phase extraction of biological	**3**
7.	High resolution purification – affinity chromatography	**3**
8.	High resolution purification – ion exchange chromatography	**3**
9.	Product polishing – spray drying or freeze drying	**3**
10.	Size exclusion chromatography	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

22HS601	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To study the nature and facts about environment.
2. To finding and implementing scientific, technological, economic and political solutions to environmental problems.
3. To study the interrelationship between living organism and environment.
4. To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
5. To study the dynamic processes and understand the features of the earth's interior and surface.
6. To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Course Content:

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
2. Public awareness of environmental is at infant stage.
3. Ignorance and incomplete knowledge has lead to misconceptions
4. Development and improvement in std. of living has lead to serious environmental disasters
5. Integrate themes, biodiversity, natural resources, pollution control and waste management.

Text Book(s):

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

Reference Books:

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi,2007
2. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

22MC601 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA

L	T	P	C
3	0	0	0

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To enjoy life happily with fun filled new style activities that help to maintain health also
2. To adapt a few lifestyle changes that will prevent many health disorders
3. To be cool and handbill every emotion very smoothly in every walk of life
4. To learn to eat cost effective but healthy foods that are rich in essential nutrients
5. To develop immunity naturally that will improve resistance against many health disorders

Course Content:

UNIT I HEALTH AND ITS IMPORTANCE **6**

Health: Definition - Importance of maintaining health - More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financialhealth - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath.

Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes careof health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

UNIT II DIET **10**

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension-PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keepsthe teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions.

Definition of BMI and maintaining it with diet: Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes: Different cooking methods, merits and demerits of each method

UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 8

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.

Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - PancheekaranaTheory / **(**Five Element Theory) 96 fundamental Principles - Uyir Thathukkal **(**Tri-Dosha Theory) - Udal Thathukkal

Prevention of illness with our traditional system of medicine

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

UNIT IV MENTAL WELLNESS 7

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

Sleep - Sleep and its importance for mental wellness - Sleep and digestion.
Immunity - Types and importance - Ways to develop immunity

UNIT V YOGA 14

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

TOTAL LECTURE PERIODS: 45 PERIODS

Expected Course Outcomes:

After completing the course, the students will be able to:

1. Learn the importance of different components of health
2. Gain confidence to lead a healthy life
3. Learn new techniques to prevent lifestyle health disorders
4. Understand the importance of diet and workouts in maintaining health
5. Enhance immunity naturally that improve resistance against many health disorders

TEXT BOOKS:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications,New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body,by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

REFERENCES:

1. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001

2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/

3. Simple lifestyle modifications to maintain health : https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better.

4. https://www.legit.ng/1163909-classes-food-examples-functions.html

5. https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926

6. https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html

7. **Food additives** https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives

8. **BMI** https://www.hsph.harvard.edu/nutritionsource/healthy-weight/ https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations

9. https://yogamedicine.com/guide-types-yoga-styles/

Ayurveda :https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living

10. **Siddha** : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp

11. **Preventive** herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

SEMESTER VII

22BT701	**PROTEIN ENGINEERING**	**L T P C**
		3 0 2 4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To identify the importance of protein biomolecules.
2. To realize the structure-function relationships in proteins

Course Content:

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 9

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, Xray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II PROTEIN ARCHITECTURE 9

Primary structure: peptide mapping, peptide sequencing - automated Edman method & massspec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turnbeta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.

UNIT III TERTIARY STRUCTURE 9

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Computer exercise on the above aspects

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects

UNIT V PROTEOMICS 9

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To analyze the various interactions in protein makeup.
2. To be familiar with different levels of protein structure.
3. To know the role of functional proteins in various field of study.
4. To practice the latest application of protein science in their research.
5. To explore expression of proteins in different diseases and disorders.

Text Book(s):

1. Branden C. and Tooze J., “Introduction to Protein Structured” 2nd Edition, Garland Publishing, 1999.
2. Creighton T.E. “Proteins” 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, “Proteomics: Protein Sequence to Function”. Viva Books, 2002.
4. Liebler, “Introduction to Proteomics” Humana Press, 2002.

Reference Books:

1. Voet D. and Voet G., “Biochemistry”. 3rd Edition. John Wiley and Sons, 2008
2. Haggerty, Lauren M.“Protein Structure: Protein Science and Engineering”. Nova Science Publications, 2011.
3. Williamson, Mike “How Proteins Work”. Garland Science, 2012.

List of Experiments:

1.	Conventional filtration	**3**
2.	Protein precipitation and recovery	**3**
3.	Aqueous two phase separation	**3**
4.	Ion exchange chromatography	**3**
5.	Gel filtration	**3**
6.	Membrane based filtration i.e. microfiltration and cross filtration in cross flow modules	**3**
7.	Theoretical determination of molecular mass, isoelectric point, phosphorylation and acetylation sites in proteins	**3**
8.	Multiple sequence alignment of orthologous proteins for phylogenetic analysis	**3**
9.	To simulate optical mapping by in silico digestion of phage DNA with hexamer cutter restriction enzyme	**3**
10.	To search interaction partners of proteins	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

22HS701	IPR, BIOSAFETY AND ETHICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn enzyme reactions and its characteristics along with the production and purification process
2. To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

Course Content:

UNIT I BIOETHICS 9

Professional conducts and responsibility, Professional Ethics, Disease prevention Vs right to privacy, genetic tests in diagnostics and therapy, patentability of DNA, Case Study.

UNIT II PATENTS AND DESIGNS 9

Patents and Utility models, Industrial designs, Patent search, Patent drafting, Patent Application, PCT, Indian IPR legislations, Case study.

UNIT III IPR FOR INDIGENOUS RESOURCES 9

Protection of Plant varieties and Farmer‟s rights, Geographical Indicators, Traditional Knowledge and Folklore.

UNIT IV TRADE RELATED IP SAFEGUARDS 9

Copy rights: Trade secrets, WTO, TRIPS, Trade Barriers.

UNIT V BIOPROSPECTING AND BIOSAFETY 9

Biodiversity, Bio-piracy, CBD, Cartagena protocol, Release of GMO into environment, safety assessment of biotechnology products, Case Study

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to gain

1. The knowledge on bioethics
2. The theoretical and practical aspects of patents and designs.
3. The knowledge on process of IPR for indigenous resources
4. Ideas on trade related IP safeguards
5. The knowledge about bioprospecting and biosafety

Text Book(s):

1. Krishna V, "“Bioethics and Biosafety In Biotechnology", 1st Edition, New Age International P Ltd, New Delhi, 2017.
2. Goel D and Parashar S, "IPR, Biosafety and Bioethics", 1st Edition, Pearson, New Delhi, 2013.

Reference Books:

1. Ma M ,"Fundamentals Of Patenting And Licensing For Scientists And Engineers", 1st Edition, World Scientific, New Jersey, 2015.
2. Gordon T T et al , "Patent Fundamentals for Scientists and Engineers 3rd Edition Canada", CRC Press, CANADA, 2012.

22BT702 **ENZYME ENGINEERING AND TECHNOLOGY**

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn enzyme reactions and its characteristics along with the production and purification process
2. To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes

Course Content:

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS 9

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES 9

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays

UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES 9

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions –aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger, Enzymes in organic synthesis – esters, amide, peptide , Modified and Artificial Enzymes , Catalytic antibodies

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to gain

1. The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
2. The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
3. The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
4. Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.
5. The knowledge on biotransformation of enzymes

Text Book(s):

1. Trevor Palmer, Enzymes IInd Horwood Publishing Ltd
2. Faber K , Biotransformation's in Organic Chemistry, IV edition , Springer

Reference Books:

1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.
3. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.

22BT703	GENOMICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide the students a broader knowledge on the structure and function of genomes, the technologies developed for genomics, functional genomics.

Course Content:

UNIT I GENOME STRUCTURE AND GENOME PROJECTS 10

Importance and strategies, Organization and structure of genomes. Genome Data Visualization (With emphasis on Human Genome) Ensembl, MapViewer. Genome databases of the following (To be explored by the students for presentation in seminars) E. coli, M. tuberculosis, Yeast, Plasmodium, C. elegans, Drosophila, Zebra fish, Human, Mouse, Arabidopsis thaliana and Rice.

UNIT II GENOME MARKERS AND MAPPING 10

Genetic maps and Physical maps STS, EST, RFLP, SNP, radiation hybrid mapping, Optical mapping. Chromosome walking, SNPs and genome wide association studies.

UNIT III GENOME SEQUENCING 8

Genome sequencing strategies. First, second and Next generation methods, Comparison of NGS methods.

UNIT IV FUNCTIONAL GENOMICS 8

Transcriptomics: Types of transcriptome studies: Microarray and RNA- seq methods, Yeast Two hybrid System, Gene Expression Analysis from Gene expression omnibus. Identification of Disease Genes & Drug Targets (in hecontext of Human Genetics and Genetics of Model organisms) OMIM Metabolic diseases and Pathogenic diseases

UNIT V EPIGENETICS AND METAGENOMICS 9

Methylation of DNA and genetics; histone modifications, HATs and HDACs in the context of gene expression regulation. ChIPchip and ChIPseq techniques. Overview of metagenomics principles, microbial and ecological aspects underlying metagenomic experiments, applications and limitations of metagenomics.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. The students would have gained a better understanding of the organization of genomes in multiple levels of taxa, and the methodologies and approaches used for the study of structural and functional genomics.
2. The students would have also acquired knowledge on various genome mapping and sequencing methods, genomic markers, and microarray technology
3. Knowledge about qualitative and quantitative DNA technology
4. Explore rDNA technology in drug production
5. Gain knowledge about epigenetics and metagenomics.

Text Book(s):

1. Primrose Sandy B., Twyman Richard. , "Principles of Gene Manipulation and Genomics.", 7th Edition, Wiley- Blackwell, 2006.
2. Brown, T.A , "Genomes", 3rd Edition, Garland Science publishers,2006

Reference Books:

1. Primrose Sandy B., Twyman Richard. ,"Principles of Genome Analysis and Genomics", 6th Edition, Wiley- Blackwell, 2003.

SEMESTER VIII

22BT801	**CLINICAL TRIALS AND HEALTH CARE POLICIES IN BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To highlight the epidemiologic methods, study design, protocol preparation
2. To gain knowledge in the basic bio-statistical techniques involved in clinical research.
3. To describe the principles involved in ethical, legal and regulatory issues in clinical trials.

Course content

UNIT I ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinicalresearch, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT II FUNDAMENTALS OF TRIAL DESIGN 9

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS 9

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT IV BASICS OF STATISTICAL ANALYSIS 9

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT V REPORTING OF TRIALS 9

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisalof report, meta-analysis.

TOTAL LECTURE PERIODS:45 periods

Expected Course Outcomes:

After completing the course, the students will be able to:

1. Learn the importance of different components of health
2. Gain confidence to lead a healthy life
3. Learn new techniques to prevent lifestyle health disorders
4. Understand the importance of diet and workouts in maintaining health and key concepts in the design of clinical trials.
5. Describe study designs used, identify key issues in data management for clinical trials and roles of regulatory affairs in clinical trials.

TEXT BOOKS:

1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & BusinessMedia, 2010
2. Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons,2007
3. Clinical Trials: A Practical Approach, Stuart J. Pocock, John Wiley & Sons, 17-Jul-2013

REFERENCES:

1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang andAmeet Bakhai. Remedica. 2006.
2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner. Pharmaceutical Press.
3. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016.

PROFESSIONAL ELECTIVE (PE)

PROFESSIONAL ELECTIVE I

		L	T	P	C
22PBT01	**AGRICULTURE AND FOOD BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To improve knowledge on principles of Agriculture and plant breeding

2. Understand the concept of agricultural microbiology and biotechnology

3. To know Food processing and packaging techniques

4. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

COURSE CONTENT:

UNIT I BASICS OF AGRICULTURE AND PLANT BREEDING 9

Factors effecting agriculture and agricultural classification of plants, Origin of cultivated plants and plant indication, Methods of breeding self pollinated and vegetatively propagated plants, Breeding of crops pollinated plants

UNIT II AGRICULTURE MICROBIOLOGY 9

Microbes of agricultural importance, Microbe based biofertilizers, Soil microbes and plant growth substances, biocontrol agents, Induced systemic resistance(ISR), Plant growth promoting rhizobacteria (PGPR)

UNIT III AGRICULTURE BIOTECHNOLOGY 9

Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Biotech industries & institutes in India & world, Concepts of Biotech park. Entrepreneurship biotechnology.

UNIT IV BIODIVERSITY AND INTELLECTUAL PROPERTY RIGHTS 9

Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots, IPR in relation to Indian Flora.

UNIT V FOOD BIOTECHNOLOGY 9

Food spoilage causes and prevention, Food borne infections and intoxication immobilization of microbial and cultured plant cells. Principles of down stream processing, industrial production of various food products

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Acquire knowledge on basics of Agriculture and Plant Breeding
2. Outline the principles Agriculture Microbiology
3. Understand the concept of Agriculture Biotechnology
4. Relate Biodiversity and intellectual property rights
5. Evaluate the advances in Food biotechnology
6. Relate Food processing and Packaging techniques.

TEXT BOOK(S):

1. Principles of Gene Manipulation and Genomics (2006) Sandy B. Primrose and Richard Twyman
2. Gene Cloning and DNA Analysis: An Introduction (2010) by T. A. Brown
3. Understanding biodiversity: Life, sustainability, and equity (1997) by Ashish Kothari
4. Plant Breeding: Principles and prospects (1993) by M.D. Hayward and N.O. Bosemark

REFERENCE BOOKS:

1. Soil Microbiology, Ecology and Biochemistry, Fourth Edition (2014) by Eldor A. Paul
2. Introduction to Soil Microbiology (1999) by Mark Coyne
3. Fundamentals of Food Biotechnology (2015) by Byong H. Lee
4. Food Biotechnology (2012) by Vinod K. Joshi and R. S. Singh
5. Principles of Aseptic Processing and Packaging (2010) by Philip E. Nelson
6. Food Microbiology (2008) by Frazier

22PBT02	BIOPOLYMER AND ITS APPLICATION	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. Application of biopolymers in the field of pharma and food industries.
2. Interaction of biopolymers and their structure – function relationship
3. Recent trends in biopolymers research

COURSE CONTENT:

UNIT I GLYCANS AND GLYCOBIOLOGY 9

Glycoconjugates – glycoproteins, glycolipids and lipopolysaccharides; Glycans and blood groups, Lectins and interaction with glycoconjugates; Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans.

UNIT II PROTEIN AND ENZYME TECHNOLOGY 9

Structure- function relationship in fibrous and globular proteins, industrially significant peptides; Protein Engineering Methods - Applications of proteins: Food industry, Environmental, Medical. Enzyme markers in disease diagnosis – hepatobiliary diseases, myocardial disorders, atherosclerosis, renal dysfunction. Oxidative stress and cancer; Enzyme based biosensors; Enzymes in food, and pharmaceutical industries. Enzyme immobilization techniques and its applications.

UNIT III HORMONES AND ANTIBODIES 9

Mechanism of actions of chemically diverse hormones, Hormone therapy, Applications of hormones in anti-ageing medicine. Antibody engineering, Abzymes

UNIT IV LIPID TECHNOLOGY AND APPLICATIONS 9

Industrial applications of fatty acids and lipids, role of lipids in pharmaceutical industry, Structured Lipids for Food and Nutraceutical Applications

UNIT V NUCLEIC ACID BIOPOLYMER 9

Applications of nucleic acid polymer in diagnosis and therapy - nucleic acid probes in clinical laboratory; Review on current status of gene therapy research.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Recall the basic structure, composition and functions of biopolymers.
2. Demonstrate the applications of biopolymers in medical, pharma, food and agro industries
3. Apply technologies such as protein engineering, glysosylation engineering, enzyme engineering, antibody engineering to study the biomolecules
4. Compare and contrast the structure functional relationship of different biomolecules
5. Appraise the applications of biomolecules as biomarkers in diagnosis of diseases and as biosensors
6. Compile, discuss and critically review the recent updates / progress in biopolymers research and their applications

TEXT BOOK(S):

1. Lehninger A. L, Nelson D. L. and CoxM. M. “Principles of Biochemistry” Seventh Edition (Freeman Publishers), New York, 2017.

REFERENCE BOOKS:

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E.,
2. “ Essentials of Glycobiology”, Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2015.
4. Donald Voet and Judith G. Voet . “Biochemistry” – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2010.
5. 4. BurcuTuranli-Yildiz, CerenAlkim and Z. PetekCakar (2012). Protein Engineering Methods and Applications, ISBN: 978-953-51-0037

22PBT03	MICROSCOPY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version V 0.1**

COURSE OBJECTIVE:

1. This course will cover the basic principles and techniques of optical and electron microscopy. This course also deals with the sample preparation techniques for the microstructural analysis.

UNIT I INTRODUCTION 9

History of Microscopy, Overview of current microscopy techniques. Light as particles and waves, Fundamental of optics: Diffraction and interference in image formation, real and virtual images, Resolution, Depth of field and focus, Magnification, Numerical aperture, Aberration of lenses. Components of Light Microscopy, Compound light microscopy and its variations.

UNIT II MICROSCOPY 9

Phase contrast microscopy: optical design, theory, image interpretation, Dark-field microscopy: optical design, theory, image interpretation, Polarization Microscopy: Polarized light, optical design, theory, image interpretation, Differential Interference Contrast (DIC): equipment and optics, image interpretation, Modulation contrast microscopy: contrast methods using oblique illumination.

UNIT III ELECTRON MICROSCOPY 9

Interaction of electrons with matter, elastic and inelastic scattering, secondary effects, Components of electron microscopy: Electron sources, pumps and holders, lenses, apertures, and resolution. Scanning Electron and Transmission Electron Microscopy: Principle, construction, applications and limitations.

UNIT IV SAMPLE PREPARATION FOR MICROSTRUCTURAL ANALYSIS 9

Optical Microscopy sample preparation: Grinding, polishing and etching, SEM sample preparation: size constrains, TEM sample preparation: Disk preparation, electro polishing, ion milling, lithography, storing specimens.

UNIT V CHEMICAL ANALYSIS 9

Surface chemical composition (Principle and applications) - Mass spectroscopy and X-ray emission spectroscopy - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy. Electron spectroscopy for chemical analysis (ESCA), Ultraviolet Photo Electron Spectroscopy (UPS), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES)- Applications.

TOTAL LECTURE PERIODS 45 PERIODS

EXPECTED COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Able to understand the physics behind the microscopy.

2. Ability to describe the principle, construction and working of light microscopy.
3. Ability to appreciate about electron microscopy.
4. Ability to understand about the important of sample preparation technique.
5. Ability to identify the appropriate spectroscopy technique for chemical analysis.

TEXT BOOKS

1. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, 2001, Wiley-Liss, Inc. USA
2. David B. Williams and C. Barry Carter, Transmission Electron Microscopy-A Textbook forMaterials Science, Springer US, 2nd edition, 2009.

REFERENCES:

1. Brandon D. G, “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA,1986.
2. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation“, Nineth Edition,ASM international, USA, 1986.
3. Thomas G., “Transmission electron microscopy of metals”, John Wiley, 1996.

22PBT04	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To develop skills of the students in the area of animal biotechnology
2. To learn the protocols involved in cell culture techniques
3. To understand the applications in Cell culture and Tissue engineering

COURSE CONTENT:

UNIT I INTRODUCTION TO CELL CULTURE 9

Layout of cell culture laboratory chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line.

UNIT II SCALING UP OF CELL CULTURES 9

Suspension cultures, Continuous flow cultures, Immobilized cultures, Cell culture as a source of various products – Vaccine Production

UNIT III TISSUE ENGINEERING 9

3D culturing, Different stages of tissue engineering, Protocols for 3D culturing of cells, Different types of cells in matrices for tissue engineering.

UNIT IV MICROMANIPULATION OF EMBRYOS 9

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, *In Vitro* fertilization and Embryo transfer technology.

UNIT V TRANSGENIC ANIMALS 9

Concepts of Transgenic Animal technology: Strategies for the production of Transgenic animals and their importance in Biotechnology, Stem cell cultures in the production of Transgenic animals, Ethical issues in Animal Biotechnology

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Acquire knowledge in primary cell culture techniques, maintenance of cell line
2. Understanding the use of scaling up of cell culture and the production of products from cell cultures
3. Gaining knowledge in the latest field of Tissue engineering and to culture cells in 3D methods and its applications
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications in this subject

TEXT BOOK(S):

1. R. *Ian Freshney*. *Introduction to Culture* of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.

2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

REFERENCE BOOKS:

1. Ramadass P, Meera Rani S. “Text Book of Animal Biotechnology”, Akshara Printers, 2000.
2. Ranga M.M. “Animal Biotechnology”, Agrobios India Limited, 2002
3. Methods in Biotechnology, Animal cell Biotechnology. Methods and Protocols. 2nd Ed., Edited by Rolf Portner. Humana Press. 2007.

22PBT05	BIOPROCESS MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. Principles and frameworks of data driven modeling
2. Mathematical models relevant to industrial and environmental bioprocess systems
3. Basics of MATLAB required for formalization of Bioprocess models and its simulation

COURSE CONTENT:

UNIT I INTRODUCTION TO BIOPROCESS MODELLING 9

Basic modeling principles – Purpose of modelling transient or steady state behavior – deterministic, stochastic, population based, mechanistic and empirical models. Fundamental laws guiding modelling framework – mass and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation.

UNIT II MATHEMATICAL FORMALIZATION OF BIOPROCESS 9

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Identifying key variables, parameters, number of equations, Kinetic expression, Conversion of algebraic to differential form for mass balance equations. Numerical modelling algorithm – initial value problem.

UNIT III MATLAB BASICS FOR MODELLING 9

Basics of Matlab environments, import from web, xls, txt file, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE solver, choice of numerical solvers ode45, ode15s, ode23. Curve fitting toolbox for kinetic models simulating a bioprocess with known process parameters

UNIT IV MATLAB APPLICATION IN BIOPROCESS MODELLING 9

Solving problems by numerical integration. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Incorporating substrate and product inhibition, multisubstrate growth models

UNIT V PARAMETER ESTIMATION AND SENSITIVITY ANALYSIS, MODEL FITNESS 9

Parameter estimation from experimental and modelled data, least square regression, Use of local and global optimization tool for parameter estimation (Genetic algorithm). Cross-validation test for overfitting, external validation, parameter Sensitivity and confidence interval estimation using boot-strapping

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Recognize the different stages and their inter-relationship in bioprocess modelling
2. Relate modelling, simulation and parameter estimation
3. Develop bioprocess system models from experimental data using Matlab tool
4. Examine the suitability of developed models in a quantitative manner
5. Interpret the bioprocess modelling outcome for refinement of model structure
6. Formulate simplification strategies and simulate bioprocess models with relevant examples

TEXT BOOK(S):

1. Verma, Ashok Kumar, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, (2014).
2. Dunn, Irving J. Biological reaction engineering: dynamic modelling fundamentals with simulation examples, Wiley-VCH, (2003).

REFERENCE BOOKS:

1. Nicoletti, Maria Carmo, Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control. Springer, (2009)
2. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. ,Dynamics of Environmental Bioprocesses: Modelling and Simulation, John Wiley & Sons, (2008)

PROFESSIONAL ELECTIVE II

22PBT06	**NANOBIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To know about biology inspired concepts, nanobiometrics, natural nano composites, nanoanalytics and molecular manufacturing
2. To study the properties of fundamental biological units used to create materials for applications in human health care
3. To understand how biology can be used to learn fundamental design principles

COURSE CONTENT:

UNIT I HISTORY AND CONCEPT OF NANOBIOTECHNOLOGY 9

Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nanobiotechnology. Various applications of Nano-biotechnology. Cell – Nanostructure interactions. Functional Principles of Nanobiotechnology- Information-Driven Nanoassembly- Energetic- Chemical Transformation- Regulation- Traffic Across MembranesBiomolecular Sensing- Self-Replication- Machine-Phase Nanobiotechnology

UNIT II NANOMATERIALS IN BIOTECHNOLOGY 9

Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP)- Biofunctionalsiation of SLP, Charatcterisation- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems-Nanotubes, Nanorods, Nanofibers, and Fullerenes for Nanoscale Drug Delivery, Carbon nanotubes biocompatibility and drug delivery. Nanoparticles, quantum dots, nanotubes and nanowires. Microbial Nanoparticle Production : Methods of microbial nano-particle production, Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications – overview, structure, photoelectric applications, photochromic applications and applications in energy conversion.

UNIT III DNA-PROTEIN NANOSTRUCTURES 9

Overview and introduction - Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology. Proteinbased Nanostructures, Nanobiomachines & Signalling - Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged Nano-particles, Cell as Nanobiomachine, link between the signaling pathways & molecular movements as well as neuron function, Concepts in nanobiomachines for information processing and communications

UNIT IV NANODEVICES AND TOOLS USED IN NANOTECHNOLOGY 9

Biosensors; different classes - molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes. Application of various transducing elements as part of nanobiosensors. Tools in Nanotechnology.

UNIT V BIOLOGICAL NANOPARTICLES 9

Production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Define basic terminology and describe concepts in Nanobiotechnology
2. Explain the principle of various applications in Nanobiotechnology.
3. Explain the properties of Nanomaterials in Biotechnology.
4. Understand Application of Nanodevices in Biological systems.
5. Explain the Application of Molecular recognition elements and transducing.
6. Discuss New trends in Nanobiotechnology and Defence.

TEXT BOOK(S):

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

REFERENCE BOOKS:

1. Tuan Vo-Dinh, Protein Nanotechnology Protocols, Instrumentation and Application, Series ; Methods in Molecular Biology (2005)

2. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology : Concepts, Applications and perspectives, Wiley VCH Weinheim (2004)
3. David. S. Goodsell, Bionanotechnology: concepts, lessons from nature, Wiley-Liss (2004)
4. 4. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).

22PBT07	VACCINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To impart knowledge on the role vaccination in improving the immune system.
2. To gain an understanding of recent developments in vaccine technology.
3. To make aware about the commercialization and regulatory guidelines in vaccine production

COURSE CONTENT:

UNIT I BASICS OF IMMUNE SYSTEM 9

Overview of the immune system and basic aspects of immune response(s) to vaccines. Active and passive immunity. Humoral and cell mediated immunity. Antibody production mechanism and factors affecting it. Cytokines, Primary and secondary immune response. Monoclonal and polyclonal antibodies. Superantigens, Induction of cell mediated immunity.

UNIT II INTRODUCTION TO VACCINATION 9

Vaccination: Introduction, history and principles of vaccine development. Conventional and modern strategies for vaccine improvement. Immunization strategies: Active and Passive. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus, Hepatitis, Human papillomavirus.

UNIT III CLASSIFICATION OF VACCINES AND ITS PRODUCTION 9

Types of vaccines: Live, attenuated, subunit, killed vaccines, Recombinant peptide vaccines, recombinant live vector vaccines, conjugate vaccines, toxoid vaccines, Naked DNA vaccines, cell-based vaccines, edible vaccines. Reverse vaccinology. Adjuvants: history, classification, mechanisms. Factors affecting adjuvants selection and production.

UNIT IV DELIVERY OF VACCINES 9

Controlled delivery system for vaccines: emulsions, microparticles, immune-stimulating complexes (ISCOMs, liposomes), Virosomes. Application of Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle-based vaccine. Role of polymeric nanoparticles in vaccine delivery. Transdermal vaccine delivery system.

UNIT V VACCINE DESIGN AND DEVELOPMENT 9

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Dendritic cells; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors, CpG adjuvant activity, Transcutaneous immunization.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Describe the role of immune cells and their mechanism and concept of vaccination.
2. Categorize the different types of vaccines available for diseases.
3. Understand the modern strategies and routes of immunization.
4. Apply the concept of vaccine technology for development of vaccines.
5. Evaluate various delivery methods suitable for vaccines.
6. Relate the quality control and regulatory guidelines involved in vaccine production.

TEXT BOOK(S):

1. Emily P. Wen Ronald Ellis Narahari S. Pujar, Vaccine Development and Manufacturing. Wiley online, 2014
2. Jose Ronnie Vasconcelos, Vaccines & Vaccine Technologies. OMICS International, 2015
3. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

REFERENCE BOOKS:

1. Myrone M. Levine , Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, RinoRappuoli., New Generation Vaccines. Fourth Edition, 2016
2. Stanley Plotkin Walter Orenstein Paul Offit, Vaccines, 6th Edition, 2012

22PBT08	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. The course objectives are imparting the basic knowledge of students about stem cell,culturing and its clinical applications.

COURSE CONTENT:

UNIT I STEM CELLS AND TYPES **9**

Stem cells: Definition, Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II STEM CELLS IN PLANTS AND ANIMALS **9**

Stem cell and founder zones in plants –particulary their roots – stem cells of shoot meristems of higher plants. Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –tumour stem cells.

UNIT III STEM CELLS DIFFERENTIATION **9**

Factors influencing proliferation, physical, chemical and molecular methods for differentiation of stem cells – hormonal role in differentiation.

UNIT IV REGENERATION AND EXPERIMENTAL METHODS **9**

Germ cells, hematopoietic organs, and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, - Stem cell Techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging

UNIT V APPLICATION AND ETHICAL ISSUES **9**

Stem cell Therapy for neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns, skin ulcers, muscular dystrophy and orthopaedic applications. Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Recognize the different stages and their inter-relationship in bioprocess modelling
2. Relate modelling, simulation and parameter estimation
3. Develop bioprocess system models from experimental data using Matlab tool
4. Examine the suitability of developed models in a quantitative manner
5. Interpret the bioprocess modelling outcome for refinement of model structure
6. Formulate simplification strategies and simulate bioprocess models with relevant examples

TEXT BOOK(S):

1. Stem cells by C.S Potten., Elsevier, 2006.
2. Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.

REFERENCE BOOKS:

1. Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
2. Embryonic Stem cells – Protocols by KursadTurksen., Second Edition Humana Press, 2002.
3. Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific PublishingCompany, 2005.
4. Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013)

22PBT09	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1.To learn the fundamentals of tissue engineering and tissue repairing
2.To acquire knowledge on clinical applications of tissue engineering
3.To understand the basic concept behind tissue engineering focusing on the stem cells,biomaterials and its applications

COURSE CONTENT:

UNIT I INTRODUCTION 9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements andphysical properties.

UNIT II TISSUE ARCHITECTURE 9

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS 9

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

UNIT V CLINICAL APPLICATIONS **9**

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedicapplications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products, ethical issues.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1.Ability to understand the components of the tissue architecture

2.Opportunity to get familiarized with the stem cell characteristics and their relevance inmedicine

3.Awareness about the properties and broad applications of biomaterials

4.Overall exposure to the role of tissue engineering and stem cell therapy inOrganogenesis

5. Ability to understand patent protection

TEXT BOOK(S):

1.Bernhard O.Palsson, Sangeeta N.Bhatia, ”Tissue Engineering” Pearson Publishers 2009.

2.Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of TissueEngineering and Regenerative Medicine.2009.

REFERENCE BOOKS:

1. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008.

2. Raphael Gorodetsky, Richard Schäfer..Stem cell-based tissue repair. RSC Publishing, 2011.

3. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two- Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells,Academic Press, 2004.

4. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, Elsevier Academicpress,2006.

5. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine” Artech House, INC Publications, 2008.

6. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press,2007.

22PBT10	COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To understand the fundamental concepts, tools and resources in Computational Biology.
2. To improve knowledge on machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To facilitate the specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

COURSE CONTENT:

UNIT I BIOMOLECULAR COMPUTING 9

DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular ComputingAdelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models,Application of RNA fold.

UNIT II MOLECULAR MECHANICS 9

Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions. Types of Potentials: Lennard-Jones, Truncated Lennard-jones. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

UNIT III MOLECULAR DYNAMICS SIMULATION 9

Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations.

UNIT IV NEXT GENERATION SEQUENCING 9

NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied Biosystems SOLiD system, HelicosHeliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing. Biological applications of NGS: Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing

UNIT V DATA MINING AND DATA WAREHOUSING 9

Need for data warehouse, definition, goals of data warehouse, Data Mart, Data warehouse architecture, extract and load process, clean and transform data, Designing fact tables, partitioning, Data warehouse and OLAP technology. Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the principles of, biological data and interpretation.
2. Demonstrate high throughput biological data and perform statistical analysis.
3. Make use of advanced data mining and machine learning techniques
4. Create skills on molecular modeling and simulation, whole cell modeling, drug discovery, and Systems Biology
5. Clarify the implementation of algorithms which may help them design their own.
6. Explain the theory and practical aspects of important computational experimental techniques.

TEXT BOOK(S):

1. Neil C. Jones, Pavel Pevzner. An introduction to bioinformatics algorithms MIT Press ,(2011)
2. Alan Hinchliffe, Molecular Modelling for Beginners, (2nd Edition) John Wiley & Sons Ltd. (2008)
3. Stuart M. Brown, Next-generation DNA sequencing Informatics, Cold Spring Harbor Laboratory, (2013).

REFERENCE BOOKS:

1. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall. (2001)
2. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc (2015)
3. Kriete A. Kriete, R.Eils,, R.Eils, Computational systems biology, Academic Press. (2005)
4. Pengcheng Fu, Systems Biology and Synthetic Biology Sven Panke, Wiley InterScience. (2009)
5. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; (2009)

PROFESSIONAL ELECTIVE III

22PBT11	**Molecular forensics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
2. To ensure students in having foundation Forensics and molecular techniques in forensics.
3. A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

COURSE CONTENT:

UNIT I INTRODUCTION TO FORENSIC SCIENCE **9**

Introduction to Crime Laboratories, Responsibilities of the Forensic Scientist, Securing and Searching the Crime Scene, Recording and Collection of Crime Scene Evidence,Document Examination, Ethics and Integrity

UNIT II DISCOVERY AND RECOVERY OF HUMAN REMAINS **9**

The Autopsy and Handling of a Dead Body, The Stages and Factors of Decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

UNIT III MOLECULAR DYNAMICS SIMULATION **9**

Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis , Forensic anthropology, Paleontology, Toxicology

UNIT IV FINGER PRINTING **9**

Mitochondrial, DNA, DNA Finger Printing- RFLP. STR Genotyping issues, VNTRS and STR, mt DNA analysis, Identification of suspects.

UNIT V RAPD IN FORENSICS **9**

RAPD in Forensics, Study of Kinnship by DNA Profilig.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. The student will understand the history and current state of forensic biological testing and the role of a forensic biologist in a forensic investigation
2. The student will learn the proper methods for the handling of biological evidence.
3. The students understand the application of molecular based techniques in forensics science.
4. The students learn the methods used to identify suspects and parental disputes.
5. The students will gain knowledge in paleo biology and anthropology and its importance in Forensics

TEXT BOOK(S):

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.

REFERENCE BOOKS:

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.

22PBT12	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

COURSE CONTENT:

UNIT I HISTORY OF DIAGNOSTICS **9**

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, Clinical Sample collection- method of collection, transport and processing of samples and Interpretation.

UNIT II TRADITIONAL DIAGNOSTIC METHODS **9**

Diagnosis of infection caused by Bacteria: *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium.,* Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Helminthic diseases- *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis.

UNIT III MAJOR METABOLIC DISORDERS **9**

Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders – Identifying human disease genes. Cancer- different types of cancers, genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex – linked inherited disorders.

UNIT IV MOLECULAR DIAGNOSIS **9**

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

UNIT V HYBRIDIZATION AND SEQUENCING 9

Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot. Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing, · Microarrays- Personalised Medicine- Pharmacogenomics (ADMET)

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Define basic terminology and describe concepts in molecular diagnostics that provide the foundation for implementing and adapting new techniques and assays.
2. Explain the principle of traditional diagnosis methods.
3. Explain the major metabolic disorders.
4. Apply molecular diagnostic techniques in the diagnosis of microbiological, hematological, thrombotic, and genetic disorders.
5. Explain and perform electrophoresis and hybridization methods, including Southern and Northern blots
6. Discuss ethical considerations and New trends in Diagnostics

TEXT BOOK(S):

1. Bailey & Scott’s Diagnostic Microbiology (2012), Betty A. Forbes , Daniel F. Sahm, Alice S.
2. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
3. Jawetz, Melnick, & Adelberg’s Medical Microbiology (2012), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

REFERENCE BOOKS:

1. Fundamentals of Molecular Diagnostics (2010). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
2. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws)

22PBT13	DRUG DESIGN AND DISCOVERY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

COURSE CONTENT:

UNIT I DRUG AND THEIR INTERACTION 9

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; How drugs work -Drug targets, drug-target interaction and dose-response Relationships.

UNIT II DRUG DESIGN PIPELINE 9

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

UNIT III FUNDAMENTAL OF DRUG ACTIONS 9

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology : Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

UNIT IV DRUG TOXICITY, ASSAYS AND TESTING 9

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

UNIT V DRUG REGULATORY AGENCIES 9

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application &New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Will be able to describe the process of drug discovery and development
2. Will be able to discuss the challenges faced in each step of the drug discovery process
3. Will be able to gaine a basic knowledge of computational methods used in drug discovery
4. Will be able to organise information into a clear report be able to demonstrate their ability to work in teams and communicate scientific information effectively
5. Will be familiar with the Construct, review and evaluate preclinical and clinical pharmaceutical studies with a general understanding of aim, choice of procedures, results, conclusions and importance.

TEXT BOOK(S):

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)

2. Essentials of Medical Pharmacology, 6the Edition (Hardcover)

by Tripathi Kd. Publisher: Jaypee Brothers (2008)

3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and

development.6th Edition. Ed Donald J AbrahamWiley-Interscience..

REFERENCE BOOKS:

1.Stromgaard, Kristian, Povl Krogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, 2009.

2. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical*

Pharmacology (LANGE Basic Science). McGraw-Hill Education, 2012.

3. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, 1994.

22PBT14	SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:Manage the solid waste effectively to maintain the hygienic conditions.

COURSE CONTENT:

UNIT I FUNDAMENTAL S OF SOLID WASTE MANAGEMENT 9

Topics:Definition of solid waste Meaning of different solid waste -Domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional wasteSources of solid waste, Classification of solid waste -hazardous and non- hazardous waste.Physical and chemical characteristics of municipal solid waste.Impact of solid waste on environment.Solid waste management techniques – solid waste management hierarchy, waste prevention and waste reduction techniques.Factors affecting the solid waste generation

UNIT II STORAGE, COLLECTION AND TRANSPORTATI ON OF MUNICIPAL SOLID WASTE 9

Topics:Storage of solid waste Collection methods of solid wasteTools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical road sweepers, Community bin – like movable and stationary bin Transportation of municipal waste.Transportation vehicles with their capacity Working -Animal carts, Auto .vehicles; Tractors or Trailers, Trucks, Dumpers, Compactor vehicles. Transfer station meaning, necessity, location Role of rag pickers and their utility for society Organization pattern of solid waste management system, practices according to Population of the town or city.

UNIT III DISPOSAL OF MUNICIPAL SOLID WASTE 9

Concept of composting of waste Principles of composting process Factors affecting the composting processting Methods of composting-A) Manual Composting - Bangalore method, Indore of hod of Fite.Method B) Moshanical Composting - Dand ProcessC) Vermicomposting. 3.3 Land filling technique, Factors tobe considered for site selection. Land filling methods-Area method Trench method and Ramp method. Leachate and its control, Biogas from landfill indignation the Advantages and disadvantages of given landfill method Recycling of municipal solid waste Incineration of waste: Introduction of incineration process.Types of incinerators - Flash, Multiple chamber Incinerators,Products of incineration process with their use, Pyrolysis of waste - Methods Definition

UNIT IV BIOMEDICAL WASTE MANAGEMENT AND HEALTH ASPECTS AND PUBLIC INVOLVEMENT IN SOLID WASTE MANAGEMENT **9**

Biomedical Waste Management,Definition of Bio medical Waste.,Sources and generation of Biomedical Was ,Classification of Biomedical Waste.,Management technologies.Health aspects and public Involvement in solid waste management,Health aspects during handling and processing,Health problems during time of segregation, recovery, recycling and reuse of solid waste.,Public involvement and participation in solid waste management practices.

UNIT V INDUSTRIAL WASTE MANAGEMENT AND E-WASTE WASTE MANAGEMENT **9**

Topics:Industrial waste Management:,Variety of industrial waste,Collection and disposal of industrial waste,Control measures for industrial waste,Recycling of industrial waste.E-waste Management,Definition of E- waste, Varieties of E- wastes, Dangers of E- waste,Recycling of E- waste.Disposal of E- waste.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Identify the different sources of solid wastes.
2. Execute the relevant method of collection and transportation of solid wastes.
3. Execute an action plan for disposal of solid wastes.
4. Implement the relevant method for disposal of Bio-medical wastes.
5. Implement the relevant method for disposal of Industrial wastes and E-waste.
6. Implement the relevant laws related to solid waste management.

TEXT BOOK(S):

1. Dubey, R.C. “Text Book of Biotechnology”, S. Chand & Co, 2nd edition, 2004.

2. Chatterjee, Introduction to Environmental Biotechnology, PHI Learning pvt ltd,3rd Edition 2011

3. Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK

International Publishing House pvt Ltd, 2011

REFERENCE BOOKS:

1. Foster C.F; Johnware D.A, “Environmental Biotechnlogy”, Ellis Harwood Ltd.3rd edition, 1987

2. Gupta P.K. “Elements of Biotechnology”, Rastogi Publications, 2004.

22PBT15	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

1. Genomics, and proteomics using model organisms representing plants and animals.
2. The course will cover recent developments in genetics, epigenetics, small RNAs, proteomics, gene expression, mutagenesis and mapping genes.
3. Develop skills in experimental design within the context of learning about biology including:signal transduction, regulation of transcription and translation, cancer, aging, drought stress and metabolic pathways

COURSE CONTENT:

UNIT I INTRODUCTION TO GENOMICS 9

Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

UNIT II DNA SEQUENCE AND MAPPING 9

Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

UNIT III FUNCTIONAL GENOMICS AND ITS APPLICATIONS 9

Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, Identifying the function of new gene, Gene Ontology

UNIT IV INTRODUCTION TO PROTEOMICS 9

Proteomics- Introduction, The proteome, Genomics Vs. Proteomics, Proteomics and the New biology

UNIT V ANALYTICAL PROTEOMICS 9

2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis(MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Genomics and Proteomics deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and databases that store various data about genes, proteins, genomes and proteomes.
2. Students would learn about genomics, proteomics and bioinformatics 3. Students would gain skills in applied bioinformatics, comparative, evolutionary, human genomics and functional genomics.
3. Students shall have basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications.
4. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
5. Perform database search and analyze genomes, proteins
6. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories

TEXT BOOK(S):

1. Brown T.A., "Genomes ", BIOS Scientific Publishers Ltd, Oxford, 2nd Edition, 2002
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for New Biology", Humana Press, Totowa, New Jersey, 2002).

REFERENCE BOOKS:

1.HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics.* USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4.

22PBT16 **METABOLIC ENGINEERING**

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.
2. To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

UNIT I INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT 9

Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties, Xenobiotic Degradation.

UNIT II MATERIAL BALANCES AND DATA CONSISTENCY 9

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors. Introduction to MATLAB

UNIT III METABOLIC FLUX ANALYSIS 9

Theory, over determined systems, under determined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

UNIT IV METABOLIC CONTROL ANALYSIS 9

Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations

UNIT V ANALYSIS OF METABOLIC NETWORKS 9

Control of flux distribution at a single branch point, grouping of reactions, case studies, extension of control analysis to inter metabolite, optimization of flux amplifications, consistency tests and experimental validation.

TOTAL LECTURE PERIODS 45 PERIODS

EXPECTED COURSE OUTCOMES

After completion of metabolic engineering, students will be able

1. To learn stoichiometry and energetics of metabolism.
2. To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
3. To understand metabolic flux analysis.
4. To integrate modern biology with engineering principles.
5. To design a system, component, or process to meet desired needs.

TEXT BOOKS:

1. Gregory N. Stephanopoulos ,Aristos A. Aristidou, Jens Nielsen, Metabolic Engineering: Principles and Methodologies ,Academic Press 1998.
2. Sang Yup Lee E. Terry Papoutsakis Marcel Dekker, Metabolic Engineering.inc 1998
3. Nielsen J and Villadsen J. (1994) Bioreaction Engineering Principles. New york: Plenum

REFERENCES:

1. Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists by Eberhard O. Voit Cambridge University Press 2000
2. Applications of Plant Metabolic Engineering. R. Verpoorte, A. W. Alfermann and T. S. Johnson (eds). Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. 2007.
3. Systems Modeling in Cellular Biology: From Concepts to Nuts and Bolts Edited by Zoltan Szallasi, JorgStelling and VipulPeriwal MIT Press Cambridge 2006.

22PBT17	STRUCTURAL BIOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students

1. To gain structural knowledge on proteins.
2. To understand energetics and kinetics of proteins.

UNIT I PROTEIN STRUCTURE 9

Conformational Properties of Amino Acids, Implications for Protein Structures, Hierarchies of Structure, Structural Characteristics of Globular Proteins.

UNIT II PROTEIN THERMODYNAMICS AND ENERGETICS 9

Driving forces in protein folding - Estimation of solvation free energies: Group contribution methods - Experiments on folding thermodynamics - Two-state and multiple state transitions.

UNIT III PROTEIN KINETICS 9

Mechanism of folding - Kinetic Intermediates - Classical kinetic modelling of protein folding/unfolding - Transition states - Effects of mutations.

UNIT IV CONFORMATIONAL DYNAMICS AND RELATIONSHIP TO FUNCTION 9

Fluctuation-dissipation theorem - Dynamics of polymeric chains - Dynamics of folded proteins: Gaussian network model - Contribution of nonlinear effects to equilibrium dynamics.

UNIT V COMPUTATIONAL STRUCTURAL BIOLOGY 9

Protein Models: Force fields and their derivation - The rugged energy surface: the difficulty to fold a protein - Methods for Conformational search – energy and free energy as criteria of stability.

TOTAL LECTURE PERIODS 45 PERIODS

EXPECTED COURSE OUTCOMES:

Upon completion of this course, students will

1. Be familiar with various mechanisms and driving forces in protein folding.
2. Understand the dynamics relationship to protein function.
3. Identify the computational approach in structural biology.
4. Understand Protein kinetics
5. Identify dynamic and functional relationship

TEXT BOOKS:

1. Liljas L, Nissen P, Lindblom G, Textbook of Structural Biology, Volume 8 of Series in structural biology, World Scientific, 2016.

2. Schwede T, Computational Structural Biology: Methods and Applications, World Scientific, 2008.

REFERENCES:

1. Liljas A, Textbook of Structural Biology, World Scientific, 2009.
2. Petsko G, Ringe D, Protein structure and Function, Oxford University Press, 2009.
3. K.P.Murphy. Protein structure, stability and folding (2001) Humana press. ISBN 0-89603682-02011.
4. Arthur M.Lesk Introduction to protein architecture (2001) Oxford University Press. ISBN -0198504748
5. A.McPherson, Introduction to Macro molecular Crystallography. 2nd edition (2009)., John Wiley Co.
6. Carl Branden and John Tooze and Carl Brandon Introduction to Protein Structure, (1999)

22PBT18 **PROTEOMICS**

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus**

Version V 0.1

COURSE OBJECTIVES:

1. To provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.
2. To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

UNIT I INTRODUCTION **9**

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. It needs Virtual labs and E-learning proteomics tools for the above said syllabus.

UNITII STRUCTURE-FUNCTION RELATIONSHIP **9**

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics.

UNIT III TECHNIQUES IN PROTEOMICS **9**

In-vitro and in vivo-labeling of proteins, One and two-dimensional gel electrophoresis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Mass spectrometry principles of MALDI-TOF, Peptide mass fingerprinting.

UNIT IV PROTEIN PROFILING **9**

Large-scale protein profiling using proteomics, Post-translational modifications, Phosphoprotein and glycoprotein analyses; Analysis of protein-protein interactions, Protein microarrays.

UNIT V PROTEOMICS **9**

Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture and Enzymes: Serine proteases.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES

1. The students would have gained a better understanding of the organization of genomes in multiple levels of taxa, and the methodologies and approaches used for the study of structural and functional genomics.
2. The students would have also acquired knowledge on various genome mapping and sequencing methods, genomic markers, microarray technology and methods for proteomics.
3. The students would have gained a better understanding on proteomics.
4. The students would have gained knowledge on Zn fingers, helix-turn helix motifs in homeodomain etc.
5. The students would have gained a better understanding on Trans-membrane segments, prediction, bacteriorhodopsin etc.

TEXT BOOKS:

1. Suhai, Sandor "Genomics and Proteomics: Functional and Computational Aspects". Springer, 2000
2. Pennington, S.R. and M.J. Dunn "Proteomics: From Protein Sequence to Function". VivaBooks Pvt. Ltd., 2002.
3. O'Connor, C.D. and B.D.Hames. " Proteomics". Scion Publishing, 2008.
4. Primrose, S.B. and Twyman. "Principles of Genome Analysis and Genomics". 7th Edition, Blackwell Publishing, 2006

REFERENCES:

1. Cantor, Charles R. and Cassandra L. Smith. "Genomics: The Science and Technology
   Behind the Human Genome Project". John Wiley & Sons, 1999.
2. Liebler, R.C. "Introduction to Proteomics". Humana Press, 2002.
3. Hunt, Stephen P. and Frederick J. Livesey. "Functional Genomics". Oxford University Press,2000.

22PBT19	BIOFUEL	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version**

V 0.1

COURSE OBJECTIVES

1. To make students understand the development of technologies in bio refineries.
2. To impart knowledge to the students about the importance of biodiesel, bioethanol.
3. To make them understand about the production of biomethane, biohydrogen and other biofuels.

COURSE CONTENT

UNIT I OVERVIEW OF BIOFUELS **9**

Generation of biofuels − Development of biological conversion technologies − Integration of
biofuels into bio refineries − Energy security and supply − Environmental sustainability of biofuels − Economic sustainability of biofuels.

UNIT II BIODIESEL **9**

Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feed stocks prior to production of the Biodiesel − Current technologies of biodiesel production − Purification of biodiesel; Industrial production of biodiesel − Biodiesel production from single cell oil.

UNIT III BIOETHANOL **9**

Bioethanol – Properties – Feed stocks − Process technology − Pilot plant for ethanol production from lignocellulosic feed stock − Environmental aspects of ethanol as a biofuel.

UNIT IV BIOMETHANE AND BIOHYDROGEN **9**

Bio methanol − Principles, materials and feed stocks − Process technologies and techniques − Advantages and limitations − Biological hydrogen production methods − Fermentation hydrogen production − Hydrogen economy − Advantages and limitations.

UNIT V OTHER BIOFUELS 9

Biobutanol production − Principles, materials and feed stocks − Process technologies – Biopropanol – Bio glycerol − Production of bio-oils via catalytic pyrolysis − Life-Cycle environmental impacts of biofuels and Co-products.

TOTAL LECTURE PERIODS 45 PERIODS

TEXT BOOKS:

1. Luque, R., Campelo, J.and Clark, J. Handbook of biofuels production, Woodhead Publishing Limited 2011
2. Gupta, V, K. and Tuohy, M, G. Biofuel Technologies, Springer, 2013
3. Moheimani, N. R., Boer, M, P, M, K, Parisa A. and Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015 .

REFERENCES:

1. Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016
2. Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, InTech,.

22PBT20 **FUNDAMENTALS OF NANOSCIENCE**

	L	T	P	C
	3	0	0	3

Pre-requisite Nil **Syllabus**

Version V 0.1

COURSE OBJECTIVE:

1. To learn about basis of nanomaterial science, preparation method, types and application

COURSE CONTENT:

UNIT I INTRODUCTION **9**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-99 ultra-thin films-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION **9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonically, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS **9**

Nanoforms of Carbon - Buck minster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis (arcgrowth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applicationsNanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclaysfictionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniquesAFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS 9

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

1. Will familiarize about the science of nanomaterials
2. Will demonstrate the preparation of nanomaterials
3. Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Propertiesand Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.

2. N John Dinardo, “Nanoscale Charecterisation of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1. G Timp, “Nanotechnology”, AIP press/Springer, 1999.

2. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.

22PBT21	ENVIRONMENTAL BIOTECHNOLOGY		L T P C
			3 0 0 3
Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To acquire the knowledge of environmental problems and develop technologies.
2. To develop skills in bioreactors and bio treatment methods of industrial wastewater.
3. To find solution to create green and clean environment.

COURSE CONTENT

UNIT I WATER QUALITY AND WATER TREATMENT 9

Environmental monitoring – sampling, physical,chemical and biological analysis, Water purification processes in natural and engineered systems – coagulation, flocculation, UV radiation, electrodialysis, Reverse osmosis and capacitance deionizer (CDi). Treatment of groundwater for hardness removal by chemical means and ion exchange. Removal of toxicants from contaminated groundwater by adsorption techniques.

UNIT II WASTEWATER TREATMENT 9

Characteristics of wastewater, Primary treatment by sedimentation, Secondary treatment by suspended growth reactors - Activated sludge process, Aerobic – digestion, Anaerobic processes and Lagoons. Attached growth reactors - Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor and Sequential batch reactor. Tertiary treatment: Removal of nitrogen and phosphorus. Polishing operations: Sand filtration, adsorption by activated carbon and chlorination. Treatment of wastewater from dye, food and pharmaceutical industries.

UNIT III: AIR POLLUTION AND CONTROL TECHNOLOGY 9

Air Quality: Definitions, Characteristics and Perspectives; Classification of pollutants, Effects of air pollution, Control devices for particulate and gaseous contaminants: Settling chambers, Cyclone separator, Venturi scrubber, Biofiltration, Fabric filters, Electrostatic precipitators, absorption, adsorption, condensation and flaring; Legal and administrative systems for air pollution control.

UNIT IV: SOLID WASTE TREATMENT AND MANAGEMENT 9

Types, sources and properties of solid waste, Collection of solid wastes, Transfer and transport, solid waste treatment methods: incineration, composting, land filling ,conversion of solid waste into useful products: Land farming, prepared beds, soil piles, bioventing and biosparging, Reuse, Recycle and Recovering (3Rs), Legal and administrative systems for waste control.

UNIT V: HAZARDOUS WASTE TREATMENT AND MANAGEMENT 9

Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification.

TOTAL LECTURE PERIODS 45Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Learn an awareness of professional responsibility towards protecting the environment.
2. Acquaint oneself with the pertinent legislation and methodology.
3. Study environmental issues involved engineering and resources projects.
4. Acquire the natural and engineered biotreatment methods to remediate the pollutants
5. Investigate the opportunities for incorporating environmental quality into products, processes and projects.

TEXT BOOKS

1. Jogdand, S.N. Environmental Biotechnology (2012) Himalaya Publishing House, New Delhi.
2. Prescott, Harley and Klein, “Microbiology”, 5th edition, McGraw Hill, 2014

REFERENCE BOOKS

1. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, Advances in Applied Biotechnology series, Vol. Gulf Publications Co. London, 2009.
2. Graty. C.P.L., Daigger, G and Lim, H.C, Biological Wastewater Treatment. 3rd Edition, Marcel Dekker, 2008 3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. (2010). Environmental Management and Business Strategy John Wiley & Sons.

22PBT22	INDUSTRIAL MICROBIOLGY	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVE:

1. To acquire the knowledge of microbiology and industry technologies

COURSE CONTENT:

Unit I Introduction To Microbiology 9

History (scientists and discoveries), classification and nomenclature of microorganisms, microscopic examination of microorganisms: light, fluorescent, dark field, phase contrast, and electron microscopy.

Unit II Stains and staining techniques 9

Definition of auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining. Extra chromosomal genetic material: plasmids, cosmids, transposons, silent genes, exons and introns.

Unit III Control of Microorganisms 9

Sterilization, Physical control of microorganisms dry and moist heat, pasteurization, tyndalization; radiation, ultra sonication, filtration. and chemical control of microorganisms (phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes, sterilizing gases) Disinfection, antiseptics and fumigation. Determination of phenol coefficient of disinfectant. Hostmicrobe interactions (types of interaction, gnotobiots, host defense and pathogen defense); antibacterial (class I, II, III), anti-fungal and anti-viral agents; mode of action and resistance to antibiotics.

Unit IV Aerobiology 9

Droplet nuclei, aerosol, assessment of air quality, airborne diseases and their control, enumeration of microbes from air.

Unit V Industrial Microbiology and Microbial Ecology 9

Microbes involved in preservation (Lactobacillus,bacteriocins), spoilage of food and food borne pathogens (E.coli, Clostridium). Primary and secondary metabolites, Industrial use of microbes (production of penicillin, vitamin B-12); bioremediation (oil spillage); biofertilizers, biopesticides.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Learn about classification and nomenclature of microorganisms.
2. Practice the staining techniques
3. Study about the control of microorganisms.
4. Learn about aerobiology.
5. Know the value of microbes in industries.

TEXT BOOKS:

1. Pelczar, M.J. Microbiology, 5th Edition, Tata McGraw-Hill, 2001.
2. Prescott. Harley, Klein. Microbiology: Authored by Wiley, Sherwood, Woolverton, Prescot 10th edition (2017) McGraw-Hill Higher Education,
3. Ananthanarayanan, R.and Jayaram PanikerC.K., Textbook of Microbiology,10th Edition, 2017 Orient Longman
4. Jeremy. W. Dale Understanding Microbes: An Introduction to a Small World. February 2013 Wiley-Blackwell

REFERENCES:

1. Casida, L.E. Industrial Microbiology, New Age International, 1968.
2. Schlegel, H.G. General Microbiology, 7th Edition, Cambridge University Press, 1993.
3. Tortora J, Funke R, Case L, Microbiology An Introduction 3rdEdition; Benjamin/Cummings publishing, 1989.

22PBT23	MARINE BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES

1. To acquire the knowledge of marine environment and organisms.
2. To develop skills in marine pharmocology
3. To learn about aquaculture technology

COURSE CONTENT:

UNIT I INTRODUCTION TO MARINE ENVIRONMENT 9

World oceans and seas, ocean currents, physical and chemical properties of sea water, abiotic and biotic factors of the sea, ecological divisions of the sea, history of marine biology, bio-eco chemical cycles, food chain and food web.

UNIT II IMPORTANT MARINE ORGANISMS 9

Phytoplanktons, zooplantons, nektons, benthos, marine mammals, marine algae, mangroves, coral reefs, deep sea animals and adaptation, intertidal zone, fauna and flora.

UNIT III MARINE ENVIRONMENTAL BIOTECHNOLOGY 9

Marine pollution, biology indicators (marine micro, algae), biodegradation and bioremediation, marine fouling and corrosion.

UNIT IV MARINE PHARMACOLOGY 9

Medicinal compound from marine flora and fauna, marine toxins , antiviral and antimicrobial agents.

UNIT V AQUACULTURE TECHNOLOGY 9

Important of coastal aquaculture, marine fishery resources, common fishing crafts and gears, aqua farm design and construction.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES

On completion of the course, the student is expected to

1. Learn about marine environment.
2. Know the importance of marine organisms.
3. Study about the techniques of marine environmental biotechnology.
4. Learn about the pharmacology of marine flora and fauna.
5. Understand the aquaculture technology.

TEXT BOOKS:

1. Recent advances in marine biotechnology volume 3 – M.Fingerman , R . Nagabhushanam Mary – Frances Thomson.
2. Recent advances marine biotechnology volume 2 – M.Fingerman , R .Nagabhushanam Mary – Frances Thomson.

22PBT24	Sustainable Bioprocess Development	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To improve knowledge on

1. Microbial Growth Kinetics
2. Enzyme kinetics
3. Bioreactor operation

COURSE CONTENT:

UNIT I MICROBIAL DIVERSITY 9

Introduction Microbial diversity, Cell construction, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up.

UNIT II MICROBIAL GROWTH KINETICS 9

Microbial Growth and Quantifying Growth kinetics, kinetics of microbial growth, Substrate-limited growth, substrate uptake and product formation- monod model, leudeking-piret models, Models with growth inhibitors, oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, Measurement of kLa

UNIT III ENZYME ENGINEERING 9

Enzyme Engineering Enzyme, How enzyme work, Enzyme kinetics, Enzyme immobilization, Industrial utilization of enzyme, Heterogeneous Reactions in Bioprocessing, Internal Mass Transfer and Reaction

UNIT IV BIOREACTOR DESIGN 9

Bioreactor Design Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor.

UNIT V OPERATION OF REACTOR 9

Ideal Reactor Operation Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor Advanced Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Bioprocessing in environmental engineering, Industrial Bioprocess

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

The students will be able to

1. Develop growth model based on the microbial characteristics
2. Understand Immobilization techniques
3. Understand the mass transfer during Immobilization reaction
4. Design bioreactor based on operational mechanism
5. Understand different configurations of bioreactors

TEXT BOOK

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995.

22PBT25	**INDUSTRIAL SAFETY**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control.
2. The disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
3. To improve knowledge about rescue methods.

COURSE CONTENT:

UNIT I SAFETY MANAGEMENT 9

Concept of Safety, Applicable areas, unsafe actions &Conditions. Responsibility of Safety - Society,Govt., Management, Union & employees. Safety Officer - Appointment, Qualification, Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee. Motivation & Training of employees for safety in Industrial operations.

UNIT II DISASTER MANAGEMENT 9

Introduction on Disaster Different Types of Disaster: Natural Disaster Man-made Disaster Biological Disasters,Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.

UNIT III RISK ANALYSIS 9

Risk and Vulnerability Analysis, Risk Reduction , Strategic Development for Vulnerability Reduction,Disaster Preparedness and Response Preparedness- Disaster Preparedness: Concept and Nature,Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.

UNIT IV RESPONSIBILITY OF ENGINEERS 9

Role of Engineers on Disaster Management. Response- Disaster Response : Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor and Panic) , Relief and Recovery ,Medical Health Response to Different Disasters

UNIT V RECONSTRUCTION AND RECOVERY 9

Rehabilitation, Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction , Sanitation and Hygiene, Safety Awareness Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning , Role of Educational Institute.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

1. To learn the different safety aspects in industrial application and daily life
2. To learn safety procedure followed in industries
3. To learn the different types of rescues
4. To know the procedure for risk analysis
5. To know different type of disaster

TEXT BOOKS:

1. Dr. Mrinalini Pandey, Disaster Management, Wiley India Pvt. Ltd. Biotechnology
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd.
3. Jagbir Singh, Disaster Management: Future Challenges and Opportunities, K W Publishers Pvt. Ltd.
4. Crowl D A, Louvar J F, "Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).

REFERENCE

1. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.

22PCS16	BIGDATA ANALYTICS	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Performing big data analytics for Biological data set

COURSE CONTENT:

UNIT I INTRODUCTION **9**

Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies, Machine learning implementation, Recommender system ,
Dashboard, Ad-Hoc analysis.

UNIT II PRINCIPLES OF CARCINOGENESIS **9**

Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

UNIT III BIG DATA METHODS **9**

Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

UNIT IV CHARTS & GRAPHS **9**

Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

UNIT V STATISTICAL METHODS **9**

Regression models, Linear Regression, Multiple regression, Logistic regression, Mean, Median, Mode, Chi-Square test, T-Test.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Demonstrate fundamental knowledge of Big data analytics.
2. Explore different types of data from different sources.
3. Write R script to analyse data from data interface.
4. Develop and generate different types of charts and graphs.
5. Perform various statistical analysis using R packages for given data set

TEXT BOOK(S):

1. Venkat Ankam, "Big Data analytics", Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, "Big Data analytics", PHI learning2016

REFERENCE BOOKS:

1. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

22PBT26	INDUSTRIAL ENZYMOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. To understand the mechanism of biocatalyst
2. To learn the kinetics of enzymatic reaction
3. To learn about applications of enzymes

COURSE CONTENT:

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanism of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory, role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions, estimation of Michaelis-Menten parameters, multi substrate reactions - mechanism and kinetics; turnover number; types of inhibition & models – substrate, product. Allosteric regulation of enzymes, Monod changeux wyman model, pH and temperature effect on enzymes and deactivation kinetics.

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS 9

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc. examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

UNIT IV PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES 9

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays.

UNIT V BIOTRANSFORMATION APPLICATIONS OF ENZYMES 9

Hydrolytic-ester bond, amide, epoxides, nitriles, Reduction reactions-aldehydes, ketones, C=C, Oxidation reactions –Alkanes, Aromatic, Baeyer-Villiger, Enzymes in organic synthesis-esters, amides, peptides, modified and artificial enzymes, Catalytic antibodies.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. The students will understand the concept of immobilization
2. The student will understand extraction and purification of enzymes
3. The student will learn the inhibition kinetics of the enzymatic reactions
4. The student will learn the application of enzymes
5. The student will learn protein engineering of enzymes

TEXT BOOK(S):

1. Trevor Palmer , Enzymes IInd Horwood Publishing Ltd
2. Faber K , Biotransformations in Organic Chemistry, IV edition , Springer

REFERENCE BOOKS:

1. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.
2. James M. Lee, Biochemical Engineering, PHI, USA.
3. James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.

22PBT27 IMMUNOTECHNOLOGY

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. Immune systems and techniques in immunology.
2. Concepts in immunotechnology
3. Advancement in immunology and immunotechnology

COURSE CONTENT:

UNIT I THE IMMUNE SYSTEM 9

Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenecity – Immunogenecity-Haptens-Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection. Preparation of antigens for raising antibodies,

UNIT II ANTIGEN-ANTIBODY INTERACTION 9

In vitro antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis. ELISA, RIA and immunoblotting, Immunofluorescence, flow cytometry & sorting, T & B cell subset analysis, immuno-electron microscopy.

UNIT III ANTIBODIES 9

MAb through hybridoma technology, MAb without hybridoma technology – viral transformation of B cell line, plant as expression systems – plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, single chain Fc, diabodies, tetrabodies, intrabodies; plastibodies; applications. Plaque Forming Cell Assay.

UNIT IV CELLULAR IMMUNOLOGY 9

PBMC seperation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

UNIT V IMMUNITY AND INFECTION MECHANISM 9

Tissue injury and Inflammation – Immunosuppression - Immunological Tolerance - Immunity to infectious agents – bacteria, virus, fungi and parasites. Transplantation – Autoimmunity - Tumor Immunology - Vaccines: Conventional Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the basics in functions of immune systems.
2. Learn the types of antibodies and the interaction between antigen and antibodies
3. Know skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
4. Acquire knowledge and understanding of research methods employing immunological techniques for application in biomedical and clinical research
5. Apply immunological techniques to manage the immunological diseases

TEXT BOOK(S):

1. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th Edn., Elsevier, 2012
2. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002

REFERENCE BOOKS:

1. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005
2. Weir DM and Stewart, J., Immunology, 10th Edn. Churchill Livingston, New York, 2000.

22PBT28	ENTREPRENEURSHIP AND MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. To impart various aspects of product design and development
2. To inculculate concept generation and selection
3. To understand technology behind the product of the service

COURSE CONTENT:

UNIT I INTRODUCTION 9

Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

UNIT II PRODUCT DESIGN 9

Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

UNIT III INNOVATION AND PROTOTYPE 9

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

UNIT IV IPR AND COPYRIGHT 9

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship. GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures

UNIT V TRIALS & REGULATIONS 9

Plant Breeder’s Rights; Biosafety – levels; Biosafety guidelines; Role of Biosafety committee; Definition of GMOs & LMOs; Risk factors; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biological material transfer procedure.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.

2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

TEXT BOOK(S):

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
3. "Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.

REFERENCE BOOKS:

1. 4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 2007.
2. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
3. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.

22PBT29	INDUSTRIAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

To enable the students to understand
1. Understanding of problems of different kind of hazardous waste from industrial process.
2. Engineering and technical options for site specific waste management
3. Cleaner Industrial process and zero waste sustainable initiatives

COURSE CONTENT:

UNIT I INTRODUCTION TO INDUSTRIAL WASTE MANAGEMENT SYSTEM 9

Uses of water by industry-Sources and types of industrial wastewater; regulatory requirements for treatment of industrial wastewater-Industrial waste survey Industrial Wastewater generation; Treatment Evaluation for Air Emission and Solid waste; Waste Characterization and classification; Population equivalent-Toxicity of Industrial effluents and Bioassay tests.

UNIT II POLLUTION PREVENTION 9

Prevention vs. control of Industrial Pollution, Benefits and Barriers-Source reduction techniques, Waste audit; Evaluation of Pollution Prevention options, Co2 mitigation in industrial environment.

UNIT III INDUSTRIAL WASTE WATER TREATMENT 9

Equalization- Neutralization- Oil separation Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption. Aerobic and anaerobic biological treatment Sequencing batch reactors-High Rate reactors Chemical; Oxidation –Ozonation. Photo catalysis Wet Air Oxidation-Evaporation IonExchange-Membrane Technologies – Nutrient removal.

UNIT IV SOLID WASTE TREATMENT AND DISPOSAL 9

Categories and Characterization, Solid waste land fill, Land-fill cover and Cap, Waste stabilization, Management of Organic industrial waste, Incineration strategies and Energy recovery, Composting Industrial waste

UNIT V CASE STUDIES WITH DIFFERENT INDUSTRIAL SCENARIOS 9

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-fertilizers-Thermal Power Plants; and Industrial Estates, Textile and Paper Industries

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Identify the purpose and strategic options for industrial waste management
2. Analysis of hazardous waste constituents understand health and environmental issues
3. Select appropriate waste-water treatment process depending on the scenarios
4. Evaluate challenges and design aspect of land-fill operation for solid-waste management
5. Apply steps in solid waste management-waste reduction at source
6. Design cleaner production strategies and cooperation in industrial complexes

TEXT BOOK(S):

1. Woodard Frank (2001) ***Industrial Waste treatment Handbook***, Butterworth Heinemann
2. Nelson Leonard Nemerow (2010) ***Industrial Waste Treatment: Contemporary Practice andVision for the Future***, Elsevier

REFERENCE BOOKS:

1. John Pichtel, ***Waste Management Practices: Municipal, Hazardous, and Industrial***, SecondEdition, CRC Press
2. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih K. (2009) ***Handbook of Advanced Industrial and Hazardous Wastes Treatment***, CRC.
3. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
4. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.

22PBT30	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. Basic biology of cancer
2. Impact of antibodies against cancer in the human body leading to more effective treatments
3. Enhanced immunology based detection methods and imaging techniques
4. Development of cell based and cytokine based immunotherapy against cancer.

COURSE CONTENT:

UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

UNIT III PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER 9

Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto-oncogene activity. Growth factors related to transformation. Telomerases.

UNIT IV PRINCIPLES OF CANCER METASTASIS 9

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT V NEW MOLECULES FOR CANCER THERAPY 9

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To appreciate the role of immune system in cancer
2. To describe self – tolerance machinery and immune surveillance
3. To understand the cancer microenvironment and its influence on immune cells
4. To have awareness on medical applications of cytokines and immune cells against cancer
5. To understand different treatment approaches for cancer

TEXT BOOK(S):

1. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
2. McDonald, F etal., “Molecular Biology of Cancer” IInd Edition. Taylor & Francis, 2004,

REFERENCE BOOKS:

1. King, Roger J.B. “Cancer Biology” Addison Wesley Longman, 1996.
2. Ruddon, Raymond W. " Cancer Biology" IIIrd Edition. Oxford University Press, 1995.

22PBT31	CANCER MANAGEMENT TECHNIQUES	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. The pathology, grades and molecular biology of cancer
2. Cancer type specific symptoms and early diagnostic markers
3. Cancer management techniques like detection, treatment, prevention and palliative care

COURSE CONTENT:

UNIT I MOLECULAR CELL BIOLOGY OF CANCER 9

Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

UNIT II CANCER SYMPTOMS AND MARKERS 9

Cancer Symptom – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples -Urine, Blood, Stool, Tumor tissue, other body fluids; Gene expressions – DNA, mRNA and Protein; scope for early diagnosis.

UNIT III CANCER DETECTION METHODS AND TECHNIQUES 9

Cancer Screening and symptoms; Clinical Examination; Radiologic Imaging Techniques – CT, MRI,and PET scans, Ultra sound and Endoscopic Examinations, Mammography and Isotopic Techniques; Laboratory Tests for cancer markers; Immunodetection techniques; Genetic Testing; Confirming cancer by pathologic report - Biopsy and Smear examinations; Early diagnostic methods

UNIT IV CANCER THERAPEUTICS 9

Combination Therapy; Adjuvant therapy- Chemotherapy and Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy – Antibody, Interferon, Molecular and Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials.

UNIT V CANCER PREVENTION AND PALLIATIVE CARE 9

Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment preventive measuresRecurrence prevention, Cancer diagnosis cum therapy; Paliative care; Herbal remedies and plant derived
drugs.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Study the molecular targets for diagnosis and therapy
2. Develop new technologies for early diagnosis, targeted therapy and for effective management of post therapy cases with the help of cancer markers
3. Analyse the future challenges in improving the efficacy of current cancer diagnosis and therapy
4. Investigate new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.
5. To understand different treatment approaches for cancer

Text Book(s):

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

Reference Books:

1. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach, 11th illustrated edition, Oncology Publishers, 2003

22PBT32	MICROBIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. To learn bacterial genetics and techniques for genetic engineering.
2. To study the role of microbiology in medicine, agriculture, and the environment.
3. To develop value added microbial products and commercialization

COURSE CONTENT:

UNIT I INTRODUCTION 9

Microbial life: Microbial Cell Cultivation Systems, Culture media- types, components and formulations. Sterilization: Batch and continuous sterilization, Types of fermentations-Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid state fermentation; Substrates used in SSF and its advantages.

UNIT II MICROBIAL GENOMICS 9

Introduction to Microbial genomes, Genome sequencing of different microbes and their importance, Techniques for genome research (chromosome walking, RFLP etc.), Metagenomics; Application of microbial genomic variability for utilizing in human welfare, Phylogenetic relationships between various genera of microbes, Methods to Compare Genomes, Evolution by Genome Expansion and Reduction, Archaeal Genomics, Microbial Genome Annotation.

UNIT III MICROBIAL PROTEOMICS 9

Introduction to microbial proteomics, 2D gel profiling, MALDI – ToF, Protein purification work station of various microbes, Microbial pathogenesis at the proteome level, Structural proteomics and computational analysis Proteomics of Archaea, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

UNIT IV MICROBES IN AGRICULTURE 9

Microbes as biocontrol agents (Baculoviruses, entomopathogenic fungi, Bacillus thurinigiensis, Bacillus sphaericus, Bacillus popilae, Microbe derived inhibitors, biology of nitrogen fixation, preparation of different types of inoculants (nitrogen fixers, phosphate solubilizers, plant growth promoting rhizobacteria (PGPR), composting, biopesticides.

UNIT V MICROBIAL INTERACTIONS 9

Interactions with microorganisms, plants and animals, Bacteriophages in control of bacteria, The gut microbiota, Cancer and the microbiota, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes, Recombinant vaccines.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Evaluate the role of micro-organisms in specific biotechnological processes
2. Study the complex processes behind the development of genetically manipulated organisms
3. Demonstrate a clear understanding of proteomics relate to biotechnological applications
4. Create an array of products to benefit humans, animals and the environment.
5. Interaction of microbiota with plants, animals, bacteriophages

TEXT BOOK(S):

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
3. Rajhi Gupta, Jagjit Singh, T.N. Lakhanpal, and J.P. Jewari, Advances in Microbial Biotechnology by Publisher: A.P.H. Pub. Corp. 2005.

REFERENCE BOOKS:

1. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. ButterworthHeinemann, 2009.
2. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.

22PBT33	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. The study of the subject constitutes the chemical engineering aspects and principles in line with temperature differences.
2. It imparts the knowledge of basic principles of science and engineering applied to Industrial Biotechnology and chemical engineering
3. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

COURSE CONTENT:

UNIT I INTRODUCTION **9**

Introduction to chemical engineering sciences and its role in the design & analysis of chemical processes. Overview of unit operations and processes in the chemical industry. Units and conversion factor. Introduction to Dimensional analysis.

UNIT II MATERIAL AND ENERGY BALANCES **9**

Overall and component material balances - Material balances without chemical reactions Material balance calculations with chemical reactions – combustion calculations. Energy balances - Entropy - Latent heat -Chemical reactions - combustion

UNIT III FLUID MECHANICS **9**

Properties of fluids; Fluid statics – forces at fluid surfaces, Pressure and measurement of pressure differences; Fluid flow concepts and basic equations of fluid flow – continuity equation and Bernoulli’s equation; shear stress relationship and viscous effects in fluid flow; non newtonian fluids; significance of dimensionless groups in fluid flow operations.

UNIT IV TRANSPORTATION OF FLUIDS **9**

Different types of pumps, compressors and valves. Measurement of fluid flow using hydrodynamic methods, direct displacement method. Types of agitators, flow patterns in agitated vessels, calculation of power consumption – applications in bioreactor design

UNIT V HEAT TRANSFER **9**

Nature of heat flow - Conduction, convection, radiation. Steady state conduction, Principles of heat flow in fluids.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Gaining knowledge on developments in unit operations.
2. Understanding the principles related to laws of thermal conductivity and movement of fluids through energy balances.
3. Analyzing the fluid dynamics in an industrial point of view.
4. Hydrodynamics of a moving fluid will be observed and it paves a way for the Rheology of fluids.
5. Analyzing the Heat and mass transfer operations in an industrial plant.

TEXT BOOK(S):

1. Bhatt B.I., Vora S.M. Stoichiometry.3rd ed., Tata McGraw-Hill, 1977.

REFERENCE BOOKS:

1. Geankoplis C.J. Transport Processes And Unit Operations. 3rd ed., Prentice Hall India

22PBT34	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

To enable the students to understand

1. To demonstrate the basics of biopharmaceutical technology to the undergraduate students.
2. To motivate the undergraduate students in analyzing the drug metabolism and mode of action.
3. To elaborate basic of formulations of drugs and to apply them in clinical trials.

COURSE CONTENT:

UNIT I DRUGS 9

Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.

UNIT II MANUFACTURING PRINCIPLES 9

Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.

UNIT III FORMULATIONS 9

Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms.

UNIT IV PHARMACEUTICAL PRODUCTS 9

Pharmaceutical Products - Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics –Antacids. Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology.

UNIT V TRIALS & REGULATIONS 9

Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. Good Laboratory Practice, good manufacturing practice.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Acquire knowledge on drug development, principles, mechanism of actions of drug.
2. Outline on preparation of biotechnology oriented pharmaceutical products.
3. Demonstrate various testing and quality assurance in drug preparation.
4. Help them to analyze the pharmaceutical products available in the market.
5. To design clinical trials and GLP

TEXT BOOK(S):

1. DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 1999.

REFERENCE BOOKS:

1. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

22OHS01 ADVANCED ENGINEERING CHEMISTRY

L	P	T	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To make the students conversant with basics of polymer chemistry
2. Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
3. To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
4. To make the student acquire sound knowledge of second law of thermodynamics andsecond law based derivations of importance in engineering applications in all disciplines.
5. To acquaint the students with the basics of nano materials, their properties and applications.

UNIT I POLYMERS AND SPECIALITY POLYMER 9

Polymers – Types of polymerization – degree of polymerization – plastics and types – mechanismof polymerization (free radical mechanism) properties of polymers - Tg and tacticity — compounding of plastics – fabrication of plastics – Blow and extrusion mouldings. Speciality polymers-conducting polymers: polyacetylene, polyaniline, synthesis, mechanism of conduction – applications of conducting polymers. Bio-degradable polymers: requirements, factors affecting degradation — PLA– preparation, properties –applications.

UNIT II ELECTROCHEMISTRY, CORROSION AND PROTECTIVE COATINGS 9

Electrode potential — Nernst equation, numerical problems — Emf series, applications, electrochemical cells, galvanic cells, electrolytic concentration cells – Emf measurement problems. Corrosion: dry & wet corrosion – mechanism, factors affecting corrosion - corrosion control, material selection and design aspects – corrosion protection – sacrificial anode and impressed current methods. Protective coatings: Metallic coatings – electroplating of Cu - electroless plating of Ni. Organic coatings: Paints - constituents and function, special paints – water repellant, heat resistant and luminous paints.

UNIT III PHOTOCHEMISTRY & ANALYTICAL TECHNIQUES 9

Photochemistry: Laws of photochemistry - Grothuss–Draper law, Stark–Einstein law and Beer-Lambert's Law. Quantum efficiency – determination - photophysical processes (Jablonski diagram). - photosensitization - chemiluminescence and bioluminescence. Analytical techniques: IR, UV – principle, Instrumentation and applications.Thermal analysis: TGA & DTA - principle, instrumentation and applications. Chromatography: Basic principles of column & TLC – principles and applications.

UNIT IV THERMODYNAMICS 9

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function- Helmholtz and Gibbs free energy functions (problems); criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations — Van't Hoff isotherm and isochore (problems).

UNIT V NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties (surface to volume ratio, melting point, optical and electrical). nanoparticles, nanocluster, nanorod, nanotube (CNT: SWNT and MWNT) and nanowire, synthesis - precipitation, thermolysis, hydrothermal, solvothermal, electrodeposition, chemical vapour deposition, laser ablation, sol-gel process and applications (electronic and biomedical). Fullerenes: Types - C_{60} - preparation, properties and applications.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. Gain knowledge on polymer chemistry
2. Get familiarized about thermodynamics
3. Comprehend on spectroscopy
4. Understand phase rule
5. Develop knowledge on nano materials

TEXT BOOKS

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.
2. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD,New Delhi, 2013
3. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd.,2012.

REFERENCES

1. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
2. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & CompanyLTD, New Delhi, 2015
3. B. K. Sharma, "Engineering Chemistry", Krishna Prakashan Media (P) Ltd, Meerut, 2012

22OAG01	AGRICULTURAL FINANCE, BANKING AND CO-OPERATION	L	P	T	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

1. To make the students aware about the agricultural Finance, Banking and Cooperation.
2. To acquaint the students with the basic concepts, principles and functions of management.
3. To understand the process of finance banking and cooperation.

UNIT I AGRICULTURAL FINANCE - NATURE AND SCOPE 9

Agricultural Finance: Definition, Importance, Nature and Scope - Agricultural Credit: Meaning, Definition, Need and Classification - Sources of credit - Role of institutional and non - Institutional agencies: Advantages and Disadvantages - Rural indebtedness: consequences of rural indebtedness - History and Development of rural credit in India.

UNIT II FARM FINANCIAL ANALYSIS 9

Principles of Credit - 5C's, 5R's and & 7P's of Credit - Project Cycle and Management - Preparation of bankable projects / Farm credit proposals - Feasibility - Time value of money: Compounding and Discounting - Appraisal of farm credit proposals - Undiscounted and discounted measures - Repayment plans - Farm Financial Statements: Balance Sheet, Income Statement andCash Flow statement - Financial Ratio Analysis.

UNIT III FINANCIAL INSTITUTIONS 9

Institutional Lending Agencies - Commercial banks: Nationalization, Agricultural Development Branches - Area Approach - Priority Sector Lending - Regional Rural Banks, Lead bank, Scale of finance - Higher financial institutions: RBI, NABARD, AFC, ADB, World Bank and Deposit Insurance and Credit Guarantee Corporation of India - Microfinance and its role in poverty alleviation - Self-Help Groups - Non -Governmental Organizations - Rural credit policies followedby State and Central Government - Subsidized farm credit, Differential Interest Rate (DIR), Kisan Credit Card (KCC) Scheme - Relief Measures and Loan Waiver Scheme and Know Your Customer (KYC).

UNIT IV CO-OPERATION 9

Co-operation: Philosophy and Principles - History of Indian Cooperative Credit Movement: Pre and Post-Independence periods and Cooperation in different plan periods - Cooperative credit institutions: Two tier and three tier structure, Functions: provision of short term and long term credit, Strength and weakness of cooperative credit system, Policies for revitalizing cooperative credit: Salient features of Vaithiyananthan Committee Report on revival of rural cooperative credit institutions, Reorganisation of Cooperative credit structure in Andhra Pradesh and single window system and successful cooperative credit systems in Gujarat, Maharashtra, Punjab etc, - Special cooperatives: LAMPS and FSS: Objectives, role and functions - National Cooperative Development Corporation (NCDC) and National Federation of State Cooperative Banks Ltd., (NAFSCOB) - Objectives and Functions.

UNIT V BANKING AND INSURANCE 9

Negotiable Instruments: Meaning, Importance and Types - Central Bank: RBI - functions - credit control - objectives and methods: CRR, SLR and Repo rate - Credit rationing - Dear money and cheap money - Financial inclusion and Exclusion: Credit widening and credit deepening monetary policies. Credit gap: Factors influencing credit gap - Non - Banking Financial Institutions (NBFI) - Assessment of crop losses, Determination of compensation - Crop insurance: Schemes, Coverage, Advantages and Limitations in implementation - Estimation of crop yields - Livestock, insurance schemes - Agricultural Insurance Company of India Ltd (AIC): Objectives and functions.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

After completion of this course, the students is expected to

1. Aware about the agricultural Finance, Banking and Cooperation.
2. Be familiar with farm financial analysis.
3. Gain knowledge about financial institutions and their functions.
4. Understand about philosophy and principles of Co-operation
5. Know about banking and insurance.

REFERENCES:

1. Muniraj, R., 1987, Farm Finance for Development, Oxford & IBH, New Delhi
2. Subba Reddy. S and P.Raghu Ram 2011, Agricultural Finance and Management,Oxford & IBH, New Delhi.
3. Lee W.F., M.D. Boehlje A.G., Nelson and W.G. Murray, 1998, Agricultural Finance, Kalyani Publishers, New Delhi.
4. Mammoria, C.B., and R.D. Saxena 1973, Cooperation in India, Kitab Mahal, Allahabad.

22OME03 AIR POLLUTION AND CONTROL ENGINEERING

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

UNIT I INTRODUCTION 9

Structure and composition of Atmosphere — Definition, Scope and Scales of Air Pollution — Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

UNIT II METEOROLOGY 9

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories — Dispersion models, Plume rise.

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 9

Factors affecting Selection of Control Equipment — Gas Particle Interaction — Working principle -Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 9

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

UNIT V INDOOR AIR QUALITY MANAGEMENT 9

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution — Measurement — Standards –Control and Preventive measures.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

The students completing the course will have

1. An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
2. Ability to identify, formulate and solve air and noise pollution problems
3. Ability to design stacks and particulate air pollution control devices to meet applicable standards.
4. Ability to select control equipments.
5. Ability to ensure quality, control and preventive measures.

TEXTBOOKS:

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, “Air Pollution ControlEngineering”, Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, “Air Pollution Control Engineering”, Waveland press,Inc 2017.
3. Anjaneyulu. Y, “Air Pollution and Control Technologies‟, Allied Publishers (P) Ltd., India 2002.

REFERENCES:

1. David H.F. Liu, Bela G. Liptak, “Air Pollution”, Lweis Publishers, 2000.
2. Arthur C. Stern, “Air Pollution (Vol.I – Vol.VIII)”, Academic Press, 2006.
3. Wayne T.Davis, “Air Pollution Engineering Manual”, John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, “Air Pollution”,Tata Mcgraw Hill Publishing Company limited,2007.
5. C.S.Rao, “Environmental Pollution Control Engineering”,New Age International(P) Limited Publishers,2006.

22OME04 **AUTOMOTIVE SYSTEMS**

L	P	T	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I AUTOMOTIVE ENGINE AUXILIARY SYSTEMS 9

Automotive engines- External combustion engines –Internal combustion engines - classification of engines- SI Engines- CI Engines- two stroke engines -four stroke engines- construction and working principles - IC engine components- functions and materials - valve timing –port timing diagram- Injection system -Unit injector system- Rotary distributor type - Electronically controlled injection system for SI engines-CI engines-Ignition system - Electronic ignition system -Transistorized ignition system, capacitive discharge ignition system.

UNIT II VEHICLE FRAMES AND STEERING SYSTEM 9

Vehicle construction and different Chassis layouts –classifications of chassis- types of frames- frameless chassis construction –articulated vehicles- vehicle body - Vehicle aerodynamics-various resistances and its effects - steering system –conventional — sophisticated vehicle- and types of steering gear box-Power Steering- Steering geometry-condition for true rolling motion-Ackermann's- Devi's steering system - types of stub axle — Types of rear axles.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, Gear Shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints —- Hotchkiss Drive and Torque Tube Drive- rear axle- Differential-wheels and tyres.

UNIT IV SUSPENSION AND BRAKES SYSTEMS 9

Suspension Systems- conventional Suspension Systems -independent Suspension Systems – leaf spring — coil spring –taper-lite - eligo,s spring Types of brakes -Pneumaticand Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control. Derive the equation of Forces acting while applying a brakes on plain surface - inclined road-gradient .

UNITV ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and HybridVehicles, Fuel Cell. Turbo chargers -Engine emission control by three way catalytic convertersystem.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

1. Upon completion of this course, the students will be able to identify the different components in automobile engineering.
2. Have clear understanding on different auxiliary and transmission systems usual.

TEXT BOOKS:

1. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2007.
2. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.
3. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 1997.

REFERENCES:

1. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
2. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
3. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart –Will Cox Company Inc, USA ,1978.
4. Newton, Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989.

22OBM04	BIOMEDICAL INSTRUMENTATION	L	P	T	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

1. To Introduce Fundamentals of Biomedical Engineering
2. To study the communication mechanics in a biomedical system with few example.
3. To study measurement of certain important electrical and non-electrical parameters
4. To understand the basic principles in imaging techniques
5. To have a basic knowledge in life assisting and therapeutic devices

UNIT I HUMAN BODY SUBSYSTEM AND TRANSDUCERS 9

Brief description of muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities. Principles and classification of transducers for Bio-medical applications. Electrode theory, different types of electrodes; Selection criteria for transducers and electrodes.

UNIT II NON ELECTRICAL PARAMETERS MEASUREMENT 9

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Blood Gas analysers, pH of blood – Measurement of blood pCO2, pO2.

UNIT III ELECTRICAL PARAMETERS MEASUREMENT AND ELECTRICAL SAFETY 9

ECG — EEG — EMG — ERG — Lead systems and recording methods — Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current - Instruments for checking safety parameters of biomedical equipments.

UNIT IV IMAGING MODALITIES AND BIO-TELEMETRY 9

Diagnostic X-rays - Computer tomography — MRI — Ultrasonography — Endoscopy — Thermography – Different types of biotelemetry systems.

UNIT V LIFE ASSISTING AND THERAPEUTIC DEVICES 9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators - Heart Lung machine –Dialysers - Diathermy — Lithotripsy.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. Understand communication mechanics in a biomedical system.
2. Develop knowledge on analysis of non-electricalparameters.
3. Gain knowledge on measurement of electrical parameters
4. Acquire knowledge on basic principles of imaging techniques,
5. Understand about life assisting and therapeuticdevices

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice hall of India, New Delhi, 2007.
2. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
3. Khandpur R.S, Handbook of Biomedical Instrumentation, , Tata McGraw-Hill, New Delhi, 2nd Edition, 2003.

REFERENCES:

1. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.
2. Duane Knudson, Fundamentals of Biomechanics, Springer, 2nd Edition, 2007.
3. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011.
4. Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.
5. M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2003.

22OAG **CLIMATE CHANGE AND ADAPTATION**

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	0.1

COURSE OBJECTIVES:

1. To understand the basics of weather and climate
2. To have an insight on Atmospheric dynamics and transport of heat
3. To develop simple climate models and evaluate climate changes using models

UNIT I BASICS OF WEATHER AND CLIMATE 9

Shallow film of Air– stratified & disturbed atmosphere – law – atmosphere Engine. Observation ofparameters: Temperature – Humidity – Wind - Pressure – precipitation-surface – networks. Constitution of atmosphere: well stirred atmosphere – process around turbopause – in dry air – ozone – carbon Dioxide – Sulphur Dioxide– Aerosol - water. Evolution of Atmosphere. State of atmosphere: Air temperature – pressure – hydrostatic – Chemistry – Distribution – circulation

UNIT II ATMOSPHERIC DYNAMICS 9

Atmosphere dynamics: law – isobaric heating and cooling – adiabatic lapse rates – equation of motion - solving and forecasting. Forces – Relative and absolute acceleration – Earth's rotation *coriolis* on sphere – full equation of motion – Geostrophy;- Thermal winds –departures – small-scale motion. Radiation, convection and advections: sun & solar radiation – energy balance – terrestrial radiation and the atmosphere – Green house effect- Global warming - Global budget –radiative fluxes - heat transport. Atmosphere and ocean systems convecting & advecting heat. Surface and boundary layer – smaller scale weather system – larger scale weather system.

UNIT III GLOBAL CLIMATE 9

Components and phenomena in the climate system: Time and space scales – interaction and parameterization problem. Gradients of Radiative forcing and energy transports by atmosphere and ocean – atmospheric circulation – latitude structure of the circulation - latitude – longitude dependence of climate features. Ocean circulation: latitude – longitude dependence of climate features – ocean vertical structure – ocean *thermohaline* circulation – land surface processes – carbon cycle.

UNIT IV CLIMATE SYSTEM PROCESSES 9

Conservation of motion: Force – *coriolis* - pressure gradient- velocity equations – Application – geotropic wind – pressure co-ordinates. Equation of State – atmosphere – ocean. Application: thermal circulation – sea level rise. Temperature equation: Ocean – air – Application – decay of sea surface temperature. Continuity equation: ocean – atmosphere. Application: coastal upwelling – equatorial upwelling – conservation of warm water mass. Moisture and salinity equation: conservation of mass – moisture. Source & sinks – latent heat. Moist processes – saturation – convection – Wave processes in atmosphere and ocean.

UNIT V CLIMATE CHANGE MODELS 9

Constructing a climate model — climate system modeling — climate simulation and drift — Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming – climate change observed to date.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

After completion of this course, the students is expected to

1. Understand the basics of weather and climate
2. Have an insight on Atmospheric dynamics
3. Gain knowledge about transport of heat and global heat
4. Understand different processes in climate system
5. Develop simple climate models and evaluate climate changes using models.

TEXTBOOKS:

1. Fundamentals of weather and climate (2nd Edition) Robin Moilveen (2010), Oxford University Press
2. Climate change and climate modeling, J. David Neelin (2011) Cambridge University press.

22OCS03	CLOUD COMPUTING		L	P	T	C
			3	0	0	3
Pre-requisite	Nil	**Syllabus Version**	V 0.1			

COURSE OBJECTIVES:

1.To learn about the concept of cloud and utility computing.

2.To have knowledge on the various issues in cloud computing.

3.To be familiar with the lead players in cloud.

4.To appreciate the emergence of cloud as the next generation computing paradigm.

UNIT I INTRODUCTION TO CLOUD 9

Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.

UNIT II VIRTUALIZATION 9

Introduction to Virtualization Technology – Load Balancing and Virtualization – Understanding Hypervisor — Seven Layers of Virtualization — Types of Virtualization — Server, Desktop, Application Virtualization.

UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE 9

NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage.

UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9

Inter Cloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Data Security –Application Security – Virtual Machine Security.

UNIT V CASE STUDIES 9

Google App Engine(GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services(AWS) – GAE Applications – Cloud Software Environments – Eucalyptus – Open Nebula – Open Stack.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On Completion of the course, the students should be able to:

1. Articulate the main concepts, key technologies, strengths and limitations of cloudcomputing.
2. Learn the key and enabling technologies that help in the development of cloud.
3. Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
4. Explain the core issues of cloud computing such as resource management and security.
5. Be able to install and use current cloud technologies.
6. Choose the appropriate technologies, algorithms and approaches for implementation anduse of cloud.

TEXT BOOKS:

1. Buyya R., Broberg J., Goscinski A., “Cloud Computing: Principles and Paradigm”, FirstEdition, John Wiley & Sons, 2011.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, FromParallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. Rittinghouse, John W., and James F. Ransome, “Cloud Computing: Implementation, Management, And Security”, CRC Press, 2017.

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach”,Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)”, O’Reilly, 2009.

22OEC02 **CONTROLLING SYSTEMS ENGINEERING**

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To introduce the components and their representation of control systems
2. To learn various methods for analyzing the time response, frequency response and stability of the systems.
3. To learn the various approach for the state variable analysis.

UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION 9

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchros -Multivariable control system

UNIT II TIME REPONSE ANALYSIS 9

Transient response-steady state response-Measures of performance of the standard firstorder and second order system-effect on an additional zero and an additional pole-steadyerror constant and system- type number-PID control-Analytical design for PD,PI,PID control systems

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation

UNIT IV CONCEPTS OF STABILITY ANALYSIS 9

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

1. Identify the various control system components and their representations.
2. Analyze the various time domain parameters.
3. Analysis the various frequency response plots and its system.
4. Apply the concepts of various system stability criterions.
5. Design various transfer functions of digital control system using state variable models.

TEXT BOOK:

1. M.Gopal, “Control System — Principles and Design”, Tata McGraw Hill, 4th Edition, 2012.

REFERENCES

1. J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 5 th Edition, 2007.
2. K. Ogata, ‘Modern Control Engineering’, 5th edition, PHI, 2012.
3. S.K.Bhattacharya, Control System Engineering, 3rd Edition, Pearson, 2013.
4. Benjamin.C.Kuo, “Automatic control systems”, Prentice Hall of India, 7th Edition,1995.

22OCS13	**DATA STRUCTURES**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To understand the various algorithm design and analysis techniques
2. To learn linear data structures – lists, stacks, and queues
3. To learn different sorting and searching algorithms
4. To understand Tree and Graph data structures

UNIT I ALGORITHM ANALYSIS, LIST ADT 9

Algorithms: Notation - analysis – running time calculations. Abstract Data Types (ADTs): List ADT – array-based implementation – linked list implementation – singly linked lists- applications of lists:Polynomial Manipulation. Implementation of List ADT using an array and using a linked list in C.

UNIT II STACKS AND QUEUES 9

Stack ADT - Applications - Evaluating arithmetic expressions- Conversion of Infix to Postfix- Recursion. Queue ADT — Priority Queue - applications of queues. Implementation of Stack ADT and palindrome checking using C. Implementation of Queue operations using arrays in C.

UNIT III SEARCHING AND SORTING ALGORITHMS 9

Divide and conquer methodology - Searching: Linear Search - Binary Search. Sorting: Insertion sort — Merge sort — Quick sort — Heap sort. Analysis of searching and sorting techniques. Implementation of linear search, binary search, insertion sort, merge sort and quick sort algorithms in C.

UNIT IV TREES 9

Tree ADT — tree traversals - Binary Tree ADT — expression trees — binary search tree ADT — applications of trees. Heap — applications of heap. Implementation of Binary search tree and its operations, tree traversal methods, finding height of the tree using C. Implementation of heap and heap sorting using arrays in C.

UNIT V GRAPHS 9

Definition – Representation of Graph – Breadth-first traversal - Depth-first traversal – Dynamic programming Technique – Warshall's and Floyd's algorithm – Greedy method - Dijkstra's algorithm – applications of graphs. Implementation of graph, graph traversal methods, finding shortest path using Dijkstra's algorithm in C

Total Lecture Periods 45 Periods

EXPECTED COURSE OUTCOMES:

At the end of this course, the students should be able to:

1. Implement linear data structures and solve problems using them.
2. Implement and apply trees and graphs to solve problems.
3. Implement the various searching and sorting algorithms.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education,1997.
2. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language”, 2nd Edition, Pearson Education, 1988.

REFERENCES:

1. Aho, Hopcroftand Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
2. S.Sridhar, “Design and Analysis of Algorithms”, First Edition, Oxford University Press. 2014
3. Byron Gottfried, Jitender Chhabra, “Programming with C” (Schaum’s Outlines Series).

22OCS14 DATABASE MANAGEMENT SYSTEMS

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To learn the fundamentals of data models
2. To learn conceptual modeling using ER diagrams.
3. To study SQL queries and database programming
4. To learn proper designing of relational database.
5. To understand database security concepts
6. To understand Information retrieval techniques

UNIT I DBMS AND CONCEPTUAL DATA MODELING 9

Purpose of Database System — Data independence - Data Models — Database System Architecture – Conceptual Data modeling: ER models - Enhanced-ER Model. Introduction to relational databases – Relational Model – Keys – ER-to-Relational Mapping. Modeling of a library management system.

UNIT II DATABASE QUERYING 9

Relational Algebra – SQL: fundamentals – DDL – Specifying integrity constraints - DML – Basic retrieval queries in SQL - Complex SQL retrieval queries – nested queries – correlated queries – joins - aggregate functions. Creating a table, populating data, adding integrity constraints, querying tables with simple and complex queries.

UNIT III DATABASE PROGRAMMING 9

Database programming with function calls, stored procedures - views — triggers. Embedded SQL. ODBC connectivity with front end tools. Implementation using ODBC/JDBC and SQL/PSM, implementing functions, views, and triggers in MySQL / Oracle.

UNIT IV DATABASE DESIGN 9

Functional Dependencies – Design guidelines – Normal Forms: first, second, third – Boyce/Codd Normal Form – Normalization algorithms. Design of a banking database system / university database system.

UNIT V ADVANCED TOPICS 9

Database security issues – Discretionary access control – role based access – Encryption and public key infrastructures – challenges. Information Retrieval: IR Concepts, Retrieval Models, Queries in IR systems.

Total Lecture Periods 45 Periods

EXPECTED COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

1. Understand relational data model, evolve conceptual model of a given problem, its mapping to relational model and Normalization
2. Query the relational database and write programs with database connectivity
3. Understand the concepts of database security and information retrieval systems

TEXT BOOKS:

1. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Sixth Edition , Pearson, 2011.
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”,Sixth Edition, Tata McGraw Hill, 2011

REFERENCES:

1. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, —Database Management Systems‖, Fourth Edition, McGraw-Hill College Publications, 2015.

22OME07	DESIGN OF EXPERIMENTS	L	P	T	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To impart knowledge on various types of experimental designs conduct of experiments and data analysis techniques.

UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS 9

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testingusing Analysis of variance.

UNIT II SINGLE FACTOR EXPERIMENTS 9

Completely Randomized Design- effect of coding the observations- model adequacy checking-estimation of model parameters, residuals analysis- treatment comparison methods-Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- testing using contrasts- Randomized Block Design — Latin Square Design- Graeco Latin Square Design – Applications.

UNIT III FACTORIAL DESIGNS 9

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- 2^K Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

UNIT IV SPECIAL EXPERIMENTAL DESIGN 9

Blocking and Confounding in 2^K Designs- blocking in replicated design- 2^K Factorial Design in two blocks- Complete and partial confounding- Confounding 2^K Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of 2^K Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of 2^K Design

UNIT V TAGUCHI METHODS 9

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments-Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

1. Able to apply experimental techniques to practical problems to improve quality of processes / products by optimizing the process / product parameters.

TEXT BOOK:

1. Krishnaiah K, and Shahabudeen P, “Applied Design of Experiments and TaguchiMethods”, PHI, India, 2011.

REFERENCES:

1. Douglas C. Montgomery, “Design and Analysis of Experiments”, John Wiley & sons, 2005
2. Phillip J. Ross, “Taguchi Techniques for Quality Engineering”, Tata McGraw-Hill, India 2005.

22OAG05 **ENERGY CONSERVATION AND MANAGEMENT**

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

At the end of the course, the student is expected to

1. understand and analyse the energy data of industries
2. carryout energy accounting and balancing
3. conduct energy audit and suggest methodologies for energy savings and
4. utilise the available resources in optimal ways

UNIT I INTRODUCTION 9

Energy - Power — Past & Present scenario of World; National Energy consumption Data — Environmental aspects associated with energy utilization — Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II ELECTRICAL SYSTEMS 9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III THERMAL SYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers — D.G. sets

UNIT V ECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. understand and analyse the energy data of industries
2. carryout energy accounting and balancing
3. conduct energy audit and suggest methodologies for energy savings and
4. utilise the available resources in optimal ways
5. understand energy economics.

TEXT BOOKS:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

REFERENCES:

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

22OAG07	ENVIRONMENT AND AGRICULTURE	L	P	T	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To emphasize on the importance of environment and agriculture on changing global scenario and the emerging issues connected to it.

UNIT I ENVIRONMENTAL CONCERNS 9

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems.

UNIT II ENVIRONMENTAL IMPACTS 9

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

UNIT III CLIMATE CHANGE 9

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

UNIT IV ECOLOGICAL DIVERSITY AND AGRICULTURE 9

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

UNIT V EMERGING ISSUES 9

Global environmental governance – alternate culture systems – Mega farms and vertical farms –Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts — Sustainable agriculture.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. appreciate the role of environment in the current practice of agriculture and concerns of sustainability,
2. understand the impacts of environment in agriculture
3. gain knowledge in the context of climate change and emerging global issues.
4. Understand ecological diversity and agriculture
5. Aware about emerging issues and policies.

TEXTBOOKS:

1. M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006.
2. Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005.

REFERENCES:

1. T.C. Byerly, Environment and Agriculture, United States. Dept. of Agriculture. Economic Research Service, 2006.
2. Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century : proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994
3. Environment and agriculture: environmental problems affecting agriculture in the Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 1989

22OBT02	**FOOD PROCESSIING AND PRESERVATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To expose the students to the principles and different methods of food processing and preservation.

UNIT I PRINCIPLES OF MASS AND ENERGY BALANCE 9

Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes and freezing. Thermal processing; calculation of process time temperature-schedules.

UNIT II CANNING OF FOOD PRODUCTS 9

Newer methods of thermal processing; batch and continuous; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods.

UNIT III DRYING PROCESS FOR TYPICAL FOODS 9

Rate of drying for food products; design parameters of different type of dryers; properties of airwater mixtures. Psychrometric chart, freezing and cold storage.freeze concentration, dehydrofreezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

UNIT IV NON-THERMAL METHODS 9

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

UNIT V FOOD PACKAGING 9

Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, costs of packaging and recycling of materials.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. To understand the role of different methods the processing of different foods and their impact on the shelf life, quality, and other physical and sensory characteristics of foods.
2. To familiarize with the recent methods of minimal processing of foods To understand the materials and types of packaging for foods
3. Be aware of the different methods applied to processing foods.
4. Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

5. Understand the role of pathogens in food borne infections. • Understand the methods used to detect pathogens in foods.

Text Book(s):

1. Sivasankar, B. “Food Processing and Preservation”. Prentice Hall of India, 2002.
2. Khetarpaul, Neelam. “Food Processing and Preservation.” Daya Publications, 2005
3. Singh, M.K. “Food Preservation” Discovery Publishing, 2007.
4. Fellows, P.J. “Food Processing Technology: Principles and Practice”. 2nd Edition, CRC Wood Head Publishing, 2000.
5. 5. GopalaRao, Chandra. “Essentials of Food Process Engineering”. B.S. Publications, 2006.

Reference Books:

1. Rahman, M. Shafiur. “Handbook of Food Preservation”. Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. “Food Preservation Techniques”. CRC / Wood Head Publishing, 2003.
3. Ranganna, S. “Handbook of Canning and Aseptic Packaging”. Tata McGraw-Hill, 2000.

22OBT03	FUEL CELL CHEMISTRY	L	P	T	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To create awareness about alternate clean fuel available.
2. To familiarize the students with the concepts and chemistry of fuel cell

UNIT I INTRODUCTION **9**

Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.

UNIT II FUEL CELL KINETICS **9**

Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

UNIT III CHARACTERIZATION TECHNIQUES **9**

Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.

UNIT IV RENEWABLE SOURCES **9**

Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V APPLICATIONS OF FUEL CELL **9**

Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power

conditioner;automotive applications, portable applications

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. aware of alternate energy sources and its importance of it.
2. Undersand the the kinetics of fuel cell.
3. Gain knowledge about the characterization of fuel cell.
4. Acquire knowledge about renewable energy sources.
5. Know the applications of fuel cell in our day-to-day life.

TEXTBOOKS

1. Gregor Hoogers, “Fuel Cell Technology Handbook”, CRC Press, 2003.
2. R.P. O’Hayre,S. Cha, W. Colella, F.B. Prinz, “Fuel Cell Fundamentals”, Wiley, 2006.
3. A. J.Bard, L. R. Faulkner, “Electrochemical Methods”, Wiley, 2004.

REFERENCES

1. S. Basu, “Fuel Cell Science and Technology”, Springer, 2007.
2. H. Liu, “Principles of Fuel Cells”, Taylor & Francis, 2006.

22OAG09	GEOGRAPHIC INFORMATION SYSTEM	L	P	T	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To introduce the fundamentals and components of Geographic Information System
2. To provide details of spatial data structures and input, management and output processes.

UNIT I FUNDAMENTALS OF GIS 9

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

UNIT II SPATIAL DATA MODELS 9

Database Structures – Relational, Object Oriented – ER diagram - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models - OGC standards - Data Quality.

UNIT III DATA INPUT AND TOPOLOGY 9

Scanner - Raster Data Input — Raster Data File Formats — Vector Data Input –Digitiser — Topology - Adjacency, connectivity and containment – Topological Consistency rules – Attribute Data linking – ODBC – GPS - Concept GPS based mapping.

UNIT IV DATA ANALYSIS 9

Vector Data Analysis tools - Data Analysis tools - Network Analysis - Digital Education models - 3D data collection and utilisation.

UNIT V APPLICATIONS 9

GIS Applicant - Natural Resource Management - Engineering - Navigation - Vehicle tracking and fleet management - Marketing and Business applications - Case studies.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

This course equips the student to

1. Have basic idea about the fundamentals of GIS.
2. Understand the types of data models.
3. Get knowledge about data input and topology.
4. Gain knowledge on data quality and standards.
5. Understand data management functions and data output

TEXT BOOKS:

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An IntroductionGeographical Information Systems, Pearson Education, 2nd Edition,2007.

REFERENCE:

1. Lo.C.P., Albert K.W. Yeung, Concepts and Techniques of Geographic InformationSystems, Prentice-Hall India Publishers, 2006

22OAG10 **GREEN BUILDING DESIGN**

	L	P	T	C
	3	0	0	3
Pre-requisite Nil	**Syllabus Version**	V 0.1		

COURSE OBJECTIVE:

1. To impart knowledge of the principles and practices of the green buildings
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings.

UNIT I ENVIRONMENTAL IMPLICATIONS OF BUILDINGS 9

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

UNIT II IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS 9

Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

UNIT III COMFORTS IN BUILDING 9

Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials andBuilding Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.

UNIT IV UTILITY OF SOLAR ENERGY IN BUILDINGS 9

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

UNIT V GREEN COMPOSITES FOR BUILDINGS 9

Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

1. Know about the principles of green buildings

2. Know about sustainable energy and its implementation to the green buildingss

TEXT BOOKS:

1. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.
2. Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.
3. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

REFERENCES:

1. Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.
2. Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.
3. Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke

22OBM11 HOSPITAL WASTE MANAGEMENT

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

The student should be made to:

1. Know about the healthcare hazard control and accidents
2. Understand biomedical waste management
3. Learn the facility guidelines, infection control and patient safety.

UNIT I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS 9

Healthcare Hazard Control: Introduction, Hazard Control: Management & Responsibilities, Hazard Analysis, Hazard Correction, Personal Protective Equipment, Hazard Control Committees, Accident Causation Theories, Accident Reporting, Accident Investigations, Accident Analysis, Accident Prevention, Workers' Compensation, Orientation, Education, and Training.

UNIT II BIOMEDICAL WASTE MANAGEMENT 9

Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling and disposal.

UNIT III HAZARDOUS MATERIALS 9

Hazardous Materials: Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Respiratory Protection.

UNIT IV FACILITY SAFETY 9

Introduction, Facility Guidelines: Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Tool Safety, Electrical Safety, Control of Hazardous Energy, Landscape and Ground Maintenance, Fleet and Vehicle Safety.

UNIT V INFECTION CONTROL, PREVENTION AND PATIENT SAFETY 9

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Healthcare-Associated Infections, Medication Safety.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. Know about the healthcare hazard control and accidents
2. Understand biomedical waste management
3. Learn the facility guidelines, infection control and patient safety
4. Gain knowledge about the concepts of facility safety
5. Know about infection control, patient safety and prevention.

REFERENCES:

1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylorand Francis (2014).
2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)

22OBT05	INDUSTRIAL CHEMISTRY	L	P	T	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

1. Elaborate study of fuels-introduction — classification, preparation, properties - alternatefuels.
2. To get introduced to high polymers such as rubber and plastics and to industrial importance of cementing materials.
3. To get introduction on the chemistry of various industrial processes such as sugar and leather processing.

UNIT I INORGANIC CEMENTING MATERIALS 9

Introduction - Lime and its manufacture - Gypsum plaster - cement - types of cement, chemical composition-manufacture of Portland cement - chemical composition of Portland cement - setting and hardening of Portland cement. Heat of hydration of cement - special cement - concrete and RCC - decay of concrete-glass and ceramics - Introduction - manufacture of glass - varieties of glasses- plasticity of clay - white wares, glazing- applications - Earthenware's and stoneware's - optical fibers.

UNIT II FUELS AND COMBUSTION 9

Introduction - classification of fuels - calorific value - gross calorific value and net calorific value - characteristics of a good fuel. theoretical calculation of calorific value of a fuel - solid fuels — wood-coal - classification of coal by rank - selection of coal - analysis of coal and its significance -types of coking - types of carbonization of coal - role of sulphur in coal - role of ash in coal. Gaseous fuels - producer gas - water gas - natural gas - oil gas - biogas - components - composition- preparation - advantages- disadvantages and applications of coal gas.

UNIT III RUBBER AND PLASTICS 9

Introduction to rubber - latex - processing latex - mastication - compounding of rubber - vulcanizations of rubber - engineering polymers thermoforming - degradation stability and environment- synthetic rubbers - preparation and applications of SBR - butyl rubber - nitrile rubber - neoprene and silicone rubber- plastic materials - classification of plastics (or resins) - moulding constituents of a plastic - fabrication techniques used for thermoplastic resin (moulding process)- important thermoplastic resins- natural resins - celluloses - polyethylene — PVC.

UNIT IV PAINTS, PIGMENTS AND INSULATING MATERIALS 9

Paints - ingredients and their functions required properties of a paint - paint constituents and their functions - manufacture of paint- types of pigments - characteristics of pigment - oils - uses in paint - emulsion paints - special paints - paint remover. varnishes - lacquers — enamels-electrical insulating materials - dielectric properties - requirements of an electrical insulating material - classification of insulating material - electrical rigid insulations.

UNIT V SUGAR AND LEATHER CHEMISTRY **9**

Sugar Chemistry - introduction - manufacture of cane sugar - recovery of sugar from molasses - preparation of celotex - manufacture of sucrose from beat root - testing and estimation of sugar- leather chemistry - introduction - manufacture of leather preparation of hides for tanning - vegetable, chrome and oil tanning - byproduct.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student

1. Will have knowledge about adsorption and oxidation process.
2. Will gain idea about various methods available for water treatment.
3. Will appreciate the necessity of water and acquire knowledge of preliminary treatment.
4. Will Gain knowledge about paints, pigments, and insulating materials.
5. Will be able to understand about sugar and leather chemistry.

TEXTBOOKS:

1. B.K. Sharma, "Industrial chemistry,Krishna Prakashan Media (p) Ltd"., 2011.
2. K. Bagavathi, "Sundari Applied Chemistry", 1st Ed., MJP Publishers, , 2006.
3. Jayashree Ghosh, "Fundamental Concept of Applied Chemistry", S. Chand & Company Ltd., 2006.

REFERENCES:

1. A. Heaton, "An Introduction to Industrial Chemistry. 3rd Ed., Chapman and Hall, New York, 1996.
2. H.L. White, "Introduction to Industrial Chemistry", 1st Ed., John Wiley, 2015.

22OME14 **INDUSTRIAL ROBOTICS**

L	P	T	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVE:

1. To introduce the basic concepts, laws, parts of robots, end effectors, sensors, programming methods, various applications of robots, justification and implementation of robot.

UNIT I INTRODUCTION 9

Introduction- Basic components of robot-Laws of robotics- classification of robot-work space - accuracy-resolution–repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives

UNIT II ROBOT END EFFECTORS 9

Introduction- Classification of end effectors — Tools as end effectors. Drive system for grippers-Mechanical - adhesive-vacuum-magnetic grippers. Hooks &scoops. Gripper force analysis and gripper design. Active and passive grippers.

UNIT III SENSORS 9

Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors, binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT IV ROBOT PROGRAMMING 9

Robot Languages- Classification of robot language-Computer control and robot software-Val system and Languages.

UNIT V FIELD APPLICATIONS OF ROBOTICS 9

Material transfer, Machine loading, Assembly, inspection, processing operations and service robots, Delivery Robots – Intelligent vehicles – Survey and inspection robots – Space Robots – Autonomous aircrafts – Underwater Inspection – Agriculture and Forestry – Military robots

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

1. Express the basic concepts, laws, components and parameters of robots
2. Explain the types of grippers and its functions.
3. Summarize and determine various types of sensors involved in controlling the robots.
4. Describing the various programming techniques used in industrial robots
5. Use of robots in various field of applications

TEXT BOOKS:

1. M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited 2nd Edition, 2012
2. Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, “Introduction toautonomous mobile robots”, 2nd edition, MIT Press, 2011.

REFERENCES:

1. John.J.Craig, " Introduction to Robotics: Mechanics & control"Pearson Publication, Fourth edition, 2018.
2. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.
3. Saeed B Niku, ‘Introduction to Robotics, Analysis, Control, Applications, Wiley India Pvt Ltd publication, 2nd Edition, 2011.

22OAG11 INTEGRATED WATER RESOURCES MANAGEMENT

L	P	T	C
3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To introduce the students to the interdisciplinary analysis of water and conceptualdesign of intervention strategies.
2. To develop a knowledge-base on capacity building on IWRM.

UNIT I IWRM FRAMEWORK 9

Definition – Objectives – Principles - Evolution of IWRM - IWRM relevance in water resourcesmanagement – Paradigm shift: Processes and prospective outcomes

UNIT II CONTEXTUALIZING IWRM 9

UN formulations - SDG goals - IWRM in Global, Regional and Local water partnership —Institutional transformation - Bureaucratic reforms - Inclusive development

UNIT III EMERGING ISSUES IN WATER MANAGEMENT 9

Emerging Issues -— Drinking water management in the context of climate change - IWRM andirrigation - Flood – Drought – Pollution – Linkages between water, health and poverty

UNIT IV IWRM AND WATER RESOURCES DEVELOPMENT IN INDIA 9

Rural Development - Ecological sustainability- -Watershed development and conservation -Ecosystem regeneration – Wastewater reuse - Sustainable livelihood - Food security

UNIT V ASPECTS OF INTEGRATED DEVELOPMENT 9

Capacity building - Conceptual framework of IWRM – Problems and policy issues - Solutions foreffective integrated water management - Case studies

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

The students will be able to

1. Understand objectives, principles and evolution of integrated water resourcesmanagement.
2. Have an idea of contextualizing IWRM
3. Gain knowledge in emerging issues in water management, flood, drought, pollution andpoverty.
4. Understand the water resources development in India and wastewater reuse.
5. Gain knowledge on integrated development of water management.

TEXTBOOKS:

1. Mollinga P. *et al.* “Integrated Water Resources Management”, Water in South Asia VolumeI, Sage Publications, 2006.
2. Sithamparanathan, Rangasamy, A., and Arunachalam, N., “Ecosystem Principles and Sustainable Agriculture”, Scitech Publications (India) Pvt.Lt, Chennai, 1999.

REFERENCES:

1. Cech Thomas V., Principles of Water Resources: History, Development, Management andPolicy. John Wiley and Sons Inc., New York. 2003.
2. Murthy, J.V.S., “Watershed Management in India”, Wiley Eastern Ltd., New York, 1995.
3. Dalte, S.J.C., “Soil Conservation and Land Management”, International Book Distribution,India, 1986.

22OBT06	**INTRODUCTION TO BIOENERGY AND BIOFUELS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. This course will be focussed on achievement, acquisition of knowledge and enhancement of comprehension of information regarding bioenergy and biofuel technologies and their sustainable applications.

UNIT I CONCEPTS **9**

Biopower, Bioheat, Biofuesl, advanced liquid fuels, drop-in fuels, biobased products

UNIT II FEEDSTOCKS **9**

Harvested Feedstocks: First generation biofuels, Second generation biofuels, third generation biofuels. Residue Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and insdustrial waste.

UNIT III CONVERSION TECHNOLOGIES **9**

Biorefinery concept – biorefineries and end products, Biochemical conversion – hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion and trans-esterification, Thermochemical conversion – Combustion, Gasification, Pyrolysis, other thermochemical conversion technologies. Scaling up of emerging technologies.

UNIT IV BIOFUELS **9**

Pros and cons of Biofuels, Algal biofuels, Cyanobacteria and producers of biofuels, Jatropha as biodiesel producer, Bioethanol, Biomethane, biohydrogen, biobutanol, metabolic engineering of fuel molecules, Engineering aspects of biofuels, Economics of biofuels

UNIT V SUSTAINABILITY & RESILIENCE **9**

Environmental Sustainability, bioenergy sustainability, emissions of biomass to power generation applications, emissions from biofuels. ILUC issues, Carbon footprint, Advanced low carbon fuels

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1. demonstrate general knowledge and understanding of some of the basic facts, language, concepts and principles relating to plants
2. Understand composition and properties of plants and the different ways in which plant products have been utilised by humans
3. demonstrate an understanding of the contribution that science can make to informed debate on issues arising from the use of plants and the threats posed to plants and their habitats
4. Make sense of information presented in different ways, including textual, numerical, graphical, multimedia and web-based material.
5. Identify their limited scope in terms of suitable sites, dependence on the elements, capital costs, and cost effectiveness compared with traditional sources.

Text Book(s):

1. Biorenewable Resources – Engineering new products. Robert C Brown. Blackwell Publishing Professional, 2003.
2. Biofuels. Wim Soetaert and Erik Vandamme (Editors) Wiley. 2009.
3. Biomass for Renewable Energy, Fuels and Chemicals. Donald Klass. Academic press. 1998

Reference Books:

1. Introduction to Bioenergy.Vaughn C. Nelson and Kenneth L. Starcher.
2. Bioenergy: Biomass to Biofuels by by Anju Dahiya
3. Bioenergy: Principles and Applications by Yebo Li and Samir Kumar Khanal
4. Bioenergy by Judy D. Wall and Caroline S. Harwood
5. Bioenergy: Sustainable Perspectives by Ted Weyland

22OHS04 **MEDICAL PHYSICS**

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To study the complete non-ionizing radiations including light and its effect in human body.
2. To understand the principles of ultrasound radiation and its applications in medicine.
3. To learn about radioactive nuclides and also the interactions of radiation with matters andhow isotopes are produced.
4. To study the harmful effects of radiation and radiation protection regulations.

UNIT I NON-IONIZING RADIATION AND ITS MEDICAL APPLICATIONS 9

Introduction to EM waves - Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model- Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light-Measurement of light and its unit- limits of vision and color vision an overview - Applications of ultraviolet in medicine, Thermography.

UNIT II ULTRASOUND IN MEDICINE 9

Ultrasound fundamentals — Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter: Cavitation, Reflection, Transmission- Scanning systems — Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications- Ultrasonography.

UNIT III PRINCIPLES OF RADIOACTIVE NUCLIDES AND DECAY 9

Introduction to Radioisotopes - Radioactive decay : Spontaneous Fission, Isomeric Transition, Alpha Decay, Beta Decay, Positron Decay, Electron Capture- Radioactive decay equations – Half life-Mean Life- Effective half-life - Natural and Artificial radioactivity, - Production of radionuclide – Cyclotron produced Radionuclide - Reactor produced Radionuclide: fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide - Radionuclide Generator-Technetium generator.

UNIT IV INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation - Interaction of X and Gamma radiation with matter: Photoelectric effect, Compton Scattering, Pair production- Attenuation of Gamma Radiation - Interaction of neutron with matter and their clinical significance- Radionuclide used in Medicine and Technology.

UNIT V RADIATION EFFECTS AND REGULATIONS 9

Classification of Radiation Damage, Stochastic and Deterministic Effects, Acute Effects of Total Body Irradiation, Long-Term Effects of Radiation, Risk Versus Benefit in Diagnostic Radiology and Nuclear Medicine, Risk of Pregnant Women, Nuclear Regulatory Commission, ALARA Program, Medical Uses of Radioactive Materials, Survey for Contamination and Exposure Rate, DoseCalibrators and Survey Meters, Bioassay, Radioactive Waste Disposal.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Analyze the low frequency and high frequency effects of non-ionizing radiation and physics of light.
2. Define various clinical applications based on ultrasound wave.
3. Explain the process of radioactive nuclide production using different techniques
4. Analyze radiation mechanics involved with various physiological systems
5. Outline the detrimental effects of radiation and regulations for radiation safety.

TEXT BOOKS:

1. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, Medical Physicsand Biomedical Engineering, 2nd Edition, IOP Publishers.2001. (Unit I & II)
2. Gopal B. Saha, Physics and Radiobiology of Nuclear Medicine, 4th Edition, Springer,2013. (Unit III & IV)
3. R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002. (Unit V)

REFERENCES:

1. S.Webb " The Physics of Medical Imaging", Taylor and Francis, 1988
2. HyltonB.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons, 1995
3. John R Cameran , James G Skofronick "Medical Physics" John-Wiley & Sons. 1978
4. W.J.Meredith and J.B. Massey " Fundamental Physics of Radiology" Third edition,Varghese Publishinghouse. 1992

22OAG14 PARTICIPATORY WATER RESOURCES MANAGEMENT

	L	P	T	C
	3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To gain an insight on local and global perceptions and approaches on participatorywater resource management

UNIT I FUNDAMENTALS: SOCIOLOGY AND PARTICIPATORY APPROACH 9

Sociology – Basic concepts – Perspectives- Social Stratification – Irrigation as a Socio technical Process - Participatory concepts– Objectives of participatory approach

UNIT II UNDERSTANDING FARMERS PARTICIPATION 9

Farmers participation –need and benefits – Comparison of cost and benefit -Sustained system performance - Kinds of participation – Context of participation, factors in the environment – WUA - Constraints in organizing FA – Role of Community Organiser – Case Studies.

UNIT III ISSUES IN WATER MANAGEMENT 9

Multiple use of water – Issues in Intersectoral Water Allocation - domestic, irrigation, industrial sectors - modernization techniques – Rehabilitation – Command Area Development - Water delivery systems

UNIT IV PARTICIPATORY WATER CONSERVATION 9

Global Challenges -Social – Economic – Environmental - Solutions –Political - Water Marketing –Water Rights -Consumer education – Success Stories Case Studies

UNIT V PARTICIPATORY WATERSHED DEVELOPMENT 9

Concept and significance of watershed - Basic factors influencing watershed development —- Principles of watershed management - Definition of watershed management — Identification of problems - Watershed approach in Government programmes —- People’s participation — Entry point activities - Evaluation of watershed management measures.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

The students will be able to

1. gain knowledge on various processes involved in participatory water resource management.
2. Understand farmers participation in water resources management.
3. Aware of the issues related to water conservation and watershed development
4. Get knowledge in participatory water conservation
5. Understand concept, principle, approach of watershed management.

TEXTBOOKS:

1. Sivasubramaniyan, K. Water Management, SIMRES Publication, Chennai, 2011
2. Uphoff.N., Improving International Irrigation management with Farmer Participation – Getting the process Right – Studies in water Policy and management, No.11, Westview press, Boulder,CO, 1986.
3. Tideman, E.M., "Watershed Management", Omega Scientific Publishers, New Delhi, 1996.

REFERENCE:

1. Chambers Robert, Managing canal irrigation, Cambridge University Press, 1989

22OBT08	PRINCIPLES OF FOOD PRESERVATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. The course aims to introduce the students to the area of Food Preservation. This is necessary for effective understanding of a detailed study of food processing and technology subjects.

UNIT I FOOD PRESERVATION AND ITS IMPORTANCE 9

Introduction to food preservation. Wastage of processed foods; Shelf life of food products; Types of food based on its perishability. Traditional methods of preservation

UNIT II METHODS OF FOOD HANDLING AND STORAGE 9

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods. retort pouch packing, Aseptic packaging.

UNIT III THERMAL METHODS 9

Newer methods of thermal processing; batch and continuous; In container sterilization-canning; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods

UNIT IV DRYING PROCESS FOR TYPICAL FOODS 9

Rate of drying for food products; design parameters of different type of dryers; properties of airwater mixtures. Psychrometric chart, freezing and cold storage.freeze concentration, dehydrofreezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

UNIT V NON-THERMAL METHODS 9

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Be aware of the different methods applied to preserving foods
2. Apply the principles and methods involved in the processing of different foods and discuss the processing of cereals and pulses
3. Discuss pulse processing and preservation techniques.

4. Explain spice processing and preservation techniques.
5. Identify oil seed processing and preservation.

Text Book(s):

1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”.Surbhi Publications, 2001.
3. Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

Reference Books:

1. Rahman, M. Shafiur. “Handbook of Food Preservation”. Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. “Food Preservation Techniques”. CRC / Wood Head Publishing, 2003.
3. Ranganna, S. “Handbook of Canning and Aseptic Packaging”. Tata McGraw-Hill, 2000.

22OBT09	**PRINCIPLES OF FOOD PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To know about the constituents and additives present in the food.
2. To gain knowledge about the microorganisms, which spoil food and food borne diseases.
3. To know different techniques used for the preservation of foods.

UNIT I FOOD AND ENERGY 9

Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.

UNIT II FOOD ADDITIVES 9

Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 9

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

UNIT IV FOOD BORNE DISEASES 9

Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

UNIT V FOOD PRESERVATION 9

Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Be aware of the different methods applied to preserving foods
2. Different constituents present in food and microorganism involved in processing of food.
3. Principles and different preservations techniques of food can also be known.
4. Unit operations in modern food processing and impact of the process on food quality
5. Discuss pulse processing and preservation techniques.
6. Explain spice processing and preservation techniques.
7. Identify oil seed processing and preservation.

Text Book(s):

1. T.P. Coultate – Food – The Chemistry Of Its Components, 2nd Edn. Royal Society,London,1992.
2. B. Sivasanker – Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. NewDelhi 2002.

Reference Books:

1. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., Mcgraw-Hill Book Co., NewYork 1988.
2. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987.

22OME25 **PRODUCT DESIGN AND DEVELOPMENT**

L	P	T	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVE:

1. The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

UNIT I INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan andestablish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION 9

Task — Structured approaches — clarification — search — externally and internally — explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailedinterface specifications.

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process

– investigation of customer needs – conceptualization – refinement – management of the industrialdesign process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs — Minimize system complexity — Prototype basics — principles of prototyping — planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

On completion of the course, the student is expected to

1. to design some products for the given set of applications
2. understand the structure and concept generation and selection
3. Gain Knowledge about product architecture.
4. Design integrated processes and assesement of industrial design
5. Make a prototypeof a problem and hence product design and development can be achieved.

TEXT BOOK:

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999.

REFERENCES:

1. Kemnneth Crow, “Concurrent Engg./Integrated Product Development”, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, “Tool Design –Integrated Methods for Successful Product Engineering”, AddisonWesley Publishing, New york, NY.

22OME27 PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To understand the concept and basic mechanics of metal cutting, working of standard machine tools, such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
2. To understand the basic concepts of Computer Numerical Control (CNC) machine tool and CNC programming.

UNIT I ENGINEERING MATERIALS 9

Engineering materials - their classification - Mechanical properties of materials, strength, elasticity, plasticity, stiffness, malleability, ductility, brittleness, toughness, hardness, resilience, machinability, formability, weldability. Steels and cast irons: Carbon steels, their classification based on percentage of carbon as low, mild, medium & high carbon steel, their properties & applications. Wrought iron, cast iron. Alloy steels: Stainless steel, tool steel.

UNIT II MACHINING 9

Basic principles of lathe - machine and operations performed on it. Basic description of machines and operations of Shaper-Planner, Drilling, Milling & Grinding.

UNIT III WELDING 9

Introduction, classification of welding processes. Gas welding, types of flames and their applications. Electric Arc welding. Resistance welding, Soldering & Brazing processes and their uses.

UNIT IV ADVANCED MANUFACTURING PROCESS 9

Abrasive flow machining - abrasive jet machining - water jet machining - Electro Discharge Machining (EDM) - Wire cut EDM - Electro Chemical Machining (ECM) - Ultrasonic Machining / Drilling (USM / USD) - Electron Beam Machining (EBM) - Laser Beam Machining (LBM).

UNIT V CNC MACHINE 9

Numerical control (NC) machine tools - CNC: types, constitutional details, special features - design considerations of CNC machines for improving machining accuracy - structural members - slide ways - linear bearings - ball screws - spindle drives and feed drives. Part programming fundamentals - manual programming.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

Upon completion of this course, the students can able to

1. Apply the different manufacturing process and use this in industry for component production.
2. Understand completely about lathe and machining.
3. Understand about different types of welding processes
4. Gain knowledge about advanced manufacturing processes
5. Acquire idea about CNC machine and programming.

TEXTBOOKS:

1. "Manufacturing Engineering and Technology", Kalpakjian and Schmid, Pearson, 2010.
2. Hajra Choudry, "Elements of workshop technology - Vol II", Media promoters, 2002.

REFERENCES:

1. Gupta. K.N., and Kaushik, J.P., 1998, Workshop Technology Vol I and II, New Heights, Daryaganj, New Delhi.
2. Arthur. D., et. al. 1998, General Engineering Workshop Practice, Asia Publishing House, Bombay.
3. Chapman W.A.J., Workshop Technology, 1992, Part I, II, III, E.L.B.S. and Edward Amold Publishers Ltd, London.

22OME30 RENEWABLE ENERGY SOURCES

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To get exposure on solar radiation and its environmental impact to power.
2. To know about the various collectors used for storing solar energy.
3. To know about the various applications in solar energy.
4. To learn about the wind energy and biomass and its economic aspects.
5. To know about geothermal energy with other energy sources.

UNIT I PRINCIPLES OF SOLAR RADIATION 9

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II SOLAR ENERGY COLLECTION 9

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 9

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT IV WIND ENERGY 9

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT V GEOTHERMAL ENERGY: 9

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Understanding the physics of solar radiation.
2. Ability to classify the solar energy collectors and methodologies of storing solar energy.
3. Knowledge in applying solar energy in a useful way.
4. Knowledge in wind energy and biomass with its economic aspects.
5. Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

TEXT BOOKS:

1. Rai G.D., “Non-Conventional Energy Sources”, Khanna Publishers, 2011
2. Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011

REFERENCES:

1. Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, 2007
2. Ramesh R & Kumar K.U, “Renewable Energy Technologies”,Narosa Publishing House,2004
3. Mittal K M, “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd, New Delhi, 2003
4. Kothari D.P, Singhal., K.C., “Renewable energy sources and emerging technologies”,P.H.I, New Delhi, 2010

22OEC23 SENSORS AND ACTUATORS

L	P	T	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systemsused in mechatronics system development.

UNIT I INTRODUCTION 9

Basics of Measurement — Classification of errors — Error analysis — Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT — RVDT — Synchro — Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors — RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 9

Photo conductive cell, photo voltaic, Photo resistive, LDR — Fiber optic sensors — Pressure — Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING and DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

The students will be able to

1. Expertise in various calibration techniques and signal types for sensors.
2 Apply the various sensors in the Automotive and Mechatronics applications
3. Study the basic principles of various smart sensors.
4. Gain knowledge about optical, pressure and temperature sensors.
5. Implement the DAQ systems with different sensors for real time applications

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements andInstrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES

1. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2010.
2. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
3. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

22OCS27	SOFTWARE ENGINEERING	L	P	T	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To understand the phases in a software development project
2. To learn project management concepts
3. To understand the concepts of requirements analysis and modeling.
4. To understand software design methodologies
5. To learn various testing methodologies
6. To be familiar with issues related to software maintenance

UNIT I SOFTWARE PROCESS 9

Introduction to Software Engineering, scope – software crisis – principles of software engineering - Software process – Life cycle models – Traditional and Agile Models - Team organization.

UNIT II PLANNING AND ESTIMATION 9

Planning and the software process – cost estimation: LOC, FP Based Estimation, COCOMO I & II Models – Duration estimation and tracking – Gantt chart - Software Project Management – plan –risk analysis and management.

UNIT III REQUIREMENTS ANALYSIS AND SPECIFICATION 9

Software Requirements: Functional and Non-Functional, Software Requirements specification

Structured system Analysis — modeling: UML based tools, DFD - Requirement Engineering Process.

UNIT IV SOFTWARE DESIGN AND IMPLEMENTATION 9

Design process – Design principles and guidelines – design techniques – coupling and cohesion - metrics – tools. Implementation: choice of programming language, programming practices – coding standards – code walkthroughs and inspections.

UNIT V TESTING AND MAINTENANCE 9

Software testing fundamentals- Testing techniques: white box, black box, glass box testing - unit testing – integration testing –system testing – acceptance testing – debugging. Post-delivery maintenance: Types – objectives - metrics - Reverse Engineering.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOMES:

At the end of this course, the students will be able to

1. Understand different software life cycle models.
2. Perform software requirements analysis
3. Apply systematic methodologies for software design and deployment.
4. Understand various testing approaches and maintenance related issues.
5. Plan project schedule, and estimate project cost and effort required.

TEXT BOOKS:

1. Roger S. Pressman, "Software Engineering – A Practitioner‟s Approach", Seventh Edition,Mc Graw-Hill International Edition, 2010.
2. Ian Sommerville, "Software Engineering", 9th Edition, Pearson Education Asia, 2011.

REFERENCES:

1. Rajib Mall, "Fundamentals of Software Engineering", Third Edition, PHI Learning PrivateLimited, 2009.
2. Pankaj Jalote, "Software Engineering, A Precise Approach", Wiley India, 2010.
3. Kelkar S.A., "Software Engineering", Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited,2007.
5. http://nptel.ac.in/.

22OME33 SUPPLY CHAIN MANAGEMENT

L	P	T	C
3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVE:

1. To provide an insight on the fundamentals of supply chain networks, tools and techniques.

UNIT I INTRODUCTION 9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies — Driversof Supply Chain Performance and Obstacles.

UNIT II SUPPLY CHAIN NETWORK DESIGN 9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain — Framework for network Decisions.

UNIT III LOGISTICS IN SUPPLY CHAIN 9

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

UNIT IV SOURCING AND COORDINATION IN SUPPLY CHAIN 9

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect — Effect of lack of co-ordination in supply chain and obstacles — Building strategic partnerships and trust within a supply chain.

UNIT V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 9

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

1. The student would understand the framework and scope of supply chain networks and functions.

TEXTBOOK:

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 2010.

REFERENCES:

1. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, 2002.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI, 2010
3. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
4. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2000.

Vertical – I (BIOPROCESS TECHNOLOGY)

22PBT35	BIOPROCESS CONTROL AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	Syllabus Version	V 0.1

COURSE OBJECTIVES:

1. To enable the students to understand measurement of cells and control of oxygen.
2. To make students understand open loop system and closed loop system.
3. To enable students gain knowledge about frequency response and advanced process control biosensors

COURSE CONTENT:

UNIT I BIOCHEMICAL PROCESS VARIABLES AND THEIR MEASUREMENTS **9**

Temperature, flow measurement and control, Pressure measurement and control, shaft power, rate of stirring, detection and prevention of foam, measurement of cells, measurement and control of dissolved oxygen, inlet and outlet gas analysis, pH measurement and control.

UNIT II OPEN LOOP SYSTEMS **9**

Laplace transformation, application to solve ODEs. Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS **9**

Closed loop control systems, development of block diagram for feed-back control systems servo and regulatory problems, transfer function for controllers and final control element.

UNIT IV FREQUENCY RESPONSE **9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings.

UNIT V ADVANCED PROCESS CONTROL AND BIOSENSORS **9**

Introduction to advanced control systems, cascade control, feed forward control On-line analysis of process parameters; Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence; Microbial biosensors; Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Artificial neural networking and use in prediction of bioprocess and control.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand biochemical process variables and their measurements.
2. Gain knowledge about open loop systems.
3. Gain knowledge about closed loop sysytems.
4. Explain about frequency response of closed loop systems.
5. Understand about advanced process control and biosensors.

TEXT BOOK(S):

1. Stephanopoulos, G., “Chemical Process Control“, Prentice Hall of India, 2003.
2. Coughnowr, D., “ Process Systems Analysis and Control “,. 3rd ed., McGraw Hill, 2008.
3. Sensors in Bioprocess Control (Biotechnology and Bioprocessing Series) by John Twork , 2020.

REFERENCE BOOKS:

1. Process Control Instrumentation Technology (8th Edition) by Curtis Johnson ,2008
2. Marlin, T. E., “ Process Control “, IInd Edn, McGraw Hill, New York, 2000.
3. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”,IInd Edn., John Wiley, New York, 1997.

22PBT36	**FERMENTATION TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Pre-requisite Nil		**Syllabus Version**			V 0.1

COURSE OBJECTIVES:

The student should be made to,

1. Recognize the overall industrial fermentation process and the process flow sheet.
2. Understand the knowledge on algal biotechnology.
3. Interpret the knowledge on production of commercially important primary metabolites & secondary metabolites.
4. Understand the biological effluent treatment process
5. Apply the knowledge for the production of modern biological products.

COURSE CONTENT:

UNIT I INTRODUCTION TO FERMENTATION TECHNOLOGY 9

History and development of fermentation industry; General requirements of fermentation processes; types of fermentation – homo fermentation, hetero fermentation: category of fermentation based on end product formed – lactic acid fermentation, alcohol fermentation, acetic acid fermentation, butyric acid fermentation.

UNIT II ALGAL BIOTECHNOLOGY 9

Microorganisms and raw materials used for microbial Oil production, Current technologies of biofuel production −. Cyanobacterial and algal fuels; Fine chemicals and neutraceuticals from algae; UV absorbing pigments Industrial products from macro algae - seaweed biotechnology; Bioweapons and Bioshields.

UNIT III FUTURE ASPECTS OF FERMENTATION TECHNOLOGY 9

Microbial fungicides and Pesticides, Chemicals and Pharmaceuticals made by fermentation, Fermented food products – Beer, Wine, Genetically Modified Organisms, Biopolymers. Microbial leaching, Effluent treatment using microbes, Future of fermentation technology and its products.

UNIT IV BIOLOGICAL EFFLUENT TREATMENT 9

Microbes involved in aerobic and anaerobic processes in nature; Water treatment- BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal; secondary waste water treatments; use of membrane bioreactor; aquaculture effluent treatment; Aerobic sludge and land fill leachate process; aerobic digestion.

UNIT V FERMENTATION PROCESS ECONOMICS 9

Process economics: General fermentation process economics; materials usage and cost; capital investment estimate; production cost estimate. Case studies –Traditional product and recombinant product; Bioprocess validation: Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP and CIP.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

After completion of the course, the candidates will be able to

1. Recall the basics of industrial fermentation and other processes.
2. Extend their knowledge on algal Biotechnology.
3. Extend their knowledge on commercial production of primary and secondary metabolites.
4. Extend their knowledge on the biological effluent treatment process.
5. Support for the commercial production of modern biological products.

TEXT BOOK(S):

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology.(2016) Butterworth-Heinemann Press. UK.
2. H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology.(2014). Academic Press.

REFERENCE BOOKS:

1. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. (2006). CRC Press, USA.
2. Pandey A, Lasroche C, Soccol C. R and Dussop C. G. Advances in Fermentation technology (2008).Asiatech publishers Inc.
3. Peter,Max S. and Timmerhaus, Klaus D,Plant Design and Economics for Chemical Engineers,McGraw Hill.

22PBT37 **FOOD PROCESSING AND TECHNOLOGY**

L	T	P	C
3	0	0	3

Pre-requisite Microbiology **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To know about the constituents and additives present in the food.
2. To gain knowledge about the microorganisms, which spoil food and food borne diseases.
3. To know different techniques used for the preservation of foods.

COURSE CONTENT:

UNIT I FOOD ENERGY AND LAWS 9

Constituents of food – Carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics. National food legislation, other food legislations/authorities and their role-essential commodities act, ISI mark of BIS and agmark, food and agricultural organization (FAO), world health organization(WHO), codex joint FAO/WHO expert committee on food additives (JECFA),world trade organization (WTO), International organization for standardization (ISO) Food safety and quality management systems.

UNIT II FOOD ADDITIVES 9

Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colorants-natural and artificial; food flavours; enzymes as food processing aids.

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 9

Bacteria, yeasts and molds- sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

UNIT IV FOOD BORNE DISEASES 9

Classification- food infections- bacterial and other types, food intoxication and poisoning; bacterial and non-bacterial, food spoilage- factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

UNIT V FOOD PRESERVATION 9

Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning, frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME

On completion of the course, the student is expected to

1. Understand the basic concepts of food constituents present in Food and microorganisms involved in food processing
2. Apply the principles and methods involved in the processing of different foods.
3. Able to understand various food processing additives
4. Familiar with the food borne diseases and factors involved in food spoilage
5. Understand different principles and food preservation techniques.

TEXT BOOK(S):

1. T.P. Coultate-Food-The Chemistry of its Components, 2nd edition. Royal society, London, 1992.
2. B. Sivasanker-Food processing and preservation, Prentice-Hall of IndiaPvt.Ltd.New Delhi, 2002.
3. George J.B. Basic Food Microbiology, CBS Publishers & Distributors, 1987.

REFERENCE BOOKS:

1. W.C.Frazier and D.C.Westhoff-Food Microbiology, 4th Ed.,McGraw-Hill book Co.,New York.
2. J.M.Jay-Modern Food Microbiology, CBS Pub.New Delhi,1987.

22PBT38	**BIOREACTOR DESIGN AND SCALE UP PROCESS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To enable students understand basic bioreactor concepts.
2. To enable students understand about bioreactor designs and scale up processes.

COURSE CONTENT:

UNIT I BASIC BIOREACTOR CONCEPTS 9

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.

UNIT II AERATION AND AGIATATION IN BIOPROCESS SYSTEMS 9

Mass transfer in agitated tanks; Power requirement for mixing; Agitation rate studies – Mixing time and residence time distribution; Bioreactor Geometry – Reactor, impeller, sparger and baffle design; shear damage, bubble damage, methods of minimizing cell damage. Case Studies for Aeration and Agitation.

UNIT III SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT 9

Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries.

UNIT IV BIOREACTOR SCALE-UP AND SCALE-DOWN 9

Scale-up Techniques: – Scale up by geometric similitude. constant power consumption per volume, constant mixing time, constant impeller tip speed, constant volumetric mass transfer co-efficient; Scale–down Related Aspects; Case Studies in Bioreactor Scaleup and Scale-down Aspects.

UNIT V CASE STUDIES 9

Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand basic bioreactor concepts with flowcharts.
2. Gain knowledge about aeration and agitation in bioprocess processes.
3. Gain knowledge about selection and design of bioprocess equipments.
4. Differentiate bioreactor scale-up and Scale down.
5. Design Case studies of bioreactor for plant and animal cell.

TEXT BOOK(S):

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa,. Bioprocess Engineering, 3rd Edition, Prentice Hal, 2017
2. Pauline Doran, Bioprocess Engineering Calculation, 2nd Edition, Blackwell Scientific Publications, 2012
3. James M. Lee, Biochemical Engineering, Prentice Hall, 1992

REFERENCE BOOKS:

1. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, 1986.
2. S.Liu, Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design, Elsevier, 2016
3. Octave Levenspiel, Chemical Reaction Engineering, Wiley 2016.

22PBT05	BIOPROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

The student should be made to,

1. To understand the mathematical models in Biochemical Engineering systems.
2. To learn about different aspects of modelling in Bioprocess system.
3. To learn various techniques to solve and simulate various bioprocess models.

COURSE CONTENT:

UNIT I BASIC MODELLING PRINCIPLES 9

Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling. Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics with examples.

UNIT II MATHEMATICAL MODELS FOR BIOREACTOR SYSTEMS 9

Batch reactor, CSTR isothermal with cooling/heating jacket or coil, Fed Batch reactor.

UNIT III MODELLING APPROACHES FOR BIOLOGICAL SYSTEMS 9

Growth kinetic Models – structured and unstructured systems; Compartment models; Cybernetic models; Genetically structured models, Single cell models, Morphologically structured models. Thermal death kinetics models, Stochastic Model for thermal sterilization of medium.

UNIT IV MODELLING APPROACHES FOR BIOLOGICAL PROCESSESS 9

Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production, Ethanol fermentation.

UNIT V SIMULATION OF BIOPROCESSES 9

Software packages for simulation of bioprocesses – MATLAB-SIMULINK, Creating bioprocess models in MATLAB and Simulink environment. Linear and non-linear estimation of the kinetic parameters for types and model.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the basic modelling principles in Biochemical Engineering systems.
2. Apply the knowledge of modeling concepts for bioreactor design.
3. Utilize modelling approaches for various bioprocess estimation.
4. Build kinetic simulation models of the cell growth and product formation.
5. Connect different models together to build a bioprocess model.

TEXT BOOK(S):

1. Luyben W.L., "Process Modeling, Simulation and control for Chemical Engineers", McGraw Hill, 2nd Edition, 2013.
2. Bailey J.A and Ollis D.F., "Biochemical Engineering Fundamentals", McGraw Hill (New York), 2nd Edition, 2010.
3. T.K.Ghose., "Bioprocess Computations in Biotechnology-Vol.I", Ellis Horwood Ltd. 1989

REFERENCE BOOKS:

1. Perry R H ,"Perry's Chemical Engineers' Handbook", McGraw-Hill, 8th Edition, 2008.

22PBT38 BIOREACTOR DESIGN AND SCALE UP PROCESSES

		L	**T**	**P**	**C**
		3	**0**	**0**	**3**
Pre-requisite	Nil	**Syllabus Version**			V 0.1

COURSE OBJECTIVES:

1. To expose students to application of recombinant DNA technology in biotechnological research.
2. To train students in strategizing research methodologies employing genetic engineering techniques.

COURSE CONTENT:

UNIT I GENETICALLY ENGINEERED ORGANISMS 9

Different host vector systems, Guidelines for choosing Host Vector systems, Proces.s constraints – Genetic instability, considerations in plasmid design, Regulatory constraints, principles and implementation of containment, good industrial large-scale practice (GILSP).

UNIT II CONSIDERATIONS FOR ANIMAL CELL CULTURES 9

Different host vector systems, Guidelines for choosing Host Vector systems, Proces.s constraints – Genetic instability, considerations in plasmid design, Regulatory constraints, principles and implementation of containment, good industrial large-scale practice (GILSP).

UNIT III CONSIDERATIONS FOR PLANT CELL CULTURES 9

Overview of plant cell cultures - Plant cells in culture compared to microbes - Bioreactor considerations for plant cell culture - Bioreactors for suspension cultures - Reactors using cell immobilization - Bioreactors for organized tissues, economics of plant cell tissue cultures.

UNIT IV DOWNSTREAM PROCESING CONSIDERATIONS 9

Release of protein from Biological Host, genetic approaches to facilitate protein purification, Solid- Liquid separation, extraction of Recombinant protein, Avoidance of proteolysis from extracts, membranes for protein isolation and purification, Chromatographic techniques, Removal of detergent from protein fractions, precipitation of proteins, protein crystallization for large scale bio separation.

UNIT V SAFETY CONSIDERATIONS ASSOCIATED WITH AGRICULTURAL AND ENVIRONMENTAL POLLUTION 9

Risk assessment methods, safety considerations, Application of rDNA organism in the environment, Survival, multiplication and/or dissemination in the environment, Interactions with species or biological systems, effects on the environment, evaluating environmental risks of rDNA organisms released from industrial applications.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected

1. To acquire skills on techniques of isolation of gene of interest and construction of recombinant DNA.
2. To apply techniques for production of pharmaceuticals, growth hormones, vaccines, gene therapy in expression system.
3. To apply rDNA technology in evolving plants for resistance to pest and disease, tolerance to herbicides and abiotic factors.
4. To identify problems associated with production of recombinant proteins and protein purification and devising strategies to overcome problem.
5. To acquire knowledge on environmental applications of genetic engineering through bioremediation.

TEXT BOOK(S):

1. Michael L. Shuler, Fikret Kargi, Matthew De Lisa,. BioprocessEngineering, 3rd Edition, Prentice Hal, 2017
2. Bailey J.A and Ollis D.F., "Biochemical Engineering Fundamentals", McGraw Hill (New York), 2nd Edition, 2010.
3. Cutler, P. ed., 2004. Protein purification protocols (Vol. 244). Springer Science & Business Media.
4. Perry R H ,"Perry's Chemical Engineers' Handbook", McGraw-Hill, 8th Edition, 2008.

REFERENCE BOOKS:

1. Pörtner, R. and Barradas, O.B.J.P., 2007. Animal cell biotechnology. Methods and Protocols, 2nd. Edition. Humana.
2. Slater, A., Scott, N. and Fowler, M., 2008. Plant biotechnology: the genetic manipulation of plants. OUP Oxford.

VERTICAL II (BIOSCIENCES)

22PBT40	BIOSENSORS	L	T	P	C
		3	0	0	3
Pre-requisite Nil		**Syllabus Version**		V 0.1	

COURSE OBJECTIVES:

1. To improve knowledge on fundamentals of biosensor
2. To understand the concept of metabolic sensors and affinity sensors
3. To know novel biosensors

COURSE CONTENT:

UNIT I FUNDAMENTALS OF BIOSENSORS 9

Biosensors as functional analogs of chemoreceptors, structure and function of transducers, qualitative and quantitative sensors, sensor parameters, transduction methods-optical, calorimetric, electrochemical and piezoelectric sensors Supports and support modifications-synthetic polymers,carbon material supports, metal supports, bifunctional crosslinkers.

UNIT II METABOLIC SENSORS 9

Methods of enzyme immobilization-adsorption, gel entrapment, covalent coupling, crosslinking immobilization effects in biosensors, characterisation of immobilized enzymes in biosensors, effectiveness factor, enzyme loading test, Metabolic sensors-glucose, ascorbic acid, lactate sensors, determination of alcohols, sensors for phenols and amines, coupled enzyme reactors, sequence electrodes for nucleic acid , enzyme sensor for inhibitors.

UNIT III AFFINITY SENSORS AND REAGENTLESS SENSORS 9

Affinity sensors based on small ligands, immunosensors, immunoassay-RIA, ELISA and TELISA, piezoelectric immunosensors, optical immunosensors, electrochemical immunoassay, Biocompatibility of sensors, biomimetic sensors, bioconjugated silica nanoparticles for bioanalysis.

UNIT IV NOVEL BIOSENSORS 9

Surface dielectric enhancement- gold nano particles enhanced surface plasmon resonance, magnetic biosensors and biochips, quantum dot based biosensors, DNA and Protein

UNIT V FOOD BIOTECHNOLOGY 9

Food spoilage causes and prevention, Food borne infections and intoxication immobilization of microbial and cultured plant cells. Principles of down stream processing, industrial production of various food products conformational changes, optical and magnetic sensors, micro and nanocantilevers, electrochemical QCM,MEMS,PCR microchamber array chip system,Detection of target DNA on a single chip.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Describe how bio specific interaction is used for various applications.
2. Compare different techniques with emphasis on selectivity and sensitivity.
3. Demonstrate knowledge of the general principles of sampling and manipulation of data generated by biosensors.
4. Apply the knowledge to identify the various types of analytical methods.
5. Design a system component or process to meet desired needs within realistic constraints.

TEXT BOOK(S):

1. Frieder Schelfer and Florian Schubert Biosensors Elsevier Science Publications 1992.
2. Challa Kumar Nanomaterials for Biosensors Wiley-VCH Verlag GMBH, Germany 2007.
3. Floriner-Gabriel Banica Chemical sensors and Biosensors-Fundamentals and Applications, John-Wiley & Sons Ltd, 2012.

REFERENCE BOOKS:

1. P. N. Bartlett (Ed.) Bioelectrochemistry- Fundamentals, Experimental techniques and applications, John Wiley & Sons, England 2008.
2. Nalwa (Ed.) Encyclopedia of Nanoscience and Nanotechnology 1 Vol. 5, 2004.

22PBT41	BIONANOTECHNOLOGY	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus Version**		V 0.1	

COURSE OBJECTIVES:

1. To improve knowledge on nanoscale processes and nanomaterials.
2. To understand the concept of bionanotechnology and protein-based nanotechnology and DNA nanotechnology

COURSE CONTENT:

UNIT I NANOSCALE PROCESSES AND NANOMATERIALS 9

Overview of nanoscale processes and characterization of nanomaterials – Physicochemical properties of nanomaterials – Concepts in nanotechnology – Natural nanomaterials –Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Polymeric nanoparticles, Buckyballs, Nanotubes)–Synthesis and assembly of nanoparticles and nanostructures using bio- derived templates.

UNIT II STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY 9

Bio molecular structure and stability – Protein folding – Self-assembly – Self-organization – Information-Driven nano assembly – Biomaterials – Bio molecular motors – Traffic across membranes – Bio molecular sensing – Self-replication – Machine-phase bio nanotechnology.

UNIT III PROTEIN-BASED NANOTECHNOLOGY 9

Overview of protein nanotechnology – Nanotechnology with S-Layer protein – Engineered nanopores – Bacteriorhodopsin and its potential – Protein assisted synthesis of metal nanoparticles – Synthesis of protein-based nanoparticles – Protein nanoparticle -hybrids – Covalent and non-covalent protein nanoparticle conjugates – Protein-carbon nanotube conjugates.

UNIT IV DNA-BASED NANOTECHNOLOGY 9

DNA-based nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – Self assembling DNA structures – DNA-nanoparticle conjugates – DNA-carbon nanotube conjugates – DNA templated electronics – DNA nanostructures for mechanics and computing – DNA nano machine.

UNIT V APPLICATIONS OF NANOTECHNOLOGY 9

Promising nanobiotechnologies for applications in medicine –Liposomes in nanomedicine – Therapeutic applications of nanomedicine – Nano-Sized carriers for drug delivery and drug carrier systems – Protein and peptide nanoparticles, DNA based nan oparticles, Lipid matrix nanoparticles for drug delivery – Nanobiosensors for imaging and diagnosis.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To recognize the nanoscale processes and nanomaterials
2. To relate the structural and functional principles
3. To develop the protein based nanomaterials
4. To construct the DNA based nanomaterials
5. To apply the theoretical knowledge for the development of nanomedicine and nanosensors

TEXT BOOK(S):

1. Niemeyer, C.M. and Mirkin, C.A., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley- VCH, 2006.

REFERENCE BOOKS:

1. Shoseyov, O. and Levy I., "Nanobiotechnology: Bioinspired Devices and Materials of the Future", Humana Press, 2008.
2. Gazit, E., and Mitraki, A., "Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology", Imperial College Press, 2013.
3. Jesus M. de la Fuente and Grazu, V., "Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles" Elsevier, 2012.

22PBT42	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To improve knowledge about stem cells and their developmental potential
2. To elaborate the understanding of stem cells in tissue engineering

COURSE CONTENT:

UNIT I INTRODUCTION TO STEM CELLS 9

Stem cell Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties

UNIT II HUMAN EMBRYONIC AND ADULT STEM CELL 9

Stem cells and their developmental potential. In vitro fertilization-culturing of embryos - blastocyst- inner cell mass-isolation and growing ES cells in lab; Identification and characterization of human ES cells. Somatic stem cells-test for identification of adult stem cells-adult stem cell differentiation- trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells.

UNIT III DIFFERENTIATION OF STEM CELLS INTO CELL TYPES 9

Factors influencing cell specialization – internal factors – asymmetric segregation, cell signaling mechanisms – diffusion, direct contact and gap junctions; environmental factors – temperature, drugs and injuries; mechanism of stem cell differentiation – errors in cell differentiation – anaplasia, dysplasia and metaplasia

UNIT IV STEM CELLS IN TISSUE ENGINERING 9

Haematopoietic Stem Cells-Growth factors and the regulation of haematopoietic stem cells, clinical applications of haematopoietic stem cells; HLA matching, patient selection, peripheral blood and bone marrow transplantation; Mesenchymal stem cells and their role in bone tissue engineering- bone repair; Stem cell based gene therapy and benefits to human. Techniques in stem cell technology - fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging

UNIT V APPLICATION AND ETHICAL ISSUES 9

Therapeutic applications-Parkinsons disease, Cancer stem cell – Neural stem cell for central nervous system repair – Spinal cord injury – use of ESC to treat heart disease – Burns and skin ulcers – Orthopaedic applications of stem cell - Insulin-producing Cells Derived from Stem cells: A Potential Treatment for Diabetes; Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To differentiate different types of stem cells and to characterize them
2. To determine the factors affecting stem cell differentiation
3. To understand the role of stem cells in tissue engineering and regenerative medicine
4. To become familiarized with stem cell technology and its applications for the betterment of society
5. To gain knowledge on animal and plant stem cell

TEXT BOOK(S):

1. Stem cells by C.S Potten., Elsevier, 2006
2. Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014

REFERENCE BOOKS:

1. Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
2. Embryonic Stem cells – Protocols by KursadTurksen., Second Edition Humana Press, 2002.
3. Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific Publishing Company,2005.
4. Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013.

22PBM23	**BIOMATREIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To Study the phenomena various metals used in implant applications
2. To Acquire knowledge importance of ceramics and polymer used biomedical diagnostics
3. To Obtain the concept of different types biomaterials applied in-vitro and in-vivo biomedical implants
4. To Gain the knowledge about biomaterials used in various biomedical implant application

COURSE CONTENT:

UNIT I INTRODUCTION 9

Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties

UNIT II METALLIC IMPLANT MATERIALS 9

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

UNIT III POLYMERIC IMPLANT MATERIALS 9

Polyolefin’s, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

UNIT IV CERAMIC IMPLANT MATERIALS 9

Definition of bio ceramics. Common types of bioceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Polymers Filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

UNIT V TESTING OF MATERIALS 9

Biocompatibility and Toxicological screening of biomaterials: Definition of biocompatibility blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the basic principle and properties of biomaterials.
2. Analyze various types of metals used in implant applications**.**
3. Know about polymeric implant materials
4. Understand host tissue reactions in relation with ceramic implant materials
5. Explain the process of importance of ceramics and polymer used biomedical diagnostics

TEXT BOOK(S):

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2003.

REFERENCE BOOKS:

1. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
2. Joon park, R.S Lakes, "Biomaterials an Introduction"Springer, 2007
3. Larry L. Hench and Julian R. Jones, Biomaterials, artificial organs and tissue engineering, CRC Press 2010.

22PBT42	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus Version**			V 0.1

COURSE OBJECTIVES:

1. To identify the importance of protein biomolecules
2. To realize the structure-function relationships in proteins

COURSE CONTENT:

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 9

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Van der walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X- ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II ARCHITECTURE 9

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turnbeta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites

UNIT III TERTIARY STRUCTURE 9

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Computer exercise on the above aspects

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects

UNIT V PROTEOMICS 9

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Be familiar with different levels of protein structure.
2. Know the role of functional proteins in various field of study.
3. Practice the latest application of protein science in their research.
4. Understand the major factors for protein folding.
5. Analyze and compare protein sequence data.

TEXT BOOK(S):

1. Branden C. and Tooze J., "Introduction to Protein Structured" 2nd Edition, Garland Publishing, 1999.
2. Creighton T.E. "Proteins" 2nd Edition. W.H. Freeman, 1993.
3. Pennington, S.R and M.J. Dunn, "Proteomics: Protein Sequence to Function". Viva Books, 2002.
4. Liebler, "Introduction to Proteomics" Humana Press, 2002.

REFERENCE BOOKS:

1. Voet D. and Voet G., "Biochemistry". 3rd Edition. John Wiley and Sons, 2008.
2. Haggerty, Lauren M."Protein Structure: Protein Science and Engineering".Nova Science Publications, 2011.
3. Williamson, Mike "How Proteins Work". Garland Science, 2012.

22PBT43	MODERN BIOANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus Version**		V 0.1	

COURSE OBJECTIVES:

1. To study the various analytical techniques used in Biotechnology

COURSE CONTENT:

UNIT I SPECTROSCOPY STUDY OF CHEMICAL COMPOUNDS AND BIOMOLECULES **9**

Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, BeerLambert's law, deviation of Beer-Lambert's equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy.

UNIT II DIFFRACTION TECHNIQUES **9**

Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).

UNIT III CHROMATOGRAPHY **9**

Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.

UNIT IV MICROSCOPY **9**

Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron, diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.

UNIT V ELECTROPHORETIC TECHNIQUES **9**

Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules.

TOTAL LECTURE PERIODS **45 Periods**

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Capable of handling different instruments in the laboratory.
2. Able to compare different separation techniques and use them effectively in research work
3. Know about Chromatogrpahic techniques
4. Gain knowledge about microscopy
5. Gain knowledge on electrophoretictechniques

TEXT BOOK(S):

1. D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series. 2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009)

2 R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012).

3 R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York, 2011).

4. D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).

6. R. L. Switzer, Experimental biochemistry (W. H. Freeman and Co, New York, 3rd ed., 1999)..

REFERENCE BOOKS:

1. R. F. Boyer, Modern experimental biochemistry (Benjamin Cummings, San Francisco, 3rd ed., 2000).
2. J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006
3. B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin ; New York, 2nd ed., 2002).
4. D. B. Williams, C. B. Carter, Transmission electron microscopy a textbook for materials science (Springer, New York, 2009.
5. R. M. Silverstein, Spectrometric identification of organic compounds (John Wiley & Sons, Hoboken, NJ, 7th ed., 2005).

Vertical III (Medical Biotechnology)

22PBT44	**HUMAN GENETICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To discuss the patterns of inheritance and its relevance in disease and therapy
2. To describe various genetic laws, learn the chromosome structure function and understand methodologies for cytogenetic applications.

Course Content:

UNIT I INTRODUCTION 9

History of genetics – Mendel’s principles and experiments, segregation, multiple alleles – Independent Assortments, Genotypic interactions, epistasis and Sex chromosomes, Sex determination, Dosage compensation, sex linkage and pedigree analysis

UNIT II COMPLEX TRAITS 9

Approaches to analysis of complex traits- 'Nature vs nurture', role of family and shared environment, monozygotic and dizygotic twins and adoption studies – Polygenic inheritance of continuous (quantitative) traits and discontinuous {dichotomous) traits – Genetic susceptibility in complex traits - Estimation of genetic components of multifactorial traits: emperic risk, heritability, coefficient of relationship, application of Baye’s theorem..

UNIT III HUMAN CYTOGENETICS 9

Origins and developments in the study of human cytogenetics - Chromosome banding – Human chromosomal pathologies: Numerical and Structural aberrations and their common syndromes – Human karyotype: banding patterns, ideogram, nomenclature of banding – Nomenclature of aberrant karyotypes.

UNIT IV APPLIED GENETICS 9

Genetic linkage and gene mapping – Genetic polymorphism, RFLP, SNP, STRP – Physical mapping of the human genome – Transcriptional mapping – Molecular techniques in human chromosome analysis (FISH, GISH, CGH, SKY).

UNIT V CLINICAL GENETICS 9

Genetic basis of syndromes and disorders – Monogenic diseases: Cystic fibrosis, Marfan syndrome – Inborn errors of metabolism: Phenylketonuria, Mucopolysaccharidosis, Galactosemia–Syndromes due to triplet nucleotide expansion: Muscle genetic disorders, Sickle cell anemia, Thalassemias, Colour Blindness, Retinitis pigmentosa.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to
1. Understand the concept of Mendelian and non-Mendelian genetics.
2. Know the concepts of complex traits inheritance and mechanism of sex determination.
3. Discuss clearly about the chromosomal pathologies.
4. Describe the principles behind DNA fingerprinting methodologies using molecular markers RFLP, RAPD, STRP, and SNP's.
5. Applying the genetic technologies knowledge in industries related to pharmaceuticals, biotechnology, and diagnostic clinics.

Text Book(s):

1. Michael Goldberg, Janice Fischer, Leroy Hood and Leland Hartwell, "Genetics: From Genes to Genomes", 7th Edition. McGraw Hill Education, 2020.
2. Tom Strachan & Andrew Read, "Human molecular genetics" 4th Edition, Taylor & Francis Group, Garland Science, 2011.
3. Anthony Griffiths; John Doebley; Catherine Peichel; David A. Wassarman, "Introduction to Genetic Analysis", 12th Edition. Macmillan Learning, 2020.

Reference Books:

1. Benjamin A. Pierce, "Genetics: A Conceptual Approach", 7th Edition, Macmillan Learning, 2020.
2. William S Klug, Michael Cummings, Charlotte A. Spencer, Michael A Palladino & Darrell Killian, "Concepts of Genetics", 12th Edition, Pearson, 2019.
3. D. Peter Snustad, Michael J. Simmons, "Principles of Genetics", 7th Edition, published by Wiley, 2015.

22PBT30	**CANCER BIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Understand the basics of cancer and cancerous cells
2. Discuss the significance of carcinogenesis in the development of cancer
3. Interpret the role of oncogenes and their growth factors
4. Make understanding on process of cancer metastasis and their dysregulation factors
5. Gain knowledge on the advancement in cancer treatment
6. Design the novel drugs to treat cancer or to reduce theeffect of carcinogenesis

Course Content:

UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9

Introduction, historical perspective, classification carcinogenesis, cancer initiation, promotion & progression, pathways of spread- Epidemology Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of Physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

UNIT III MOLECULAR BIOLOGY OF CANCER 9

DNA repair defects and genomic instability in cancer cells. Signal targets and cancer, activation of kinases; Oncogenes, identification & retroviruses. Detection of oncogenes & proto oncogene activity. Growth factors related to transformation. Telomerase.

UNIT IV CANCER METASTASIS 9

Clinical significances of invasion, Molecular genetic of metastasis development, stromal microenvironment and carcinogenesis, dysregulation of cancer, associated genes Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT V ADVANCES IN CANCER THERAPY 9

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy. Recent technology to detect cancer diseases and advanced technology to cure cancer diseases. Targeted drug delivery methods to cure cancer.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Explain the development and proliferation of cancer with specific causes
2. Describe the influence of carcinogenesis in the cancer development
3. Identify the pathways and therapeutic targets of cancer
4. Outline the steps involved in metastasis and tumour cell invasion
5. Develop novel drugs and technologies for the treatment of cancer
6. Summarize the microenvironment of cancer cells and their attack on immune cells

Text Book(s):

1. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004.
3. Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). (2019). Oxford textbook of cancer biology. Oxford University Press.
4. Pelengaris, S., & Khan, M. (Eds.). (2013). The molecular biology of cancer: A bridge from bench to bedside.
5. Hejmadi, M. (2014). Introduction to cancer biology. Bookboon.

Reference Books:

1. King, RogerJ.B."Cancer Biology" Addison Wesley Longman, 1996.
2. Ruddon, RaymondW."CancerBiology"IIIrdEdition.OxfordUniversityPress,1995
3. Margaret A. Knowles, PeterJ Selby, An Introduction to Cellular and Molecular Biology of Cancer,4th Edition, Oxford Medical Publication,1991.
4. https://oncouasd.files.wordpress.com/2014/09/cancer-principles-and-practice-of-oncology-6e.pdf
5. https://archive.org/details/biologyofcancera00burc.
6. http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf

22PBT45	BIOPHARMACEUTICALS AND BIOSIMILARS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.
2. To impart the knowledge of the various dosage forms and its implications in pharmaceutical technology.

Course Content:

UNIT I INTRODUCTION 9

Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.

UNIT II DOSAGE FORMS 9

Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenterals – Pressurized dosage forms – Packaging techniques.

UNIT III ADVANCED DRUG DELIVERY SYSTEMS 9

Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release.

UNIT IV BIOSIMILARS 9

Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.

UNIT V CASE STUDIES ON BIOPHARMACEUTICALS 9

Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Comprehend the factors influencing the bioavailability and bioequivalence of drugs.
2. Grasp the current regulatory acts and safety norms of the modern pharmaceutical industries.
3. Recognize the formulation concepts and evaluate different dosage forms to meet out the compendial requirements.
4. Acquired knowledge on novel drug delivery systems and their applications in therapeutic fields.
5. Understand the design and analysis of biosimilar drugs.
6. Demonstrate knowledge and understanding of current topical and newly emerging aspects of biopharmaceuticals.

Text Book(s):

1. Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm, "Pharmaceutical Biotechnology: Fundamentals and application", Springer, 4th Edition, 2013.
2. Gary Walsh, "Pharmaceutical Biotechnology-Concepts and Application", John Wiley and Sons Publishers, 1st Edition, 2007.
3. Shein-Chung Chow, "Biosimilars: Design and Analysis of Follow-on Biologics", CRC Press, 3rd Edition, 2013.

Reference Books:

1. James Swarbrick, "Encyclopedia of Pharmaceutical Technology", CRC Press, 4th Edition, 2013.
2. Shayne Cox Gad, "Pharmaceutical Manufacturing Handbook: Production and Processes", Wiley, 2nd Edition, 2011.

22PBT09	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn the fundamentals of tissue engineering and tissue repairing
2. To acquire knowledge on clinical applications of tissue engineering
3. To understand the basic concept behind tissue engineering focusing on the stem cells
4. To study the biomaterials and its applications

Course Content:

UNIT I INTRODUCTION 9

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics ,appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT II TISSUE ARCHITECTURE 9

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS 9

Biomaterials: Properties of biomaterials ,Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation,Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

UNIT V CLINICAL APPLICATIONS 9

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedicapplications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products, ethical issues.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Ability to understand the components of the tissue architecture
2. Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
3. Awareness about the properties and broad applications of biomaterials
4. Overall exposure to the role of tissue engineering and stem cell therapy
5. Apply tissue engineering in diseases and disorders

Text Book(s):

1. Bernhard O.Palsson, Sangeeta N.Bhatia, ”Tissue Engineering” Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

Reference Books:

1. Bernard N. Kennedy (editor). Stem cell transplantation, Tissue engineering, and cancer applications, Nova Science Publishers, 2008.
2. Raphael Gorodetsky, Richard Schäfer.Stem cell-based tissue repair. RSC Publishing, 2011.
3. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two
4. Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004.
5. R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E. .l Thomas, J. Thomson, I. W.Gearhart, Essential of Stem Cell Biology, Elsevier Academic Press, 2nd Edition , 2009.
6. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine” Artech House, INC Publications, 2008.
7. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press, 2007.

22PBT46	MOLECULAR THERAPEUTICS AND DIAGNOSTICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. The basics of vaccinology, molecular immunology, antigen delivery system, adjuvants and regulatory aspects in vaccine.
2. To improve the knowledge of diagnostic techniques used for detecting diseases and monitoring disease evolution in infected hosts.

Course Content:

UNIT I INTRODUCTION TO MOLECULAR DIAGNOSTICS 9

History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites; general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples

UNIT II TRADITIONAL DISEASE DIAGNOSIS METHODS AND TOOLS 9

Diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium., Diagnosis of major fungal infections: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis.

UNIT III DIAGNOSIS AND TREATMENT OF COMMON DISEASES 9

Atherosclerosis, ischemic heart disease and cerebrovascular disease; coagulation system and hypertension; metabolic syndrome and diabetes mellitus; asthma, allergy and inflammatory diseases of the lung; gastrointestinal system, including inflammatory bowel diseases.

UNIT IV TARGETED THERAPY 9

Objective and types of targeted therapy, working mode of targeted therapy against cancer – by immunotherapy, by cell signaling interruption, by angiogenesis inhibitors, monoclonal antibody therapy, by apoptosis, hormone therapy for prostate cancer and hormone therapy for breast cancer; side effects of cancer treatment and drawbacks of targeted therapy. Targeted drug delivery – active and passive targeting, drug delivery vehicles

UNIT V TECHNIQUES IN MOLECULAR AND CLINICAL DIAGNOSTICS 9

PCR-based methods for mutation detection, alternative methods for mutation detection and DNA sequencing for disease association, microarray approaches for gene expression analysis, methods for analysis of DNA methylation; clinical diagnostic technologies: flow cytometry, medical cytogenetics, fluorescence in situ hybridization, immunohistochemistry and laser capture microdissection (FFPE).

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Ability to understand the components of the tissue architecture
2. Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
3. Awareness about the properties and broad applications of biomaterials
4. Overall exposure to the role of tissue engineering and stem cell therapy
5. Apply tissue engineering in diseases and disorders

Text Book(s):

1. Molecular Diagnostics by Harald Seitz Sarah Schumacher, Springer 2013 Ed.
2. Fundamentals of Molecular Diagnostics by David E. Bruns, Edward.R, Ashwood, Carl A. Burtis, Elsevier Health Sciences 2007

Reference Books:

1. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications by Lela Buckingham, F. A. Davis Company 2019
2. Molecular Cancer Therapeutics: Strategies for Drug Discovery and Development, by GeorgeC. Prendergast, Wiley & Sons, Inc. 20043.
3. Molecular and Cellular Therapeutics by David Whitehouse, Ralph Rapley, Wiley & Sons, Ltd. 2012.

22PBT47	BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn the fundamentals of tissue engineering and tissue repairing
2. To acquire knowledge on clinical applications of tissue engineering.
3. To understand the basic concept behind tissue engineering focusing on the stem cells.
4. To study the biomaterials and its applications

Course Content:

UNIT I HUMAN BODY SUBSYSTEM AND TRANSDUCERS 9

Brief description of muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities. Principles and classification of transducers for Bio-medical applications. Electrode theory, different types of electrodes; Selection criteria for transducers and electrodes.

UNIT II NON ELECTRICAL PARAMETERS MEASUREMENT 9

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Blood Gas analysers, pH of blood – Measurement of blood pCO2, pO2.

UNIT III ELECTRICAL PARAMETERS MEASUREMENT AND ELECTRICAL SAFETY 9

ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current - Instruments for checking safety parameters of biomedical equipments.

UNIT IV IMAGING MODALITIES AND BIO-TELEMETRY 9

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography Different types of biotelemetry systems

UNIT V LIFE ASSISTING AND THERAPEUTIC DEVICES 9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators - Heart Lung machine – Dialysers - Diathermy – Lithotripsy.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Identify, analyze and solve the real-life problems by applying principles of biomedical engineering.
2. Design, develop and specify the mathematical model to understand the inter relation among various physiological systems.
3. Demonstrate various applications of engineering and physiological subsystems in designing and developing human body systems.
4. Apply the knowledge to identify the various types of analytical and diagnostic equipments used in biomedical engineering
5. Design a system component or process to meet desired needs within realistic constraints.
6. Develop healthcare information system for automation and remote access.

Text Book(s):

1. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice Hall of India, New Delhi, 2007.
2. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
3. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2nd Edition, 2003.

Reference Books:

1. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.
2. Duane Knudson, Fundamentals of Biomechanics, Springer, 2nd Edition, 2007.
3. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011.
4. Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.
5. M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2003

Vertical IV (Bio Chemical Engineering)

22PBT47	**MASS TRANSFER OPERATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.
2. To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

Course Content:

UNIT I DIFFUSION AND MASS TRANSFER **9**

Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.

UNIT II GAS LIQUID OPERATIONS **9**

Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.

UNIT III VAPOUR LIQUID OPERATIONS **9**

V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCABE-THIELE & ONCHON-SAVARIT Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.

UNIT IV EXTRACTION OPERATIONS **9**

L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.

UNIT V SOLID FLUID OPERATIONS **9**

Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves-Time of Drying; Batch and continuous dryers.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To recognize and apply analogies among momentum, heat and mass transfer in various types of mass transfer operations.
2. To investigate gas -liquid, vapour-liquid, solid-liquid and liquid-liquid equilibrium in mass transfer operations
3. To employ the engineering correlations of diffusion and mass transfer coefficients to model a separation process
4. To demonstrate a multi-stage equilibrium separation process.
5. To apply the knowledge on downstream processing
6. To attain the desired products by mass transfer operations

Text Book(s):

1. Treybal R.E. Mass Transfer Operations.IIIrd edition. Mcgraw Hill, 2017.
2. Kiran D.Patil Principles of Mass transfer Operations , 6th edition, Nirali Prakashan publisher,2017

Reference Books:

1. Binay K. Dutta Principles of Mass Transfer and Separation Processes, Prentice Hall India publisher,2006
2. Geankoplis C.J. Transport Processes and Unit Operations. IIIrd edition, Prentice Hall of India, 1993.

22PBT49 TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEM

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.
2. To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products.

Course Content:

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNIT II MOMENTUM TRANSPORT 9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III HEAT TRANSPORT 9

VShell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations ofchange (non-isothermal), equation of motion for forced and free convection, equationof energy (non-isothermal).

UNIT IV MASS TRANSPORT 9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalystand the effectiveness factor, equation of continuity for binary mixtures, equation of change to set updiffusion problems for simultaneous heat and mass transfer.

UNIT V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multi component systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Employ shell balance equations to obtain desired profiles for velocity, temperature and concentration.
2. Reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.
3. Reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.
4. Utilize information obtained from solutions of the balance equations to obtain engineering quantities of interest.
5. Recognize and apply analogies among momentum, heat and mass transfer.
6. Appreciate relevance of transport principles in diverse applications of chemical, biological, and materials science and engineering.

Text Book(s):

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley, 2021
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.

Reference Books:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles,Pearson publishers., 4th Edition, 2013
2. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
3. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.

22PBT50	BIOENERGY AND BIOFUEL	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Acquire knowledge and accomplish a decent employment in energy sector and advance quickly to significant positions of leadership in their Profession.
2. Inclination towards advanced research for mitigating the short comings in energy systems.
3. Ascending as an energy consultant for providing solutions towards improving the efficacy of energy systems.

Course Content:

UNIT I INTRODUCTION **9**

Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.

UNIT II ETHANOL **9**

Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

UNIT III BIODIESEL **9**

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions Expanding biodiesel production.

UNIT IV OTHER BIOFUELS **9**

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts-Biobutanol,Biopropanol, bioglycerol –Principles,materials and feedstocks-Process technologies and techniques-Advantages and Limitations.

UNIT V APPLICATIONS OF BIOFUELS **9**

Life cycle environmental impacts of biofuels and co products – Environmental sustainability of biofuels – Energy security and supply,Economic sustainability of biofuels.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Determine the important properties of biomass.
2. Produce solutions to real world problems related to bio energy.
3. Analyse bio energy systems and their potential in future energy supply.
4. Use of biomass an inexpensive feedstock as sustainable and renewable energy.
5. Replace fossil-based products with biodiesel.
6. Source other alternate energy such as bio hydrogen and bio refinery.mation system for automation and remote access.

TEXT BOOK:

1.Gupta. V. K. and TUOHY. M. g. Biofuel Technologies, Springer, 2013.

2.Luque, R., Campelo, J.and Clark, J. Handbook of biofuels production, Woodhead Publishing Limited 2011.

3.Moheimani, N. R., Boer, M, P, M, K, Parisa A. and Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015.

REFERENCE BOOKS:

1.Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.

2.Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016.

3.Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, InTech, 2011.

22PBT21	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. To acquire the knowledge of environmental problems and develop technologies.
2. To develop skills in bioreactors and bio treatment methods of industrial wastewater.
3. To find solution to create green and clean environment

Course Content:

UNIT I BIODEGRADATION 9

Aerobic degradation of aliphatic and aromatic compounds – Co-metabolic degradation of organopollutants – Anaerobic degradation of aromatic compounds, halogenated organics and sulfonates – Biodegradation of herbicides and pesticides –Biodesulphurization of coal and oil – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals.

UNIT II MICROBIAL METABOLISM IN WASTEWATER TREATMENT 9

Decomposition of organic compounds in natural and manmade ecosystems – Mass and energy balance for aerobic and anaerobic reactions – Hydrolysis of biopolymers by aerobic and anaerobic microorganisms – Anaerobic degradation of carbohydrates, proteins, fats and lipids – Nitrogen removal – Ammonification, nitrification, denitrification, anaerobic ammonia oxidation – Enhanced biological phosphorus removal

UNIT III BIOLOGICAL TREATMENT OF WASTEWATER 9

Physico-chemical characteristics of wastewater – Overview of aerobic and anaerobic treatment processes – Process design of aerobic and anaerobic system – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Upflow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors – Algal photosynthesis in wastewater treatment.

UNIT IV BIOTECHNOLOGY FOR AIR POLLUTION AND SOLID WASTE MANAGEMENT 9

Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

UNIT V BIOPRODUCTS FROM RENEWABLE SOURCES 9

Overview of renewable sources – Production of biocompost and vermicompost – Production of biofertilizers and biopesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Determine the important properties of biomass.
2. Produce solutions to real world problems related to bio energy.
3. Analyse bio energy systems and their potential in future energy supply.
4. Use of biomass an inexpensive feedstock as sustainable and renewable energy.
5. Replace fossil-based products with biodiesel.
6. Source other alternate energy such as bio hydrogen and bio refinery mation system for automation and remote access.

TEXT BOOK:

1. Jordening,H.J.andWinter,J.,"EnvironmentalBiotechnology:ConceptsandApplication ",Wiley-VCHVerlagGmbH & Co.,2005.
2. Evans,G.G.andFurlong,J.,EnvironmentalBiotechnology:TheoryandApplication,2ndEd ition, JohnWiley& Sons,2011.

REFERENCE BOOKS:

1. Henze, M., Harremoes, P., Jansen, J.C. and Arvin, E., "Wastewater Treatment: Biological and Chemical Processes", 2nd Edition, Springer, 2013.
2. Zarook, S. and Ajay,S., Biotechnology for Odor and Air Pollution Control, Springer, 2005.
3. Wong J.W-C., Tyagi R.D., and Pandey. A., "Current Developments in Biotechnology and Bioengineering Solid waste" Elsevier, 2016.

22PBT51	APPLIED CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of reactions.
2. To provide the information about different reactor systems, deriving the performance.
3. Equations and predicting the rate equations in chemical reaction engineering system.

Course Content:

UNIT I SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 9

ABroad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors..

UNIT II IDEAL REACTORS 9

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT III NON IDEAL REACTORS 9

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 9

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS 9

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To design and conduct an experimental investigation in order to determine rate equations.
2. To demonstrate an ability to solve material and energy balances in order to analyze the performance of a reactor.
3. To demonstrate an experimental data using standard statistical methods to establish quantitative results.
4. To design a reactor for biobased products to achieve production and yield specifications.
5. To recognize and apply analogies among momentum, heat and mass transfer in various types of chemical reactions.

TEXT BOOK:

1. Levenspiel O. Chemical Reaction Engineering. IIIrd Edition. John Wiley.2006.
2. Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002

REFERENCE BOOKS:

1. K.A.Gavhane Chemical Reaction Engineering I, Nirali Publications 23rd Edition,2016

2. K..A.Gavhane Chemical Reaction Engineering II, Nirali Publications 25rd Edition,2014

3.Dawande, S.D., "Principles of Reaction Engineering", Ist Edition, Central Techno Publications, 2001.

4. Richardson, J.F. and Peacock, D.G., "Coulson Richardson - Chemical Engineering", Vol.III, IIIrd Edition, Butterworth- Heinemann- Elsevier, 2006

22PBT52	PETROLEUM TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To impart the knowledge about biotransformation in petroleum industries.
2. To provide a core foundation for the analysis and design of Bio refineries.

Course Content:

UNIT I INTRODUCTION TO PETROLEUM BIOTECHNOLOGY 9

Introduction: Petroleum microbiology, principles of biotechnology, Biotransformation of petroleum constituents, Alkane derivatives, Aromatic hydrocarbon derivatives, Factors affecting biotransformation, Reservoir character, Temperature and Pressure effects.

UNIT II MICROBIAL ENHANCED AND BIO UPGRADING OIL RECOVERY 9

Oil Recovery: Primary, secondary and Tertiary process. Mechanism and effects-permeability, wettability, Biological demulsification of crude oil, Bio desulfurization, Biodemetallization, Biodearomatization. Bio degrading microorganisms-Aerobic and anaerobic biotransformation, Biotransformation of Asphalts. Case studies and challenges.

UNIT III BIO CATALYTIC DESULFURISATION AND DENITROGENATION 9

Desulfurization-Hydro desulfurization, Adsorptive desulfurization, Oxidative desulfurization. Crude oil and its fractions-Enzymatic oxidation of organosulfur compounds, Immobilization. Nano biocatalytic desulfurization. Hydro and Thermal denitrogenation, Biocatalytic denitrogenation. Case studies and challenges.

UNIT IV BIOREMEDIATION 9

Kinetics of petroleum biotransformation in soil: Indigenous and augmented microbial population, pollutant type and concentration, soil characteristics studies- soil type, Degree of weathering, nutrient concentration, moisture content, temperature, soil interactions with macro and microorganisms, aeration, acidity-alkalinity, heavy metals, surfactants. Oil spill remediation methods, factors influencing rates of oil spill remediation, bioremediation technology for marine oil spill. Case studies and challenges.

UNIT V THE FUTURE OF PETROLEUM BIOTECHNOLOGY 9

Biorefining, technology potential, biorefinery products and by products, petroleum nano biotechnology-modern applications for sustainable future. Challenges and prospects in biotechnology.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. To demonstrate an ability to apply various process parameters.
2. To conduct an experimental investigation in order to determine biotransformation process.
3. To apply bioprocess and biochemical principles in petroleum refineries.
4. To maintain a suitable environment to obtain quantitative qualitative outputs.
5. To design an equipment for bio-based products to achieve production and yield Specifications in petroleum industries.

TEXT BOOK:

1. James G.Speight, Nour Shafik El-Gendy "Introduction to petroleum biotechnology" Elsevier Gulf Professional Publishin-2017

VERTICAL V (Animal biotechnology)

22PBT53	**FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide the fundamentals of animal cell culture, details of the diseases and therapy
2. To offer the knowledge about the micromanipulation and transgenic animals

Course Content:

UNIT I ORIGIN AND EVOLUTION OF LIFE 9

Theories of the origin of life, early earth, modern self-assembly theories, Oparin Haldanetheory of chemical evolution, The Miller Urey experiment, Organic evolution, Development of evolution theory, Darwin's theory, Origin and evolution of human being.

UNIT II ANIMAL DIVERSITY 9

Basis of classification, levels of organization (Symmetry, diploblastic and triploblastic organization), Coelom, segmentation, Notochord. The nature of natural selection, Examples of natural selection, levels of selection, selection of organisms and groups, species selection.

UNIT III STRUCTURAL ORGANIZATION AND CELL CULTURE TECHNIQUES 9

Animals Tissues: Epithelial Tissue, connective Tissue, Muscle Tissue, Neural Tissue. Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture- monolayer culture, suspension culture

UNIT IV MICROMANIPULATION OF EMBRYOS 9

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT V TRANSGENIC ANIMALS 9

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Understand the evolution of life and animal diversity
2. Understand the animal cell culture
3. Know the concepts of micromanipulation technology and transgenic animal technology
4. Understand the concept of transgenic animals
5. Know the strategies for production of transgenic animals.

Text Book(s):

1. Sue Dallas, Emily Jewell. Animal Biology and Care Wiley-Blackwell; 3rd edition.
2. Franklin Shull A, George R. Larue, Alexander G. Ruthven. Principles of animal biology. Mc GrawHill agricultural and Biological publications.
3. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002 Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997

Reference Books:

1. Sue Dallas, Emily Jewell. Animal Biology and Care Wiley-Blackwell; 3rd edition.
2. Franklin Shull A, George R. Larue, Alexander G. Ruthven. Principles of animal biology. Mc GrawHill agricultural and Biological publications.
3. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
4. Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

22PBT54	ANIMAL HEALTH AND NUTRITION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide the basic nutritional requirements for laboratory animals
2. To gain knowledge about the animal health management and its behavior

Course Content:

UNIT I BASIC NUTRITIONAL REQUIREMENTS AND FEEDING 9

Nutritional requirements for rat, Mice, guinea pigs, rabbit. Types of diets: Natural, semi synthetic and synthetic. Feeding of water, nutritions to kids, young adults, mature adults. Significance of carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins.

UNIT II ANIMAL HEALTH AND DISEASE MANAGEMENT 9

Bacterial and viral diseases in animals like rat, Mice, guinea pigs, rabbit, monkeys and horse-Type of diseases, Symptoms, causative agent, colonization and disease transmission. Control of parasites.

UNIT III ANIMAL DISEASE DIAGNOSIS 9

Monoclonal antibodies and their use in diagnosis; Antigen-antibody based diagnostic assays including radio immunoassay and enzyme immunoassays; Immunoblotting; Nucleic acid based diagnostic methods including nucleic acid probe hybridization; Restriction endonuclease analysis; PCR, Real time PCR; Nucleic acid sequencing; Probiotics.

UNIT IV ANIMAL VACCINES AND THERAPEUTICS 9

Introduction to the concept of vaccines; Conventional methods of vaccine production; Recombinant approaches to vaccine production; Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; gene therapy for animal diseases.

UNIT V ANIMAL BEHAVIOR IN EXPERIMENTAL RESEARCH 9

Types of behavior, Behavioral observation of Mice, guinea pigs, rabbit. neuroscience research, chicken welfare, Spatial behavior, rat social behavior, zebrafish studies. Livestock and wild life summary data sheet.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1.Understand the basic nutritional requirements

2.Know the various diseases and its diagnostic methods.

3.Know the concepts of therapeutic methods

4.Understand the behavior of animal on experiments

5. Understand recombinant approaches to vaccine production

Text Book(s):

1.Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

2.Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

Reference Books:

1. Zipser, B.; Schleking, A.; Kaiser, S.; Sachser, N. (2014). Effects of domestication of biobehavioural profiles: a comparison of domestic guinea pigs and wild cavies from early to late adolescence. Frontiers in Zoology, 11, 30.

2. Boix, J.; von Hieber, D.; Connor, B. (2018). Gait Analysis for Early Detection of Motor Symptoms in the 6-OHDA Rat Model of Parkinson's Disease. Frontiers in Behavioral Neuroscience, 12, 39.

22PBT55	ANIMAL PHYSIOLOGY AND METABOLISM	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To gain knowledge about the animal physiology
2.To understand the concept of various system
3.To know the nutrient transport and metabolism

Course Content:

UNIT I INTRODUCTION TO ANIMAL PHYSIOLOGY 9

The various physiological organ---systems and their importance to the integrative functionsof the animal body. The concept of homeostasis, including set point, negative and positivefeedback loops, and compensatory responses. Body fluid and its dynamics. Transport ofthrough biological membranes.

UNIT II BLOOD AND CIRCULATORY SYSTEM 9

Composition of blood, structure & functioning of its constitutes. Blood coagulation and anti-coagulants. Hemoglobin and its polymorphism. Anaemias. Sreticule---endothelial System. Body defense mechanism and immunogenesis. Structure and functions of the cardiovascular system, including the mechanical and electrical properties of cardiac muscle function. Excitation---contraction coupling in cardiac muscle. Reflex regulation of blood pressure.

UNIT III RESPIRATORY SYSTEM AND DIGESTIVE SYSTEM 9

Respiration: Structure and functions of the respiratory system, Structure and functions of smooth muscle, including excitation---contraction coupling in smooth muscle. Digestion: Structure, function and physiology of digestive system. Control of motility and secretion of alimentary canal and reflexes in the control of digestive functions. Control of rumen motility. Digestion in ruminant and monogastric animals.

UNIT IV NUTRIENT TRANSPORT AND ENERGY METABOLISM 9

Food, energy, ATP, carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins, metabolic disorders, comparative nutrition, nutrigenomics, endocrinology, ruminology.

UNIT V MICROMANIPULATION OF EMBRYOS AND REPRODUCTION 9

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1.Understand the basics of animal physiology

2.Know the various animal system

3.Understand the nutrient transport and metabolism

4.Learn the micromanipulation technique

5.Understand artificial insemination and germ cell manipulation

Text Book(s):

1.Schmidt---Nielsen, Animal Physiology, Cambridge University Press.

2.Christopher D. Moyes and Patricia M. Schulte, Principles of Animal Physiology, Pearson Press.

3. Arthur C. Guyton and John E. Hall, Textbook of Medical Physiology, W.B. Saunders Company.

Reference Books:

1. William S. Hoar, General and Comparative Animal Physiology, Prentice Hall, India
2. Animal Physiology, Richard W, Gordon A and Margaret A. Sinauer Associates, USA
3. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
4. Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

22PBT56	ANIMAL CELL CULTURE TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To know the basic requirements of animal cell culture laboratory
2.To understand the cell culture media, types and reactors
3.To understand the applications of cell culture

Course Content:

UNIT I BASIC REQUIREMENTS OF LAB FACILITY 9

Safety: biosafety levels, SDS, safety equipments, personal protective equipments, safe laboratory practices.cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage,cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination.

UNIT II MEDIA PREPARATION AND TYPES 9

Media Components-Serum, tissue extracts, growth factors, hormones, carrier proteins, lipids, vitamins, additive, detergents. Types: natural media, synthetic media, chemically defined and serum free media – advantages, disadvantages, BSS, CMRL, Eagle's, RPMI, animal cell cultures, their maintenance and preservation

UNIT III BIOREACTORS AND GROWTH OF CELLS 9

Bioreactor process control, stirred animal cell culture, Air-lift fermentor, hemostat/Turbidostat; Culturing: various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; growth of cells.

UNIT IV GENETIC ENGINEERING OF ANIMAL CELL 9

Gene therapy-prospects and problems, Recent advancements in Gene therapy; Knock out mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications. Recent advancements in diagnostic tool development and its diagnostic procedure

UNIT V PRODUCTS FROM ANIMAL CELL 9

Enzymes – asperagenase, collagenase, urokinase, pepsin, hyaluronidase. Hormones-leutinizing hormones, FSH, chronic. Vaccines - FMD, measles and mumps, rubella, rabies monoclonal antibodies, interferons, plasminogen activator.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1.Understand the basic requirements of lab facility

2.Know the various types of media

3.Understand the bioreactor and growth of cells

4.Learn the role of genetic engineering in animal cell culture

5.Understand the valuable products from animal cell

Text Book(s):

1. Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

Reference Books:

1. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.
2. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002
3. Freshney R.I. Animal Cell Culture- a practical approach, 6th ed., 2010Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.

22PBT57	ADVANCES IN ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To educate the students about the scope, regulatory issues and commercially available products produced using of animal biotechnology.
2. To provide depth knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research/project work related to biopharming.
3. To teach the importance of cell culture study for invitro study purposes and for scaling upthe products at commercial level.
4. To educate the principle behind invitro fertilization and biopharming in order to createtransgenic animal of commercial importance.

Course Content:

UNIT I BASICS OF ANIMAL BIOTECHNOLOGY 9

Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins..

UNIT II MOLECULAR BIOLOGY 9

Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus. Applications of commercially available viral vectors and their pros and cons.

UNIT III CELL CULTURE TECHNOLOGY IN ANIMAL SCIENCE 9

Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture- monolayer culture, suspension culture; Various bio-reactors used for animal cell culture-Roller bottleculture; Bioreactor process control, stirred animal cell culture, Air-lift fermentor, hemostat/Turbidostat;High technology vaccines; Hybridoma technology; Cell lines and their applications

UNIT IV GENETIC ENGINEERING APPLICATIONS IN ANIMAL SCIENCE 9

Gene therapy-prospects and problems, Recent advancements in Gene therapy; Knock out mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes,evaluation and applications.Recent advancements in diagnostic tool development and its diagnostic procedure

UNIT V ADVANCEMENTS AND APPLICATIONS IN ANIMAL BIOTECHNOLOGY **9**

Rumen manipulation- probiotics embryo transfer technology, invitro fertilization, transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Biopharming – Transgenic animals (case study : Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1.Understand the scope, regulatory issues and commercially available products produced using of animal biotechnology.

2.Gain knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research/project work related to biopharming.

3.Understand the importance of cell culture study for invitro study purposes and for scaling up the products at commercial level.

4.Gain knowledge in creating recombinant products for gene therapy purpose and the importance of molecular probe which is an important tool for medical and forensic studies.

5.Understand the principle behind invitro fertilization and biopharming in order to create transgenic animal of commercial importance.

Text Book(s):

1.Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007

2.Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

Reference Books:

1. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.
2. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002

22PBT58	BIO-TECHNIQUES IN ANIMAL BREEDING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:
1.To educate the students about the basic tools requirement for cell culture and micromanipulation
2.To provide depth knowledge about micromanipulation and application.
3.To teach the importance of stem cell mediated production and guidelines.

Course Content:

UNIT I BASIC TOOLS REQUIREMENTS FOR CELL CULTURE AND MICROMANIPULATION 9

Biosafety levels, safety equipments, personal protective equipments, safe laboratory practices. cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage, cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination. Micromanipulation tools: micromanipulator, pipette puller, pipette grinder, holding pipette

UNIT II MICROMANIPULATION AND ITS APPLICATION 9

Enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT III STEM CELLS AND TRANSGENIC ANIMALS 9

Stem cells – sources, types, uses, ES cells, pluripotent stem cells, adult stem cell, epithelial stem cell, bone marrow and hematopoietic, neural stem cell, transgenic techniques, Stem cell mediated transgenic animals.

UNIT IV TRANSGENIC ANIMALS IN RESEARCH 9

Ethics of transgenic technology, Dolly (transgenic sheep), Transgenic mice, rat, sheep, goat, rabbit, pig, fish, cow- case studies.

UNIT V ETHICAL GUIDELINES ON ANIMAL BREEDING 9

Justification on research, care and housing of laboratory animals, acquisition of laboratory animals, experimental procedure, CPCSEA guidelines. Animal integrity and ethical limits to breeding. Animal welfare issues. Record Maintenance as per guidelines.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1.Understand the concept of basic tools requirement for cell culture and micromanipulation

2.Gain knowledge on micromanipulation and its application

3.Know the concept of stem cells and ES cell of transgenic animals.

4.Understand the research importance in transgenic animals.

5.Gain knowledge on ethical CPCSEA guidelines

Text Book(s):

1.Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007

2.Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

Reference Books:

1. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.

Vertical VI (Computational Biotechnology)

22PBT59	**PROGRAMMING FOR BIOINFORMATICS APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. To improve the programming skills and database development of the student.
2. To introduce the fundamentals of Perl programming language to the student.
3. To familiarize with Perl modules and to write scripts for manipulating/processing genomic and proteomic data

Course Content:

UNIT I INTRODUCTION 9

Introduction to Operating systems, Linux commands, File transfer protocols FTP and telnet,Datalifecycle,Databasemanagementsystemmodels.StructuredQueryLanguage(SQL)-DataDefinition Language (DDL), Data Manipulation Language (DML) and Query by example.PL/SQL-Stored procedure, Database triggers; Relational DataBase Management system.

UNIT II PERL PROGRAMMING 9

Perl overview, variables and data types, control Structure, loops whileloop, forloop, untilloop, File handles - opening and closing files, reading and writing file handles, Library Functions: String specific functions, User defined functions.

UNIT III OPERATORS 9

Arithmetic Operators, Assignment Operators, Logical operators, Equality Operators, Increment and Decrement Operators, String Concatenation and Repetition, Operators precedence and Associativity, Conditional Operators, Logical Operators, Operators for manipulating arrays, Operators for Manipulating hashes.

UNIT IV REGULAR EXPRESSIONS 9

Simplecharacters,*specialcharacter,.character,|character,Groupingwith()s,anchorcharacters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl.

UNIT V APPLICATIONS OF PERL IN BIOINFORMATICS 9

Concatenating DNA Fragments, Transcription: DNA to RNA, Reading Protein Files, Finding Motifs, Simulating DNA, Generating Random DNA, Analysing DNA, Translating DNA to Proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation, Parsing Annotation, Parsing PDB files, Parsing BLAST output, Bio-perl

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basics of Linux operating system and the SQL for database creation and management.
2. Use the Perl data types to construct programs in Perl.
3. Apply the various operators, Regular expressions, conditional statements and loops in Perl program.
4. Understand the applications of Perl Programming in hand genomics and Proteomics data.
5. Understand FASTA format

Text Book(s):

4. James Tisdall,“BeginningPerlforBioinformatics”,O’Reilly&Associates,2001
5. James Tisdall,“MasteringPerlforBioinformatics”,O’Reilly,2003.
6. Elmasri and Navathe.2006. Fundamentals of Database Systems. Addison Wesley.

Reference Books:

5. Cynthia Gibas & PerJam beck, “Developing Bioinformatics Computer Skills”, O’Reilly & Associates, 2000.
6. RexA. Dawyer, “GenomicPerl”, Cambridge University Press3. Learning Perl, 3rdEdition, Author: Randal L. Schwartz and Tom Phoenix, O’Reilly

22PBT60	FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To study various Algorithm design techniques and applying it in bioinformatics.
2. To understand the algorithms such as Dynamic programming, HMM and ANN in Biological applications.

Course Content:

UNIT I INTRODUCTION 9

Algorithms Complexity of algorithms and running time, Polynomial, NPcomplete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling salesman problem, sorting.

UNIT II DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS 9

Dynamic programming Principles and its uses. Local and Global alignment principles, Findinglongestcommonsubsequences,Heuristicssecondgenerationalignmenttoolsford atabasesearching : (Blast, FASTA, ClustalW), Statistical and Similarity based methods for gene prediction, Models ofevolution

UNIT III EXACT MATCH AND HIDDEN MARKOVMODELS 9

Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm, Hidden Markov Model: Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm ,Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA

UNIT IV ARTIFICIAL NEURAL NETWORKS 9

Introduction to Artificial Neural Networks (ANN): A Simple Neuron, Firing rule, Network layers, Architectures of Artificial Neural Network: Feed – Forward networks, Feed-Back networks, Perceptrons, Pattern recognition problems, Back Propagation Algorithm, Applications of Neural Networks.

UNIT V DNA AND RNA RELATED ALGORITHMS 9

Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, Finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basics of algorithms used in Bioinformatics.
2. Apply dynamic programming in sequence analysis.
3. Analyse the macromolecules using HMM, ANN and other related algorithms.
4. Understand DNA computing
5. Understand the application of RNA fold

Text Book(s):

1. Dan Gusfield – Algorthims on Strings, Tree and Sequences :Computer Science and Computational Biology (1997) Cambridge University Press.ISBN-10:0521585198.
2. Horowitz,S .Sahini, and Raja sekharan :Fundamentals of ComputerAlgorithms, Galgotia Publications.

Reference Books:

1.NeilC. Jones and Pavel.A Pevzner An introduction to Bioinformatics Algorthims.(computational Molecular Biology)(2004)MITpress.ISBN-10:0262101068.
2. R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic models of Proteins and Nucleic acids(2005) Cambridge UniversityPress0521540798
3.Michael.S.WatermanIntroductiontoComputationalBiology:Maps,SequencesandGenomes.Waterman.Edition2(2012)ChapmanandHall/CRCPressISBN:1439861315

22PBT61	MOLECULAR MODELING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Understand the molecular behaviour of proteins, nucleic acids and small molecules in the biological system.
2. Explain the principles involved in molecular modelling

Course Content:

UNIT I INTRODUCTION 9

Newtons laws of motion–time intervals-algorithms

UNIT II INTRODUCTION TO STATISTICAL MECHANICS 9

Boltzman'sEquation–Ensembles–Distributionlawfornoninteractingmolecules–Statisticalmechanics of fluids.

UNIT III QUANTUM MECHANICS 9

Photoelectric effect – DeBroglies hypothesis – Uncertainity principle – Schrodingers time independent equation–particle in a one-dimensional box.

UNIT IV GROMOS, GROMACS, AMBER & DOCK 9

Various force fields for proteins and nucleic acids – Molecular mechanics – Molecular dynamics – Molecular dynamics simulations in water and organic solvents.

UNIT V GAUSSIAN 9

Preparing input files– job types– model chemistries– basis sets– molecule specifications running Gaussian–examples.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Understand the behaviour of Small and macro molecules in biological system.
2. Simulate the biomolecules using molecular modelling software's.
3. Assess and utilize various software's and tools which utilizes quantum and molecular mechanics principles
4. Prepare input files
5. Analyse various force fields for proteins and nucleic acids

Text Book(s):

1. Leach, AndrewR. “Molecular Modelling: Principles and Applications” IIndEdition, Pearson,2010.
2. Cohen,N.C.“GuideBook on Molecular Modeling in Drug Design” Academic Press/ Elsevier, 1996.

Reference Books:

1. Statistical Mechanics; D.McQuarrie, Narosa, University Science Books; 1st edition2000
2. Quantum Mechanics; D.McQuarrie, Narosa,1999.
3. GROMOS Handbook www.gromacs.org

22PBT62	COMPUTER AIDEDDRUG DESIGN	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
2. To know the informatics approaches to the prediction of chemical properties of new drugs
3. To present the appropriate tools for such a modelling, ranging from electronic Structure
4. Methods, Molecular modelling, Structure Activity Relationships in drug design ,QSAR, Molecular docking and Molecular dynamics

Course Content:

UNIT I ELECTRONIC STRUCTURE METHODS 9

Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.

UNIT II MOLECULAR MODELING 9

Bioactivevs. Global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modelling including artificial intelligence methods.

UNIT III STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN 9

Qualitative versus quantitative approaches advantages and disadvantages. Random screening ,Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand based drug design.

UNIT IV QSAR: ELECTRONIC EFFECTS 9

Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter inter-dependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2DQSAR;3D-QSARexamples of CoMFA and Co MSIA.

UNIT V MOLECULAR DOCKING **9**

Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, Flex-S, Autodock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Gain knowledge about fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.
2. Interpret and practice the fundamental concepts of Molecular Modeling and Computer aided Drug Design.
3. Develop practical skills in computational approaches to analyse, predict, and engineer biomolecules and biomolecular systems.
4. Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.
5. Present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics

Text Book(s):

1. Andrew R. Leach, Molecular Modelling Principle and Application, 2nd Edition, Prentice Hall, England,2001.
2. RichardB. Silverman, Mark W.Holladay, Organic Chemistry of Drug Design and Drug
3. Action,3rd Edition, Academic Press,USA, 2014.
4. Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, MarcelDekker, NewYork,1997.
5. J.M.Goodman, Chemical Applications of Molecular Modelling, TheRoyal Society of Chemistry ,Cambridge,1998.

Reference Books:

1. DonaldJ. Abraham, Burger's Medicinal Chemistry and Drug Discovery ,VolV, 6th Edition, John Wiley and Sons,Inc., 2003.
2. JohnB. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science,2006.
3. GrahamL. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.
4. David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and SonsLtd, Hoboken, UnitedStates,2009.
5. AlanHinchliffe, Molecular Modelling for Beginners, 2ndEdition,Wiley, United University of California,2008.

22PBT63	METABOLOMICS AND METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

Course Objectives:

1. To provide the fundamental knowledge on upcoming field of Metabolomics and the metabolic engineering in post genomic era.
2. To introduce the redesign of metabolism to enable cells to produce new products.

Course Content:

UNIT I INTRODUCTION 9

Role of metabolomics in systems biology –application of metabolomics- Analytical methods in metabolomics –Data standards Databases for Chemical, Spectral and Biological Data–Reconstruction of dynamic metabolic network model- examples-study of metabolome of a simple organism like *E.coli*

UNIT II BIOINFORMATICS IN METABOLOMICS 9

Online databases and pipelines for metabolomics – GC-MS based metabolomics – Computational methods to compute and integrate metabolic data-software for metabolomics - metabolomics and medical sciences

UNIT III INTRODUCTION TO METABOLIC ENGINEERING 9

Metabolic engineering: introduction, mass balance, black box, metabolic flux analysis, stochiometry, Principles of metabolic engineering, Importance of metabolic engineering-comprehensive models for cellular reactions-material balances & data consistency-metabolic pathway synthesis.

UNIT IV METABOLIC FLUX ANALYSIS 9

Flux balance analysis, flux balance methods, group based flux balance, metabolic control analysis: overview, control coefficients, methods of measuring control. Flux analysis of networks- top down approach, bottom up approach.

UNIT V METABOLIC NETWORKS AND APPLICATIONS 9

Kinetic model of metabolic networks Systems metabolic engineering of E.coli. Applications of Metabolomics to biology: examples and case studies, Metabolome informatics, data integration and mining.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

On completion of the course, the student is expected to

1. Understand the concept of Metabolome and Metabolomics.
2. Apply the Bioinformatics tools in metabolomics.
3. Understand the fundamentals of Metabolic engineering.
4. Analyze the metabolic pathways using flux control.
5. Apply the fundamental tools in techniques like docking, modelling, electronic structure methods which leadstone drug target design.

Text Book(s):

1. Jens Hřiriis Nielsen, Michael C.Jewett, "Metabolomics: A Powerful Tool In Systems Biology", Springer, 2007.
2. Dr. Christoph Wittmann, SangYup.Lee, "Systems Metabolic Engineering", Springer 2012.
3. Gregory N. Stephanopoulos, "Metabolic Engineering- Principles and Methodologies", Academic press, First Edition,1998.
4. Sang Yup Lee, E.Terry Papoutsakis, "Metabolic engineering", CRCPress, 1999.'

Reference Books:

1. TomitaM., T.Nishioka, "Metabolomics: The Frontier of Systems Biology", Springer, 2003.
2. GregoryN. Stephanopoulos, "Metabolic Engineering: Principles and Methodologies", Academic press, First Edition, 1998.
3. Wolfram Weckwerth, "Metabolomics: Methods And Protocols", Humana Press,2007.
4. CortassaS. "An Introduction to Metabolic and Cellular Engineering", World scientific public company Ltd., 2002.

22PBT64	DATAMINING AND MACHINE LEARNING TECHNIQUES FOR BIOINFORMATICS	L	T	P	C
		3	0	0	3
Pre-requisite Nil	**Syllabus Version**			V 0.1	

Course Objectives:

1. To learn various data mining techniques used to analyses huge biological data to find the hidden patterns.
2. To familiarize students with an rapidly evolving field of machine learning and mining

Course Content:

UNIT I INTRODUCTION **9**

Supervised and unsupervised techniques. Empirical Risk Minimization, Structural Risk Minimization; Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation ,learning curves, and statistical hypothesis testing.

UNIT II MACHINE LEARNING TECHNIQUES **9**

Classification: Decision tree, Bayesian, Rule based classification, ANN, SVM, HMM; Case based reasoning and Applications in Bioinformatics. Clustering: Partition Methods, Hierarchical methods, Density based methods, Grid based clustering, Model based clustering, clustering of high dimensional data, constraints based clustering, Analysis of MD trajectories, Protein Array data Analysis.

UNIT III INTRODUCTION TO DATA MINING **9**

Introduction to Data mining, Data mining Functionalities, Classification of Data mining Systems, Data Mining Task Primitives, Integration of Data mining systems, Major issues of Data mining.

UNIT IV DATA PRE PROCSSING AND VISUALIZATION **9**

Overview of data preprocessing, Data cleaning, Data integration, Data reduction, Data transformation and discretization, Visualization- Visualizing a single attributes, Visualizing pair of attributes, Visualizing several attributes, Visualizing results of machine learning.

UNIT V APPLICATIONS OF DATA MINING **9**

Application of Data Mining in Biodata analysis: DNA/protein sequence Analysis, Genome analysis, Protein Structure Analysis, Pathway analysis, microarray data analysis, annotation, gene ontology, gene mapping. Biological datamining tools: Entrez, Blast, sequence retrieval system (SRS).

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Know the basic notions and terminology used in Machine learning and Data mining.
2. Understand fundamental principles of modern data analysis.
3. Understand the applications of Machine learning and Datamining in biological data processing and visualization.
4. Understand data mining in big data analysis.
5. Analyse protein structure, pathway analysis, annotation, gene ontology etc.

Text Book(s):

1. Witten, H.I., Frank, E. and Hall, M.A. 2011. Data Mining: Practical Machine Learning Tools and Techniques.
2. Hastie,T., Tibshirani,R., Friedman, J.H.2009. The Elements of Statistical Learning: Data Mining Interface and Prediction.
3. Clarke,S.B., Fokoue,E. and Zhang, H.H. 2009 Principles and Theory for Data Mining and Machine Learning.

Reference Books:

1. Data Mining: Concepts and Techniques by Jiawei Han and Micheline Kamber,2000
2. Data Mining Techniques, A.K.Pujari, University Press, Hyderabad, 2006
3. Datamining in bioinformatics by Wang etal ,Springer - Verlag, 2005

22PBT65	**Vertical VII (Quality and Regulatory Affairs)** **CLINICAL TRIALS AND HEALTH CARE POLICIES IN BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To highlight the epidemiologic methods, study design, protocol preparation.
2. To gain knowledge in the basic bio-statistical techniques involved in clinical research.
3. To describe the principles involved in ethical, legal and regulatory issues in clinical trials.
4. To familarize the students with monitoring clinical trials.
5. To make the students understand various techniques of safety monitoring.

COURSE CONTENT:

UNIT I REQUIREMENTS IN CLINICAL RESEARCH 9

Good clinical practice (ICH GCP E6), Clinical trial materials (Documentation, Investigational drugs, logistical materials)

UNIT II TYPES AND DESIGNS IN CLINICAL RESEARCH AND SAFETY MONITORING IN CLINICAL TRIALS 9

Types of research designs based on Controlling Method (Experimental, Quasi experimental, and Observational methods) Randomization techniques (Simple randomization, restricted randomization, blocking method and stratification),Time Sequences (Prospective and Retrospective), Sampling methods (Cohort study, case Control study and cross sectional study), Health outcome measures (Clinical & Physiological, Humanistic and economic).

UNIT III CLINICAL TRIAL STUDY AND GOVERNING REGULATIONS 9

Roles and responsibilities of: Investigator, Study Coordinator, Sponsor, Monitor, Contract Research Organization, Site management Organizations Guidelines to the preparation of following documents: Protocols, Investigator’s Brochure, Informed Consent Form, Case report forms, Contracts and agreements, Trial Master File preparation and maintenance, Investigator Site File, Pharmacy File, Dairy Cards.

UNIT IV OVERVIEW TO UNDERSTANDING THE HEALTHCARE SYSTEM 9

HEALTH CARE SYSTEM COMPONENTS, Elements of a Health Care System, The Role and Financing Methods of Third-Party Payers, The Production of Medical Services, An Overview of the U.S. Health Care System, Production of Health Services and Provider Choice in the United States.

UNIT V HEALTH CARE POLICIES 9

Health care policy- overview- Private health care sectors, Health policy and planning.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

1. On completion of the course, the student is expected to
2. Explain key concepts in the design of clinical trials.
3. Describe study designs used, identify key issues in data management for clinical trials.
4. Describe the roles of regulatory affairs in clinical trials.
5. Students will be able to apply this in health care companies.

TEXT BOOK(S):

1. Guidance for Industry on Submission of Clinical Trial Application for Evaluating Safety and Efficacy by CDSCO (Central Drug Standard Control Organisation).
2. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
3. Santerre, Rexford E. Health economics. 2009.
4. Griffin(1992) :Bhat.R1993 The private-public mix in health care in India *Health Policy and Planning.*

REFERENCE BOOKS:

1. Pharmaceutical Process Validation; By Fra. R. Berry and Robert A. Nash
2. Analytical Method validation and Instrument Performance Verification by Churg Chan, Heiman Lam, Y.C. Lee, Yue. Zhang, Wiley Inter Science.
3. Book: Leachables and Extractables Handbook: Safety Evaluation, Qualification, and Best Practices Applied to Inhalation Drug Products, Douglas J. Ball, Daniel L. Norwood, Cheryl L. M. Stults and Lee M. Nagao,
4. Book: Medical Device 1st edition, Seeram Ramakrishna Lingling Tian Charlene Wang Susan Liao Wee Eong Teo, Woodhead Publishing, Hardcover ISBN: 9780081002896.
5. Book: Biomaterials, Medical Devices and Combination Products: Biocompatibility Testing and Safety Assessment, Shayne Cox Gad, Samanta Gad-McDonald, CRC Press
6. Fermentation Microbiology and Biotechnology by M. El-Mansi and C.Bryce
7. Process Validation: General Principles and Practices-FDA Guidelines

22PBT66	BIOTECHNOLOGICAL PRODUCTS AND ITS VALIDATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To gain knowledge in the product validation.
2. The student shall be able to understand the scope of quality certifications.
3. Appreciate the importance of documentation.
4. To understand the responsibilities of QA & QC departments in biotechnology industries
5. Express the knowledge in pharmaceutical production.

COURSE CONTENT:

UNIT I INTRODUCTION 9

Process validation and quality assurance: a) Installation Qualification (IQ), Operational Qualification (OQ) and Performance Qualification (PQ) for laboratory instruments. b) Methods of validation and calibration of equipments c) Documentation: importance and significance d) Current Good Manufacturing Practices (cGMP) and Current Good Laboratory Practices (cGLP).

UNIT II VALIDATION OF PHARMACEUTICAL PRODUCTION 9

Introduction to Pharmaceutical Validation, Scope & merits of Validation, Validation and calibration of Master plan, ICH & WHO guidelines for calibration and validation of equipm ents, Validation of specific dosage form, Types of validation. Government regulation, Manufacturing Process Model, URS, DQ, IQ, OQ & P.Q. of facilities, Analytical method validation

UNIT III VALIDATION OF FOOD NEUTRACEUTICALS AND COSMETICSS 9

Microbiological quality control for Nutraceuticals.

UNIT IV VALIDATION OF MEDICAL DEVICES 9

Validation and Verification of Medical device Physical and Mechanical Testing of medical device, Chemical Testing of Medical Device materials, Biological Testing of Medical Devices.

UNIT V BIOTECHNOLOGY PROCESS AND EQUIPMENT VALIDATION 9

Process validation, General considerations for process equipments, Regulatory requirements for process validation, Documentation, Analytical methods.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

1. On completion of the course, the student is expected to
2. This course deals with the various aspects of quality control and quality assurance aspects of various biotechnological industries.
3. It covers the important aspects like cGMP, QC tests, documentation, quality certifications, GLP and regulatory affairs.
4. Understand the importance of clinical studies
5. To gain knowledge in the validation of medical devices.

TEXT BOOK(S):

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005
2. Kumar, H.D. "A Textbook on Biotechnology" IInd Edition. Affiliated East West Press Pvt.Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004.

REFERENCE BOOKS:

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968. .
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.

22PBT67	QUALITY ASSURANCE AND QUALITY CONTROL IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. The student shall be able to understand the scope of quality certifications.
2. Appreciate the importance of documentation.
3. The cGMP aspects in a pharmaceutical industry.
4. To understand the responsibilities of QA & QC departments in biotechnology industries.
5. To apply the knowledge of QC & QC in industries.

COURSE CONTENT:

UNIT I INTRODUCTION 9

Quality Assurance , Quality Control , Role of Quality Assurance**,** QA testing, Role of Quality Control, Test for quality control, Quality assurance – Quality control – Practice of cGMP-Overview of ICH Guidelines - QSEM, with special emphasis on Q-series guidelines. Good Laboratory Practices: Scope of GLP, Definitions, Quality assurance unit, protocol for conduct of non clinical testing, control on animal house, , scope of quality certifications - responsibilities of QA & QC departments, Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), Developing specification (ICH Q6 and Q3)

UNIT II QUALITY ASSURANCE AND QUALITY CONTROL IN CLINICAL TRIALS 9

Audit criteria, Audit process, Responsibilities of stakeholders in audit process, Audit follow-up and documentation, Audit resolution and Preparing for FDA inspections, Fraud and misconduct management - Clinical Trial Data Management- Standard Operating Procedures, Data management plan, CRF & Data base design considerations, Study set-up, Data entry, CRF tracking and corrections, Central lab, IVRS, source data. Data cleaning, managing laboratory and ADR data, Data transfer and database lock, Quality Control and Quality Assurance in CDM, Data mining and warehousing

UNIT III QUALITY ASSURANCE AND QUALITY CONTROL IN PHARMACEUTICAL INDUSTRIES 9

Schedule M – USFDA- Quality audit and self inspections SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

UNIT IV QUALITY SYSTEM REGULATIONS AND QUALITY CONTROL OF MEDICAL DEVICES 9

Quality System Requirements 21 CFR Part 820, Labeling requirements 21 CFR Part 801, Post marketing surveillance of MD and Unique Device Identification (UDI), Quality System requirements and clinical evaluation and investigation. IMDRF study groups and guidance documents, ISO 13485, Quality Risk Management of Medical Devices: ISO 1497-

UNIT V QUALITY IN FOOD, NUTRACEUTICALS, BIOLOGICAL AND COSMETIC PRODUCTS **9**

WHO guidelines on nutrition. NSF International: Its Role in the Dietary Supplements and Nutraceuticals Industries, NSF Certification, NSF Standards for Food And Dietary Supplements. Good Manufacturing Practices for Nutraceuticals, Quality, safety and legislation for herbal products in India, USA and European Union, Analysis of Cosmetics, Toxicity screening and test methods: Quality control and toxicity studies as per Drug and Cosmetics Act, Analysis of Food additives- milk constituents and milk products- Pesticide analysis

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. This course deals with the various aspects of quality control and quality assurance aspects of various biotechnological industries.
2. It covers the important aspects like cGMP, QC tests, documentation, quality certifications, GLP and regulatory affairs.
3. Will understand the scope of GLP.
4. Will come to know about te quality system requirements.
5. To recognize different form of quality in food, neutraceuticals.

TEXT BOOK(S):

1. Willig, H., Tuckeman, M.M. and Hitchings, W.S., "Good Manufacturing Practices for Pharmaceuticals", 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000.
2. Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J. Tobin and Gary Walsh
3. P.P.Sharma. Cosmetics - Formulation, Manufacturing & Quality Control, Vandana Publications, New Delhi

REFERENCE BOOKS:

1 Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Pharmalogika Inc., USA, 2009.

22PBT68	ENTREPRENEURSHIP AND PATENT DESIGN	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. Student will be able to develop entrepreneurial skills and writing of business plan market strategies
2. They will gain knowledge on patent filing and design
3. To apply the knowledge in IPR.
4. To know how to apply for patent.
5. To learn about the trademarks, patent and copyright.

COURSE CONTENT:

UNIT I ENTREPRENEUR 9

Entrepreneurial motivation – dynamics of motivation. Entrepreneurial competency –Concepts. Developing Entrepreneurial competencies - requirements and understanding the process of entrepreneurship development, self-awareness, interpersonal skills, creativity, assertiveness, achievement, factors affecting entrepreneur role.

UNIT II BUSINESS PLAN, MARKETING PLAN 9

Develop a Business Plan

UNIT III MARKETING PLAN 9

Choose Your Location and Set Up for Business, Market Your Business, Hire and Manage a Staff

UNIT IV OPERATIONS MANAGEMENT 9

Finance, Protect and Insure Your Business, Record Keeping and Accounting, Financial Management.

UNIT V QUALITY IN FOOD, NUTRACEUTICALS, BIOLOGICAL AND COSMETIC PRODUCTS 9

Patents – objectives and benefits of patent, Trademarks, copyright, Geographic indicators, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Ability to manage Intellectual Property portfolio to enhance the value of the firm.
2. Will understand the benefits of paptent.
3. Student will be able to develop entrepreneurial skills and writing of business plan market Strategies.
4. They will gain knowledge on patent filing and design .
5. Ability to manage Intellectual Property portfolio

TEXT BOOK(S):

1. Hisrich, R.D. and Peters, M.P. (1995): Entrepreneurship – Starting, Developing and Managing a New Enterprise, Richard D., Inwin, INC, USA.
2. Entrepreneurship Ideas in Action—South-Western, 2000.
3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

REFERENCE BOOKS:

1. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament,
3. "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

22PBT69	INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. Student will be able to develop entrepreneurial skills and writing of business plan market strategies
2. They will gain knowledge on patent filing and design
3. Ability to manage Intellectual Property portfolio to enhance the value of the firm.
4. Will understand the benefits of paptent.
5. Student will be able to develop entrepreneurial skills and writing of business plan market Strategies.

COURSE CONTENT:

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 9

Meaning and practical aspects of registration of CopyRights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs 9

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Ability to manage Intellectual Property portfolio to enhance the value of the firm.
2. Survey literature on their topic of research and present comprehensively CO-2:
3. Understand and explain research problem after completion of course curriculum project CO-3: Interpret and communicate project data
4. They will gain knowledge on patent filing and design.
5. Ability to manage Intellectual Property portfolio

TEXT BOOK(S):

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S. V. Satakar, “Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

REFERENCE BOOKS:

1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli, ”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

22PBT70	BIOSAFETY AND HAZARD MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification.
2. Understand the concept of basic tools requirement for biosaftey in cell culture and micromanipulation
3. Gain knowledge on biosaftey and its application
4. Understand the research importance in hazard management.
5. Gain knowledge on ethical biosaftey guidelines.

COURSE CONTENT:

UNIT I INTRODUCTION **9**

Need for safety in industries; Safety Programmes – components and realization; Potential hazards-extreme operating conditions, toxic chemicals; safe handling

UNIT II QUALITY CHECKS **9**

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety.

UNIT III RISK ANALYSIS **9**

Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV SAFETY AUDITS **9**

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras- Vizag Bopal analysis.

UNIT V HAZARDOUS OPERATIONS **9**

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Appreciate the importance of documentation.
2. The cGMP aspects in a pharmaceutical industry.
3. To understand the responsibilities of QA & QC departments in biotechnology industries
4. The student shall be able to understand the scope of quality certifications.
5. Will understand the need for saftey in industry.

TEXT BOOK(S):

1. Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.
2. Skeleton, B., Process Safety Analysis: An introduction, Institution of chemical Engineers, U.K., 1997.
3. Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004.
4. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

REFERENCE BOOKS:

1. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
2. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ, 1990.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994.
4. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company,1969.

VERTICAL VIII (Agro Biotechnology)

22PBT71	**PLANT ANATOMY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To make the student to become familiar and to understand the plant cell, tissues, and internal structures of stem, root and leave.
2. To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
3. The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant
4. Able to extract living cell samples from plants for genetic research
5. To make the student to become familiar and to understand the plant cell, tissues, and internal structures of stem.

COURSE CONTENT:

UNIT I PLANT CELL STRUCTURE 9

Plant cell structure and tissues Plant cell structure –nature of plant cell wall. Tissue and tissue systems -meristematic tissue, permanent tissue and secretary cells

UNIT II MORPHOLOGICAL CHARACTERS OF PLANT CELL 9

Morphogenesis and Differentiation Morphogenesis in plants -Differentiation of stem, root and leaf- Vascular bundles and Vascular cambium.

UNIT III CELLULAR ORGANIZATION OF MERISTEMS 9

Organization of meristems Meristems – types of meristems: apical, intercalary and lateral; primary meristem and secondary meristem. Apical meristems – theories on organization of meristems – apical cell theory, Tunica-Corpus theory and histogen theory.

UNIT IV ANATOMY OF STEM AND ROOT 9

Structure of Dicot stem–primary and secondary structure; Structure of Monocot stem; Nodal anatomy. Structure of Dicot root–primary and secondary structure; Structure of monocot root

UNIT V ANATOMY OF LEAF AND ANOMALOUS 9

Secondary growth Leaf anatomy–dorsiventral and isobilateral; Stomatal types Anomalous secondary growth –Bignonia, Aristolochia, Boerhaavia (dicot stem)Dracaena(monocot stem).

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To make the student to become familiar and to understand the plant cell, tissues, and internal structures of stem, root and leave.
2. The main objective is to provide an overview of the plant derived natural products for their occurrence, sources, basic chemistry and therapeutic applications.
3. The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant
4. Able to extract living cell samples from plants for genetic research
5. To make the student to become familiar and to understand the plant cell, tissues, and internal structures of stem.

TEXT BOOK(S):

1. Vashishta, P.C. 1997. Plant Anatomy, Pradeep Publications. 2. Fahn, A.1992. Plant Anatomy. Pergamon Press

REFERENCE BOOKS:

1. Esau, K. 1990. Plant Anatomy. Wiley Eastern Pvt Ltd New Delhi.

22PBT72	THERAPEUTIC APPLIATION OF PHYTOCHEMICALS	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus Version**		V 0.1	

COURSE OBJECTIVES:

1. The main objective is to provide an overview of the plant derived natural products for their occurrence, sources, basic chemistry and therapeutic applications
2. To gain knowledge in the field of pharma
3. To understand the basics of phytochemicals

COURSE CONTENT:

UNIT I INTRODUCTION PLANT NATURAL PRODUCTS 9

History- general significance- classification- list of floral sources- general detection, extraction and characterization procedures

UNIT II GLYCOSIDES AND FLAVONOIDS GLYCOSIDES 9

Classification, therapeutic value, chemical properties & tests for identification. Flavonoids: Sources, classification, biogenesis, extraction, isolation, identification and therapeutic applications.

UNIT III ANTHOCYANINS AND COUMARINS ANTHOCYANINS 9

Sources, classification, extraction, isolation, identification and therapeutic applications. Coumarins: Sources, classification, biosynthesis - furanocoumrarins and pyranocoumarins: pharmacological properties and photo-toxicity.

UNIT IV LIGNANS, TERPENES, VOLATILE OILS, SAPONINS LIGNANS AND NEOLIGNANS: 9

Classification, naturalsources and pharmacological applications. Terpenes: Classification, biosynthesis, origin of 5-carbons isoprene unit, head to tail coupling and tail-totail coupling of isoprene units - Volatile Oils: Classifications, sources, medicinal and non-medicinal uses - Saponins : Sources, classification, physical and biological properties

UNIT V CAROTENOIDS AND ALKALOIDS CAROTENOIDS: 9

Sources, biogenesis, classification and therapeutic values. Alkaloids: Classification, distribution in nature, localization, nomenclature, physico -chemical properties, extraction, detection, isolation, purification, biosynthetic origin and pharmacological activities.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Will get to know about basics of pharmaceutical
2. Students will understand the concept of phytochemical.
3. Understanding about the plant natural products
4. To make the student to become familiar and to understand the plant cell, tissues, and internal structures of stem, root and leave.
5. Gain knowledge in Immunotherapeutic development for Clinical Applications

TEXT BOOK(S):

1. Farooqui, A. A. and Sreeraman, B. S. 2001.Cultvation of medicinal and aromatic crops. Universities Press.
2. Harborne, J. B. 1998. Phytochemical methods –a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
3. Yesodha, D., Geetha, S and Radhakrishnan, V. 1997.Allied Biochemistry. Morgan publications, Chennai.

REFERENCE BOOKS:

1. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry.
2. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
3. Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I.Himalaya Publishing hs.

22PBT73	BIO-FERTILIZER PRODUCTION AND MUSHROOM CULTIVATION	L	T	P	C
		3	0	0	3

Pre-requisite	Nil	**Syllabus Version**	V 0.1

COURSE OBJECTIVES:

1. To equip the students with skills in bio-composting and biofertilizer production.
2. To instill in students the ability and skills required to become self-employed / entrepreneur.
3. To gain knowledge on the marketing potential of the produced mushroom and composts.
4. To train the students to gain hands on experience in mushroom cultivation, using different types of mushrooms.

COURSE CONTENT:

UNIT I MUSHROOM BIOLOGY MORPHOLOGY 9

Classification: edible and poisonous mushrooms. Life cycle of Basidiomycetes fungi Breeding and Genetic improvement of mushroom strains. Medicinal and Nutritional value of mushrooms.

UNIT II MUSHROOM CULTIVATION TECHNIQUES 9

Cultivation conditions for tropical and temperate countries. Isolation, spawn production, growth media, spawn running and harvesting of mushrooms (Volvariella spp., Pleurotus spp., Agaricus spp., Calocybe spp., and Lentinus spp). Diseases / contamination; Post Harvest Technology: Freezing, drying, freeze drying and canning..

UNIT III ECONOMICS OF MUSHROOM CULTIVATION 9

Economics of the production of oyster mushroom, milky mushroom and paddy straw mushroom cultivation : Infrastructure facilities, expenditure on fixed assets, plant and machinery, cost of the project, recurring expenditure , interest and depreciation of the expenditure, cost of production and profit. Entrepreneurship in mushroom cultivation

UNIT IV COMPOSTING TECHNIQUE INTRODUCTION- 9

History of composting – compost - composting processes - microbiology of composting fate of pathogens - ingredients in composting - various methods of composting: vermi- composting and home composting-steps in composting.

UNIT V BIO-FERTILIZERS AND THEIR PRODUCTION 9

Introduction - Types: Microbes as biofertilizer, Green manure, importance of macronutrients;Biofertilizers vs Chemical fertilizers; Nitrogen fixers – types and examples; Phosphate solubilizers role of bacteria and Mycorrhizae -Mass cultivation and Application of the following biofertilizers: i)Rhizobium ii)Azospirillum iv) Cyanobacteria v) Mycorrhizae Quality control; Challenges and opportunities; Biofertilizer Entrepreneurship

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To train the students to gain hands on experience in mushroom cultivation, using different types of mushrooms.
2. To equip the students with skills in bio-composting and biofertilizer production.
3. To instill in students the ability and skills required to become self-employed / entrepreneur.
4. To gain knowledge on the marketing potential of the produced mushroom and composts.
5. This course is intended to give some idea to students how mushroom plants can be improved quantitatively and qualitatively using biotechnological approaches.

TEXT BOOK(S):

1. Biswas, S, Datta, M and Nagachan, S.V. 2012.Mushrooms- A manual for cultivation. PHI Learning Private Limited, New Delhi.
2. Krishnamoorthy, 1999. Hand Book of Mushroom Cultivation. TNAU Publications, Coimbatore, TN, India.
3. SubbaRao, N. S., 1988, Biofertilizers in agriculture. Oxford & IBH Publishing Company, New Delhi.
4. SubbaRao, N. S., 1977, Soil microorganisms and Plant Growth. Oxford & IBH Publishing Company, New Delhi.
5. SubbaRao, N. S., 1998, Biofertilizers in agriculture and forestry. India Book
6. House Ltd. New Delhi.
7. Nita Bahl, 2002. Hand Book on Mushroom Cultivation. 4th Edition, Vijay Primlani for Oxford & IBH Publishing Co., Press, New York, New Delhi.

REFERENCE BOOKS:

1. Chang, T.S. and Hayes, W.A. 1978. The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.
2. M. C. Nair, C. Gokulapalan and Lulu Das, 1997. Topics on Mushroom Cultivation. Scientific Publishers, Jodhpur, India.

22PBT74	BIOTECHNOLOGICAL APPROACH IN CROP IMPROVEMENT	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus Version**		V 0.1	

COURSE OBJECTIVES:

1. The crops produced need to increase with ever increasing population. ConventionalØ methods for crop improvement are not able to deliver fully. Therefore, high use of throughput technologies is need of the hour.
2. This course is intended to give some idea to students how crop plants can be improved quantitatively and qualitatively using biotechnological approaches. Students are able to understand plant genome organization. To acquaint students with recent techniques for crop improvement Application of molecular markers for crop improvement.

COURSE CONTENT:

UNIT I PLANT GENOME ORGANIZATION 9

Features of plant chromosomes: centromere, telomere, euchromatin, heterochromatin and nucleolus organizing region (NOR); karyotype (asymmetric and symmetric). C-value paradox, range of interspecific and intraspecific variation, origin of quantitative DNA variation. Estimation of various components of higher-plant genome: highly repetitive sequences, middle repetitive sequences, and unique DNA sequences. Rice and maize genome sequencing projects; cereal genome databases.

UNIT II BIOTECHNOLOGICAL APPROACH FOR CROP IMPROVEMENT 9

Biotechnological approaches for disease resistance, protection against fungal pathogens and drought tolerance. Modification of crop-plant nutritional content (vitamins, amino acids and lipids). Modification of crop-plant taste and appearance (sweetness, starch and preventing discoloration). Polyploidy: induction of polyploidy by artificial methods; role of polyploidy in crop improvement.

UNIT III MOLECULAR MARKERS AND CROP IMPROVEMENT 9

Types of molecular markers used in analyzing genetic diversity for crop improvement; molecular mapping and tagging of agronomically important traits. Molecular cytogenetic markers: FISH and GISH, their application in crop improvement. Transposable elements: mechanism of action and their role in crop improvement. Quantitative trait loci (QTL) mapping: introduction, types of mapping populations; role in crop improvement.

UNIT IV APPLICATION OF MOLECULAR MARKERS 9

Construction of molecular maps (using F2, DH, RILs); gene tagging using bulked segregant analysis (BSA) and near isogenic lines (NILs); QTL analysis; map-based cloning of genes; elementary idea of marker-assisted selection (MAS) in plant breeding.

UNIT V PRODUCTION OF TRANSGENIC PLANTS IN VARIOUS FIELD CROPS **9**

cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecularfarming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. The crops produced need to increase with ever increasing population. Conventional methods for crop improvement are not able to deliver fully.
2. This course is intended to give some idea to students how crop plants can be improved quantitatively and qualitatively using biotechnological approaches.
3. To acquaint students with recent techniques for crop improvement Application of molecular markers for crop improvement.
4. Therefore, high use of throughput technologies is need of the hour.
5. Students are able to understand plant genome organization.

TEXT BOOK(S):

1. Abelson, P. H. (1984). Biotechnology and Biological Frontiers. American Association for the Advancement of Science, Washington, U.S.A.
2. Ammirato, P. V., Evans, P. V., Evans, D. A., Sharp, W. R. and Yamada, Y. (Eds.) (1984). Handbook of Plant Cell Culture. Vols. 1, 2 & 3. MacMillan Publishing Co, New York.
3. Dodds, J. H. and Roberts, L. W. (1985). Experiments in Plant Tissue Culture. Cambridge University Press, Cambridge.
4. Mantell, S. H. and Smith, H. (Eds.) (1983). Plant Biotechnology. Cambridge University Press, Cambridge.
5. Swaminathan, M. S. (1991). Biotechnology in Agriculture – A dialogue. MacMillan India, New Delhi.
6. Gupta, P. K. (2004). Biotechnology and Genomics. Rastogi Publications, Meerut
7. Kung, S. and Arntzen, C. J. (Eds.). (1989). Plant Biotechnology. Butterworth, Boston.
8. Grierson D (Ed.). (1991). Plant Genetic Engineering: Plant Biotechnology Series, Volume I. Blockie, Glasgow, London.

REFERENCE BOOKS:

1. The main objective is to provide an overview of the plant derived natural products for their
2. occurrence, sources, basic chemistry and therapeutic applications

22PBT75	ADVANCE TECHQNIQUES IN AGRO FORESTRY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To introduce the students to the essential basics of phytogeography and forestry of India.

COURSE CONTENT:

UNIT I SILVICULTURE 9

General silvicultural principles; ecological and physiological factors influencing vegetation; natural and artificial regeneration of forests; nursery techniques; seed technology collection, storage, pre- treatment and germination; establishment and tendings. Silvicultural systems-clear felling, uniform, shafter-wood, selection, coppice and conversion systems. Social forestry-objectives, scope, necessity; agro-forestry; extension forestry: recreation forestry; people's participation.

UNIT II FOREST MENSURATION, MANAGEMENT AND UTILIZATION 9

Methods of measuring-diameter, girth, height and volume of trees; form factor; volume estimation of stand: sampling methods; yield calculation; current annual increment; mean annual increment; sample plots; yield and stand tables; scope and objectives of forest inventory; aerial survey and remote-sensing techniques. Forest management-objectives and principles; techniques; sustained yield relation; normal forest; growing stock; regulation of yield-methods of application; working plans-preparation and control. Forest utilisation: Logging and extraction techniques and principles; transport, storage and sale. Minor and major forest product : definition and scope. Collection, processing and disposal of minor and major forest products.

UNIT III ADVANCES IN TREE IMPROVEMENT 9

Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees. Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees. Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT IV ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS 9

Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing. Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT V CLIMATE CHANGE AND FORESTRY 9

Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. To introduce the students to the essential basics of phytogeography and forestry
2. Understand the basics of animal physiology
3. Know the various animal system
4. Understand the nutrient transport and metabolism
5. Learn the micromanipulation technique

TEXT BOOK(S):

1. McManus B. Collins and Fred M White, 1981. Elementary Forestry. Reston Publishing Company, Inc., Reston, Virginia.
2. MacDonald, G.2003. Biogeography: Introduction to Space, Time and Life. John Wiley & Sons, Inc.
3. Sagreiya, K.P.,1967.Forestsand Forestry. National Book Trust, India.

REFERENCE BOOKS:

1. Dwivedi, A.P.,1993.A Text Book of Silviculture.International Book Distributors, Dehra Dun.
2. Lal, J.B., 2003. TropicalSilviculture: NewImperatives: NewSystems, International Book
3. Longman, K.A. and Jenik, J., 1987. Tropical forest and its Environment: ELBS, 2nd edn. London.
4. Shanmughavel, P., 2003: Techniques in Forestry, Pointer, Jaipur.
5. Simmons, I. G. 1979. Biogeography: Natural and Cultural. Edward Arnold Ltd.
6. Tiwari, K.M. and Singh, R.V., 1984. Social Forestry Plantations. Oxford & IBH Publishing Co., New Delhi

22PBT76	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUES	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

COURSE OBJECTIVES:

1. To Understand the basic principles of plant tissue culture
2. To gain knowledge & methods in biotechnology
3. To get an insight into Recombinant DNA technology and Methods of gene transfer.
4. To study the applications of Biotechnology

COURSE CONTENT:

UNIT I PLANT TISSUE CULTURE **9**

History of plant tissue culture research - basic principles of plant tissue callus culture, meristem culture, organ culture, Totipotency of cells, differentiation and dedifferentiation. Methodology - sterilization (physical and chemical methods), culture media, Murashige and Skoog's (MS medium), phytohormones, medium for micro-propagation/clonal propagation of ornamental and horticulturally important plants Callus subculture maintenance, growth measurements, morphogenesis

UNIT II PLANT TISSUE CULTURE **9**

Endosperm culture – Embryo culture -culture requirements – applications, embryo rescue technique. Production of secondary metabolites. Cryopreservation; Germ plasm conservation

UNIT III ORGAN CULTURE **9**

Anther, Embryo & Meristem culture. Organogenesis, somatic embryogenesis and artificial seeds. Somatic Hybridization: Isolation, fusion and protoplast culture. Somoclonal Variation & cryopreservation.

UNIT IV TISSUE CULTURE IN FOREST TREES **9**

In vitro propagation via enhanced release of auxiliary buds. Somatic organogenesis and somatic embryo genesis, leaf diseases, embryoid and synthetic seed production. Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration.

UNIT V TRANSFORMATION TECHNIQUES **9**

Genetic transformation techniques in plants: Gene transfer methods in plants – Direct DNA transfer methods, Agro bacterium mediated nuclear transformation. Ti and Ri plasmids, binary & cointegrated vector systems; genetic markers; reporter genes; genetic transformation techniques for overcoming biotic and abiotic stress. Green house and green home technology. Arid and semiarid technology.

TOTAL LECTURE PERIODS 45 Periods

EXPECTED COURSE OUTCOME:

On completion of the course, the student is expected to

1. Understand the basic principles of plant tissue culture
2. Understand the methods in biotechnology
3. Get an insight into Recombinant DNA technology and Methods of gene transfer.
4. Appreciate the applications of Biotechnology
5. Learn the micromanipulation technique

TEXT BOOK(S):

1. Botany-Plant tissue culture and its biotechnological applications, by B. R. C. Murthy & V. S.T. Sai, Venkateswara Publications, Gu

REFERENCE BOOKS:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani,S.S. and Bhatnagar, S.P. (2011).The Embryology of Angiosperms. VikasPublicationHouse Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue culture. Scientific Publishers, New Delhi.