



VIVEKANANDHA



COLLEGE OF ENGINEERING FOR WOMEN

(An Autonomous Institution Affiliated to Anna University-Chennai)

Approved by AICTE – Accredited by NBA New Delhi and ISO 9001:2015 Certified)

Elayampalayam, Tiruchengode – 637 205, Namakkal District, Tamilnadu.

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM & SYLLABI

FOR

UG – B.TECH. BIOTECHNOLOGY

REGULATION 2023

(CBCS)

(After 18th BoS)

(Applicable to the students admitted in the academic year 2023-2024 onwards)



VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS]
Tiruchengode -637 205



Department of Biotechnology

Department Vision

To nourish the world of Technology & research with highly skilled women Biotechnologists to invent, innovate and disseminate the knowledge for the benefit of society & environment.

Department Mission

- ✓ To create excellent prospects for multifaceted bioengineering exercise and research in biotechnology.
- ✓ To produce tailored human resource to drive innovative biotechnological processes.
- ✓ To disseminate the knowledge in upcoming opportunities evolving sustainable entrepreneurship and research in the field of biotechnology for present and future.

Program Outcomes

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: : Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives


The Graduates of Biotechnology have

PEO1	The ability to provide the students with a solid foundation and the ability to apply mathematics, science in Biotechnology and to analyze data and technical concepts for application in Quality assurance and enabling placements/higher education .
PEO2	An ability to inculcate the professional and ethical attitudes, effective communication skills, team work skills, multidisciplinary approach among the students and an ability to relate environmental issues in broader social context .
PEO3	To provide with an excellent training to enhance the core profession career in the field of agriculture, pharmaceuticals, biochemical, food tech and other allied biosciences.

Program Specific Outcomes

The Graduates of Biotechnology will be able to

PSO1	Demonstrate expertise in basic sciences and foundation courses.
PSO2	Demonstrate a working knowledge of advanced biological sciences
PSO3	Demonstrate competence in application of engineering principles to biological systems.


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MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEO) WITH PROGRAMME OUTCOMES (PO)



PEO	PROGRAMME OUTCOMES											
	Po1	Po2	Po3	Po4	Po5	Po6	Po7	Po8	Po9	Po10	Po11	Po12
1	√	√	√	√	√					√		√
2	√				√	√	√	√	√	√	√	√
3	√				√	√	√	√		√		√

Credit Distribution

S.No.	Course Components	Credits per semester								Total number of credits for each component
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences Courses (HSMC)	4	4	-	-	-	-	-	-	8
2	Basic Science Courses (BSC)	8	8	4	4	-	-	-	-	24
3	Engineering Science Courses (ESC)	7	8	-	-	-	-	-	-	15
4	Programme Core Courses (PCC)	-	-	14	14	14	14	10	-	66
5	Programme Elective Courses (PEC)	-	-	-	-	3	6	6	-	15
6	Open Elective Courses (OEC)	-	-	-	-	3	3	3	-	9
7	Employability Enhancing Courses (EEC)	1	-	2	2	2	2	3	10	22
8	Mandatory Course	-	-	-	-	-	1	-	-	01
Total Credits										160




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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai)Elayampalayam, Tiruchengode – 637 205										
Programme	B.Tech.	Programme Code	105	Regulation	2023						
Department	BIOTECHNOLOGY			Semester	I						
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)											
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks				
			L	T	P		C	CA	ESE	Total	
THEORY											
U23MA101	Matrices and Calculus*	BSC	3	1	0	4	40	60	100		
U23EN101	English For Communication*	HSMC	3	0	0	3	40	60	100		
U23PH101	Engineering Physics [§]	BSC	3	0	0	3	40	60	100		
U23CS101	Programming for Problem Solving*	ESC	3	0	0	3	40	60	100		
U23TA101	Heritage of Tamils*	HSMC	1	0	0	1	40	60	100		
THEORY INTEGRATED WITH PRACTICAL											
U23GE101	Engineering Graphics*	ESC	2	0	3	3	50	50	100		
PRACTICAL INTEGRATED WITH THEORY											
U23GE102	Design Thinking*	EEC	1	0	2	1	50	50	100		
PRACTICAL											
U23PH102	Physics Laboratory [§]	BSC	0	0	3	1	60	40	100		
U23CS102	Programming for Problem Solving Laboratory*	ESC	0	0	3	1	60	40	100		
MANDATORY COURSES											
-	Induction Programme*	3 Weeks				0	-	-	-		
U23MCFY1	Environmental Science and Engineering [§]	MC	2	0	0	0	100	-	100		
Total							20	520	480	1000	

BSC - Basic Science Courses, ESC- Engineering Science Courses, MC- Mandatory courses, HSMC- Humanities and Social Sciences including management courses, EEC- Employability Enhancement Courses, CA- Continuous Assessment, ESE - End Semester Examination.

*Common for all branches [§]Common for AI & DS, CSE, CST, IT&BT

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Programme	B.Tech.	Programme Code	105	Regulation	2023					
Department	BIOTECHNOLOGY			Semester	II					
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)										
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks			
			L	T	P		C	CA	ESE	Total
THEORY										
U23MA202	Complex Analysis and Ordinary Differential Equations*	BSC	3	1	0	4	40	60	100	
U23CH201	Engineering Chemistry [§]	BSC	3	0	0	3	40	60	100	
U23EE201	Basic Electrical and Electronics Engineering [#]	ESC	3	0	0	3	40	60	100	
U23TA202	தமிழரும் தொழில்நுட்பமும் / Tamil and Technology*	HSMC	1	0	0	1	40	60	100	
THEORY INTEGRATED WITH PRACTICAL										
U23CS203	Python Programming [@]	ESC	3	0	2	4	50	50	100	
U23EN202	Professional Communication *	HSMC	2	0	3	3	50	50	100	
PRACTICAL										
U23CH202	Chemistry Laboratory [§]	BSC	0	0	2	1	60	40	100	
U23GE204	Engineering Practices Laboratory*	ESC	0	0	3	1	60	40	100	
MANDATORY COURSES										
U23MCFY2	Indian Constitution [§]	MC	2	0	0	0	100	-	100	
Total						20	480	420	900	

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*Common for all branches



#Common for BT, CSE, CST, IT, AI & DS

@Common for ECE, EEE, BME, BT, CIVIL & AGRI

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Programme	B.Tech.	Programme Code	105	Regulation			2023		
Department	BIOTECHNOLOGY			Semester			III		
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)									
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U23MA303	Transforms and Partial Differential Equations*	BSC	3	1	0	4	40	60	100
U23BT302	Microbiology	PCC	3	0	0	3	40	60	100
U23BT303	Cell Biology	PCC	3	0	0	3	40	60	100
U23BT304	Thermodynamics for Biotechnologists	PCC	3	0	0	3	40	60	100
U23BT305	Biochemistry and Bioenergetics	PCC	3	0	0	3	40	60	100
U23CTCP1	Verbal, Quantitative Aptitude and Reasoning – I@	EEC	2	0	0	1	40	60	100
PRACTICAL									
U23BT306	Cell & Microbiology Laboratory	PCC	0	0	2	1	60	40	100
U23BT307	Biochemistry Laboratory	PCC	0	0	2	1	60	40	100
U23CTCP2	Personality Development@	EEC	1	0	2	1	60	40	100
Total Credits						20	420	400	900



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Programme	B.Tech.	Programme Code	105	Regulation			2023			
Department	BIOTECHNOLOGY			Semester			IV			
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)										
Course Code	Course Name	Hours / Week			Credit	Maximum Marks				
		L	T	P	C	CA	ESE	Total		
THEORY										
U23MA408	Biostatistics	BSC	3	1	0	4	40	60	100	
U23BT408	Plant and Animal Biotechnology	PCC	3	0	0	3	40	60	100	
U23BT409	Molecular Biology	PCC	3	0	0	3	40	60	100	
U23BT410	Instrumentation Methods of Analysis	PCC	3	0	0	3	40	60	100	
	Additional Language@	EEC	2	0	0	1	100	-	100	
THEORY INTEGRATED WITH PRACTICAL										
U23BT411	Unit Operations	PCC	3	0	2	4	50	50	100	
PRACTICAL										
U23BT412	Plant and Animal Biotechnology Laboratory	PCC	0	0	3	1	60	40	100	
CAREER TRACK COURSES										
	Career Track Course – I@	EEC	2/0	0	0/2	1	40/60	60/40	100	
Total Credits						20	410/ 430	390/ 370	800	

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Programme	B.Tech	Programme Code	105	Regulation			2023		
Department	BIOTECHNOLOGY			Semester			V		
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)									
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U23BT514	Enzyme Engineering	PCC	3	0	0	3	40	60	100
U23BT515	Genetic Engineering	PCC	3	0	0	3	40	60	100
U23BT516	Heat and Mass Transfer Operations	PCC	3	0	0	3	40	60	100
	Professional Elective - I	PEC	3	0	0	3	40	60	100
	Open Elective - I	OEC	3	0	0	3	40	60	100
THEORY INTEGRATED WITH PRACTICAL									
U23BT517	Computational Biology	PCC	3	0	2	4	50	50	100
PRACTICAL									
U23BT518	Molecular Biology & Genetic Engineering Laboratory	PCC	0	0	2	1	60	40	100
U23BT519	Mini project –I	EEC	0	0	2	1	100	-	100
CAREER TRACK COURSES									
	Career Track Course – II@	EEC	2	0	0	1	40	60	100
Total Credits						22	450	450	900

ESC- Engineering Science Courses, MC- Mandatory courses, EEC- Employability Enhancement Courses, PCC- Professional core courses, PEC- Professional Elective courses, OEC- Open Elective courses, CA- Continuous Assessment, ESE - End Semester Examination

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Programme	B.Tech	Programme Code	105	Regulation			2023		
Department	BIOTECHNOLOGY			Semester			VI		
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)									
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
THEORY									
U23BT620	Biopharmaceutical Technology	PCC	3	0	0	3	40	60	100
U23BT621	Bioprocess Engineering and Technology	PCC	3	0	0	3	40	60	100
U23BT622	Chemical Reaction Engineering	PCC	3	0	0	3	40	60	100
	Professional Elective – II	PEC	3	0	0	3	40	60	100
	Professional Elective – III	PEC	3	0	0	3	40	60	100
	Open Elective – II	OEC	3	0	0	3	40	60	100
THEORY INTEGRATED WITH PRACTICAL									
U23BT623	Immunology	PCC	3	0	2	4	50	50	100
PRACTICAL									
U23BT624	Bioprocess Laboratory	PCC	0	0	2	1	60	40	100
U23BT625	Mini project –II	EEC	0	0	2	1	100	-	100
MANDATORY COURSES									
U23BT626	Comprehensive Examination	MC	2	0	0	1	100	-	100
CAREER TRACK COURSES									
	Career Track Course – III@	EEC	2	0	0	1	40	60	100
Total Credits						26	590	510	1100

ESC- Engineering Science Courses, MC- Mandatory courses, EEC- Employability Enhancement Courses, PCC- Professional core courses, PEC- Professional Elective courses, OEC- Open Elective courses, CA- Continuous Assessment, ESE - End Semester Examination
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Programme	B.Tech	Programme Code	105	Regulation			2023			
Department	BIOTECHNOLOGY			Semester			VII			
CURRICULUM (Applicable to the students admitted from the academic year 2023 – 2024 onwards)										
Course Code	Course Name	Hours / Week			Credit	Maximum Marks				
		L	T	P	C	CA	ESE	Total		
THEORY										
U23BT727	Downstream Processing	PCC	3	0	0	3	40	60	100	
U23BT728	AI in Proteomics and Genomics	PCC	3	0	0	3	40	60	100	
U23BT729	Principles of Food Processing	PCC	3	0	0	3	40	60	100	
	Professional Elective – IV	PEC	3	0	0	3	40	60	100	
	Professional Elective – V	PEC	3	0	0	3	40	60	100	
	Open Elective – III	OEC	3	0	0	3	40	60	100	
PRACTICAL										
U23BT730	Downstream Processing Laboratory	PCC	0	0	3	1	60	40	100	
U23BT731	Internship Training cum Project phase- I	EEC	0	0	3	3	100	-	100	
Total Credits						22	400	400	800	


ESC- Engineering Science Courses, MC- Mandatory courses, EEC- Employability Enhancement Courses, PCC- Professional core courses, PEC- Professional Elective courses, OEC- Open Elective courses, CA- Continuous Assessment, ESE - End Semester Examination


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Programme	B.Tech	Programme Code	105	Regulation				2023	
Department	BIOTECHNOLOGY			Semester				VIII	
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total	
PRACTICAL									
U23BT832	Project Phase - II	EEC	0	0	16	10	60	40	100
Total Credits						10	60	40	100



Cumulative Course Credit: 160


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Career Track Courses											
Sem	Course Code	Course Name	Category	Periods/Week				Credit	Maximum Marks		
				L	T	P	C		CA	ESE	Total
Track 1 - Entrepreneurship											
IV	U23CTCE1	Entrepreneurial Mindset and Business Model Canvas	EEC	-	-	2	1	60	40	100	
V	U23CTCE2	Product Innovation, Commercialization and Finance	EEC	2	-	-	1	40	60	100	
VI	U23CTCE3	Intellectual Property Rights	EEC	2	-	-	1	40	60	100	
Track 2 - Competitive Examination											
IV	U23CTCP3	Verbal , Quantitative Aptitude and Reasoning -II	EEC	2	-	-	1	40	60	100	
V	U23CTCG1	History & Culture of India and Indian Geography	EEC	2	-	-	1	40	60	100	
VI	U23CTCG2	Indian economy and Freedom struggle in India & Tamil Nadu	EEC	2	-	-	1	40	60	100	
Track 3 - Higher Studies											
IV	U23CTCP3	Verbal, Quantitative Aptitude and Reasoning -II	EEC	2	-	-	1	40	60	100	
V	U23CTCH1	Higher Studies in Abroad & India	EEC	2	-	-	1	40	60	100	
VI	U23CTCH2	Social Networking for Higher Studies	EEC	2	-	-	1	40	60	100	
Track 4 - Placement											
IV	U23CTCP3	Verbal , Quantitative Aptitude and Reasoning -II	EEC	2	-	-	1	40	60	100	
V	U23CTCP4	Leveraging Arithmetic and Codes Snippet	EEC	2	-	-	1	40	60	100	
VI	U23CTCP5	Integrated Reasoning and Pseudo Code	EEC	2	-	-	1	40	60	100	


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Programme	B.Tech.	Programme Code	105	Regulation	2023			
Department	BIOTECHNOLOGY			Semester	-			
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)								
LIST OF OPEN ELECTIVES								
Course Code	Course Name	Hours / Week			Credit C	Maximum Marks		
		L	T	P		CA	ESE	Total
OPEN ELECTIVE - I								
U23BTOE1	Biology for Engineers	3	0	0	3	40	60	100
U23BTOE2	Food and Nutrition	3	0	0	3	40	60	100
U23BTOE3	Biosensors	3	0	0	3	40	60	100
OPEN ELECTIVE –II								
U23BTOE4	Basics of Bioinformatics	3	0	0	3	40	60	100
U23BTOE5	Human Health and Nutritional Disorders	3	0	0	3	40	60	100
U23BTOE6	Biobusiness	3	0	0	3	40	60	100
OPEN ELECTIVE –III								
U23BTOE7	Food Processing and Preservation Technology	3	0	0	3	40	60	100
U23BTOE8	Forensic Technology	3	0	0	3	40	60	100
U23BTOE9	Organic farming for sustainable agriculture	3	0	0	3	40	60	100


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ADDITIONAL LANGUAGE COURSES										
Sem	Course Code	Course Name	Category	Periods/Week			Credit	Maximum Marks		
				L	T	P	C	CA	ESE	Total
IV	U23ADL01	French	EEC	2	0	0	1	100	-	100
IV	U23ADL02	German	EEC	2	0	0	1	100	-	100
IV	U23ADL03	Japanese	EEC	2	0	0	1	100	-	100

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

S.No.	Vertical I		Vertical II		Vertical III		Vertical IV		Vertical V		Vertical VI	
	Environmental Biotechnology	Waste Water Treatment	Food Technology	Food Processing & Preservation Techniques	Industrial Biotechnology	Clinical Biotechnology	Quality and Regulatory Affairs	Computational Biotechnology				
1	Waste Management	Waste Water Treatment	Food Processing & Preservation Techniques	Food Processing & Preservation Techniques	Basic Industrial Biotechnology	Stem cell Technology	Good Manufacturing Practices	Fundamentals of protein chemistry				
2	Waste Management	Waste Management	Fermented Products	Fermented Products	Fermentation Technology	Clinical Biochemistry	Entrepreneurship & IPR	Protein Engineering				
3	Bioremediation	Bioremediation	Dairy Technology	Dairy Technology	Analytical Techniques in Bioindustries	Cancer Biology	Audit and Regulatory Compliance	Molecular Modeling and Drug design				
4	Ecology & Environmental Management	Ecology & Environmental Management	Food additives and Nutraceuticals	Food additives and Nutraceuticals	Instrumentation and Process Control	Biomedical nanotechnology	Supply Chain Management	Computer Aided Drug Design				
5	Air Pollution and Control Engineering	Air Pollution and Control Engineering	Food Quality and Safety Standards	Food Quality and Safety Standards	Bioreactor Design and Scale Up process	Population and Molecular genetics	QA and QC in Biotechnology	Data mining and Machine Learning for Bioinformatics				
6	Green and Energy Audit	Green and Energy Audit	Bakery and Confectionery Products	Bakery and Confectionery Products	Bioprocess Technology	Basics of Human Physiology and Anatomy	Industrial Biosafety	System Biology				
7	Environmental Impact & Risk Assessment	Environmental Impact & Risk Assessment	Food Packaging Technology	Food Packaging Technology	Bioenergy and Biofuels	Tissue Engineering	Product development and Technology transfer	Molecular Simulation of Biomolecules				
8	Sustainable product development	Sustainable product development	Food Microbiology	Food Microbiology	Hazard Assessment and Mitigation	Cell Culture Technologies	Innovation and Design Thinking for Biotechnologists	Fundamentals of Algorithm for Bioinformatics				
9	Marine Biotechnology	Marine Biotechnology	Food Nutrition and Health Science	Food Nutrition and Health Science	Bioprocess Economics and Plant Design	Clinical Trials and Healthcare Policies in Biotechnology	Resource Management & Lean Start-up Management	Programming for Bioinformatics Applications				


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Programme	B.Tech.	Programme Code	105	Regulation			2023		
Department	BIOTECHNOLOGY			Semester			-		
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)									
LIST OF VERTICALS									
Course Code	Course Name	Hours / Week			Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total	
Vertical - I Environmental Biotechnology									
U23BTV11	Waste Water Treatment	3	0	0	3	40	60	100	
U23BTV12	Solid Waste Management	3	0	0	3	40	60	100	
U23BTV13	Bioremediation	3	0	0	3	40	60	100	
U23BTV14	Ecology & Environmental Management	3	0	0	3	40	60	100	
U23BTV15	Air Pollution and Control Engineering	3	0	0	3	40	60	100	
U23BTV16	Green and Energy Audit	3	0	0	3	40	60	100	
U23BTV17	Environmental Impact & Risk Assessment	3	0	0	3	40	60	100	
U23BTV18	Sustainable product development	3	0	0	3	40	60	100	
U23BTV19	Marine Biotechnology	3	0	0	3	40	60	100	
Vertical - II Food Technology									
U23BTV21	Food Processing & Preservation Techniques	3	0	0	3	40	60	100	
U23BTV22	Fermented Products	3	0	0	3	40	60	100	
U23BTV23	Dairy Technology	3	0	0	3	40	60	100	
U23BTV24	Food additives and Nutraceuticals	3	0	0	3	40	60	100	
U23BTV25	Food Quality and Safety Standards	3	0	0	3	40	60	100	
U23BTV26	Bakery and Confectionery Products	3	0	0	3	40	60	100	
U23BTV27	Food Packaging Technology	3	0	0	3	40	60	100	
U23BTV28	Food Microbiology	3	0	0	3	40	60	100	
U23BTV29	Food Nutrition and Health Science	3	0	0	3	40	60	100	
Vertical - III Industrial Biotechnology									
U23BTV31	Basic Industrial Biotechnology	3	0	0	3	40	60	100	

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U23BTV32	Fermentation Technology	3	0	0	3	40	60	100
U23BTV33	Analytical Techniques in Bioindustries	3	0	0	3	40	60	100
U23BTV34	Instrumentation and Process Control	3	0	0	3	40	60	100
U23BTV35	Bioreactor Design and Scale Up process	3	0	0	3	40	60	100
U23BTV36	Bioprocess Technology	3	0	0	3	40	60	100
U23BTV37	Bioenergy and Biofuels	3	0	0	3	40	60	100
U23BTV38	Hazard Assessment and Mitigation	3	0	0	3	40	60	100
U23BTV39	Bioprocess Economics and Plant Design	3	0	0	3	40	60	100
Vertical - IV Clinical Biotechnology								
U23BTV41	Stem cell Technology	3	0	0	3	40	60	100
U23BTV42	Clinical Biochemistry	3	0	0	3	40	60	100
U23BTV43	Cancer Biology	3	0	0	3	40	60	100
U23BTV44	Biomedical Nanotechnology	3	0	0	3	40	60	100
U23BTV45	Population and Molecular genetics	3	0	0	3	40	60	100
U23BTV46	Basics of Human Physiology and Anatomy	3	0	0	3	40	60	100
U23BTV47	Tissue Engineering	3	0	0	3	40	60	100
U23BTV48	Cell Culture Technologies	3	0	0	3	40	60	100
U23BTV49	Clinical Trials and Healthcare Policies in Biotechnology	3	0	0	3	40	60	100
Vertical - V Quality and Regulatory Affairs								
U23BTV51	Good Manufacturing Practices	3	0	0	3	40	60	100
U23BTV52	Entrepreneurship & IPR	3	0	0	3	40	60	100
U23BTV53	Audit and Regulatory Compliance	3	0	0	3	40	60	100
U23BTV54	Supply Chain Management	3	0	0	3	40	60	100
U23BTV55	QA and QC in Biotechnology	3	0	0	3	40	60	100
U23BTV56	Industrial Biosafety	3	0	0	3	40	60	100
U23BTV57	Product development and Technology transfer	3	0	0	3	40	60	100
U23BTV58	Innovation and Design Thinking for Biotechnologists	3	0	0	3	40	60	100
U23BTV59	Resource Management & Lean Start-up Management	3	0	0	3	40	60	100
Vertical - VI Computational Biotechnology								
U23BTV61	Fundamentals of protein chemistry	3	0	0	3	40	60	100
U23BTV62	Protein Engineering	3	0	0	3	40	60	100
U23BTV63	Molecular Modeling and Drug design	3	0	0	3	40	60	100

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U23BTV64	Computer Aided Drug Design	3	0	0	3	40	60	100
U23BTV65	Data mining and Machine Learning for Bioinformatics	3	0	0	3	40	60	100
U23BTV66	System Biology	3	0	0	3	40	60	100
U23BTV67	Molecular Simulation of Biomolecules	3	0	0	3	40	60	100
U23BTV68	Fundamentals of Algorithm for Bioinformatics	3	0	0	3	40	60	100
U23BTV69	Programming for Bioinformatics Applications	3	0	0	3	40	60	100



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Vertical - V Quality and Regulatory Affairs
For Minor Degree in Biotechnology



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Programme	B.TECH.	Programme Code	105	Regulation	2023				
Department	BIOTECHNOLOGY			Semester	-				
CURRICULUM (Applicable to the students admitted from the academic year 2023- 2024 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U23BTV51	Good Manufacturing Practices	PEC	3	0	0	3	40	60	100
U23BTV52	Entrepreneurship & IPR	PEC	3	0	0	3	40	60	100
U23BTV53	Audit and Regulatory Compliance	PEC	3	0	0	3	40	60	100
U23BTV54	Supply Chain Management	PEC	3	0	0	3	40	60	100
U23BTV55	QA and QC in Biotechnology	PEC	3	0	0	3	40	60	100
U23BTV56	Industrial Biosafety	PEC	3	0	0	3	40	60	100
U23BTV57	Product development and Technology transfer	PEC	3	0	0	3	40	60	100
U23BTV58	Innovation and Design Thinking for Biotechnologists	PEC	3	0	0	3	40	60	100
U23BTV59	Resource Management & Lean Start-up Management	PEC	3	0	0	3	40	60	100


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SEMESTER I

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Programme	B.TECH	Programme Code	105	Regulation	2023																																																																																																																																																						
Department	Biotechnology			Semester	I																																																																																																																																																						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks																																																																																																																																																					
		L	T	P	C	CA	ESE	Total																																																																																																																																																			
U23MA101	Matrices and Calculus	3	1	0	4	40	60	100																																																																																																																																																			
Course Objective	The Main Objective of the course is <ul style="list-style-type: none"> To develop the use of matrix algebra techniques that is needed by engineers for practical applications. To familiarize the students with differential calculus. To familiarize the student with functions of several variables. This is needed in many branches of engineering. To make the students understand various techniques of integration. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications. 																																																																																																																																																										
	At the end of the course the students will be able to							Knowledge level																																																																																																																																																			
Course Outcome	CO1: Use the matrix algebra methods for solving practical problems.							K3																																																																																																																																																			
	CO2: Apply differential calculus tools in solving various application problems.							K4																																																																																																																																																			
	CO3: Able to use differential calculus ideas on several variable functions.							K5																																																																																																																																																			
	CO4: Apply different methods of integration in solving practical problems.							K5																																																																																																																																																			
	CO5: Apply multiple integral ideas in solving areas, volumes and other practical problems.							K3																																																																																																																																																			
Pre-requisites	-																																																																																																																																																										
<table border="1"> <thead> <tr> <th colspan="13">CO / PO Mapping</th> <th colspan="3">CO/PSO Mapping</th> </tr> <tr> <th colspan="13">(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak</th> <th colspan="3"></th> </tr> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="3">PSOs</th> </tr> <tr> <th>PO 1</th> <th>PO 2</th> <th>PO 3</th> <th>PO 4</th> <th>PO 5</th> <th>PO 6</th> <th>PO 7</th> <th>PO 8</th> <th>PO 9</th> <th>PO 10</th> <th>PO 11</th> <th>PO 12</th> <th>PSO 1</th> <th>PSO 2</th> <th>PSO 3</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>3</td> <td>2</td> <td></td> <td>1</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>CO 2</td> <td>3</td> <td>3</td> <td>2</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>CO 3</td> <td>3</td> <td></td> <td>2</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>CO 4</td> <td>3</td> <td>2</td> <td>2</td> <td>1</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>CO 5</td> <td>3</td> <td></td> <td>1</td> <td>1</td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> </tr> </tbody> </table>													CO / PO Mapping													CO/PSO Mapping			(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak																COs	Programme Outcomes (POs)												PSOs			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	CO 1	3	2		1	1								2			CO 2	3	3	2		1								2			CO 3	3		2	1									2			CO 4	3	2	2	1	1								2			CO 5	3		1	1	1								2		
CO / PO Mapping													CO/PSO Mapping																																																																																																																																														
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3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	MATRICES	Periods	9+3
Characteristic equation – Eigen values and Eigenvectors of a real matrix– Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem(excluding proof) – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms. Simple application in encoding message using 2×2 matrix.			
Unit - II	DIFFERENTIAL CALCULUS	Periods	9+3
Limit, Continuity, Differentiability, Rules of differentiation, Differentiation of various functions, Rolle's theorem(excluding proof), Mean value theorem(excluding proof), Taylor's theorem(excluding proof), Maxima and Minima. Applications: Newton's law of cooling – Heat flow problems.			
Unit – III	FUNCTIONS OF SEVERAL VARIABLES	Periods	9+3
Partial differentiation – Homogeneous functions and Euler's theorem(excluding proof) – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables(excluding proof) – Maxima and minima of functions of two variables. Applications: Lagrange's method of undetermined multipliers.			
Unit - IV	INTEGRAL CALCULUS	Periods	9+3
Definite and Indefinite Integrals- Methods of integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions -Reduction formula on $\int_0^{\frac{\pi}{2}} \cos^n x dx$, $\int_0^{\frac{\pi}{2}} \sin^n x dx$.			
Unit - V	MUTIPLE INTEGRALS	Periods	9+3
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.			
Total Periods			45+15=60
Text Books			
1.	Stewart, J. Calculus: Early Transcendentals (8 th Edition), Cengage Learning, 2015.		
2.	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 45 th Edition, 2024.		
References			
1.	Kreyszig E, Advanced Engineering Mathematics (10 th Edition), John Wiley (2015).		
2.	Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7 th Edition, 2009.		
3.	Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus ", 14 th Edition, Pearson India, 2018.		
4.	Anton H, Calculus: Early Transcendentals, 10 th Edition, Wiley (2016).		
5.	B V Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Pvt Ltd., New Delhi (2016)		
E-Resources			
1.	https://freevideolectures.com > All Courses > Calculus > UCLA		
2.	www.learnerstv.com /Free-engineering-Video-lectures		
3.	www.nptel.ac.in		


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Programme	B.Tech.	Programme Code			105	Regulation	2023								
Department	Biotechnology				Semester		I								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23EN101	English for Communication	3	0	0	3	40	60	100							
Course Objective	<p>The main objective of this course is to:</p> <ul style="list-style-type: none"> • Improve the communicative ability of learners. • Make learners read widely in order to practice writing • Make learners develop vocabulary and strengthen grammatical understanding • Assist students in the development of intellectual flexibility, creativity, and cultural literacy so that they may engage in life-long learning. • Identify and begin to apply the language features of academic and professional writing and speaking 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Use appropriate vocabulary in a professional context						K1								
	CO2: Write appropriately based on the knowledge gained through reading of a variety of materials						K1								
	CO3: Use language through their grammatical acquisition						K2								
	CO4: Read and infer meanings of technical texts						K2								
Pre-requisites	Nil						K3								
	CO5: Comprehend and retain the contextual and syntax understanding from reading.						K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1						2			3	3		3		2	
CO 2						2			3	3		3		2	
CO 3						2			3	3		3		2	
CO 4						2			3	3		3		2	
CO 5						2			3	3		3		2	




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
Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I		Periods	9
Listening -Introduction to Different Types of Listening, Listening to Casual Conversations, Speaking -Introduction to develop the Art of Speaking, Giving Self Introduction, Reading -Understanding the Basics of Reading Skills, Reading Instructions and Technical Manuals, Writing - Introduction to writing strategies, Writing Definitions, Focus on Language - -Technical terms (Jargon), Word Formation with Prefixes and Suffixes, Using Active Voice and Passive Voice, Basic sentence patterns, Tenses (past, present, perfect and continuous tenses).			
Unit – II		Periods	9
Listening - Listening to lectures, listening to description of equipment, Speaking - Strategies for Developing Conversational Skills, Short Conversations through Role Play Activities, Reading - Reading Comprehension, Reading e-mails, Reading Headlines, Predicting the Content, Writing - Note making, Writing Descriptions, Focus on Language -Collocations, One word substitution, Subject - verb agreement			
Unit – III		Periods	9
Listening - Listening to different kinds of interviews (Face - to - face, radio, TV and telephone interviews), Speaking -Describing an Object, Asking Questions, Participating in Discussions Reading - Intensive reading, Reading passages for gist. Writing - Writing short& lengthy e-mails with emphasis on Brevity, Clarity, Coherence and Cohesion), Focus on Language -Sequential Connectives, Impersonal Passive			
Unit – IV		Periods	9
Listening -Note Taking, Speaking - Improving Fluency through Narration. Reading -Reading passages for specific information- Phone messages, Reading and Transferring Information. Writing - Effective writing strategies, Informal writing, Writing a Memo, Focus on Language - Cause and Effect, Conditional Statements (if - clauses and types), Usage of Modal Verbs.			
Unit – V		Periods	9
Listening - Listening to understand Modulation, Listening to Welcome Speeches, Speaking - Delivering Welcome Address, Understanding Segmental and Supra-segmental Features-Practicing Stress, Pause and Intonation, Reading - Reading for a purpose, Reading Business Documents, Interpreting Charts and Graphs. Writing - Describing a Process. Focus on Language -Synonyms and Antonyms, Common Errors in English.			
Total Periods			45
Text Books			
1.	Dr. S. R. Kannan & Faculty from the Department of English -English for Communication, Karun Printers Pvt. Ltd, 2023.		
2.	Sokkaalingam, S.R.M., The Art Of Speaking, English Versatile Publishing House, 2019.		
References			
1.	Dr. Padma Ravindran, Poorvadevi, M. Y. Abdur Razack- English for life, English for work, students Book, Ebek language laboratory pvt ltd, 2011.		
2.	Dutt Rajeevan, Prakash. A Course in Communication Skill (Anna University, Coimbatore edition): Cambridge University Press India Pvt.Ltd, 2007.		
3.	S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient Blackswan Pvt, Ltd, 2009.		
4.	Technical English – I & II, Sonaversity, Sona College of Technology, Salem, First Edition, 2012.		
5.	Meenakshmi Raman and Sangeeta Sharma- Technical communication English Skills for		

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	Engineers; oxford University Press, 2008.
E-Resources	
1.	http://www.sparknotes.com/lit/the-chemist/summary.html
2.	https://www.stephencovey.com/7habits/7habits.php
3.	http://en.wikipedia.org/wiki/The_Seven_Habits_of_Highly_Effective_People


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Programme	B.Tech.	Programme Code			105	Regulation	2023								
Department	Biotechnology				Semester		I								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23PH101	Engineering Physics	3	0	0	3	40	60	100							
Course Objective	The student should be made to,														
	<ul style="list-style-type: none"> • understand the basic concepts of properties of matter • gain knowledge about the conduction properties of metals • identify the different types of crystal structures and crystal growth techniques. Study the production and applications of ultrasonics. • correlate better understanding the carrier concentration and its variations with temperature in a semiconductor. Study the properties of modern engineering materials and its uses • categorize the types of laser and fiber optics 														
Course Outcome	At the end of the course, the student will be able to							KL							
	CO1: Understand the elastic properties of the materials							K2							
	CO2: Gain knowledge about the conduction properties of metals							K3							
	CO3: Determine packing factor for various unit cells and understand different types of crystal imperfections and learn the engineering, medical applications.							K1							
	CO4: Discuss the basic idea of semiconducting materials and realize the function of modern engineering materials							K1							
	CO5: Learn the optical properties of materials and its uses							K3							
Pre-requisites	---														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	1	2									2	
CO 2	3	2	3	3	1										
CO 3	3	3		3	1									2	
CO 4	3		2	1	1								3	2	
CO 5	3			1	2	2								2	
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignments and Mind map															
3. End-Semester examinations															
Indirect															
Course - end survey															



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Content of the syllabus			
Unit – I	PROPERTIES OF MATTER	Periods	9
<p>Elasticity: Types of moduli of elasticity - Poisson's ratio - Stress - Strain Diagram – uses - Hooke's law. Young's modulus: Uniform bending (qualitative) Experimental determination by non-uniform bending - Twisting couple on a wire – Application: I shape girders, Torsional pendulum.</p> <p>Viscosity: Co-efficient of viscosity - Poiseuille's formula - Experimental determination – uses.</p>			
Unit - II	ELECTRICAL PROPERTIES OF METALS	Periods	9
<p>Classical theory: Classical free electron theory of metals- Expressions for electrical conductivity and Thermal Conductivity of metals – Wiedemann-Franz law (Qualitative) - Success and failures.</p> <p>Quantum theory: de Broglie's hypothesis - Schrodinger's time independent and time dependent wave equations - Fermi – Dirac Statistics - Density of energy states (Qualitative).</p>			
Unit – III	CRYSTAL PHYSICS AND ULTRASONICS	Periods	9
<p>Crystallography: Unit cell - Crystal systems - Bravais lattices- Lattice planes - Miller indices - Inter-planar spacing in cubic lattice- Calculation of number of atoms per unit cell- Atomic radius – Coordination number- Packing Factor for HCP structures - Crystal defects – point and line defects (qualitative).</p> <p>Ultrasonics: Introduction - Properties and Generation of Ultrasonics – Magnetostriction and Piezoelectric Oscillator methods – Applications: Sound Navigation and Ranging (SONAR), Non – Destructive Testing (NDT) and Sonogram.</p>			
Unit - IV	SEMICONDUCTING & MODERN ENGINEERING MATERIALS	Periods	9
<p>Semiconductors: Elemental and Compound semiconductors - Intrinsic semiconductor: (Qualitative only) – Carrier concentration – Fermi level – Electrical conductivity - Band gap determination. Extrinsic semiconductors: Carrier concentration in n – type and p – type semiconductor (Qualitative) – Variation of Fermi level with temperature. Application; Construction and working of LED.</p> <p>Metallic glasses: preparation, properties and applications - Shape memory alloys (SMA): Characteristics and applications of NiTi alloy.</p>			
Unit – V	LASER AND FIBER OPTICS	Periods	9
<p>Laser: Interactions of Radiations with matters - Characteristics of laser – Derivation of Einstein's A and B coefficients. Types: CO2 laser - Semiconductor laser: Homo junction - Applications.</p> <p>Optical fiber: Principle of propagation of light through optical fiber - Numerical aperture and acceptance angle (Qualitative) -Types of optical fibers -Fiber optical communication system (block diagram) - Application: Temperature sensor.</p>			
Total Periods			45
Text Books			
1.	R.K. Gaur and Gupta. S.L, Engineering Physics, Dhanpat Rai Publishers, 2017.		
2.	S.O Pillai., Solid state physics, New Age International Private Limited.		
3.	Dr.A.Panneerselvam and Dr.P.Mani, "Engineering Physics", Dhanam publisher, Chennai – 600 042. (2024)		
References			
1.	B.K. Pandey, S. Chaturvedi. "Engineering Physics", 1 st Edition, Cengage Learning India Pvt Ltd, (2012).		
2.	David Halliday, Robert Resnick Jearl Walker, Fundamentals Of Physics Extended 8/Ed 8th Edition, , Wiley India Pvt Ltd, 2008.		
3.	Lawrence H.Vanvlack, "Elements of materials Science Engineering, 6 th Edition, Pearson		

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	Publication.
4.	S.O.Pillai, "Solid State Physics", New Age International Publishers
5.	Dr.V.Rajendran, "Engineering Physics", Tata McGraw Hill Education Private Limited, New Delhi.
E-Resources	
1.	www.e-booksdirectory.com
2.	Home.iitk.ac.in
3.	physics.cu.ac.bd



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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205													
Programme	B.E./B.Tech.	Programme Code				Regulation	2023							
Department	CSE, EEE, ECE, IT, BT, CST & BME				Semester		I							
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks								
		L	T	P	C	CA	ESE	Total						
U23CS101	Programming for Problem Solving	3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to: <ul style="list-style-type: none"> Learn the fundamentals of computers, languages, number systems and acquire problem solving skills in C Programming 													
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level						
	CO1: Examine number systems and to apply problem solving techniques							K3						
	CO2: Learn the basics of C programming with branching and looping statements							K2						
	CO3: Experiment the C programs using Arrays and Pointers for simple applications							K3						
	CO4: Solve C programs with the Functions and Strings							K3						
CO5: Apply Structures, Union and File concepts to solve simple real world problems							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping	
COs	Programme Outcomes (POs)												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO 1	3	2	1	1	2							2	3	3
CO 2	2	1	1		2							2	2	2
CO 3	3	2	1	1	2							2	3	3
CO 4	3	2	1	1	2							2	3	3
CO 5	3	2	1	1	2							2	3	3
Course Assessment Methods														
Direct														
1. Continuous Assessment Test I, II & III														
2. Assignment / Quiz / Seminar														
3. End-Semester examination														
Indirect														
1. Course - end survey														
Content of the syllabus														
Unit – I		INTRODUCTION TO PROBLEM SOLVING						Periods		9				
Basic organization of Computer - Programming languages - Compilers – Interpreter - Flowchart – Pseudocode – Algorithm.														

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Number Systems – Decimal, Binary, Octal and Hexadecimal conversions			
Unit - II	BASICS OF C PROGRAMMING	Periods	9
Introduction to C – Features - Data Types – Constants – Variables - I/O Statement - Operators –Expressions - Decision Making and Branching – Looping Statements - Break, Go to, Continue.			
Unit – III	ARRAYS AND POINTERS	Periods	9
Arrays: Concepts – Need – one dimensional array – array declaration – features – array initialization - Two-Dimensional Arrays Multidimensional Arrays.			
Pointers: Introduction, pointer declaration-accessing variable through pointer- Pointers and Arrays, Pointers and strings – Pointers structures - Pointer Arithmetic - Array of Pointers – dynamic memory allocation - malloc, realloc, free.			
Unit - IV	FUNCTIONS AND STRINGS	Periods	9
Functions: Introduction, function declaration, defining and accessing functions, User-defined Functions-storage classes-function prototypes-parameter passing methods-recursion.			
Strings: Concepts – Strings manipulation - String Input / Output Functions- Strings standard functions - Arrays of Strings.			
Unit – V	STRUCTURES, UNIONS AND FILE SYSTEMS	Periods	9
Structures: Introduction- nested structures- Arrays of Structures - Structures and Functions - Pointers to Structures – Unions.			
File: opening, defining, closing, File Modes, File Types , Writing contents into a file, Reading file contents, Appending an existing file, File permissions and rights, Changing permissions and rights.			
Total Periods			45
Text Books			
1.	S.Kuppuswami, S.Malliga, C. S. Kanimozhi and K.Kousalya, “Problem Solving and Programming”, McGraw Hill, 2019.		
2.	E. Balagurusamy, “Programming in ANSI C”, 8 th Edition, Mc Graw Hill, 2019.		
References			
1.	Herbert Schildt, C: The Complete Reference, Mc Graw Hill, 4th Edition, 2017		
2.	Kernighan BW and Ritchie DM, “The C Programming Language”, 2 nd Edition, Prentice Hall of India, 2017.		
3.	Dr.V.Rameshbabu, Dr.R.Samyutha, M.Muni Rathnan, “Computer Programming”, VRB Publishers Pvt.Ltd, 2016.		
Tools Required			
	Codetandra/HackerRank/ HackerEarth / Any online Problem Solving Platforms		
E-Resources			
1.	https://www.geeksforgeeks.org/c-language-set-1-introduction/		
2.	https://www.programiz.com/c-programming		
3.	https://www.cprogramming.com/		


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Programme	B.TECH	Programme code	105	Regulation						2023	
Department	Biotechnology			Semester						I	
Course code	Course name	Periods per week			Credit	Maximum Marks					
		L	T	P	C	CA	ESE	Total			
U23TA101	Heritage of Tamils / தமிழர் மரபு	1	0	0	1	40	60	100			
Content of the syllabus											
அலகு 1	மொழி மற்றும் இலக்கியம்				Periods	3					
இந்திய மொழிக்குடும்பங்கள் – திராவிடமொழிகள் – தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்றத்தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் திருக்குறளில் மேலாண்மைக்கருத்துக்கள் – தமிழ்க்காப்பியங்கள் – தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசனின் பங்களிப்பு.											
அலகு 2	மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை				Periods	3					
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன்சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப்பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறதெய்வங்கள் – குமரிமுனையில் திருவள்ளூர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, யாழ், வீணை, நாதஸ்வரம் – தமிழர்களின் பொருளாதார வாழ்வில் கோவில்களின் பங்கு.											
அலகு 3	நாட்டுப்புறக்கலைகள் மற்றும் வீரவிளையாட்டுக்கள்				Periods	3					
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஓயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுக்கள்.											
அலகு 4	தமிழர்களின் திணைக்கோட்பாடுகள்				Periods	3					
தமிழகத்தின் தாவரங்களும் விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடுகள் – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவு, கல்வியறிவு – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.											
அலகு 5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்கு				Periods	3					


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இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப்பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்தமருத்துவத்தின் பங்கு - கல்வெட்டுகள் கையெழுத்துப்படிக்கள் - தமிழ்ப்புத்தகங்களின் அச்சுவரலாறு.

Total Periods 15

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
U23TA101	Heritage of Tamils / தமிழர் மரபு	1	0	0	1	40	60	100
Content of the syllabus								
UNIT I	LANGUAGE AND LITERATURE				Periods	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 and -Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry– Development of Modern literature in Tamil-Contribution of Bharathiyar and Bharathidhasan.								
UNIT II	HERITAGE-ROCK ART PAINTINGS TO MODERN ART-SCULPTURE				Periods	3		
Herostone to modern sculpture - Bronzeicons- Tribes and their handicrafts- Art of temple car making—Massive Terracotta sculptures Villagedeities , Thiruvalluvar Statue at Kanyakumari, Making of musical instruments-Mridhangam,Parai Veenai,Yazhand Nadhaswaram – Role of Temples in Social and Economic Life of Tamils.								
UNIT III	FOLK AND MARTIAL ARTS				Periods	3		
Therukoothu, Karagattam, VilluPattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance-Sports and Games of Tamils.								
UNIT IV	THINAI CONCEPT OF TAMILS				Periods	3		
Flora and Fauna of Tamils & Ahamand Puram Concept from Tholkappiyam and Sangam Literature- Aram Concept of Tamils- Education and Literacy during Sangam Age- Ancient Cities and Portso Sangam Age-Export and Import during Sangam Age- Overseas Conques to Cholas.								
UNIT V	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE				Periods	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 Periods	15		

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TEXT-CUM-REFERENCE BOOKS

1	தமிழகவரலாறும் – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணிணித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்க நகர நாகரிகம் (தொல்லியல் துறை 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 of Tamil Studies)
7	Historical Heritage of the Tamils (Dr.S.V.Subaramanian, 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & 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 Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

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Programme	B.Tech.	Programme Code	105		Regulation	2023									
Department	Biotechnology				Semester	I									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23GE101	Engineering Graphics	2	0	3	3	50	50	100							
Course Objective	The main objective of this course is to: <ul style="list-style-type: none"> Develop skills to enhance their ability to know the concept of engineering graphics and to draw the points kept in various positions, lines and planes. Project the drawing of various solids. Sketch sectioned views of solids. Draw the development of surfaces. Draw the isometric and orthographic projections for any given object to the required standard. 														
	At the end of the course, the student should be able to						Knowledge Level								
	CO1: Construct plane curves and develop projection of points , lines and plane surfaces						K2								
	CO2: Construct projection of solids with various conditions.						K4								
	CO3: Design the section of solids and analyze the true shape of the section						K3								
CO4: Design and develop the different solid surfaces.						K2									
CO5: Construct isometric and orthographic projection of different solids.						K2									
Pre - requisites	Nil														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	-	-	-	-	-	-	-	2	-	-
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	2	-	-
CO 3	3	2	2	2	3	-	-	-	-	-	-	-	2	2	-
CO 4	3	2	3	3	2	-	-	-	-	-	-	-	2	-	-
CO 5	3	3	2	3	3	-	-	-	-	-	-	-	2	2	-
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examination															
Indirect															
1. Course - end survey															

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Content of the Syllabus			
Concepts & Conventions (Not for Examination)	Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.	Periods	1
Unit – I	PROJECTION OF POINTS, LINES AND PLANE SURFACES	Periods	3+8
Introduction to Plane curves, Orthographic projection – principles – projection of points, straight lines (only first angle projections) and plane surfaces (polygonal and circular).			
Unit - II	PROJECTION OF SOLIDS	Periods	3+8
Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane.			
Unit - III	SECTION OF SOLIDS	Periods	3+8
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.			
Unit - IV	DEVELOPMENT OF SURFACES	Periods	3+8
Development of lateral surfaces of simple solids like prisms, pyramids, cylinders and cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.			
Unit - V	ISOMETRIC PROJECTIONS, ORTHOGRAPHIC VIEWS FROM PICTORIAL VIEWS	Periods	5+10
Isometric Projection and Introduction to AutoCAD / Solid Edge: Principles of isometric projection - Isometric scale -Isometric projections of simple solids like prisms, pyramids, cylinders and cones & orthographic views from pictorial views.			
Demonstration only: Computer Aided Drafting (Auto CAD / Solid Edge): Introduction to drafting packages and demonstration of their use.			
Total Periods			60
Text Book:			
1.	Basant Agrawal and C.M Agrawal ,“Engineering Drawing ”,Tata McGraw Hill ,2019		
2.	Jain and Gautam ,“Engineering Graphics & Design ”,Khanna Publishing House, 2020		
Reference Book :			
1.	Dr.P.Kannan and Dr.J.Bensam Raj, “Engineering Graphics”, JBR Tri Sea Publishers Pvt. Ltd,2024		
2.	K.V Natarajan, "Engineering Drawing and Graphics", M/s. N.Dhanalakshmi, Chennai,2020		
3.	K.Venugopal and V. Prabhu Raja, “Engineering Graphics”New Age International Publishers,2016		
4.	N.S Parthasarathy and Velamurali, “ Engineering Graphics”, Oxford University, New Delhi,2015		
5.	Bhatt N.D and Panchal V.M, “Engineering Drawing”, Charotar Publishing House,2014		
e-RESOURCES:			
1.	http://nptel.ac.in/courses/105104148 , “Engineering Graphics” - Dr. Nihar Ranjan Patra , IIT Kanpur		
2.	http://cfd.annauniv.edu/webcontent.htm , “Engineering Graphics” - Dr.Velamurali		
3.	http://link.springer.com/ “Engineering Graphics”-Springer Nature.		

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Elayampalayam, Tiruchengode – 637 205






Programme	B.Tech.	Programme code	105	Regulation	2023									
Department	Biotechnology	Semester			I									
Course Code	Course name	Periods per week			Credit	Maximum Marks								
U23GE102	Design Thinking	L	T	P	C	CA	ESE	Total						
		1	0	2	1	50	50	100						
Course Objective	The student should be made to, <ul style="list-style-type: none"> Familiarize with design thinking concepts and principles Practice the methods, processes and tools of design thinking. Apply the design thinking approach and have ability to model real world situations. 													
Course Outcome	At the end of the course, the student should be able to,							KL						
	CO1: Understand and apply the concept of team building activity							K2						
	CO2: Understand Design Thinking and apply the design thinking approach to empathize situations in real world							K3						
	CO3: Identify various methods of empathy and define the problem							K3						
	CO4: Develop creative ideas through design thinking							K4						
CO5: Understand benefits of learning through observation, experience and application							K5							
Pre-requisites	-													
CO / PO Mapping													CO/PSO Mapping	
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak														
Programme Outcomes (POs)													PSOs	
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3	3	3	3	2	2	3	3	3	2	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	2	2
CO 3	3	3	1	2	2	2	2	1	2	1	-	-	2	2
CO 4	3	3	3	3	3	2	2	2	2	2	2	1	2	2
CO 5	3	3	3	3	1	2	2	2	1	2	2	1	2	2
Course Assessment Methods														
Direct														
1. Continuous Assessment Test through activities, assignment & Quiz														
2. Models (Chart/paper/3D)														
3. Prototype & Presentation														
Indirect														
1. Course - end survey														


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Content of the Syllabus		
SESSION - I	Periods	6
Introduction – Team Building - Types – 4 C’s of Team Building – Levels of Team Building – Benefits of Team Work – Team Building Activity.		
SESSION - II	Periods	9
Introduction to Design Thinking – Purpose of Design Thinking – Design Thinking Framework, Empathy and related case studies		
SESSION - III	Periods	6
Define: Examine and Reflect on the problem.		
SESSION - IV	Periods	12
Generating Ideas – Identifying ideas – Bundling the ideas and create concepts – Rapid Prototyping – Idea Refinement.		
SESSION - V	Periods	12
Importance & testing the design with people - Retest and redefine results		
Total Periods		45
Textbooks		
1.	Solving Problems with Design Thinking - Ten Stories of What Works by Jeanne Liedtka 2013.	
2.	Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.	
3.	Yousef Haik and Tamer M. Shatin, "Engineering Design Process", Cengage Learning, 2 nd edition, 2011	
4.	Design of Business: Why Design Thinking is the Next Competitive Advantage by Roger L. Martin 2009.	
5.	Change by Design: How Design thinking transforms organizations and empires Innovation, 2009, Harper Business, Brown, Tim and Berry.	
References		
1.	Design thinking toolbox by Michael Lewick, Wiley 2020	
2.	Design thinking playbook by Michael Lewrick, Wiley 2019	
3.	Creative Confidence: Unleashing the Creative Potential Within Us All by Tom 2014	
4.	The Design of Everyday Things: by Don Norman 2013	
E-Resources		
1.	https://www.collectivecampus.io/blog/6-resources-to-help-you-learn-design-thinking	
2.	https://thisisdesignthinking.net/on-design-thinking/design-thinking-resources/	
3.	http://hs.griet.ac.in/pdf/studymaterialsgr20/Design%20Thinking%20Lab%202020-21.pdf	
4.	https://www.mindtools.com/brainstm.html	
5.	https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit	
6.	https://www.youtube.com/watch?v=2mJSDIBaUIM	
7.	thevirtualinstructor.com/foreshortening.html	
Activity Based Learning/Practical Based Learning		
http://dschool.stanford.edu/dgift/		
Online Course		
1	https://onlinecourses.nptel.ac.in/noc19_mg60/preview	
2	https://www.ibm.com/design/thinking/page/badges/core-skills	

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Programme	B.Tech.	Programme Code		105	Regulation	2023								
Department	Biotechnology				Semester	I								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks								
		L	T	P		C	CA	ESE	Total					
U23PH102	Physics Laboratory	0	0	3	1	60	40	100						
Course Objective	<ul style="list-style-type: none"> ➤ Understand elastic behavior of Materials ➤ Predict viscous force in liquids. ➤ Gain knowledge in measuring the lowest thickness materials ➤ To Identify wavelengths of prominent lines using polychromatic lamp ➤ Observe heat conduction in bad conductor ➤ Understand the principle of interferometer ➤ To learn about the characteristics of Lasers 													
Course Outcome	At the end of the course, the student will be able to						Knowledge Level							
	CO1: Measure the young's modulus of the materials, Rigidity modulus – Torsion pendulum						K3							
	CO2: Calculate Coefficient of viscosity of liquid and thickness of thin wire using Air wedge						K3							
	CO3: Observe and measure the different wavelengths of mercury Spectrum and dispersive power of a prism						K3							
	CO4: Illustrate the conductivity of bad conductors. To know how to determine the velocity of ultrasonic waves in liquid						K3							
CO5: To understand the importance of laser beam compared to ordinary light						K2								
Pre-requisites	Nil													
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)											PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO 1	3	1											2	
CO 2	3	3	1	2	2								2	
CO 3	3	2			2								3	
CO 4	3	3		1									1	
CO 5	3	1	1		1								2	


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Course Assessment Methods**Direct**

1. Prelab and post lab test
2. Execution of experiment and Viva-Voce
3. End-Semester examinations

Indirect

Course - end survey


Content of the syllabus**PHYSICS LABORATORY**



S.No.	Experiments	CO
1.	Determination of Young's modulus of the material - Uniform bending method	CO1
2.	Determination of Young's modulus of the material - Non uniform bending method	CO1
3.	Determination of Rigidity modulus – Torsion pendulum	CO1
4.	Determination of Coefficient of viscosity of a liquid – Poiseuille's method	CO2
5.	Determination of thickness of a thin material – Air wedge method	CO2
6.	Determination of wavelength of mercury spectrum – spectrometer grating	CO3
7.	Determination of Dispersive power of a prism – Spectrometer	CO3
8.	Determination of thermal conductivity of metallic glass using Lee's Disc Method	CO4
9.	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer	CO4
10.	Determination of Wavelength and particle size using Laser	CO5
Total Periods		30


Lab Manual

1.	R. Jayaraman, Engineering Physics Laboratory Manual, Pearson Pub, Edition-2021.
2.	A.K. Katiyar & C.K. Pandey Engineering Physics: Theory and Practical, Wiley Pub, 2 nd Edition.
3.	Dr.P.Mani, "Physics laboratory manual ", Dhanam publisher, Chennai – 600 042. (2024)
4.	Dr.G.Senthil Kumar, "Physics laboratory manual", VRB Publishers Private Limited, Chennai. 2024.

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U23CS102	Programming for Problem Solving Laboratory	0	0	2	1	60	40	100																																																																																																																																								
Course Objective	The main objective of the course is to <ul style="list-style-type: none"> Develop simple C programs to illustrate the applications of User Defined and Derived Data Types such as Arrays, Pointers, Structures, and Functions. 																																																																																																																																															
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level																																																																																																																																									
	CO1: Develop C programs for computer based solution of simple real world problems using Conditional and Looping statements						K3																																																																																																																																									
	CO2: Implement simple C Programs using Strings and Arrays						K3																																																																																																																																									
	CO3: Implement C program for simple applications using Pointers						K3																																																																																																																																									
	CO4: Write C programs that perform operations on File						K4																																																																																																																																									
	CO5: Demonstrate C Programs using Structures						K3																																																																																																																																									
<table border="1"> <thead> <tr> <th colspan="12">CO / PO Mapping</th> <th colspan="2">CO/PSO Mapping</th> </tr> <tr> <th colspan="14">(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak</th> </tr> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="2">PSOs</th> </tr> <tr> <th>PO 1</th> <th>PO 2</th> <th>PO 3</th> <th>PO 4</th> <th>PO 5</th> <th>PO 6</th> <th>PO 7</th> <th>PO 8</th> <th>PO 9</th> <th>PO 10</th> <th>PO 11</th> <th>PO 12</th> <th>PSO1</th> <th>PSO 2</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 2</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 3</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 4</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 5</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> </tr> </tbody> </table>													CO / PO Mapping												CO/PSO Mapping		(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak														COs	Programme Outcomes (POs)												PSOs		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	CO 1	3	2	1	1	2							2	3	3	CO 2	3	2	1	1	2							2	3	3	CO 3	3	2	1	1	2							2	3	3	CO 4	3	2	1	1	2							2	3	3	CO 5	3	2	1	1	2							2	3	3
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List of Experiments	CO's
1. Write a C program that accepts an employee's ID, total worked hours in a month and the amount he received per hour. Print the ID and salary (with two decimal places) of the employee for a particular month.	CO1
2. Write a program in C to calculate the sum of three numbers with input on one line separated by a comma.	CO1
3. Write a program in C to find the sum of the series $[x - x^3 + x^5 + \dots]$.	CO1
4. Write a program in C to find the number and sum of all integers between 100 and 200 which are divisible by 9.	CO1
5. Write a program in C to count the total number of duplicate elements in an array.	CO2
6. You are given an input string 'S'. Your task is to find and return all possible permutations of the input string. Note: 1. The input string may contain the same characters, so there will also be the same permutations. 2. The order of permutation does not matter. Sample Input xyz sample Output xyz, xzy, yxz, yzx, zxy, zyx Sample Output : All the possible permutations for string "XYZ" will be "XYZ", "XZY", "YXZ", "YZX", "ZXY" and "ZYX".	CO2
7. Find the Smallest and Largest Element in an Array Method 1: Traverse the array iteratively and keep track of the smallest and largest element until the end of the array. Method 2: Traverse the array recursively and keep track of the smallest and largest element until the end of the array. Method 3: Sort the array using STL and return the first element as the smallest element and the last element as the largest element. For example, consider the array. $arr = \{1, 2, 3, 4, 5\}$ Sample output: Smallest element: 1 Largest element: 5	CO2
8. Write a C program to find the sum of all the multiples of 3 and 5 below 100 using pointers. We have to find the number of numbers which are multiples of both 3 and 5 in the first 100 natural numbers. Multiples of both 3 and 5 in the first 100 natural numbers are the multiples of LCM of 3 and 5. $LCM \text{ of } 3 \text{ and } 5 = 3 \times 5 = 15$ Sample output: Multiples of 15 below 100 are 15, 30, 45, 60, 75 and 90.	CO3
9. Write a C program to count number of characters, words and lines in a text file. Logic to count characters, words and lines in a file in C program. How to count total characters, words and lines in a text file in C programming.	CO4

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<p>Example Source file I love programming. Working with files in C programming is fun. I am learning C programming at VCEW. Sample output Total characters = 100 Total words = 18 Total lines = 3</p>	
<p>10. Write a C program to implement Student database using Structure Sample output: Enter details of student: Name :abi RollNo:101 Percentage :89.7 Entered details: Name: abi RollNo: 101 Percentage: 89.70</p>	CO5
Total Periods	45
Tools Required	
Codetandra / HackerRank / HackerEarth / Any online Problem Solving Platforms	
E-Resources	
1.	https://www.programiz.com/c-programming
2.	https://www.cprogramming.com/
3.	https://beginnersbook.com/2015/02/simple-c-programs/


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Programme	B.TECH	Programme Code		105	Regulation	2023									
Department	Biotechnology				Semester		I								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23MCFY1	Environmental Science and Engineering	2	0	0	0	100	0	100							
Course Objective	The main objective of this course is to:														
	<ul style="list-style-type: none"> Familiarize basics of ecosystem and creating environmental awareness. Congregate about environmental pollution. Contrast on solid waste and social issues. Acquire knowledge in environmental legislation and protection. Summarize population growth, human rights and Environment														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Acquire knowledge about Eco-system, Natural resources and Bio-diversity.							K1							
	CO2: Be aware of Environmental Pollution and its control.							K3							
	CO3: Infer and express Solid waste management and Social issues.							K3							
	CO4: Acquire Knowledge about Environmental legislation and protection.							K3							
CO5: Awareness about population growth, human rights and Environment							K2								
Pre-requisites	NIL														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO 1	1	2	2			2	3					2	2		
CO 2	3	2	2		1	2	3				1	3	3		2
CO 3	3	2	2		1	3	3				1	2	3		2
CO 4	1	1	1			2	3				1	2	2		1
CO 5	1	2	1			2	2				1	3	1		1
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	INTRODUCTION TO ENVIRONMENTAL SCIENCE AND ENGINEERING										Periods	6			
Nature and scope of environmental education- natural resources – (forest, water, food,& land resources)															

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problems and remedial measures. Ecosystem-Structure, characteristics and functions of ecosystem. Biodiversity – definition – conservation of biodiversity (in-situ and Ex-situ)-environmental awareness and sustainable development.			
Unit – II	ENVIRONMENTAL POLLUTION AND ITS CONTROL	Periods	6
Water pollution-causes, effects and control measures of water pollution- waste water treatment process (secondary-BOD,COD) . Air Pollution – types of air pollutants-CO ₂ , SO ₂ , NO ₂ , PAN-sources- control measures (electro static precipitator, bag house filter, wet scrubber and cyclone separator).			
Unit – III	SOCIAL ISSUES AND SUSTAINABILITY	Periods	6
Solid waste Management-Types (E-Waste, Hazardous waste, Bio-waste)-Disposal method. Sustainability-Definition-Sustainable development Goals-Environmental issues-global warming and Ozone depletion, Climate change, Acid rain, Carbon foot print-Possible solutions to Environmental issues.			
Unit – IV	SUSTAINABILITY PRACTICES AND ENVIRONMENTAL LEGISLATION	Periods	6
Zero waste and R-concept-circular economy, material life cycle assessment- energy efficiency and management-environmental legislation-air act, water act-wildlife protection act-environmental protection act.			
Unit – V	HUMAN POPULATION AND THE ENVIRONMENT	Periods	6
Population growth, human rights, value education, environment and human health, family welfare program, women and child welfare, role of information technology in environment – satellite, data base, Geographical Information System (GIS), Environmental impact Analysis (EIA) and human health.			
Total Periods			30
Text Books			
1.	Dr.S. Vairam - “Environment Science and Engineering” Gems publication. Edition 2018		
2.	Gilbert.M.Masters-“Environmental Science”-Pearson education. Edition-2-2013		
3.	Dr.S.Mageswari, Dr.G.Vijayakumar, Ms. A. Preethi-“Environment Science and Engineering” RK Publication. Edition 2022.		
References			
1.	Linda Williams- “Environmental Science”-Tata McGRAW – Hill Edition. Edition-I-2008		
2.	T.G.Miller Jr-“Environmental Science”-Wadsworth publishing Co. Edition -10-2004		
3.	William P. Cunningham, Barbara Woodworth Saigo- Tata McGraw Hill.Edition-4-2011		
4.	NPTEL Course Notes		
5.	Cunnighum and cooper-“Environmental Science”-Jaico Publ, House Edition-4-2007		
E-Resources			
1.	https://libraries.ou.edu/		
2.	https://libguides.reading.ac.uk/		
3.	https://www.loc.gov/ , https://rdl.lib.uconn.edu/		


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SEMESTER II

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Programme	B.TECH	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	II										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23MA202	Complex Analysis and Ordinary Differential Equations	3	1	0	4	40	60	100							
Course Objective	The Main Objective of the course is to														
	<ul style="list-style-type: none"> Understand the Analytic functions and Bilinear transformations. Proficiently understand the Complex Integration. Demonstrate Vector Differentiation and Integration. Know about the Ordinary Differential Equations. Identify the Laplace Transform of Derivatives and Integrals. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge level								
	CO1: Analyze the construction of analytic functions.						K4								
	CO2: Understand the concepts of cauchy's integral theorem and residue theorem in evaluation of complex integrals.						K3								
	CO3: Explore the concepts of Green's , Stoke's and Gauss Divergence theorems in real life problems.						K5								
	CO4: Understand the concepts of solving second order differential equations.						K5								
CO5: Apply the concepts of Laplace transform in solving ODE.						K3									
Pre-requisites	-														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	1								2		
CO 2	3	2	1	1									2		
CO 3	3	2		1									2		
CO 4	3	2		1	1								2		
CO 5	3	2	1	1									2		
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment.															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	ANALYTIC FUNCTIONS										Periods	9+3			



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Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $c+z$, cz , $1/z$ and Bilinear transformation.			
Unit - II	COMPLEX INTEGRATION	Periods	9+3
Problem solving using Cauchy's integral theorem and integral formula- Taylor's and Laurent's expansions- Residues- Cauchy's residue theorem- Application: Contour integration over unit circle.			
Unit – III	VECTOR DIFFERENTIATION & INTEGRATION	Periods	9+3
Vector Differentiation: Vector and Scalar Functions- Derivatives- Curves, Gradient of a Scalar Field- Directional Derivative -Divergence of a Vector Field - Curl of a Vector Field – Line, Surface and Volume integrals (concepts only), Green's theorem in a plane(excluding proof), Gauss Divergence theorem(excluding proof), Stoke's theorem (Excluding proof).			
Unit - IV	ORDINARY DIFFERENTIAL EQUATIONS	Periods	9+3
Second order Linear ordinary differential equations with constant coefficients, Cauchy's - Euler equations (excluding proof)- Legendre's Linear differential equations(excluding proof) - Method of variation of parameters.			
Unit – V	LAPLACE TRANSFORMS	Periods	9+3
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems(excluding proof) -Transforms of derivatives and integrals – Initial and final value theorems(excluding proof) – Inverse transforms – Convolution theorem(excluding proof) – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.			
Total Periods			45+15=60
Text Books			
1.	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 45 th Edition, 2024.		
2.	Ravish R Sing , Mukul Bhatt, "Engineering Mathematics", Mc Graw Hill Education Pvt. Ltd-2018		
3.	Sivaramakrishna Das. P, Vijayakumari.C, " Engineering Mathematics – II", Pearson India Education Pvt. Ltd-2022.		
References			
1.	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" , Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.		
2.	Kreyszig, E., Advanced Engineering Mathematics (10th Edition), John Wiley (2015).		
3.	Alan Jefferis , Advanced Engineering Mathematics, Academic Press- New Delhi-2003		
4.	Yunus A.Cengel, William J.Palm III," Differential equations for Engineers & Scientists", Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.		
5.	John Bird, Higher Engineering Mathematics, Anuradha Agencies(2004)		
E-Resources			
1.	https://en.wikipedia.org/wiki/Ordinary_differential_equation		
2.	www.learnerstv.com/Free-engineering-Video-lectures		
3.	www.nptel.ac.in		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.TECH	Programme Code			105	Regulation		2023							
Department	Biotechnology				Semester		II								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23CH201	Engineering Chemistry	3	0	0	3	40	60	100							
Course Objective	<p>The main objective of this course is to:</p> <ul style="list-style-type: none"> Recognize the basic technology requirements in water treatment Gain knowledge in basics and preparations, properties and applications of Polymers. Enrich the Knowledge of the students with the basics of Nano materials, their properties and applications. Familiarize about the Non renewable, renewable energy and different types of storage devices in the engineering application. <p>Gain knowledge in destruction and protection of metals for engineering applications.</p>														
Course Outcome	The students who complete this course successfully are expected to:							Knowledge Level							
	CO1: Implement innovative solutions in wastewater treatment process.							K3							
	CO2: Familiarize with the applications of polymers in the field of engineering.							K3							
	CO3: Identify the synthesis methods of Nanoparticles and their industrial applications							K2							
	CO4: Recognize the renewable, non renewable energy and storage devices for domestic and industrial applications.							K3							
CO5: Categorize the metal corrosion in different environment and find out appropriate control techniques to avoid corrosion							K3								
Pre-requisites	Nil														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)											CO/PSO Mapping			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	2	1	2	2	2					1	1	2
CO 2	3	2	2	2		2	2	1					2	2	2
CO 3	3	2	2	3	2	1	2	1					2	1	1
CO 4	3	3	2	2	1	1	3	2					3	2	2
CO 5	3	3	3	2	1	2	2	1					2	1	2
Course Assessment Methods															
Direct															
<ol style="list-style-type: none"> Continuous Assessment Test I, II & III Assignment End-Semester examinations 															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit - I	WATER TECHNOLOGY	Periods	9
Introduction-sources and impurities in water-soft and hard water- water quality parameters.Types of hardness. Determination of hardness by EDTA method. Domestic water treatment. Boiler feed water –requisites, scale and sludge formation in boilers-caustic embrittlement- boiler corrosion- treatment of boiler feed water. Internal conditioning (carbonate, phosphate, and calgon conditioning) ,external conditioning – ion exchange process, zeolite process, Electrodialysis. Brackish water –water purification by reverse osmosis.			
Unit - II	POLYMER CHEMISTRY	Periods	9
Introduction - occurrence, definitions – functionality - degree of polymerization- classification of polymers – structure (linear, branched & network polymer structure) block, random & graft copolymers, tacticity, Tg (Factors influencing Tg), molecular weight - number and weight average method. Types of polymerizations - addition, condensation and copolymerization. Mechanism of polymerization (Free radical). Preparation, properties and applications of PE, nylon6, nylon 66, Poly Urethane, poly isoprene and Vulcanization of rubber, TEFLON ,PET, and Bakelite			
Unit - III	NANO CHEMISTRY	Periods	9
Basics- distinction between molecules, nanoparticles and bulk materials; size dependent properties. Nanoparticles: nanocluster, nanorod, nanotube (CNT) and nanowires. Synthesis: Top down process- laser ablation,spray pyrolysis, chemical vapour deposition, electro deposition. Bottom up process- precipitation, sol-gel, thermolysis - hydrothermal, solvothermal -properties and applications of nano materials in medical and electronic devices.			
Unit - IV	ENERGY RESOURCES AND STORAGE DEVICES	Periods	9
Non renewable energy - nuclear energy, nuclear reaction and its types; Nuclear power plant and its working (light water nuclear power plant & breeder reactor).Renewable energy and its sources - solar Energy - photo voltaic cells-working of photovoltaic cell, recent advances in solar cell materials; wind energy - types of wind power plants (WPPs), components and working of WPPs. Batteries and fuel cells: types of batteries -alkaline battery, lead storage battery, Ni-Cd battery, lithium battery, fuel cell - H ₂ -O ₂ fuel cell-applications.			
Unit - V	CORROSION AND ITS CONTROL	Periods	9
Introduction, types of corrosion - chemical and electrochemical corrosion, mechanism, pilling -bedworth rule, types of electrochemical corrosion – galvanic corrosion, pitting corrosion, crevice corrosion, corrosion on wire fence and pipeline corrosion, factors influencing rate of corrosion. Corrosion control methods – sacrificial anode and impressed cathodic current. Protective coatings – paints: constituents and functions, metallic coatings - steps involved in cleaning the surface for electroplating, electroplating (Au), and electro less plating (Ni).			
Total Periods			45
Text Books			
1.	Dr.S.Mageswari, Dr.K.Balachandran, M.S.Viswaksean, Engineering Chemistry : First Edition, RK publication, Edition-2022.		
2.	O.G.Palanna, “Engineering Chemistry “Tata Mc GrawHill PVT,Ltd. Second Edition -2017		
References			
1.	P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, DhanpatRai Publishing company (P) Ltd, New Delhi, 2018.		
2.	Arun Bahl, B.S. Bahl, G.D. Tuli, “Essentials of Physical Chemistry” Published by S. Chand & Company Ltd, 2014		
3.	Sashi Chawla, Dhanpat Rai & Co (pvt.)Ltd.”Engineering Chemistry” Edition- 5- 2013.		
4.	Dr.S.Vairam ,Dr.Suba Ramesh, “Engineering Chemistry” First Edition, Wiley publication,Reprint-2016		

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E-Resources	
1.	https://www.who.int/water_sanitation_health/dwq/arsenicun6.pdf
2.	https://www.schandpublishing.com/books/tech-professional/applied-science/a-textbook-polymer-chemistry/9788121941129/#.XdZ214MzY2w
3.	https://www.elsevier.com/books/nanochemistry/klabunde/978-0-444-59397-9



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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.E./B.Tech		Programme Code					Regulation			2023				
Department	Common to CSE,IT,BT,CST branches					Semester			II						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ES E	Total						
U23EE201	Basic Electrical and Electronics Engineering	3	0	0	3	40	60	100							
Course Objective	The students should made to <ul style="list-style-type: none"> • Introduce the basics of electric circuits and analysis • Impart knowledge in the basics of working principles and application of electrical machines • Learn the electrical wiring methods • Analyze the characteristics of Semiconductor devices • Educate on the fundamental concepts of digital electronics and introduce the functional elements and working of measuring instruments 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Understand the basics of electric circuits and type of the connection										K2				
	CO2: Understand the basics of electromagnetic laws and basic working principle of DC and AC machines.										K2				
	CO3: Understand the concepts of tariff, energy saving, illumination, electric lamps and safety measures.										K2				
	CO4: Understand the basic operating characteristics of semiconductor devices.										K2				
CO5: Understand the fundamentals of digital logics and measuring instruments										K2					
Pre-requisites	Basic concepts and understanding of magnetic fields														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO3
CO 1	3	2	1					1				3	3		2
CO 2	3	2	1					1				3	3		2
CO 3	3	1	1					1				3	3		3
CO 4	3	2	1					1				3	3		2
CO 5	3	2	1					1				3	3		2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course –end Survey															

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Content of the syllabus			
Unit – I	INTRODUCTION OF ELECTRICAL CIRCUITS	Periods	9
Definition of Voltage, Current, Power, Energy, Power factor, Circuit parameters, Ohm's law, Kirchoff's law Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Real power, Reactive power and Apparent power, Power factor. Introduction to three phase systems - types of connections Concept of DC circuits.			
Unit - II	ELECTRICAL MACHINES AND ITS APPLICATIONS	Periods	9
Faraday's laws of electromagnetic induction - Lens law - Fleming's left hand rule and Right hand rule. Working principle and construction of AC and DC machines - Construction, Working principle and Applications of single phase Transformer. Motor used for domestic applications.			
Unit – III	WIRING AND ILLUMINATION	Periods	9
Types of wiring-staircase and corridor wiring - wiring accessories. Different types of safety measures - Earthing. Electrical tariff -Energy conservation. Simple layout of power system-various energy resources, The Laws of Illumination- Different types of electrical lamps.			
Unit - IV	SEMICONDUCTOR DEVICES	Periods	9
PN junction diodes - Zener diodes - characteristics. Transistors: PNP and NPN transistors - Theory of operation - Transistor configurations -characteristics - comparison. Special semiconductor devices: FET - SCR - LED – V-I characteristics – Rectifier and Inverters -UPS – SMPS.			
Unit – V	DIGITAL FUNDAMENTALS AND MEASUREMENTS	Periods	9
Number systems - Boolean Theorems – DeMorgan's Theorem - Logic gates -Implementation of Boolean Expression using Gates - SOP and POS forms- Functional elements of an instrument, Standards and calibration, Operating Principle of Ammeters and Voltmeters.			
Total Periods			45
Text Books			
1.	S.K.Bhattacharya, "Basic Electrical and Electronics Engineering", Pearson, 2017		
2.	D.P. Kotharti and I.J Nagarath, "Basic Electrical and Electronics Engineering", Mc Graw Hill, Third Edition, 2020.		
References			
1.	S.B. Lal Seksena and Kaustuv Dasgupta, "Fundamentals of Electrical Engineering", Cambridge, 2016		
2.	Mittle, Mittal, Basic Electrical Engineering, 2nd Edition, Tata McGraw-Hill Edition, 2016.		
3.	T.K. Nagsarkar and M.S. Sukhija, "Basic Electrical Engineering", Oxford, 2017.		
4.	John Bird, "Electrical and Electronic Principles and Technology", Fourth Edition, Elsevier, 2010.		
5.	K MurugeshKumar, "Elements of Electrical Engineering", Vikas Publishing House Pvt. Ltd. 2011.		
E-Resources			
1.	https://nptel.ac.in/courses		
2.	https://www.electrical4u.com/electrical-engineering-articles/illumination-engineering/		
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes		
4.	https://www.google.co.in/books/edition/_/4nJROSC7iK8C?hl=en&gbpv=1		


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Programme	B.TECH	Programme code	105	Regulation	2023			
Department	Biotechnology			Semester	II			
Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U23TA202	தமிழரும் தொழில் நுட்பமும்/ TAMILS AND TECHNOLOGY	1	0	0	1	40	60	100
Content of the syllabus								
அலகு 1	நெசவு மற்றும் பானைத்தொழில்நுட்பம்				Periods	3		
சங்ககாலத்தில் நெசவுத்தொழில்- பானைத்தொழில்நுட்பம் - கருப்புசிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.								
அலகு 2	வடிவமைப்பு மற்றும் கட்டிடத்தொழில்நுட்பம்				Periods	3		
சங்ககாலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்ககாலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள்-மாமல்லபுரச்சிற்பங்களும் கோவில்களும் - சோழர்காலத்துப் பெருங்கோயில்கள் மற்றும் பிறவழிபாட்டுத்தலங்கள் - நாயக்கர்காலக்கோயில்கள்-மாதிரிகட்டமைப்புகள் பற்றி அறிதல் மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக்கட்டிடக்கலை.								
அலகு 3	உற்பத்தித் தொழில்நுட்பம்				Periods	3		
கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத்தொழிற்சாலை - இரும்பை உருக்குதல் எஃகு - வரலாற்றுச்சான்றுகளாக - செம்பு மற்றும் தங்கநாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடிமணிகள் - சுடுமண்மணிகள் - சங்குமணிகள் - எலும்புத்துண்டுகள் - தொல்லியல்சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.								
அலகு 4	வேளாண்மை மற்றும் நீர்ப்பாசனத்தொழில்நுட்பம்				Periods	3		
அணை, ஏரி, குளங்கள் ,மதகு - சோழர்காலக்குழுழித்தாம் பின் முக்கியத்துவம் - கால்நடைபராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச்சார்ந்த செயல்பாடுகள் - கடல்சார்அறிவு - மீன்வளம் - முத்துமற்றும்முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார்சமூகம்.								

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அலகு 5	அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்	Periods	3
அறிவியல் தமிழின் வளர்ச்சி - கணினித்தமிழ் வளர்ச்சி - தமிழ்நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மின் பொருட்கள் உருவாக்கம் - தமிழ் இணையக்கல்விக்கழகம் - தமிழ் மின்நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்க்குவைத்திட்டம்.		Total Periods	15


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Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
U23TA202	TAMILS AND TECHNOLOGY	1	0	0	1	40	60	100
Content of the syllabus								
UNIT I	WEAVING AND CERAMIC TECHNOLOGY				Periods	3		
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) –Graffiti on Potteries								
UNIT II	DESIGN AND CONSTRUCTION TECHNOLOGY				Periods	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				Periods	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				Periods	3		
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thooppu 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				Periods	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 Periods	15		

TEXT-CUM-REFERENCE BOOKS

1	தமிழகவரலாறும் – மக்களும்பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2	கணினித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன்பிரசுரம்).
3	கீழடி – வைகைநதிக்கரையில்சங்கநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4	பொருதை - ஆற்றங்கரைநாகரிகம். (தொல்லியல்வெளியீடு)
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



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	Tamil Studies
7	Historical Heritage of the Tamils (Dr.S.V.Subaramanian, 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 Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & 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: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.


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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205													
Programme	B.E. / B.Tech.		Programme Code				Regulation		2023					
Department	EEE, ECE, BT, BME						Semester		II					
Course Code	Course Name			Periods Per Week			Credit	Maximum Marks						
				L	T	P	C	CA	ESE	Total				
U23CS203	Python Programming			3	0	2	4	50	50	100				
Course Objective	The student should be made to,													
	<ul style="list-style-type: none"> • Understand the fundamentals of Python programming • Handle list, tuples, sets and Dictionaries data types • Learn function prototypes and string functions. • Use files and modules for data processing • Understand packages in Python and data visualization 													
Course Outcome	At the end of the course, the student should be able to,											Knowledge Level		
	CO1: Interpret the fundamental Python syntax and semantics and be fluent in the use of Python control flow statements.											K3		
	CO2: Perform operations on list, tuples, sets and Dictionaries using python.											K3		
	CO3: Implement function prototypes and string functions.											K3		
	CO4: Apply files and modules and perform operations on CSV files.											K3		
	CO5: Perform data visualization and apply Python packages for CSV files											K3		
Pre-requisites	Nil													
CO / PO Mapping													CO/PSO Mapping	
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak														
Cos	Programme Outcomes (POs)												PSOs	
	PO.1	PO.2	PO.3	PO.4	PO.5	PO.6	PO.7	PO.8	PO.9	PO.10	PO.11	PO.12	PSO1	PSO 2
CO.1	3	2	1	-	1	-	-	-	-	-	-	2	3	2
CO.2	3	3	1	1	2	-	-	-	-	-	-	2	3	2
CO.3	3	3	1	2	2	-	-	-	-	-	-	2	3	2
CO.4	3	3	1	2	2	-	-	-	-	-	-	2	3	2
CO.5	3	3	1	2	2	-	-	-	-	-	-	2	3	2
Course Assessment Methods														
Direct														
1. Continuous Assessment Test I, II & III														
2. Assignments / Quiz														
3. End-Semester examinations														
Indirect														
1. Course - End survey														
Content of the syllabus														
Unit – I		INTRODUCTION TO PYTHON										Periods	9	
Introduction to Python, features, installing Python, writing and executing Python program — native data types, comments, constants, variables, operators, expression, conditional statements, control statements,														

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continue, pass, break.			
Unit - II	LISTS, TUPLES, SETS AND DICTIONARIES	Periods	9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Sets: methods and operators, Dictionaries: operations and methods.			
Unit – III	FUNCTIONS AND STRINGS	Periods	9
Functions definition, declaration, arguments, parameters – formal and local, parameter passing methods - function prototypes, recursion; Strings: string slices, immutability, string functions and methods, string module, regular expressions.			
Unit - IV	FILES AND MODULES	Periods	9
Files and exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, accessing CSV file.			
Unit – V	PACKAGES AND DATA VISUALIZATION	Periods	9
Text processing, Numerical processing: numpy package – mean, median and mode, pandas package – vector, data frame, data visualization: matplotlib, Time operations.			
Total Periods			45
Suggested List of Experiments			
List of Experiments			CO's
1.	Write a program to demonstrate different number data types in Python.		CO1
2.	Write a program to perform different Arithmetic Operations on numbers in Python.		CO1
3.	Write a program to create, append and remove lists and demonstrate the tuples in python.		CO2
4.	Write a program to demonstrate working with dictionaries in python.		CO2
5.	Write a program to create, concatenate and print a string and accessing sub-string from a given string.		CO3
6.	Write a Python function to calculate the factorial of a number (a non-negative integer). The function accepts the number as an argument.		CO3
7.	Write a program to compute the number of characters, words and lines in a file.		CO4
8.	To write a Python program to find the most frequent words in a text read from a file.		CO4
9.	Find mean, median, mode for the given set of numbers in a list.		CO5
10.	Draw a horizontal bar chart with Matplotlib		CO5
Lecture 45: Practical 30; Total: 75			
Text Books			
1.	Anurag Gupta,G.P BISWAS ,” Python Programming – Problem solving, packages and Libraries, Edition 1, McGraw Hill, 2019		
2.	E Balagurusamy, “Problem Solving and Python Programming”, Edition1, McGraw Hill, 2018		
3.	Reema Thareja, “Python Programming using Problem Solving Approach”, OXFORD University Press, 2017.		
References			
1.	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist“, 2 nd edition, Updated for Python 3, Shroff/O’Reilly Publishers, 2016.		
2.	John V Guttag, — Introduction to Computation and Programming Using Python“, Revised and expanded Edition, MIT Press , 2021		

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3.	Guido van Rossum (Author), The Python Development Team (Author), An Introduction to Python Tutorial and What's New ,2022,Shroff Publishers first edition
E-Resources	
1.	http://greenteapress.com/wp/think-python/
2.	https://www.python.org/about/gettingstarted/
3.	https://beginnersbook.com/2018/03/python-tutorial-learn-programming/
4.	https://www.tutorialspoint.com/python/index.htm
5.	https://www.learnpython.org/
6.	https://www.udemy.com/topic/python/free




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Programme	B.Tech.	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	II										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23EN202	Professional Communication	2	0	3	3	50	50	100							
Course Objective	The main objective of this course is to:														
	<ul style="list-style-type: none"> • Provide suitable reading & writing tasks to develop communicative ability for academic and professional progress • Inculcate channelized reading to make learners proficient in the chosen professional writing contexts. • Improve learners' vocabulary and grammar to supplement their language use at professional contexts • Assist students in the development of intellectual flexibility, creativity, and cultural literacy so that they may engage in life-long learning. • Identify and begin to apply the language features of academic and professional writing and speaking 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Acquire sufficient command over language to speak at an academic or professional context						K1								
	CO2: Write technically well at professional contexts through exposing them to similar readings.						K1								
	CO3: Use language at length at technical and professional situations through enrichment of vocabulary and strengthening of grammatical knowledge.						K2								
	CO4: Ethically gather, understand, evaluate and synthesize information from a variety of written and electronic sources.						K2								
	CO5: Be proficient in oral communication and writing.						K3								
Pre-requisites	Nil														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1						2			3	3		3		2	
CO 2						2			3	3		3		2	
CO 3						2			3	3		3		2	
CO 4						2			3	3		3		2	
CO 5						2			3	3		3		2	
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I & II															

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2. Continuous Assessment Test III in the Communication Skills Lab			
3. Assignments			
4. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I		Periods	15
Listening- Listening for Cultural Awareness, Listening to Professional Conversations, Talks, Interviews and Lectures Speaking- Developing Confidence to get rid of Fear on the Dias, Discussion at a Corporate Context. Reading- Inferential Reading, Reading Short Messages and Technical Articles, Writing- Introduction to Letter Writing, Writing Formal and Informal Letters, Thanking Letters, Letters Calling for Quotations, Letters Placing an Order, Seeking clarification, Letters of Complaint. Focus on Language- Adjectives and Degrees of Comparisons			
Unit – II		Periods	15
Listening- Listening to specific information relating to technical content, Listening for statistical information Speaking- Expressing opinions, Formal Discussions, Describing Role Play at Business Context and Consolidating Ideas. Reading- Reading Technical Articles in Journals and Comparing Articles. Writing- Letter seeking permission to undergo practical training and to undertake project work. Focus on Language- Simple, compound and complex sentences and Transformation of Sentences.			
Unit – III		Periods	15
Listening- Listening to understand the overall meaning, Listening to Interviews and Presentations. Speaking- Giving Instructions and Showing Directions and Rephrasing Instructions. Reading- Skimming and Scanning, Reading Job Advertisements. Writing- Applying for a Job, Writing a CV. Group Discussion: Introduction – Topic Analysis – Thematic Expressions-Objective and content of discussion.			
Unit – IV		Periods	15
Listening- Listening and retrieving Information. Speaking- Developing fluency and Coherence, Accent Neutralization, Voice Modulation, and Intonation, Improving Voice Quality. Reading- Reading and understanding Advertisements. Writing- Letters to the Editor, Letter of Complaint, Various kinds of Reports, Permission to go for Industrial visits. Presentation skills: Making Self Introduction Effectively-Elements of effective presentation – Structure of presentation - Presentation tools – Voice Modulation – Audience analysis - Body language – Accents analysis – Stylistics.			
Unit – V		Periods	15
Listening- Listening to Fragmented Texts and Filling in the Blanks. Speaking- Mind Mapping, Developing Coherence and Self-Expression, Making presentations, Paralinguistic and Extra linguistic Features (body language), Reading- Predicting content, Interpreting Reports. Writing- Writing Proposals, Agenda, Minutes of the Meeting. Soft Skills: Introduction - Change in Today’s Workplace: Soft Skills as a Competitive Weapon - Antiquity of Soft Skills - Classification of Soft skills - Ability to work as a team.			
Total Periods			75
Text Books			
1.	Dr. S. R. Kannan, Sumant. S, Pereira Joyce, Professional Communication, Vijay Nicole Imprints Pvt. Ltd., 2023.		
2.	Sokkaalingam, S.R.M., The Art Of Speaking, English Versatile Publishing House, 2019.		
References			
1.	Norman Whitby - Business Benchmark Pre-Intermediate to Intermediate, Students Book, Cambridge University Press, 2008. , 1997.		
2.	Dutt, Rajeevan, Prakash .A Course in Communication Skills (Anna University, Coimbatore edition) .: Cambridge University Press India Pvt.Ltd, 2007.		
3.	Meenakshi Raman and Sangeeta Sharma-'Technical Communication English Skills for Engineers'; Oxford University Press, 2008.		

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4.	S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient Blackswan Pvt, Ltd, 2009.
5.	Technical English – I & II, Sonaversity, Sona College of Technology, Salem, First Edition, 2012.
E-Resources	
1.	http://www.kalevleetaru.com/Publish/Book_Review_Who_Moved_My_Cheese.pdf
2.	http://www.bookbrowse.com/reviews/index.cfm/book_number/304/who-moved-my-cheese
3.	http://www.imdb.com/title/tt0482629/plotsummary



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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23CH202	Chemistry Laboratory	0	0	2	1	60	40	100							
Course Objective	The main objective of this course is to:														
	<ul style="list-style-type: none"> Gather basic simple acid-base reactions and study the mechanism of acid mixture with base. Learn pH and potential of hydrogen in a sample solution. Study the redox reaction through potential difference. Infer iron forms complex with thiocyanate. Gather knowledge on hardness producing salts and removal of hardness through estimation. Collect data required for dissolved oxygen present in water sample. Understand alkalinity and available chlorine present in water sample. 														
Course Outcome	The students who complete this course successfully are expected to:							Knowledge Level							
	CO1: Infer knowledge on neutralization reaction between acid, acid mixture with base and identify the concentrations.							K3							
	CO2: Identify the concentration of sample using pH.							K3							
	CO3: Spot the concentration of sample solution through redox reaction by potentiometric method							K4							
	CO4: Estimate Iron by complexation reaction spectrometric ally.							K4							
Pre-requisites	Nil														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3		2	2	1	1						2	2	2
CO 2	3	3		2	2	2	2						2	1	2
CO 3	3	3		2	2	1							1	2	2
CO 4	3	3	1	2	2	1							2	2	
CO 5	2	3	1	2		2	3						2	2	
Course Assessment Methods															
Direct															

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1. Pre lab and Post lab
2. Execution of Experiment and Viva-voce
3. End semester examination

Indirect

Course - end survey

Content of the syllabus

S.No	Name of the Experiment	Course Outcome
1.	Estimation of HCl using NaOH by Conductometric titration	CO1
2.	Estimation of Mixture of acid [standard HCl+ unknown CH ₃ COOH] using NaOH by Conductometric titration.	CO1
3.	Estimation of Barium Chloride using sodium sulphate by Conductometric precipitation titration	CO1
4.	Determination of HCl using NaOH by pH metry	CO2
5.	Estimation of Ferrous iron by Potentiometric titration.	CO3
6.	Estimation of Ferric ion by Spectrophotometry	CO4
7.	Determination of Total, Temporary and Permanent hardness of water by EDTA method.	CO5
8.	Estimation of Dissolved Oxygen content in water by Winkler's method	CO5
9.	Estimation of Alkalinity in water sample.	CO5
10.	Estimation of available Chlorine in bleaching powder.	CO5
Total Periods		30
Lab Manuals suggested:		
1	Chemistry laboratory I & II by Dr.A.Ravikrishnan,Sri Krishna Pub,Revised Edition-2017	
2	Chemistry laboratory Manual by Dr.Veeraiyan, Revised Edition-2017	


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Programme	B.Tech.	Programme Code			105	Regulation			2023						
Department	Biotechnology					Semester			II						
Course Code	Course Name	Periods Per Week			Credit			Maximum Marks							
		L	T	P	C	CA	ESE	Total							
U23GE204	Engineering Practices Laboratory	0	0	3	1	60	40	100							
Course Objective	<p>The main objective of this course is to: The students should made to</p> <ol style="list-style-type: none"> 1. Know the plumbing line assemblies. 2. Weld lap joint, butt joint and T-joint. 3. Learn the assembling and dismantling methodology of home appliances. 4. Learn the resistor value identification through colors coated on resistor. 5. Learn the basics of signal generation in CRO. 6. Learn the soldering techniques in PCB board for designing the projects. 														
Course Outcomes	At the end of the course, the student should be able to,								Knowledge Level						
	CO1: Perform basic machining operations and finish the job to the requirements and quantify the accuracy.								K2						
	CO2: Make various joints such as cross lap joint and Tee lap joint in the carpentry.								K2						
	CO3: Understand the basics of house wiring techniques and the measurements of basic electrical quantities.								K2						
	CO4: Understand the resistor value identification through colors coated on resistor.								K2						
CO5: Understand the soldering techniques in PCB board for designing the projects.								K2							
Pre -requisites	Nil														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	2	2	-	-	-	2	-	-	-	2	2	-
CO 2	3	2	3	2	2	-	-	-	2	-	-	-	3	2	-
CO 3	3	2	2	3	2	2	-	-	2	-	-	-	2	-	-
CO 4	3	2	2	3	2	2	-	-	2	-	-	-	2	3	-
CO 5	3	2	3	3	2	2	-	-	2	-	-	-	3	-	-
Course Assessment Methods															
Direct															
1.Pre lab and Post lab 2.Record mark 3.End- Semester Examinations															
Indirect															
1.Course –End survey															

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Content of the Syllabus	
GROUP A (CIVIL & MECHANICAL ENGINEERING)	
CIVIL ENGINEERING PRACTICE:	COs
1.Plumbing: a) Single Tap G.I / PVC pipe connection involving the fitting like valves, taps & bends. b) Two Tap G.I / PVC pipe connection involving the fitting like valves, taps & bends.	CO2
2.Carpentry: a) To make a Cross Lap Joint from the given work piece. b) Preparation of ' T ' Lap Joint from the given work piece.	CO2
MECHANICAL ENGINEERING PRACTICE:	
3.Welding: a) To join the metal plates by a Butt Joint in arc welding machine. b) To join the metal plates by a Lap Joint in arc welding machine.	CO1
4.Basic Machining: a) To perform simple facing & turning operation. b) To perform of step turning operation.	CO1
5.Sheet Metal: a) To make a rectangular tray from the given sheet metal. b) To make a basket from the given sheet metal.	CO1
STUDY EXPERIMENT: 6. Study of 3D Printing machine and its applications. 7. Study of CO2 Laser engraving & cutting machine and its applications. 8. Study of Wood routing machine and its applications.	CO1
GROUP B (ELECTRICAL & ELECTRONICS ENGINEERING)	
ELECTRICAL ENGINEERING PRACTICE	
1. Residential house wiring and stair case wiring using switches, fuse, indicator & lamp.	CO3
2. LED lamp assembly.	CO3
3. Measurement of voltage, current, power & power factor using R-Load.	CO3
4. Measurement of energy using single phase meter.	CO3
5. Measurement of resistance to earth of electrical equipment.	CO3
ELECTRONICS ENGINEERING PRACTICE	
1. Study of Electronic components and equipment's – Resistor color-coding, Inductor, Capacitor and CRO.	CO4
2. Logic gates AND, OR, NOR, NAND and NOT.	CO4
3. Generation of Clock Signal.	CO4
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.	CO5
Total Periods	
45	
Reference Book :	
1. Dr.P.Kannan, Mr.T.Satheeskumar & Mr.K.Rajasekar, "Engineering Practices Laboratory" Manual. First Edition, 2017.	
2. Mr.T.Jeyapooan, Mr.M.Saravana Pandian, "Engineering Practices Lab" Manual, Vikas Publishing House Pvt Ltd, 2017.	


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Programme	B.Tech.	Programme Code		105	Regulation		2023								
Department	Biotechnology				Semester		II								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ES E	Total							
U23MCFY2	Indian Constitution	2	0	0	0	100	NA	100							
Course Objective	The main objective of this course is to: i) To know about the basic structure of Indian constitution. ii) To know about our Central Government Executive system of India iii) To know about our State Government Executive system of India iv) To learn the Election system, Amendments and Emergency Provisions given by the constitution. v) To know about the Special Constitutional Provisions in India														
Course Outcome	At the end of the course, the student should be able to,						Knowledge level								
	• Understand the functions of the Indian government						K1								
	• Know about our Central Government, political structure & codes, procedures						K1								
	• Understand our State Executive & Elections system of India.						K1								
	• Remember the Election system, Amendments and Emergency Provisions given by the constitution.						K2								
• Understand our Special Constitutional Provisions in India						K2									
Pre-requisites	---														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1						3		3	2						
CO 2						3		3	3						
CO 3						3		3	2						
CO 4						3		3	3						
CO 5						3		3	3						

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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III 2. Assignment			
Indirect			
Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION	Periods	6
Historical Background – Constituent Assembly of India – Fundamental Rights – Citizenship – Constitutional Remedies for citizens			
Unit – II	STRUCTURE AND FUNCTION OF CENTRAL	Periods	6
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India			
Unit – III	STRUCTURE AND FUNCTION OF STATE	Periods	6
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts			
Unit - IV	ELECTION PROVISIONS, EMERGENCY PROVISIONS, AMENDMENT OF THE CONSTITUTION	Periods	6
Election Commission of India-composition, powers and functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.			
Unit – V	SPECIAL CONSTITUTIONAL PROVISIONS	Periods	6
Directive Principles of State Policy: Importance and its relevance. Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes, Women & Children.			
Total Periods			30
Text Books			
1.	Durga Das Basu, “Introduction to the Constitution of India “, Prentice Hall of India, New Delhi.		
2.	The Constitution of India (Coat Pocket Edition) by Gopal Sankaranarayanan - 17th Edition. (2024)		
References			
1.	R.C.Agarwal, (1997) “Indian Political System”, S.Chand and Company, New Delhi.		
2.	M.Laksmikanth, Indian polity, Tata mchraw hill publications.		
E-Resources			
1.	https://mhrd.gov.in/		
2.	https://niti.gov.in/content/niti-aayog-library		
3.	www.drishtias.com/		


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SEMESTER III

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Programme	B.TECH	Programme Code	105	Regulation	2023										
Department	Bio Technology			Semester	III										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23MA303	Transforms and Partial Differential Equations	3	1	0	4	40	60	100							
Course Objective	<p>The Main Objective of the course is</p> <ul style="list-style-type: none"> To solve boundary value problems by using Fourier series. To introduce the basic concepts of PDE for solving standard partial differential equations. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations. To acquaint the student with Fourier transform techniques used in wide variety of situations. To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge level								
	CO1: Understand the concepts of Fourier series which plays a vital role in engineering applications.						K4								
	CO2: Understand how to solve the given standard partial differential equations.						K4								
	CO3: Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.						K5								
	CO4: Understand the mathematical principles on transforms which will provide them the ability to formulate and solve some of the physical problems of engineering.						K5								
CO5: Use Z transform techniques for analyzing discrete time systems.						K3									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 –Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2		1	1								2		
CO 2	3	2	1	1									2		
CO 3	3	2	1		1								2		
CO 4	3	2	1	1									2		
CO 5	3	2	1	1	1								2		
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															

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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	FOURIER SERIES	Periods	9+3
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.			
Unit - II	PARTIAL DIFFERENTIAL EQUATIONS	Periods	9+3
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of Standard types of first order partial differential equations -Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients.			
Unit – III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	Periods	9+3
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).			
Unit - IV	FOURIER TRANSFORM	Periods	9+3
Fourier Integral theorem (without proof) – Fourier transform pair – Properties (without proof) – Transforms of simple functions – Fourier Sine and Cosine transforms – Properties (without proof) – Convolution theorem and Parseval's identity (Statement and applications only).			
Unit – V	Z –TRANSFORM	Periods	9+3
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z-transform: Partial fraction method –Initial and Final value theorem- Convolution theorem – Applications of Z-transforms: Solution of difference equations.			
Total Periods			45+15=60
Text Books			
1.	Grewal B.S., "Higher Engineering Mathematics", 45 th Edition, Khanna Publishers, Delhi, 2024.		
2.	Churchill, R.V. and Brown, J. W., Fourier series and boundary value problems.(8 th Edition), McGraw-Hill, 2011.		
References			
1.	Veerarajan T, Engineering Mathematics, McGraw Hill Education, 2013.		
2.	Kreyszig, E., Advanced Engineering Mathematics (10th Edition), John Wiley (2015).		
3.	Ramana.B.V., " Higher Engineering Mathematics" , Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2008.		
4.	P.R.Vittal, " Differential equations Fourier and Laplace Transforms", Margham Publishers, 2nd Edition, 1999.		
5.	Ray Wylie. C and Barrett.C, " Advanced Engineering Mathematics " Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition ,New Delhi 2012.		
E-Resources			
1.	https://learnengineering.in		
2.	www.learnerstv.com/Free-engineering-Video-lectures		
3.	www.nptel.ac.in		



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Programme	B.Tech.	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	III										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23BT302	Microbiology	3	0	0	3	40	60	100							
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> To have a basic knowledge about the microbial world Understand the history of microbiology, nomenclature of microorganisms Identify microbes, their structure, their metabolism To learn about various techniques to control microbes Analyze the applications of microbiology in various fields 														
Course Outcome	Students who complete this course successfully are expected to							Knowledge Level							
	CO1.Outline about historical perspective of microbiology							K2							
	CO2.Explain the concepts of Identification and multiplication of microorganism							K2							
	CO3.Interpret the microbial requirements, growth and its metabolism							K2							
	CO4.Make use of physical, chemical and biological methods to control microorganism							K3							
CO5. Illustrate the role of microbes and microbial products in various fields							K3								
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	2	1	1	3		3	1				1	3	2	3
CO 2	3	1	1	1	3		3	3				2	3	2	3
CO 3	3	3	3	3	3		3	3				2	3	2	3
CO 4	3	3	3	2	3		3	3				2	3	2	3
CO 5	3	3	3	2	3		3	3				3	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment & Quiz															
3. End-Semester examinations															
Indirect															
1. Course - end survey															

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Content of the syllabus			
Unit – I	INTRODUCTION	Periods	8
Scope of microbiology, History of microbiology, Whittaker five kingdom classifications, nomenclature of microorganism, Identification of microbes, Principle and applications of Light and electron microscope; Principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.			
Unit - II	STRUCTURE AND MULTIPLICATION OF MICROBES	Periods	10
Structural organization and multiplication of microbes-bacteria, viruses, algae, fungi, bacteriophage (TMV); actinomycetes and mycoplasma. Nutrition based classification of microbes.			
Unit – III	MICROBIAL NUTRITION, GROWTH RATE AND METABOLISM	Periods	9
Nutritional requirements of different media used for bacterial culture; Cultivation of pure culture, Colony morphology study on bacteria growth curve. Factors affecting growth and different methods to quantitative bacterial growth. Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Nitrogen fixation.			
Unit - IV	CONTROL OF MICROORGANISMS	Periods	9
Physical and chemical control of Microorganisms-Sterilization and disinfection- Dry heat, Moist heat, Filtration, Pasteurization, Radiation, Ultrasound and Various chemical agents. Techniques to preserve microorganisms, Drinking water microbe and treatment, Preservation of food.			
Unit – V	APPLICATION OF MICROBIOLOGICAL APPROACH	Periods	9
Bio gas, role of Bio-fertilizers and bio-pesticides; bioremediation; leaching of ores by microorganisms; microorganisms in pollution control; Interaction between microorganisms – Synergism, Mutualism (symbiosis), Host-microbe interactions, antimicrobial drugs - mode of action and drug resistance.			
Total Periods			45
Text Books			
1.	Michael J. Pelczar, Noel R. Krieg. Microbiology, 5th Edition, Affiliated East West Press Private Limited New Delhi, 2023		
2.	Prescott L.M., Harley J.P and Klein D.A. Microbiology, Wm. C. Brown Publishers, 2007		
References			
1.	Ray B and Bhuniya A. Fundamental Food Microbiology, (5 th Edn.) CRC Press, USA, 2013.		
2.	Talaron K., Talaron A. Casita., Pelczar and Reid, Foundations in Microbiology, W.C. Brown Publishers, 2005.		
3.	Cruger, Wulf and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, (3 rd Edn) Panima Publishing, 2017.		
E-Resources			
1.	https://microbiologysociety.org/		
2.	https://www.britannica.com/science/microbiology		
3.	https://microbiologyonline.org/about-microbiology		

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Programme	B.Tech.	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	III										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23BT303	Cell Biology	3	0	0	3	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Understand the structure and functions of cellular components. • Articulate the events of the cell cycle and its regulatory mechanisms. • Categorize the mechanisms and regulation of membrane transport across cells. • Analyze the cell signaling pathways and signal transduction. • Categorize the types, characteristics, and management of cell lines and cultures. 														
Course Outcome	At the end of the course, the student should be able to,							KL							
	CO1: Identify and explain the structure and function of major cellular components and their roles in cellular processes.							K2							
	CO2: Integrate the stages of the cell cycle and the mechanisms that control cell cycle progression.							K3							
	CO3: Distinguish the types and roles of membrane transport mechanisms.							K4							
	CO4: Correlate the regulation of signal transduction at various levels.							K4							
	CO5: Classify, characterize, generate, and manage cell lines and cultures, including contamination control and three-dimensional culture techniques.							K4							
Pre-requisites	-														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2		2	3							3	2	3
CO 2	3	2		2		3		2	2	2	2	2	2	3	2
CO 3	3	2	3			2							2	3	3
CO 4	3					3							2	3	3
CO 5	2					3		2		2	2	2	3	3	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment & Quiz															
3. End-Semester examinations															
Indirect															
1. Course - end survey															



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Content of the syllabus			
Unit – I	CELL STRUCTURE AND FUNCTIONS	Periods	9
History & Discovery of Cell - Cell Theory – Types of Cell – Structural organization of Prokaryotic and Eukaryotic Cells – Structure & Function of Cell Organelles: Nucleus, Cytoplasm, Plastids, Chloroplast, Endoplasmic Reticulum, Golgi Body, Peroxisomes, Lysosomal and Vacuolar membrane – Cytoskeleton: Structure and Composition – Microfilaments, Intermediate Filaments, Microtubules – Extracellular Matrix			
Unit - II	CELL CYCLE AND ITS CONTROL	Periods	9
Nuclear Division – Cell cycle – Amitosis, Mitosis, Meiosis – Cytokinesis Molecules controlling cell cycle – Cyclins, CDK, Regulation of Cell Cycle – Cell Cycle Check Points			
Unit – III	MEMBRANE TRANSPORT	Periods	9
Classes of Membrane Transport Proteins – Lactose Permease –ATP Dependent Proton Pump: P Class, F Class, V-Class, ABC Superfamily – Transporters: cotransporters, Types: Symport, Antiport, Transport Process: Passive Diffusion, Primary Active Transport, Secondary Active Transport – Endocytosis & Exocytosis – Entry of virus into cells			
Unit - IV	SIGNAL TRANSDUCTION	Periods	9
Cell signaling & its stages – Signal Transduction – Signal Amplification – Mechanism of action of cytosolic receptors - Structural Organization of Nuclear Receptor Estrogen receptor - Second Messengers: c AMP: Structure, Function, Mechanism and Regulation, Application - G Protein: Types – Heterotrimeric G Protein, Small G Protein, Role of G Protein in Signal Transduction, GPCR – Structure, Role, Classification, Mechanism of Action			
Unit – V	CELL CULTURE	Periods	9
Definition – Types of cell culture – Cell line and its classification, Features, Characteristics, and Requirements of the Cell line – Characterization of the cell line – Techniques for cell line generation: LEAP – Contamination of cell culture – Source, Route cause, and its Prevention – Methods to monitor contamination – Procedures for disposal of contaminated culture – Three-Dimensional Culture – Role of matrix in Cell Growth			
Total Periods			45
Text Books			
1.	Darnell J, Lodish H, Baltimore D, “Molecular Cell Biology”, W.H. Freeman and Co 8 th edition 2016		
2.	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P, “Molecular Biology of the Cell”, 6 th Edition, Garland Science., New York, 2014		
References			
1.	Lodish H, Berk A., Kaiser CA., Krieger M, Bretscher A., Ploegh H, Amon A and Scott MP. “Molecular Cell Biology”. W H Freeman & Co, New York, 1150p, 2012		
2.	Nelson D.L and M.M. Cox. “Lehninger Principles of Biochemistry”, 7 th Edition, W. H. Freeman and Company, New York, USA. p.1328, 2017		
3.	Rastogi, S C., “Cell and Molecular Biology”, 3 rd edition, New Age International Publishers, 2010		
4.	Voet, D. and Voet, J. G, “Biochemistry” 4 th edition, Wiley, 2004		
5.	Karp, G. “Cell and molecular biology: Concept and experiment”. 6 th edition, Wiley, 2009		
E-Resources			
1.	https://archive.nptel.ac.in/courses/102/103/102103012/		
2.	https://archive.nptel.ac.in/courses/102/106/102106025/		

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Programme	B.Tech.	Programme Code		105	Regulation	2023									
Department	Biotechnology			Semester		III									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT304	Thermodynamics for Biotechnologists	3	0	0	3	40	60	100							
Course Objective	The learners are able to 1. Learnt about basic thermodynamic relations and properties of fluids. 2. Understand the phase and chemical reaction and concepts of biochemical thermodynamics. 3. Classify the various laws of thermodynamics involving in biological process. 4. Differentiate chemical thermodynamics and biological thermodynamics. 5. Equip the students for design of various equipment's														
Course Outcome	At the end of the course, the student should be able to,							KL							
	CO1: Understand the basic laws of thermodynamics							K1							
	CO2: Compare the various thermodynamic properties of solutions and pure fluids							K2							
	CO3: Analyze heat effect with and without phase change							K4							
	CO4: Apply the concept of chemical reaction equilibria and equilibrium conversion							K3							
CO5: Understand the bioenergetics and thermodynamics of biochemical reactions							K2								
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	2	2	2				1	2	1	3	3	2	
CO 2	3	2	2	2	3				2	3	1	2	2	2	
CO 3	2	1	2	1	3	2			1	2	2	3	2	3	
CO 4	2	2	1	2	2	2			2	2	1	2	3	2	
CO 5	2	2	1	2	3	2			1	1	2	2	2	3	
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III 2. Assignment															




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3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO THERMODYNAMICS	Periods	9
Generalized concept of Thermodynamics- Law of Thermodynamics, Enthalpy, Entropy, Free energy & Chemical Equilibria - Higher energy bonds & Compounds			
Unit – II	SOLUTION THERMODYNAMICS	Periods	9
Volumetric properties of pure liquids - Ideal gas law -law of corresponding state, Partial molar properties - concept of chemical potential and fugacity in solutions - activity - activity coefficients –Gibbs-Duhem equations			
Unit – III	BASICS OF HEAT AND ITS APPLICATIONS	Periods	9
Heat effects- Heat capacities, equation and charts- Heat effect with and without phase changes- Standard heat of formation and combustion- Heat effect of industrial reaction			
Unit – IV	THERMODYNAMICS PROPERTIES OF FLUIDS	Periods	9
Thermodynamics properties of fluids- Maxwell Relation-Thermodynamic relations-Carnot cycle - Third law of Thermodynamics-Enthalpy & Entropy changes in ideal gases			
Unit – V	THERMO-BIOENERGETICS	Periods	9
Thermodynamics and energetic of metabolic pathway, Oxygen requirement and Heat generation in aerobic growth, Energy Coupling - Thermodynamics of Oxidation-reduction - Energetics of DNA- Protein Interaction.			
Total Periods			45
Text Books			
1.	Sandler S.I, “Chemical and Engineering Thermodynamics”, John Wiley,4 th edition, 2006.		
2.	Royels, JA, “Kinetics and Energetics in Biotechnology”, Elsevier, 2006.		
References			
1.	Smith J.M, Van Ness H.C, Abbot M.M, “Chemical Engineering Thermodynamics”, 6 th Edition, McGraw-Hill, 2019		
2.	Narayanan K.V, “A Text Book of Chemical Engineering Thermodynamics”, Prentice Hall India, 2001.		
3.	Nag P K, “Engineering Thermodynamics”, 3 rd Edition, Tata McGraw-Hill, 2017.		
4.	Rathakrishnan E, “Fundamentals of Engineering Thermodynamics ,2 nd Edition, PHI Learning Pvt. Ltd, 2017.		
5.	Christiana D. Smolke, The Metabolic Pathway Engineering Handbook Fundamentals, CRC Press Taylor & Francis Group, 2013		
E-Resources			
1.	https://nptel.ac.in/courses/102106026/ , “Thermodynamics (Classical) for Biological Systems” – Dr. G.K. Suraishkumar, IIT Madras		
2.	ncert.nic.in >ncerts> kech106		
3.	https://nptel.ac.in/courses/104105040 , “Chemistry and Biochemistry” IIT Kharagpur		



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	III										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT305	Biochemistry and Bioenergetics	3	0	0	3	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Familiarize different types of bio molecules, classifications and its structure. Acquire knowledge in molecular structures and metabolic reactions. Generalize theory of nitrogen metabolisms. Grab knowledge about different types of energy compounds. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Recall the metabolism of carbohydrates through various anabolic and catabolic pathways.							K1							
	CO2: Discuss the pathway of various metabolisms related to lipids.							K2							
	CO3: Classify different types amino acids and its interconnection pathways							K3							
	CO4: Compare the structural properties and mechanism of different nucleic acids.							K4							
CO5: Evaluate the yield of high energy compounds for many metabolic reactions.							K5								
Pre-requisites	-														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	1			2	2	2	3	3	3
CO 2	3		3	2	1	1		1	1	2	3	1	2	2	2
CO 3	3	2	1	3	2		2			2	2	2	3	2	1
CO 4	3	2	3	2	3				1			2	3	3	2
CO 5	3	3	2		2	1	1	2			1	1	3	2	1
Course Assessment Methods															
Direct															
<ol style="list-style-type: none"> Continuous Assessment Test I, II & III Assignment/Quiz End-Semester examinations 															



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Indirect			
1. Course - End Survey			
Content of the syllabus			
Unit – I	CARBOHYDRATES & ITS METABOLISM	Periods	9
Types of functional groups, water, pH & buffers, Introduction to bio-molecules, Classification, Functions and Reactions of Carbohydrates - Glycolysis, TCA cycle, Gluconeogenesis, Pentose Phosphate Shunt, Glyoxylate Shunt.			
Unit – II	LIPIDS & ITS METABOLISM	Periods	9
Classification, Functions and Reactions of Fatty acids and Glycerol- Saponification, Iodination and hydrogenation - Phospholipids, Glycolipids, Sphingolipids, Cholesterol, Steroids, Prostaglandins. Fatty acid synthesis and oxidation.			
Unit – III	METABOLISM OF AMINO ACIDS & PROTEIN	Periods	9
Nitrogen metabolism, Classification, Functions and Reactions of Proteins. Biosynthesis and degradation of all Amino acids. Metabolic disorders and important molecules derived from amino acids, Interconnection of pathways and metabolic regulation.			
Unit – IV	NUCLEIC ACIDS & ITS METABOLISM	Periods	9
Classification, Functions and Reactions of Nucleic acids. Purines, Pyrimidines, Nucleoside, Nucleotide, RNA, DNA-Watson-Crick structure of DNA, Reactions, Properties, Nucleoprotein complexes.			
Unit – V	BIOENERGETICS	Periods	9
High energy compounds, Electronegative potential of compounds, Respiratory chain (Aerobic and Anaerobic), ATP cycle, Calculation of ATP yield during oxidation of glucose and fatty acids.			
Total Periods			45
Text Books			
1.	Nelson D.L and Cox M.M, "Lehninger's Principles of Biochemistry", 8 th Edition, W.H. Freeman & Co., 2021.		
2.	Berg J. M, Tymoczko J. L and Lubert Stryer, "Biochemistry", 9 th Edition, W.H. Freeman & Co., 2019.		
References			
1.	Satyanarayana. "Biochemistry", 6 th Edition, Elsevier, India, 2021.		
2.	Voet D, Voet J. G and Pratt C. W, "Fundamentals of Biochemistry- Life at the Molecular level", 5 th Edition, John Wiley & Sons, New Jersey, 2016		
3.	McKee T. and McKee J. R, "Biochemistry- The Molecular Basis of Life", 6 th Edition, Oxford University Press, London, 2015.		
4.	Zubay G L, "Biochemistry", WCB/McGraw-Hill publishers, Iowa, 2015		
E-Resources			
1.	https://nptel.ac.in/courses/102/105/102105034/		
2.	https://web.expasy.org/pathways/		
3.	https://www.ncbi.nlm.nih.gov/books/NBK21208/		

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Programme	B.Tech.	Programme code	105	Regulation	2023										
Department	Biotechnology			Semester	III										
Course Code	Course Name	Periods per week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23CTCP1	Verbal, Quantitative Aptitude and Reasoning - I	2	0	0	1	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Identify and begin to apply the language features Understand the mathematical techniques for solving the real life problems Use number theory arguments to justify relationships involving divisors, multiples and factoring Help in preparation of competitive exams 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Use language through acquisition of grammar rules							K2							
	CO2: Demonstrate the use of mathematical reasoning by justifying the patterns and relationships							K2							
	CO3: Face external competitive exams							K3							
	CO4: Solve a question in a fraction of minute using shortcut methods							K3							
CO5: Enhance their problem solving skills and logical Skills							K4								
Pre-Requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1		2		3	2					3		3	3	2	3
CO 2	3	3		2	2					3		3	3	2	2
CO 3	3	3		3	2					3		3	2	3	3
CO 4	3	3		2	3					2		2	3	3	3
CO 5		2		2	2					2		2	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment/Quiz															
3. End-Semester Examination															
Indirect															
1. Course -end survey															


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Content of the syllabus			
Unit -I	VERBAL ABILITY (ERROR SPOTTING)	Periods	5
<p>CONJUNCTIONS: Error on coordinative conjunction: The seven coordinating conjunctions are (fan boys): for, and, nor, but, or, yet, so, Errors on Subordinate Conjunction After, although, as soon as, because, before, by the time, in case, now that, since, unless, when, whether or not, while, yet....., Errors on correlative conjunction (Either.....or, neither.....nor, not only.... but also, as....as, both.....and, whether.... or, so...as, such...that, the)</p> <p>CONDITIONAL CLAUSES: Errors on Zero condition, Errors on first condition of If clauses, Errors on second condition of If clauses, Errors on third condition of If clauses</p> <p>ADVERBS: Errors on conjunctive adverb, Errors on adverbs of frequency, Errors on adverbs of time, Errors on adverbs of manner, Errors on adverbs of place, Errors on adverbs of degree</p> <p>ADJECTIVES: Errors on descriptive adjectives, Errors on demonstration adjectives, Errors on distributive adjectives, Errors on interrogative adjectives, Errors on numeral, Errors on quantitative adjectives, Errors on proper adjectives, Errors on possessive adjectives</p> <p>DETERMINERS: Definite Article, Indefinite Article, Quantifying Article – few, many, Possessive Article, (my, your, his, her, its, our, your, their....)</p> <p>NOUNS: Pronoun, Common Noun, Collective Noun, Abstract Noun, Material Noun</p> <p>SUBJECT – VERB AGREEMENT: Singular Subjects and Singular Verbs, Errors on plural subjects with plural verbs, Errors on indefinite pronouns, Errors on compound subjects, Errors on collective noun, Errors on singular or plural verb</p>			
Unit-II	NUMBER SYSTEMS	Periods	6
<p>NUMBER SYSTEMS (Divisibility Rule, Unit Digit, Remainder Theorem(1 Or -1, Cancellation, Wilson, Fermets), Progressions(Arithmetic, Geometric, Harmonic), Log, Surds And Indices, Simplification)</p>			
Unit – III	AVERAGE AND LCM & HCF PROBLEMS	Periods	8
<p>AVERAGE (Basic Model, Partial Average, 3. Overall Average, Inclusion/Exclusion of A Value in a Group, Increased or Included or Added or More and Replaced, Substituted, Cricket Based Model, Misread Model, Allegation and Mixture, Mean, Median and Mode, Miscellaneous)</p> <p>LCM and HCF (Find The LCM, HCF and Its fractions, Product of Two Numbers Model, LCM, HCF with Remainders Model, Smallest/Largest Based Model, Tolling Together Model, HCF Related Questions (Keyword: Distinct, Divided, Equal Number of Rows (Distributed Equally)), Mensuration Related Questions, No. of Pairs Model, LCM, HCF With Ratios Model, Algebraic Expressions Model, Reduce To Lowest Terms</p>			
Unit- IV	RATIO AND PROPORTION	Periods	5
<p>RATIO (Zig Zag Model, Finding The Individual Component, Coins & Values Based Ratios, Number Based Ratios, Increment/Decrement Based Ratios, Miscellaneous)- PROPORTION (Continuous, Third, Fourth, Mean)</p>			
Unit-V	LOGICAL REASONING	Periods	6
<p>CODING-DECODING- Types of Coding and Decoding (Letter Coding, Conditional Coding, Crypt arithmetic –Addition, Crypt arithmetic – Subtraction)</p> <p>BLOOD RELATION (Type 1: Pointing or Introducing, Type 2: Family Tree or Relational Puzzle, Type 3: Coded Relation)</p> <p>NUMBER SERIES (Pattern 1: Perfect Square Series, Pattern 2: Perfect Cube Series, Pattern 3: Geometric Series, Pattern 4: Ratio series, Pattern 5: Multi Stage Series)</p> <p>SYLLOGISM (Type 1: BASIC SYLLOGISM, Type 2: Either or Neither nor, Type 3: Only – Only a few)</p>			
Total Periods			30
Text books			
1.	Rajeev Varma, “Fast Track Objective Arithmetics”, Arihant Publications, 2024		

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2.	R.S. Aggarwal, "Modern Approach to Logical Reasoning", S Chand Publishing, 2022
3.	SP Bakshi, "Objective General English", Arihant Publications, 2024
References	
1.	R.S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand Publishing, 2013
2.	Dinesh Khattar, "The Pearson guide to Quantitative Aptitude for Competitive Examinations", 3 rd edition, 2016
3.	Arun Sharma, "How to Prepare for Logical reasoning for CAT", McGraw Hill Education; 2014
4.	Jaikishan and Premkishan, "How to Crack Test of Reasoning", Arihant Publications, 2016
5.	R.S. Agarwal, "A modern Approach to verbal and non-verbal reasoning", S Chand Publishing, 2018
E-Resources	
1.	Aptitude: https://www.indiabix.com
2.	Reasoning: https://placement.freshersworld.com
3.	Verbal: https://testbook.com

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT306	Cell & Microbiology Laboratory	0	0	2	1	60	40	100							
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> Learn to follow experimental procedures and become proficient at laboratory skills To learn the staining techniques and culturing of microorganism. Transfer living microbes using aseptic techniques To demonstrate various techniques to learn the morphology, identification and propagation of cells and microbes. Learn how to make careful observations, collect and analyze the obtained data 														
Course Outcomes	The students who complete this course successfully are expected to:							Knowledge Level							
	CO1: Know the various aseptic techniques and sterilization methods							K1							
	CO2: Describe the physiology of cells and growth requirements of bacteria							K2							
	CO3: Learn various staining techniques to identify the cells & microorganisms							K3							
	CO4: Identify the various stages of mitosis							K3							
	CO5: Control the growth of bacteria using antimicrobial agents							K4							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	1	2	2	3	2	3	2	1	3	3	2	2	3	3	2
CO 2	2	2	2	3	1	1	2	2	2	3	3	2	2	3	3
CO 3	3	3	1	3	3	2	1	1	3	3	2	2	3	3	2
CO 4	3	3	3	3	3	3	2	2	3	3	3	2	2	2	3
CO 5	3	3	2	3	3	2	2	3	3	3	3	2	3	3	2
Pre-requisites	Nil														
Direct															
1. Pre lab and Post lab 2. Execution of Experiment and Viva-voce 3. End semester examination															
Indirect															
Course - end survey															


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List of Experiments		
S.No	Name of the Experiment	Course Outcome
1.	Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques	CO1
2.	Microscopy principle & identification of given plant, animal and bacterial cells	CO1
3.	Staining Techniques Simple, Differential- Gram's Staining, Acid fast staining, Capsular staining, Giemsa, and Leishman Staining	CO2
4.	Staining for different stages of mitosis in Allium cepa (Onion)	CO2
5.	Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, spread plates, streak plates, slants, stabs	CO3
6.	Culturing & Quantification of Microbes from different sources (Soil OR water) using Serial Dilution Technique	CO3
7.	Growth curve observation on bacteria	CO4
8.	Trypan Blue Assay	CO4
9.	Biochemical test	CO4
10.	Antibiotic sensitivity assay	CO5
Total Periods		60


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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT307	Biochemistry Laboratory	0	0	2	1	60	40	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Learn fundamental approaches for experimentally investigating biochemical problems. Able to extract living cell samples from plants and animals for genetic research 														
Course Outcomes	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Understand the applicability of biochemical methods to realistic solution and Analyze current biochemical and molecular techniques to plan and carry out experiments.							K1							
	CO2: Perform good biochemical laboratory practices.							K2							
	CO3: Adapt methods for biochemical analysis.							K3							
	CO4: Carry out experiments in biomolecular separations.							K3							
CO5: Learn and understand the principles behind the qualitative and quantitative estimation of biomolecules.							K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
Cos	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO 2	3	2	3	2	2	2	3	3	3	2	3	2	2	2	2
CO 3	3	2	2	3	2	3	2	2	3	2	3	2	3	2	1
CO 4	3	2	3	2	3	3	3	3	2			2	3	3	2
CO 5	3	3	2	2	2	2	2	2	3			2	3	2	1
Pre-requisites	Nil														
Direct															
1. Pre lab and Post lab															
2. Execution of Experiment and Viva-voce															
3. End semester examination															
Indirect															
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List of Experiments		
S.No	Name of the Experiment	Course Outcome
1.	Preparation of buffer –titration of a weak acid and a weak base.	CO1
2.	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.	CO1
3.	Quantitative method of carbohydrate estimation by DNSA	CO2
4.	Extraction of lipids and analysis by TLC.	CO2
5.	Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.	CO3
6.	Protein estimation by Bradford method.	CO3
7.	Protein estimation by Lowry's method.	CO4
8.	Estimation of Cholesterol by Zak's methods	CO4
9.	Estimation of nucleic acids by absorbance at 260 nm	CO4
10.	Enzymatic assay: phosphatase from potato.	CO5
Total Periods		60


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Course code	Course name	Periods per week			Credit	Maximum Marks									
		L	T	P	C	CA	FSF	Total							
U23CTCP2	Personality Development	1	0	2	1	60	40	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Equip comprehensive understanding of various psychological and cognitive assessment tools Analyze, interpret, and apply these tools to improve personal and professional development Enhance communication Manage stress effectively 														
	Course Outcome	At the end of the course, the student should be able to,						Knowledge Level							
CO1: Enhance Self-Awareness						K2									
CO2: Improve Communication Skills						K1									
CO3: Acquire Better Academic and Life Satisfaction						K2									
CO4: Enhance Problem-Solving Abilities						K3									
CO5: Effective Stress Management						K3									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO3
CO 1					2			2	2		2	1	2	1	
CO 2					2			2	2		2	3	3	3	
CO 3					2			1	2		2	3	3	3	
CO 4					2			2	1		2	3	3	3	
CO 5					2			2	1		2	1	1	2	
Course Assessment Methods															
Direct															
1. Self-Assessment															
2. Viva-Voce															
3. End-Semester Examination															
Indirect															
1.Course -end survey															
Content of the Syllabus															




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S. No.	List of Experiments	CO
1.	Rosenberg's and Hare's Self Esteem tool	CO1
2.	Myers Brigg's 16 types of Personality	CO1
3.	Social Functioning scale	CO3
4.	Huebner, Laughlin, Ash, & Gilman's Multidimensional Students Life Satisfaction Scale	CO3
5.	Body language Assessment	CO2
6.	Fleming's VARK Learning Theory, bloom's taxonomy based on learners' queries	CO2
7.	Alexi's Presentation Secrets Assessment	CO2
8.	Deductive and inductive logical reasoning assessment	CO4
9.	Procter and Gamble Assessment Gamified Tests	CO4
10.	Psychometric Test	CO3
11.	Stress buster Assessment	CO5
Total Periods : 30		
References		
1. Allan Pease, "Body language – how to read other's thoughts by their gestures", Sheldon press, London publication, Tenth Impression 1988		
2. Alexei Kapterev, "Presentation Secrets", John Wiley and Sons, 2011		
E-Resources		
1. https://scales.arabpsychology.com		
2. http://DOMWebserver.Hitchcock.org/mbti/		
3. https://www.assessmentday.com/free/deductive-reasoning-1/DeductiveFreeTest-Solutions.pdf		
4. www.prepinsta.com		


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SEMESTER IV



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	IV										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23MA408	Biostatistics	3	1	0	4	40	60	100							
Course Objective	The main objective of the course is to														
	<ul style="list-style-type: none"> • Able to understand laws of Probability and the use of Baye's theorem • Proficiently understand the expected value, variance, and higher-order moments of Random variables (for both discrete and continuous types). • Identify and demonstrate suitable sampling and data collection process. • Know about the different non-parametric tests. • Introduce the basic concepts of statistical quality control. 														
	At the end of the course, the student should be able to,						Knowledge level								
	CO1: Apply the concept of probability to find the outcome of random events.						K3								
	CO2: Translate the density and distribution functions for discrete and continuous random variables.						K3								
CO3: Apply appropriate modern technology to explore probability/statistical concepts.						K5									
CO4: Use the different types of non parametric tests and the test of randomness.						K4									
CO5: Have the notion of sampling distributions and statistical techniques used in engineering and management problems.						K5									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1		1								2		
CO 2	3	2	1	1									2		
CO 3	3	2	1										2		
CO 4	3	2		1									2		
CO 5	3	2	1		1								2		
Course Assessment Methods															
Direct															
<ol style="list-style-type: none"> 1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations 															

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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO PROBABILITY	Periods	9+3
Introduction to Probability, Axioms of Probability: Sample spaces and events, axioms of Probability, sample spaces having equally likely outcomes – Conditional Probability and independence- Baye’s theorem (without proof) and its applications.			
Unit – I	RANDOM VARIABLES	Periods	9+3
Random variables, Probability mass function, Probability generating function, moments, moment generating function and their properties-Chebyshev inequality.			
Unit - III	ESTIMATION THEORY	Periods	9+3
Unbiased estimators- Efficiency- Consistency- Sufficiency- Robustness- Method of moments- Method of maximum likelihood- Interval estimation of means- Differences between means, variations and ratio of two variables.			
Unit – IV	NON- PARAMETRIC TESTS	Periods	9+3
Introduction-The sign test- The Signed- Rank test- Rank- Sum tests- The U test- The H test- Tests based on Runs- Test of randomness- The Kolmogorov tests.			
Unit – V	STATISTICAL QUALITY CONTROL	Periods	9+3
Control charts for measurements (\bar{X} and R charts)- Control charts for attributes (p,c and np charts) – Tolerance limits – Acceptance sampling.			
Total Periods			45+15=60
Text Books			
1.	Montgomery, D.C. and Runger, C.G., Applied Statistics and Probability for Engineers, 7 th Edition, Wiley Students Edition, Wiley, 2020.		
2.	Ravichandran, J., Probability and statistics for Engineers, 1 st Edition, Wiley India Ltd, 2012.		
References			
1.	Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, 12 th Edition, Sultan an Sons, 2020.		
2.	Devore, J.L., Probability and Statistics for Engineering and the Sciences, 8 th Edition, Cengage Learning, 2014.		
3.	Johnson, R.A., Miller, I. and Freund, J., Miller & Freund's Probability and Statistics for Engineers 9 th Edition, Pearson Education, 2016.		
4.	Ronald E.Walpole; Raymond H.M.yers; Stiaron L. Myers,"Probability and Statistics for Engineering and the Scientists",Pearson Publishers, 9 th Edition,2010.		
5.	Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2004.		
E-Resources			
1.	https://online.stanford.edu		
2.	www.learnerstv.com/Free-engineering-Video-lectures		
3.	www.nptel.ac.in		


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Programme	B.Tech	Programme Code				105	Regulation			2023					
Department	Biotechnology					Semester			IV						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ES E	Total							
U23BT408	Plant and Animal Biotechnology	3	0	0	3	40	60	100							
Course Objective	The objective of this course is <ul style="list-style-type: none"> Summarize the basics of plant tissue culture, including media, sterilization, and totipotency. Categorize direct and indirect methods of gene transfer in plants. Interpret the key requirements for animal cell culture, including media and sterilization. Infer how viral vectors are used for gene transfer. Exemplify genetic engineering strategies in plants and animals. 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Relate different tissue culture methods to their applications in plant biotechnology.										K2				
	CO2: Compare Agrobacterium-mediated transformation with direct gene transfer techniques.										K2				
	CO3: Contrast anchorage-dependent and non-anchorage-dependent cell cultures.										K2				
	CO4: Articulate the differences between stable and transient transfection methods.										K3				
CO5: Integrate the role of genetic modifications in agriculture and medicine.										K3					
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak															
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2	2			2	3	2			2		2	3	3	3
CO 2	2		1		2			2			2		3	2	2
CO 3	3		2		1	3	2			2		2	3	2	2
CO 4	2			1		3	2	2	2				3	3	2
CO 5	3		2			2		2	2	2		2	3	2	2
Pre-requisites	NIL														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	PLANT TISSUE CULTURE	Periods	9
Lab Facilities - Features of plant cells – Plasticity & Totipotency - Tissue Culture media – Sterilization of Nutrient media and plant material – Types of Cultures: Callus Culture - Protoplast culture – Cell Suspension Culture – Hairy Root Culture – Application of tissue culture - Organogenesis and Somatic embryogenesis – Somatic hybridization and Cybridization – Plant Growth Regulators and Elicitors.			
Unit – II	GENETIC TRANSFORMATION IN PLANT CELLS	Periods	9
Direct (particle bombardment, PEG mediated transformation, electroporation, silicon carbide fibres) and Indirect gene transfer methods - <i>Agrobacterium</i> mediated gene transfer –Ti-plasmid- process of T-DNA transfer and integration - Co-integrative and Binary vectors - Selectable markers - Reporter genes – Plastid Transformation			
Unit – III	ANIMAL CELL CULTURE	Periods	9
Equipment used for animal cell culture - Media for culturing animal cells and tissues - Chemically defined and serum-free media - Sterilization of various equipment and apparatus – Physical Environment for culturing for animal Cells – Types of animal cell culture - Anchorage and Non-Anchorage Dependent Cell culture – Micro and Macro Career Culture Cell line – Growth cycle of animal cell – Animal Cloning			
Unit – IV	ANIMAL GENE TRANSFER METHODS	Periods	9
Virus mediated gene transfer method; Biology and Construction of viral vectors like adenovirus, lentivirus, herpes virus, and adeno associated virus, baculovirus , Transfection methods; stable and transient methods.			
Unit – V	APPLICATION OF TRANSGENIC PLANTS & ANIMALS	Periods	9
Strategies for engineering herbicide resistance - round up ready crops. Genetic engineering approaches for insect resistance - Bt gene and mode of action - Monoclonal antibody production - Manipulation of Growth hormone - Somatotropic hormone – Manipulation of lactation - Probiotics as growth promoters - Ideal characteristics of probiotics; Mode of action and uses of probiotics - Knock out and Knock in animals			
Total Periods			45
Text Books			
1.	Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1 st Edition, 2017.		
2.	Davis, D., Animal Biotechnology, National Academic Press, Washington, 1 st Edition, 2002.		
3.	Chawla, H.S., Introduction to Plant Biotechnology, Science Publishers, 3 rd Edition, 2009.		
4.	Adrian Slater, Nigel Scott and Mark Fowler., Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, 2 nd Edition, 2007.		
References			
1.	Freshney, R. I., Culture of Animal Cells: A manual of Basic technique, John ,Wiley & sons, 2010.		
2.	Masters, J.R.W., Animal Cell Culture: Practical Approach, Oxford University Press, New York, 2000.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc19_bt18/preview		
2.	https://archive.nptel.ac.in/courses/102/104/102104059/		

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester		IV									
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks										
		L	T		P	C	CA	ESE	Total						
U23BT409	Molecular Biology	3	0	0	3	40	60	100							
Course Objective	The objectives of this course are 1. To gain conceptual understanding on central dogma of biology. 2. To acquire in-depth knowledge on prokaryotic and eukaryotic genome organization and evaluate the feasibility of gene expression and molecular biology tools.														
Course Outcome	At the end of the course, the student should be able to,								KL						
	CO1: Understand the composition, structure and characteristics of nucleic acids.								K2						
	CO2: Critique the concepts of replication in prokaryotes and eukaryotes.								K4						
	CO3: Explain how synthesis of RNA occurs in the cell								K4						
	CO4: Describe the mechanism of protein synthesis and localization								K2						
CO5: Articulate applications of molecular biology in the modern world.								K3							
Pre-requisites	Cell Biology														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	2	2	3		1	3	1			1	1	2	1
CO 2	2	3	2	2	2	2		3	2			3	2	3	2
CO 3	3	3	3	3	2	2	2	3	2				2	3	2
CO 4	2	2	2	2	2	1		1	1				2	3	2
CO 5	3	2	3	3	2	2	2		1	3	3	2	2	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															



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1. Course - End survey			
Content of the syllabus			
Unit – I	NUCLEIC ACIDS AND THEIR PROPERTIES	Periods	9
Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of DNA and RNA, Primary, Secondary and Tertiary Structure of DNA, DNA supercoiling, Molecular Structure of Genes and Chromosomes, Prokaryotic and Eukaryotic Organization of Chromosomes.			
Unit – II	DNA REPLICATION AND REPAIR	Periods	9
Overview of Central dogma. DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, phage replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. DNA Damage and Repair.			
Unit – III	TRANSCRIPTION	Periods	9
Structure and function of mRNA, rRNA and tRNA, Characteristics of promoter and enhancer sequences, Transcription in Prokaryotes and Eukaryotes, micro RNA, RNA interference, Post-Transcriptional Modification - 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.			
Unit – IV	TRANSLATION	Periods	9
Genetic Code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance. Protein Synthesis in Prokaryotes and Eukaryotes- Initiation, Elongation and Termination, inhibitors of protein synthesis, Post Translational Modification and its importance, Mutation and Mutagenesis			
Unit – V	REGULATION OF GENE EXPRESSION	Periods	9
Prokaryotic gene regulation –lac and trp operon, DNA sequencing-classical and automated DNA sequencing methods, Tools and techniques in Molecular Biology-Overview. Molecular markers- PCR and hybridization based molecular markers.			
Total Periods			45
Text Books			
1.	Friefelder, David. "Molecular Biology." Narosa Publications, 2004		
2.	S.C. Rastogi, "Cell and Molecular biology" New Age International Private Limited, 5 th Edition, 2023		
References			
1.	Freifelders Essentials Of Molecular Biology by Jones & Bartlett 4 th Edition, 2015		
2.	De Robertis E.D.P., "Cell And Molecular Biology" 8 th Edition, 2017		
3.	James D. Watson, "Molecular Biology of the Gene" Pearson Education, 7th Edition, 2017		
4.	Harvey Lodish et al., "Molecular Cell Biology" W H Freeman & Co, 9th Edition, 2021		
5.	Robert F.Weaver, "Molecular Biology", McGraw-Hill Higher Education, 5 th Edition, 2018		
Resources			
1.	https://onlinecourses.swayam2.ac.in/cec20_ma13/preview		
2.	https://www.biointeractive.org/classroom-resources?search=&f%5B0%5D=topics%3A26		


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
	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	Biotechnology			Semester	IV										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	E S E	Total						
U23BT410	Instrumentation Methods of Analysis	3	0	0	3	40	60	100							
Course Objective	The main objective of this course is: <ul style="list-style-type: none"> To discuss the basic concepts and applications of fundamental statistical, and thermal methods To apply and interpret the data originated from spectroscopy, chromatography and electrophoretic methods To know the concept of centrifugal technique, and apply mass spectrometry, x-ray diffraction and NMR techniques 														
	Course Outcome														
	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand and apply the statistical principles to solve biological issues, and apply appropriate thermal analysis method to process biological samples						K2								
	CO2: Recognize the application of electromagnetic radiation in optical instruments. Compare, apply and interpret the data of biological solutions acquired from different spectroscopy techniques						K2								
	CO3: Describe, apply and evaluate the data originated by chromatographic techniques to solve biological problems						K2								
	CO4: Explain, apply and evaluate the data obtained from different electrophoretic techniques						K4								
	CO5: Describe and apply mass spectrometry, x-ray diffraction and NMR techniques in the broad field of biotechnology and Discuss the fundamentals of centrifugation techniques						K4								
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	2	1	3	2			3	3		3	3	3	2
CO 2	3	3	3	3	3				3	3		3	3	3	3
CO 3	3	3	3	3	2				3	3		3	3	3	3
CO 4	3	3	3	2	2							2	3	3	2
CO 5	3	3	2	3						2			2	2	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	BASICS OF MEASUREMENT AND THERMAL ANALYSIS METHODS	Periods	9
Classification of instrumental methods; Fundamentals of accuracy, calibration, validation, precision and limits of detection (LOD) and limits of quantification (LOQ); Signal to noise ratio (S/N) - Classification and Signal to noise ratio Enhancement; Thermo-gravimetric methods, Differential thermal Analysis, Differential Scanning calorimetry.			
Unit – II	SPECTROSCOPY	Periods	9
Properties of electromagnetic radiation-wave properties, Components of optical instruments; Principle and instrumentation - UV-Vis, IR, Raman, XPS and atomic absorption spectroscopy; Principle and instrumentation - Fluorometry, and Circular Dichroism (CD);			
Unit – III	CHROMATOGRAPHY	Periods	9
Factors affecting the resolution of chromatography; Rate and plate theory; Van Deemter equation; Principle and instrumentation - Thin layer chromatography, Supercritical fluid chromatography, Gel permeation chromatography, ion exchange chromatography, High Performance Chromatography (HPLC), Ultra performance liquid chromatography (UPLC), Affinity chromatography and Gas chromatography (GC)			
Unit – IV	ELECTROPHORESIS	Periods	9
Electrophoresis – introduction & trouble shooting parameters; Principle and Instrumentation -Paper, agarose gel, polyacrylamide gel (PAGE), SDS-PAGE, denaturing gradient gel electrophoresis (DGGE) or temperature gradient gel electrophoresis (TGGE), capillary electrophoresis, isoelectric focusing .			
Unit – V	STRUCTURAL ELUCIDATION METHODS	Periods	9
Principle and instrumentation - Mass spectrometry (electron spray ionization [ESI] & chemical ionization [CI]), FTIR, GC-MS; X-ray diffraction and Nuclear magnetic resonance (NMR) – principle and instrumentation.			
Total Periods			45
Text Books			
1.	Skoog, D., Holler, F., & Crouch, S, “Principles of Instrumental analysis”, 6th Edition, USA: Brooks Cole Publishing Company, 2014.		
2.	Chatwal.G.R, and Sham K. Anand.,” Instrumental Methods of Chemical Analysis”, 5th Edition, Himalaya Publishing House, 2012.		
3.	Sivasankar B., “Instrumental methods of analysis” Oxford University Press, 2012		
References			
1.	Sharma, B, “Instrumental methods of chemical analysis (analytical chemistry)”, 24 th Edition, GOEL Publishing House, 2014.		
2.	Patil, V.P., Tathe, R. D., Devdhe, S. J., Angadi, S.S and Kale, S. H. “Ultrapromance liquid chromatography: A review, International Research Journal of Pharmacy”, 2011.		
3.	Wilson, K., & Walker, J. “Principles and techniques of biochemistry and molecular biology”, 7th Edition, Cambridge University Press, 2006.		
E-Resources			
1.	https://pharmdbm.com/instrumental-methods-of-analysis-notes/		
2.	https://microbenotes.com/nuclear-magnetic-resonance-nmr-spectroscopy/		
3.	https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumentation_and_Analysis/Chromatography/Chromatography		




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 VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205															
Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	Biotechnology		Semester		IV										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ES E	Total							
U23BT411	Unit Operations	3	0	3	4	50	50	100							
Course Objective	The student should be made to, 1. To ensure students to having strong fundamental knowledge about Unit operation. 2. To introduce them to the unit operation calculation for bio process and biochemical industries 3. To understand the industrial application and significance of these equipment in biotechnology.														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	1. Understand the concept of basic stoichiometric calculation involved in bioprocess industries						K1								
	2. Ability to make material balances and Energy balances on unit operations and processes						K2								
	3. Analyze the fluid flow problems with the application of the momentum and energy equations						K3								
	4. Exhibit the mechanism of different fluid flow measuring devices includes orifice meter, venturi meter, rotameter and pitotube						K4								
5. Infer knowledge on various fluid transport processes with understanding of solution approximation methods and their limitations						K4									
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3					2	1	2	2	2	2	2
CO 2	3	2	1	2	2	1			1	1	2	2	2	2	1
CO 3	3	2	2	2	1		1		2	2	2	2	2	2	2
CO 4	1	2	1	2	1				2	1	2	2	2	1	2
CO 5	1	2	2	2	1			1	2	1	2	2	2	1	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															

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Unit – I	Introduction & Basic Concepts	Periods	12
Introduction concepts of units and dimension, Mole, atomic and molecular weight, Ideal gas law, Dalton's law, Specific gravity, Concept of Simpson rules and its application Engineering Practice: Verify the Rayleigh equation of Simple Distillation			
Unit - II	Energy Balance	Periods	12
Material balance with Chemical reactions – Distillation- Evaporation- Laws of conservation of mass- limiting and excess reactant, recycle, bypass and purging. Conservation of energy Engineering Practice: Determine the settling velocity and concentration of given dry solids			
Unit – III	Fluid Flow Measurement	Periods	12
Classification of flow-meter, Detailed study (Principle, construction and working) of Venturi meter- orifice meter – Rotameter - Pitot-tube - Simple numerical problems Engineering Practice: Determine the friction factor of the given pipe.			
Unit - IV	Particles Size Reduction	Periods	12
Principle of Comminution-Types of crushers, Grinders-Energy & power requirement for size reduction- laws of crushers & work index. Concept of sedimentation - settling velocity Engineering practice: Determine the effectiveness of given Screen by analysis of Oversize & Under size			
Unit – V	Fluidizations	Periods	12
Introduction to fluidization - types of fluidizations - minimum fluidization velocity - pressure drops in fluidized beds - Correlations of Ergun equation- Properties of fluidized beds. Engineering Practice: Calibrate the rotameter and study the characteristics of percentage error.			
Total Periods			60
Text Books			
1.	Holman, J. P., Heat Transfer, 9th Edition, McGraw Hill, Singapore, 2017		
2.	Donald Q. Kern, Process Heat Transfer, Tata McGraw Hill, New Delhi, 2019		
References			
1.	McCabe, W. L., Smith, J. C., and Harriot, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6 TH Edition, 2019		
2.	Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2018		
3.	GK Ray, Heat and mass Transfer solved problems, Tata McGraw Hill, New Delhi 5 th Edition 2018		
E-Resources			
1.	https://nptel.ac.in/courses/103/106/103106116/		
2.	https://nptel.ac.in/courses/103/101/103101141/		


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	Biotechnology		Semester	IV											
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT412	Plant and Animal Biotechnology Laboratory	0	0	3	1	60	40	100							
Course Objective	The students should be able to Summarize the key techniques in plant and animal tissue culture, including media preparation, sterilization, culture initiation, and cell viability assessment.														
Course Outcomes	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Interpret the steps involved in tissue culture media preparation for plant and animal cells.						K2								
	CO2: Categorize different sterilization techniques for plant tissues and animal culture media.						K2								
	CO3: Exemplify the process of shoot tip, embryo, and anther culture for plant propagation.						K2								
	CO4: Compare protoplast isolation, callus induction, and synthetic seed preparation for plant biotechnology applications.						K2								
CO5: Compare viability assessment methods like Trypan Blue staining and hemocytometer-based cell counting.						K2									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
Cos	Programme Outcomes (POs)											PSOs			
	PO 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	P O 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	2	2	2	2	2	2	3	3	3
CO 2	3	2	3	2	2	2	3	3	3	2	3	2	2	2	2
CO 3	3	2	2	3	2	3	2	2	3	2	3	2	3	2	1
CO 4	3	2	3	2	3	3	3	3	2			2	3	3	2
CO 5	3	3	2	2	2	2	2	2	3			2	3	2	1
Pre-requisites	Nil														
Direct	<ol style="list-style-type: none"> 1. Pre lab and Post lab 2. Execution of Experiment and Viva-voce 3. End semester examination 														
Indirect															


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Course - end survey		
List of Experiments		
S.No	Name of the Experiment	Course Outcome
1.	Preparation of Tissue culture Media	C01
2.	Surface sterilization	C01
3.	Shoot Tip Culture	C02
4.	Embryo & Anther culture	C02
5.	Isolation of protoplasts	C03
6.	Callus induction	C03
7.	Preparation of synthetic Seed	C04
8.	Media Preparation for animal tissue culture.	C04
9.	Preparation of sera and Fibroblast Culture	C04
10.	Viability checking (Trypan Blue) and cell counting by Hemocytometer	C05
Total Periods		60

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CAREER TRACK COURSE – I



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Course code	Course Name	Periods per week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23CTCE1	Entrepreneurial Mindset and Business Model Canvas	0	0	2	1	60	40	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Cultivate an entrepreneurial mindset that embraces innovation and risk-taking. • Learn the components of the Business Model Canvas and develop skills using the Business Model Canvas as a tool for business planning. • Design innovative business models based on customer needs and market opportunities. • Understand the process of transforming a business model into a comprehensive business plan. • Understand the application processes and legal implications of business licenses and permits. 														
	Course Outcome														
	At the end of the course, the student should be able to,							KL							
	CO1: Explain the key traits and behaviors of successful entrepreneurs.							K2							
	CO2: Identify and describe the components of the Business Model Canvas.							K2							
	CO3: Design innovative business models tailored to specific customer needs and market conditions.							K6							
	CO4: Demonstrate the ability to write comprehensive business plans, incorporating elements such as market analysis, financial projections, and operational strategies.							K4							
	CO5: Identify different types of licenses and permits necessary for various types of businesses.							K2							
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	1	1	2	1	1			1	2	1	3	3	1	1	1
CO 2	2	1	3	3	2			1	2	1	3	3	2	2	
CO 3	2	1	3	2	3			1	2	1	3	3		1	1
CO 4	1	1	3	1	2			1	2	1	3	3	1	2	2
CO 5	1	1	3	1	2			1	2	1	3	3	1		


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Course Assessment Methods			
Direct			
1. Continuous Assessment through Reviews			
2. End Semester Examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit - I	Introduction to Entrepreneurial Mindset	Periods	6
Introduction-Evolution of the Concept of Entrepreneur - Characteristics of Successful Entrepreneurs - The Charms of Becoming an Entrepreneur - The Entrepreneurial Decision Process –Need and types of Entrepreneur – Role of Entrepreneurship in Economic Development -Women Entrepreneurship and Rural Entrepreneurship – Case Study – Opportunities Identification and Selection			
Unit – II	Understanding the Business Model Canvas	Periods	6
Definition of a Business Model- Types of Business Models -Customer Segments - Value Propositions – Channels and Partners - Customer Relationships - Revenue Model and Streams			
Unit – III	Designing and Testing Business Models	Periods	6
Key Resources - Key Activities - Key Partnerships - Cost Structure - Prototyping Business Models - Evaluating Business Models			
Unit – IV	Business Model to Business Plan	Periods	6
Business Plan - reasons for writing a Business Plan - who reads a business plan and what they’re looking for - guidelines for writing an effective business plan - business plan Outline - present a business plan to potential investors.			
Unit - V	Licenses, Permits and Funding	Periods	6
Ethical culture in the entrepreneurial ventures – Dealing Effectively with legal Issues - Obtaining business licenses and permits – forms of Business Organization – Creating new-venture team – Skill Profile – case study – Need for Funding –Sources of Personal Funding, equity funding, debt financing			
Total Periods			30
Text Books			
1	Khanka. S.S., “Entrepreneurial Development” S.Chand and Co. Ltd., New Delhi, 2011, Revised Edition		
2	Osterwalder, A., & Pigneur, Y. “Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers” John Wiley & Sons, Inc., 2010		
3.	R. Duane Ireland Bruce R. Barringer “Entrepreneurship: Successfully Launching New Ventures”, Pearson Education. 2020, 6 th Edition		
References			
1.	Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, Cengage Learning, 2016. 10 th Edition		



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2.	Ries, E.” The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses “ , Currency, 2017, 9th Edition
E-Resources	
1.	https://fastercapital.com/content/Entrepreneurship-Education-via-Business-Model-Canvas.html
2.	https://online.bath.ac.uk/articles/business-models
3.	https://creately.com/guides/business-model-canvas-explained/



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Programme	B.Tech.			Programme code	105			Regulation	2023						
Department	Biotechnology				Semester				IV						
Course Code	Course Name				Periods per week			Credit	Maximum Marks						
					L	T	P		C	CA	ESE	Total			
U23CTCP3	Verbal, Quantitative Aptitude and Reasoning - II				2	0	0	1	40	60	100				
Course Objective	The student should be made to, <ul style="list-style-type: none"> Identify and begin to apply the language features Understand the mathematical techniques for solving the real life problems Use number theory arguments to justify relationships involving divisors, multiples and factoring Perform well in all competitive exams 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Use language through acquisition of grammar rules										K2				
	CO2: Demonstrate the use of mathematical reasoning by justifying the patterns and relationships										K2				
	CO3: Face external competitive exams										K3				
	CO4: Solve a question in a fraction of minute using shortcut methods										K3				
CO5: Enhance their problem solving skills and logical Skills										K4					
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1		2		3	2					3		3	3	2	3
CO 2	3	3		2	2					3		3	3	2	2
CO 3	3	3		3	2					3		3	2	3	3
CO 4	3	3		2	3					2		2	3	3	3
CO 5		2		2	2					2		2	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignments / Seminar/Quiz															
3. End-Semester Examination															
Indirect															
1. Course -end survey															
Content of the syllabus															

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Unit-I	VERBAL ABILITY	Periods	4
Verbal Analogy, Sentence completion, Gen-Z lexis STATEMENT ANALYSIS: Statements and Conclusions, Statements and Assumptions, Statements and Agreements, Cause and effect, Making Judgements.			
Unit-II	PROFIT AND LOSS	Periods	8
PROBLEMS ON PROFIT AND LOSS PERCENTAGE: Profit Percentage, Cost Price and Selling Price are equal, Cost Price and Selling Price are different, Selling Price alone, Selling Price same for two objects, Selling Price and Cost Price are compared, Mixture, Profit Percentage and Loss Percentage are equal, False rate, Problems on Cost Price, Selling Price, Profit, Discount, Successive Discount and Discount Percentage. SIMPLE AND COMPOUND INTEREST: Simple Interest: Find Principal, Amount, Rate of Interest, Number of Years, Simple Interest based on lend into two parts, in case of instalments. Compound Interest: Find Principal, Amount, Rate of Interest, Number of Years, Compound Interest, Simple Interest in co-relation with Compound Interest, Instalments, Population, Present Worth.			
Unit - III	TIME AND WORK	Periods	6
Chain Rule, Combination of people working together, Individuals working together, Joining and Relieving, Efficiency Ratio Model, Works and Wages, Pipes open together: Doubling, Efficiency Ratio Model, Pipes opening and Closing, Capacity based model.			
Unit- IV	TIME, SPEED AND DISTANCE	Periods	6
Basic models, Ratio based model, Average speed based model, Relative speed based model, Algebra based model, Problems on Trains, Boats and Streams, Race and Games. Circular Track, Game based model.			
Unit-V	LOGICAL REASONING	Periods	6
DIRECTION SENSE: Direct yourself, based on Angle, Directional reference point, correct map based on wrong map, Direction in Clocks, Shadowing. SEATING ARRANGEMENT: Linear Seating Arrangement, Single row Uni-Directional and Bi-Directional, Dual row, Triple row, Square, Rectangular and Triangular Arrangement, Seating Arrangement in photograph, Circular Arrangement, Inside and Outside (Linear and Circular), Concentric Arrangement.			
Total Periods			30
Text books			
1.	Rajeev Varma, "Fast Track Objective Arithmetics", Arihant Publications, 2024		
2.	R.S. Aggarwal, "Modern Approach to Logical Reasoning", S Chand Publishing, 2022		
3.	SP Bakshi, "Objective General English", Arihant Publications, 2024		
References			
1.	R.S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand Publishing, 2013		
2.	Dinesh Khattar, "The Pearson guide to Quantitative Aptitude for Competitive Examinations", 3 rd edition, 2016		
3.	Arun Sharma, "How to Prepare for Logical reasoning for CAT", McGraw Hill Education, 2014		
4.	Jaikishan and Premkishan, "How to Crack Test of Reasoning", Arihant Publications, 2016		
5.	R.S. Agarwal, "A modern Approach to verbal and non-verbal reasoning", S Chand Publishing, 2018		
E-Resources			
1.	Aptitude: https://www.indiabix.com		
2.	Reasoning: https://placement.freshersworld.com		
3.	Verbal: https://testbook.com		

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ADDITIONAL LANGUAGE COURSES

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Programme	B.Tech	Programme Code	105	Regulation	2023			
Department	Biotechnology		Semester		IV			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U23ADL01	French	2	0	0	1	100	-	100
Content of the syllabus								
Unit –I					Periods	6		
<p>ENGLISH :Introduction about the language and the country, Alphabets and accents,Important phrases in french, pronunciation rules,Days,Months,Numbers 1- 50.</p> <p>FRANÇAIS : Introduction sur le pays France et langue français, L'alphabet et accents,les phrases en français,règles pour prononciation,Les jours, Les mois et les nombres 1-50.</p>								
Unit –II					Periods	6		
<p>ENGLISH : How are you? what is your name? What is it? Who is he? To be, To have – Verb.Pronoun, Family, School, Adjectives,Nationality, Yes/No type Answering, Negative, professions</p> <p>FRANÇAIS : Comment vas tu?, Comment t'appelles? Qu'est – ce-que c'est?Quiestce? Le verbe – être, avoir,pronoun et conjugation , La famille, L'ecole, Adjectives,Nationalité , oui/Non, Négatif, Question Words et professions.</p>								
Unit –III					Periods	6		
<p>ENGLISH :Verbs—Er , IR ,RE and pronominal verbs and conjugation. Preposition, Types of articles, Demonstrative and possessive adjectives Sentence formation.</p> <p>FRANÇAIS :Verbs de er, ir , re et pronomialverbes , conjugation , prepositions et articlesDémonstratif et possessifadjectifs.</p>								
Unit –IV					Periods	6		
<p>ENGLISH :Introduce the personne , Express the interest, speak about the family and small topics.Verbs - to go, to come, to do, can , want. Vocabulary.</p> <p>FRANÇAIS :Décrire les personnes,Exprimer les goûts, et parler de la famille et petitstires.Verbes – allervenir, faire pouvoir, vouloirvocablaire.</p>								
Unit –V					Periods	6		
<p>ENGLISH :Encouraging students to speak , write and listen the language.</p> <p>FRANÇAIS :Encourage les étudiants pour parler ,becrire et ecouer la langue.</p>								
					Total Periods	30		
Text Books								
1.	BabushaVerma, DeeptiWalia, “Idésméthod de francai”, Goyal Publishers.							
2.	A.MonnerieBeinvenueEn France. Documentation MarrieFranchoiseBoullet							
3.	G.MaugerCours DE Languet De CivilisationFrancaises							
4.	Annie Heminway, Complete French all in one Premium Second Edition, Tata McGraw Hill Education							
5.	Diamond French-Aprenons Le Francois New Saraswathi House (India)Private Limited							



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 VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	B.Tech	Programme Code	105	Regulation	2023			
Department	Biotechnology		Semester		IV			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U23ADL02	German	2	0	0	1	100	-	100
Content of the syllabus								
Unit –I						Periods	6	
English: Intro of German and Germany, Letters- German Alphabets and Other letters, Pronunciation- Vowel, Consonants; Greetings, Courtesy, The days of the week, The months of the year. German: Einführung in Deutsch, Deutschland - Das Alphabet, Der Umlaut, Aussprache, Vokale, Konsonanten, Die Begrüßungen, WieHeizensie, Die Wochentage, Monate.								
Unit –II						Periods	6	
English: Articles, Nominative Case, Masculine, Feminine, and Neuter; Gender of nouns; Colours, Seasons, Numbers, Cardinal (1-100) & Ordinal (1-20), Types of Verb. German: Artickel, Masculine, Feminine & Neuter, Nomen, Kleuren, Zeiten; Jaherzeiten; Zahlen, Kardinalzahlen (1-100) und Ordnungszahlen (1-20), Zuge in Deutschland, Verbtypen.								
Unit –III						Periods	6	
English: Nationality, Personal pronoun, Auxiliary verb, Professions, Verb (to have), to call oneself, Regular 1st group (er)verbs - speak, live, like, watch, etc., German: Nationalität, Personal pronomen, Hilfsverben, Sein, Beruf, Haben, Heißen, Reguläreverben, sprechen, wohnen, lieben, schauen.								
Unit –IV						Periods	6	
English: Irregular Verbs, Model Auxiliary verbs, Negation, Ask Questions, Prepositions, Conjunctions, Time units, Form of registration. German: Unregelmäßigeverben, Modalehilfsverben, Negationen, Fragewörter, die präposition, Verbindungen, Zeiteinheiten, Anmeldeformular.								
Unit –V						Periods	6	
English: Pronoun, Personnel, Possessive, Indefinite – Reflexive – Relative- Adjective- Adverb- Le verbprefix – Word order- Dialogues in German – Tourist attractions in German German: Das Pronomen - Das Adjektiv- Das Adverb- Die Verb-Präfixe- Die Wortreihenfolge–Dialoge In Deutscher Sprache - Touristenattraktionen								
						Total Periods	30	
Text Books / Manuals								
1.	Grasp the Basics of Deutsch im schnellgang by Edward Swick							
2.	Netzwerk Deutsch als Fremdsprache A1.1 Kursbuch							
3.	Netzwerk Deutsch als Fremdsprache A1.1 Arbeitsbuch							
4.	Grasp the Basics of Deutsch im schnellgang by Edward Swick							

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 VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	B.Tech.	Programme Code	105	Regulation	2023			
Department	Biotechnology		Semester		IV			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U23ADL03	Japanese	2	0	0	1	100	-	100
Content of the syllabus								
Unit –I					Periods	6		
Introduction to Hiragana and Katakana: Chart 1, Chart 2, Chart 3, Annexures 1 and 2 and basic Japanese rules along with similar sounded vocabularies for each chart.								
Unit –II					Periods	6		
Introduction to Nouns, various particles and usages: Forming simple sentences, asking questions, positioning differentiation and owning fundamentals – new particles and usages.								
Unit –III					Periods	6		
Introduction of Verbs, time and place markers: Usage of action words in sentences and framing them – place and time markers usages – giving and receiving – omission of certain particles in a sentence.								
Unit –IV					Periods	6		
Introduction of Adjectives, Adverbs and usages: Describing nouns and verbs and framing them to relate day to day conversations- positive and negative ending of the same – introduction of the likes and dislikes expressions								
Unit –V					Periods	6		
Introduction to Counters and Kanji: How to use numbers-How to use quantifiers-Present form of adjectives and Nouns-Other necessary particles-How to use numbers and quantifiers – 55 kanji characters								
					Total Periods	30		
Text Books / Manuals								
1.	Takuji Kobayashi “MINNA NO NIHONGO –Japanese for Everyone”, 2 nd Edition GOYAL Publishers & distributors Pvt.Ltd, New Delhi, 2017.							
2.	“SPEED MASTER N5”							
3.	MINNA NO NIHONGO 1-1 Translation & Grammatical notes in English elementary							
4.	SHIN NIHONGO NO KISO 1 (Grammatical Notes in English)							

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SEMESTER V

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	V										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT514	ENZYME ENGINEERING	3	0	0	3	40	60	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To study about the nomenclature and classifications of enzymes. To understand the various kinetics of enzymes. To understand the method of enzyme inhibition and role of inhibitors. To understand different purification techniques involved in enzyme production. To analyze the role and applications of different enzymes in various industries. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Understand the classification of enzymes and its mechanism of action							K2							
	CO2: Identify the Kinetics of Enzyme and Substrate							K2							
	CO3: Apply the mechanism of inhibition of enzyme using different inhibitors							K3							
	CO4: Infer knowledge on isolation and purification of various enzymes and development of enzymatic assays.							K4							
CO5: Analyze the role of different enzymes at industrial level.							K4								
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	2	2	3						2	3	3	3
CO 2	2	3	1	2	2	1						3	3	2	2
CO 3	3	3	3	3	1	3	2					2	3	2	2
CO 4	2	2	2	2	3	3	2	2				2	3	3	2
CO 5	3	2	2	3	3	2	2	2				2	3	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
2. Course - end survey															
Content of the syllabus															


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Unit – I	INTRODUCTION TO ENZYMES	Periods	9
Nomenclature and classification of enzymes, Enzyme units - Katal, IU, Principles of catalysis - collision theory, transition state theory, Mechanism and Specificity of Enzyme Action, Active site - Determination of active site amino acids - chemical probe, affinity label, Nature and function of enzyme. Coenzyme / Cofactor			
Unit – II	KINETICS OF ENZYME ACTION	Periods	9
Kinetics of single substrate reactions; Michaelis Menten equation, Importance of V_{max} , K_m and turnover number; Lineweaver - Burk plot, Eadie - Hofstee plot, Hanes - Woolf plot, Kinetics of multi substrate enzyme catalysed reactions - Ping-pong bi-bi, random order and compulsory order mechanism, Kinetics of Allosteric enzymes, MWC model, Hill equation coefficient.			
Unit – III	ENZYME INHIBITION	Periods	9
Enzyme Inhibition - Types of Inhibition- Reversible inhibition - competitive, uncompetitive, noncompetitive - allosteric inhibition. Irreversible inhibition – Suicide Inhibition. Feedback inhibition and Product Inhibition, Allosteric regulation of enzymes; Deactivation kinetics, Mechanism of Inhibitors like Iodoacetamide and DIPF.			
Unit – IV	PURIFICATION, CHARACTERIZATION AND IMMOBILIZATION OF ENZYMES	Periods	9
Isolation of Enzymes: Extraction and Purification of Crude Enzyme extracts from plant (Pectinase, Invertase), animal (Trypsin) and microbial sources (Protease, Lipase), Methods of characterization of enzymes, Development of enzymatic assays for Pectinase and Trypsin., Physical and chemical techniques for enzyme immobilization – Advantages and Disadvantages			
Unit – V	APPLICATIONS OF ENZYMES IN VARIOUS INDUSTRY	Periods	9
Lactase in Dairy industry, enzymes for production of glucose fructose syrup in fruit juice industry, Proteolytic enzymes in leather and detergent industry, Cellulase in Paper Production, Diagnostic and therapeutic enzymes - Streptokinase as thrombolytic agents, Collagenase in Skin aging process, Protease in Brewing Process,			
Total Periods			45
Text Books			
1.	Malcolm Dixon, Edwin C. Webb, "Enzymes ", Elsevier, 3 rd edition ebook , 2014.		
2.	Klaus Buchholz, Volker Kasche, Uwe Theo Bornscheuer, "Biocatalysts and enzyme technology", John Wiley & Sons, 2 nd edition, 2012.		
References			
1.	Nicholas C. Price and Lewis Stevens, "Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins", Oxford University Press, 2009.		
2.	Trevor Palmer and Philip Bonner, "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry " II edition Horwood Publishing Ltd, 2007.		
3.	Alan Wiseman, "Handbook of Enzyme Biotechnology", 3 rd Edition, Ellis Horwood Publication, 1995.		
Resources			
1.	https://nptel.ac.in/courses/102/102/102102033/		
2.	http://www.nptelvideos.in/2012/11/enzyme-science-and-engineering.html		
3.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview		


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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT515	GENETIC ENGINEERING	3	0	0	3	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Familiarize students with the cloning vector system and its types. Recall basics of recombinant molecules. Acquire basic fundamental knowledge on genetic engineering . Analyze the molecular techniques protocol of DNA. Understanding the application of GMO in genetic engineering.														
	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Describe the basics of genetic engineering.							K1							
	CO2: Discuss clearly about the mechanisms and control of recombinant molecules.							K2							
	CO3: Describe the gene cloning and expression.							K3							
CO4: Understands the regulation of molecular techniques at various levels.							K4								
CO5: Articulate applications of genetic engineering cell techniques in Biotechnology.							K4								
Pre-requisites															
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
Programme Outcomes (POs)													PSOs		
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	2	1	2	1	-	-	-	1	2	1	2	3	2	1
CO2	3	3	2	2	2	-	-	-	1	2	2	3	3	3	2
CO3	3	3	3	3	2	-	1	-	1	2	2	3	3	3	3
CO4	3	3	3	3	3	-	1	-	1	3	3	3	3	3	3
CO5	3	3	3	3	3	-	1	-	1	3	3	3	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II&III															
2. Assignment															
3. End-Semester examinations															


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Indirect			
1. Course -end survey			
Content of the syllabus			
Unit –I	BASICS OF GENETIC ENGINEERING	Periods	9
Cloning vector; properties of a cloning vector, Plasmid Vectors; Lambda phage vectors, phagemid, cosmid, shuttle vector, expression vectors; yeast vectors ,Baculoviral based insect vector- mammalian expression vectors, plant transformation vector; binary vector (Ti plasmid based), high capacity vectors, YAC.			
Unit-II	RECOMBINANT MOLECULES	Periods	9
Construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms; Calcium chloride mediated- electroporation- micro injection, gene gun, selection methods for recombinants; antibiotic resistance - blue & white selection, GFP and Luciferase based selection.			
Unit –III	GENE CLONING AND EXPRESSION METHODS	Periods	9
DNA Replication in prokaryote and eukaryotes, Construction of genomic and cDNA libraries, synthesis and labeling of DNA and RNA probes, Screening of cDNA and Genomic libraries, hybridization probe method, cloning and its types, over-expression and purification of recombinant His tag fusion proteins using Ni ⁺ column.			
Unit –IV	MOLECULAR TECHNIQUES	Periods	9
Blotting techniques; Southern-northern-western blotting, Polymerase Chain Reaction (PCR); principle types- applications of PCR; RT-PCR, RAPD-RFLP-applicaion, DNA fingerprinting using molecular markers, DNA sequencing-Maxmum-Gilbert, Sanger's, Automated DNA sequencing, next generation DNA sequencing, RNAi and gene knock-out techniques, gene modification using site directed mutagenesis.			
Unit –V	APPLICATION OF GENETIC ENGINEERING	Periods	9
Application of genetically modified organisms; medicine-recombinant therapeutic proteins-recombinant vaccines- Molecular Diagnosis of human genetic diseases, pathogenic virus and bacteria, agriculture – Transgenic Bt cotton- round-up ready soybean transgenic crops, Biosafety levels.			
Total Periods			45
TextBooks			
1.	Old, R. W. and Primrose, S. B., “Principles Of Gene Manipulation: An introduction To Genetic Engineering”, Blackwell Science. 7 th edition,2006		
2.	Clark DP and Pasternick NJ, Biotechnology: Aademic Cell Updates, Academic Press, Elsevier, 2012.		
References			
1.	Gupta, P.K., “Biotechnology and Genomics”, Rastogi Publications,1 st Ed, 2014		
2.	Brown, T.A., “Gene Cloning and DNA Analysis”, Blackwell Science Ltd,2006		
3.	Seidman and Moore, Basic laboratory methods for biotechnology,Longman,2 nd Edition,2009		
E-Resources			
1.	https://di.uq.edu.au/community-and-alumni/sparq-ed/cell-and-molecular-biology/experiences/introduction-cell-biology		




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2.	https://www.nature.com/scitable/topic/cell-cycle-and-cell-division-14122649/
3.	https://www.microscopemaster.com/cell-culture.html



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Programme	B.Tech	Programme Code		105	Regulation	2023									
Department	BIOTECHNOLOGY			Semester		V									
Course Code	Course name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT516	Heat and Mass Transfer Operations	3	0	0	3	40	60	100							
Course Objective	This course equips biotechnology students with the tools to optimize thermal and mass transport processes critical for innovation and efficiency in biotechnological production and research.														
Course Outcome	By the end of this course, students will be able to:							Knowledge Level							
	CO1: Understand the fundamental principles of conduction, convection and radiation heat transfer.							K2							
	CO2: apply the knowledge of heat transfer in the design of evaporators and analyse the performance of heat exchangers.							K3							
	CO3: Understand diffusional operations and theories of mass transfer							K2							
	CO4 : acquire knowledge in vapor-liquid operations and its application in bioprocess industries							K3							
CO5: apply the concept of absorption and extraction in bioprocess industries							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	P O 10	P O 11	PO 12	PS O1	PS O 2	PSO 3
CO 1	3	2	3	2	2	2	2	2		2		2	2	2	3
CO 2	3	2	3	2	3		2	3	2	2	3	2	3	3	2
CO 3	3	2	2	2	2	2	3	2		3		3	3	2	3
CO 4	3	2	2	3	2		3	2	2	2	3		2	2	2
CO 5	3		3	3	2		2	3	3		2	2	2	2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Modes of Heat Transfer	Periods	9
Nature and Modes of heat transfer. Concept of heat conduction - Fourier's law, thermal conductivity of biological materials. one dimensional steady state heat conduction equation for flat plate and hollow cylinder. Relationship between Individual and overall heat transfer coefficients. Natural and forced convection- definition and types only. Concept and nature of thermal radiations, Black and grey bodies, Stefan Boltzmann and Kirchhoff's law. Combined Conduction, convection and radiation in bioprocess industries.			
Unit – II	Heat Transfer with Phase Change and Heat Exchangers	Periods	9
Introduction to boiling and condensation (principles only). Evaporator- Principle, steam capacity and economy. Types of evaporators- Standard tube, long vertical tube, Forced circulation evaporator. Methods of feeding multiple effect evaporator. Heat Exchangers-Flow arrangements, LMTD, Fouling factors. Heat Exchange Equipment's- 1-1 shell and tube heat exchangers, Plate type heat exchangers.			
Unit – III	Diffusion	Periods	9
Molecular and eddy diffusion in gases and liquids-steady state diffusion under stagnant and laminar flow conditions-Diffusivity measurement and prediction-multi component diffusion, diffusion in solids and its applications. Theories of mass transfer-mass transfer in laminar and turbulent flow.			
Unit – IV	Distillation	Periods	9
Distillation-Vapour-Liquid Equilibrium, Boiling point diagram, Dalton's law, Raoult's law, Relative Volatility. Analysis of fractionating column- McCabe-Thiele method, determination of theoretical plate's procedure and limitations (principles only). Minimum and Optimum reflux ration (concept only). Various plates used for phase contacting- Bubble cap, Sieve plate and Valve plate. Simple distillation, Flash and Fractional distillation, Batch distillation and packed column distillation (working principles only).			
Unit – V	Gas Absorption and Liquid-Liquid Extraction	Periods	9
Gas absorption-Types and principle, solvent selection, Material balance for Absorption tower (one component). Tower Packings and types. Gas Absorption Equipment's-Mechanically agitated vessels, Packed Columns/towers (construction and working only). Extraction-Application, solvent selection, Steps and terminology in Liquid Extraction. Extraction equipment's- Mixer settlers, Plate tower, Spray tower, Packed tower and Rotating Disc Contractor.			
Total Periods			45
Text Books			
1.	McCabe W.L., Smith J.C. and Harriot P., —Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill International Edition, New York, 2006.		
2.	Treybal, Robert Ewald, and E. Treybal Robert. Mass-transfer operations. Vol. 3. New York: McGraw-Hill, 1968.		



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References	
1.	Dutta Binay K., "Heat Transfer Principles and Applications", Prentice Hall of India, New Delhi, 2001.
2.	Coulson J.M. and Richardson J.F., —Chemical Engineeringl, Volume I, 4 th Edition, Asian Books Pvt. Ltd., 1998.
E-Resources	
1.	https://nptel.ac.in/courses/103103032/
2.	https://nptel.ac.in/courses/103101137/
3.	https://nptel.ac.in/courses/103103035/


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Programme	B.Tech.	Programme Code					105	Regulation		2019					
Department	BIOTECHNOLOGY					Semester			V						
Course Code	Course Name		Periods Per Week			Credit	Maximum Marks								
			L	T	P		C	CA	ESE	Total					
U23BT517	COMPUTATIONAL BIOLOGY		3	0	2	4	50	50	100						
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Understand scope of Bioinformatics • Understanding of popular bioinformatics database • Learn Fundamentals of Databases and Sequence alignment • Acquire knowledge on different bioinformatics tools • Gain knowledge of fundamentals of phylogenetics 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Understand the basics of sequence data and annotation of the same										K1				
	CO2: Know the importance of machine learning in analysis of biological data										K2				
	CO3: Interpret phylogenetic relationships among different species										K4				
	CO4: Understand different approaches in protein structure prediction and evaluation										K3				
CO5: Identify various applications of bioinformatics techniques in biological science										K4					
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2	1	1	2	3	3						1	3	2	3
CO 2	2	2	2	2	3	3						2	2	3	2
CO 3	2	3	3	2	2	3						1	2	3	3
CO 4	2	2	2	3	3	3							2	3	3
CO 5	2	2	2	2	3	2							3	3	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	Basics of Bioinformatics	Periods	12
Basic terms and nomenclature in bioinformatics, Molecular sequences, Biological databases: Protein and Nucleotide databases, Sequence Alignment- Local and Global Alignment, BLAST, FASTA algorithm, Functional Annotation, Multiple sequence alignment, Applications. Practical: Biological Databases and resources- Genbank., PDB, Uniprot. Sequence Analysis Tools- BLAST and FASTA, CLUSTAL W			
Unit - II	Machine Learning	Periods	12
Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Artificial Neural Networks, clustering and prediction. Introduction to system biology, DNA computing. Applications of machine learning in bioinformatics. Practical: Basics commands in windows, Hidden Markov Model (HMM)			
Unit – III	Phylogeny	Periods	12
Introduction to Phylogenetics, Ultrameric trees, Properties of trees, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Parsimonious trees, Bootstrapping. Molecular theory in phylogenetics. Practical: Phylogenetic Analysis using PHYLIP – Rooted and Unrooted trees			
Unit - IV	Protein structure and analysis	Periods	12
Classification of Protein Structure, Visualization, Prediction methods of Secondary Structure and Tertiary Structure of novel proteins, Homology Modeling, Threading, Ramachandran Plot –critical assessment and validation of protein model structure. Structure visualization tools available – PyMol, Rasmol, etc., Practical: Homology Modeling – Swiss modeler and Open Source Software - Modeller			
Unit – V	Tools for Analysis in Bioinformatics	Periods	12
Molecular Docking basics and applications, Molecular dynamics simulations, Microarrays and Clustering techniques for microarray data analysis, sequencing, assembly of genome, next generation sequencing techniques. Practical: Molecular docking and Molecular Dynamics Simulation			
Total Periods			60
Text Books			
1.	David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.		
2.	Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.		
References			
1.	Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.		
2.	Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003.		
3.	Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002.		
4.	Tisdall, James, Beginning PERL for Bioinformatics, O'Reilly Publications, 2001.		
5.	Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall, 2001.		
E-Resources			
1.	https://nptel.ac.in/courses/102/106/102106065/		
2.	https://openlab.citytech.cuny.edu/biology/bioinformatics-online-resources/		
3.	https://guides.lib.berkeley.edu/bioinformatics		


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Coursecode	Course name	Periods / week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT518	MOLECULAR BIOLOGY & GENETIC ENGINEERING LABORATORY	0	0	2	1	60	40	100							
Objective	The main objective of this course is 1. To provide hands on practical training in the isolation of genomic DNA from different sources. 2. To explain the concept of transformation. 3. To develop the skills of the students by providing hands on practical training in Molecular biology														
CO/PO Mapping (3/2/1 indicates strength of correlation)3-Strong,2-Medium,1-Weak													CO/PSO Mapping		
Programme Outcomes(POs)													PSOs		
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PS O3
CO1	2			2	2				2		2	2	3	2	3
CO2	2	2	2	2	2	2	2		2		2	1	3	3	2
CO3	2	2	2	2	2			1	2		1	1	2	3	2
CO4	2	3	2	3	3				3	1	2	2	3	2	2
CO5	3	2	3	3				1	1		1	1	2	2	2
LIST OF EXPERIMENTS													Course Outcomes		
1. Agarose gel electrophoresis													CO1		
2. Isolation of bacteria, plant and animal DNA.													CO1		
3. Isolation of RNA													CO2		
4. Elution of DNA from agarose gel using silica column.													CO2		
5. PCR amplification of DNA fragment													CO3		
6. Restriction enzyme digestion													CO4		
7. Ligation of digested DNA													CO4		
8. Competent cells preparation													CO4		
9. Transformation and screening for recombinants													CO5		
10. SDS PAGE gel electrophoresis													CO5		
Total periods : 60															


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Outcomes:


Students who complete this course successfully are expected to

1. Demonstrate basic techniques of DNA isolation and manipulation.
2. Illustrate the principle behind each techniques and applications of each methodology in applied biological research.
3. Acquire ability to use PCR techniques.
4. Apply genetic and biotechnological techniques to manipulate genetic materials and their application.


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	V										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT519	MINI PROJECT-I	0	0	2	1	100	-	100							
Course Objective	The student should be made														
	<ul style="list-style-type: none"> To understand the process of identifying a relevant research area in biotechnology. To interpret and summarise scientific literature related to the chosen project topic. To develop an appropriate experimental design or prototype based on the identified problem. To analyse experimental results or design data and derive meaningful conclusions. To evaluate the outcomes of the project and document findings with future research scope. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Demonstrate a clear understanding of the selected project problem by explaining its significance, scope, and relevance to the chosen domain.						K2								
	CO2: Conduct a comprehensive literature review to justify the project rationale and formulate specific, measurable research objectives.						K3								
	CO3: Critically analyze the problem and develop an appropriate methodology or design strategy to address it.						K4								
	CO4: Implement the proposed methodology through experiments, modeling, or simulations, and analyze the results using suitable tools and techniques.						K5								
	CO4: Evaluate the overall outcomes of the project, compile a comprehensive technical report, and propose future scope or applications.						K6								
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3					2						3	2	-
CO 2		3		3								2	2	3	-
CO 3			3		2						2		-	2	3
CO 4				3	3				2				-	2	3
CO 5										3	2	2	2	-	3
Course Assessment Methods															
Direct															
1. Project Reviews															
2. End Semester Examinations(Viva Voce)															
Indirect															
2. Course - End survey															


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SEMESTER VI

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


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Programme	B.Tech	Programme Code	105	Regulation	2023			
Department	BIOTECHNOLOGY			Semester	VI			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P		C	CA	ESE
U23BT620	BIOPHARMACEUTICAL TECHNOLOGY	3	0	0	3	40	60	100
Course Objective	The student should be made							
	<ul style="list-style-type: none"> To develop foundational knowledge of biopharmaceuticals, drug targets, and various routes of drug administration. To understand the processes involved in drug discovery, development, and regulatory practices. To distinguish between pharmacokinetics and pharmacodynamics and their roles in drug action. To explore various drug dosage forms and their corresponding delivery methods. To analyze the therapeutic roles of bioactive compounds in the treatment of different diseases. 							
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level	
	CO1: Explain the basic terminologies of pharmaceuticals, drug targets, and various routes of drug administration.						K2	
	CO2: Interpret the processes involved in drug development, regulatory practices, and animal ethics.						K2	
	CO3: Illustrate the various mechanisms of drug action.						K2	
	CO4: Apply the principles for designing drug dosages and selecting appropriate delivery methods.						K3	
CO5: Analyze the therapeutic applications of bioactive substances in disease treatment.						K4		
Pre-requisites	Cell biology, Biochemistry, Microbiology, Molecular Biology, Bioprocess Engineering & Technology, Immunology.							

COs	CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2			2		1		1		1	3	2	2
CO2	2	3	2		3	3		3		1	2	2	2	2	3
CO3	3	3	2		2							2	3	3	2
CO4	3	3	3	2	2				1	2	2	2	2	3	3
CO5	3	3	2	2	3	2		1	2	2	2	3	3	3	3

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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO BIOPHARMACEUTICALS	Periods	9
Drug – Definition , Classification , Physiochemical properties , Basic Terminologies in Drug – Agonist, Antagonist, Biopharmaceuticals , Biosimilars, Biogenerics, Drug Target : Lipids, Proteins, Nucleic acids and Carbohydrates , Routes of drug administration.			
Unit – II	DRUG DEVELOPMENT PROCESS	Periods	9
Drug Discovery - Drug development stages, History of clinical trial, Clinical Trial Phases, CDSCO, ICH, EMA, & USFDA guidelines and approvals, Patenting, Drug and Cosmetics Act-Introduction to animal ethics-Toxicity Studies, Post Marketing Surveillance, Pharmacovigilance An Overview.			
Unit – III	MECHANISM AND PRINCIPLES OF DRUG ACTION	Periods	9
Pharmacokinetics: Drug Absorption, Distribution, Metabolism and Elimination (ADME), Factors influencing ADME process, Pharmacodynamics: Basic principles, Biotransformation, Bioavailability & Bioequivalence			
Unit – IV	DRUG DOSAGE AND DELIVERY	Periods	9
Definition of Dosage forms - Classification of dosage forms - Solid Dosage - Tablets Production, Capsules Preparation, Semisolid Dosage - Ointments – Cream – Paste – Gels, Liquid Dosage – Solutions – Injection – Lotions - Suspensions, Drug Delivery – Delivery system of proteins, Nucleic acids, Transdermal Drug Delivery.			
Unit – V	BIOPHARMACEUTICALS AND IT'S THERAPEUTIC APPLICATIONS	Periods	9
Pharmaceuticals derived from microbes, Recombinant Insulin, Role of pharmaceuticals in Gene therapy, Nutraceuticals for Cancer, Vaccine – Definition & Its Types, Vaccines for COVID-19 - COVAXIN, Pfizer-BioNTech and Moderna Vaccine, Mode of action of Laxatives, Analgesics, Contraceptives, Penicillin as Antibiotics, Analytical Methods in Drug production, Packing and Preservation.			
Total Periods			45
Text Books			
1.	Harvey, R.A., Clark, M.A., Finkle, R., “Pharmacology”, Lippincott Illustrated Reviews Series, LWW Publishers, 5 th Edition, 2011.		
2.	Gary Walsh, “Biopharmaceuticals; Biochemistry and Biotechnology”, John Wiley & Sons, Inc., 2 nd Edition, 2003.		
References			
1.	Katzung, B., Masters, S., Trevor, A., “Basic and Clinical Pharmacology (LANGE Basic Science)”, McGraw-Hill Medical, 11 th edition, 2009.		
2.	Manohar A. Potdar and Ramkumar Dubey, “cGMP Current Good Manufacturing Practices for Pharmaceuticals”, Pharmamed Press / Bsp Books, Second Edition, 2018.		
3.	Lee, Chi-Jen et. al, “Clinical Trials of Drugs and Biopharmaceuticals.” CRC/Taylor & Francis, 2011.		


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4.	Ansel, H.C. "Pharmaceutical Dosage Forms and Drug Delivery Systems", 11 th Edition, Lippincott Williams & Wilkins, 2018.
5.	Misra, Ambikanandan, Shahiwala, Aliasgar "Novel Drug Delivery Technologies", 1 st Edition, Springer, 2019.
6.	Surendra Nimesh, Ramesh Chandra, Nidhi Gupta."Nanotechnology for the Delivery of Therapeutic Nucleic Acids". 1 st Edition, Woodhead Publishing, 2017.
E-Resources	
1.	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of-pharmacology-spring-2005/lecture-notes/
2.	https://onlinelibrary.wiley.com/doi/book/10.1002/9780470259818
3.	https://www.bharatbiotech.com/covaxin.html




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Programme	B.Tech	Programme Code	105	Regulation	2023																																																																																																																						
Department	BIOTECHNOLOGY			Semester	VI																																																																																																																						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks																																																																																																																					
		L	T	P	C	CA	ESE	Total																																																																																																																			
U23BT621	Bioprocess Engineering and Technology	3	0	0	3	40	60	100																																																																																																																			
Course Objective	<p>The student should be made to,</p> <ul style="list-style-type: none"> Infer knowledge on different types of bioreactors, stoichiometry and media optimization. Apply the concept of sterilization to prevent contamination in media. Outline the importance of mass transfer methods and scale-up in bioprocess. Compare the different modes of bioreactor and analyze the difference between various models in bioprocess. Analyze the role of mixed cultures in industries and various immobilization methods. 																																																																																																																										
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level																																																																																																																			
	CO1: Understand the different types of bioreactors, medium requirements and optimization methods.							K2																																																																																																																			
	CO2: Choose the sterilization kinetics of the medium and equipment.							K3																																																																																																																			
	CO3: Implement the mass transfer criteria and scale-up criteria in the design of bioreactors.							K4																																																																																																																			
	CO4: Compare batch, fed-batch and continuous cultivation and different models.							K4																																																																																																																			
	CO 5: Link the importance of mixed culture for various industrial products and correlate the different immobilization methods.							K4																																																																																																																			
Pre-requisites	-																																																																																																																										
<p align="center">CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak</p> <table border="1"> <thead> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="3">CO/PSO Mapping</th> </tr> <tr> <th>PO 1</th><th>PO 2</th><th>PO 3</th><th>PO 4</th><th>PO 5</th><th>PO 6</th><th>PO 7</th><th>PO 8</th><th>PO 9</th><th>PO 10</th><th>PO 11</th><th>PO 12</th> <th>PSO 1</th><th>PSO 2</th><th>PSO 3</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td></td><td></td><td>2</td><td>2</td> <td>3</td><td>3</td><td>3</td> </tr> <tr> <td>CO 2</td> <td>3</td><td>3</td><td></td><td>2</td><td>3</td><td>2</td><td>2</td><td>2</td><td></td><td></td><td>2</td><td>2</td> <td>2</td><td>1</td><td>2</td> </tr> <tr> <td>CO 3</td> <td>3</td><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td></td><td></td><td>2</td><td>2</td> <td>2</td><td>2</td><td>1</td> </tr> <tr> <td>CO 4</td> <td>3</td><td>2</td><td></td><td>3</td><td>3</td><td>2</td><td></td><td>1</td><td></td><td></td><td>2</td><td>2</td> <td>3</td><td>3</td><td>2</td> </tr> <tr> <td>CO 5</td> <td>3</td><td>2</td><td></td><td>2</td><td></td><td>2</td><td>2</td><td>2</td><td></td><td></td><td>2</td><td></td> <td>3</td><td>1</td><td>1</td> </tr> </tbody> </table>													COs	Programme Outcomes (POs)												CO/PSO Mapping			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	CO 1	2	2	2	2	2	2	2	2			2	2	3	3	3	CO 2	3	3		2	3	2	2	2			2	2	2	1	2	CO 3	3	3	3	2	2	2	2	2			2	2	2	2	1	CO 4	3	2		3	3	2		1			2	2	3	3	2	CO 5	3	2		2		2	2	2			2		3	1	1
COs	Programme Outcomes (POs)													CO/PSO Mapping																																																																																																													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3																																																																																																												
CO 1	2	2	2	2	2	2	2	2			2	2	3	3	3																																																																																																												
CO 2	3	3		2	3	2	2	2			2	2	2	1	2																																																																																																												
CO 3	3	3	3	2	2	2	2	2			2	2	2	2	1																																																																																																												
CO 4	3	2		3	3	2		1			2	2	3	3	2																																																																																																												
CO 5	3	2		2		2	2	2			2		3	1	1																																																																																																												

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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	TYPES OF BIOREACTOR AND MEDIA OPTIMIZATION	Periods	9
General requirements, basic design, and construction of fermenters and ancillaries. Types of bioreactors; batch, Fed batch, PFR, CSTR, bubble-column reactor; packed & fluidized bed reactor; air-lift reactor; Types of Media – Simple, Complex, Media Formulation; medium optimization methods: Plackett-Burman design, and response-surface methodology.			
Unit – II	STERILIZATION KINETICS	Periods	9
Thermal death kinetics of microorganisms; batch and continuous heat sterilization of liquid media; filter sterilization of liquid media; sterilization of air; design of sterilization equipment for batch and continuous Process.			
Unit – III	MASS TRANSFER OPERATIONS AND BIOREACTOR SCALE – UP	Periods	9
Rheology of fermentation fluids; Oxygen mass transfer in bioreactors; Methods for the determination of mass transfer coefficients; Factors affecting K_La , Scale-up criteria for bioreactors; Constant Mass Transfer Coefficient; Constant Mixing Quality, Constant Reynold's number, Constant Pressure/Volume			
Unit – IV	MODELLING AND SIMULATION OF BIOPROCESSES	Periods	9
Unstructured kinetic models – Logistic Equation, Monod model; Leudeking-Piret models – Growth Associated kinetics for production of Gluconic acid; Growth of filamentous organisms, Structured model: Compartmental model - Williams model, Ramakrishna model; Age Distribution model for production of antibiotics; single cell models, Simulation of Batch, Fed batch, Continuous			
Unit – V	MIXED CULTURE AND IMMOBILIZATION OF CELLS	Periods	9
Introduction, major classes of interactions in mixed cultures, mixed cultures in nature and industrial utilization of mixed cultures for Solid-state fermentation. Active and Passive Immobilization of cells, Diffusional limitations in Immobilized cells, Bioreactor considerations for Immobilized System.			
Total Periods			45
Text Books			
1.	Shuler M. L, and Kargi F, "Bioprocess Engineering: Basic Concepts", New Delhi, Prentice-Hall of India, 2017.		
2.	Stanbury P. F, Hall S, and Whitaker A, "Principles of Fermentation Technology", 2nd Edition, Butterworth-Heinesmann, 2016.		
References			
1.	Blanch H. W. And Clark D. S, "Biochemical Engineering", CRC Press, London, 2007.		
2.	Pauline M Doran, "Bioprocess Engineering Principles", Academic Press, New York, 2012.		
3.	Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw-Hill, New Delhi, 2010.		



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4.	Lee J. M, "Biochemical engineering", Englewood Cliffs, NJ: Prentice Hall, 2012.
5.	Rajiv Dutta, "Fundamentals of Biochemical Engineering", Ane Books India, New Delhi, 2008
E-Resources	
1.	https://nptel.ac.in/courses/102/106/102106053/
2.	https://onlinecourses.nptel.ac.in/noc22_bt19/preview
3.	http://link.springer.com/book/10.1007%2F978-1-4684-0324-4
4.	https://berkeley-madonna.myshopify.com/







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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	VI										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT622	CHEMICAL REACTION ENGINEERING	3	0	0	3	40	60	100							
Course Objective	The student should be made ,														
	<ul style="list-style-type: none"> To understand the basic concepts of chemical kinetics studies and types of reactions. To learn the mass and energy balance of ideal reactors of batch and continues operations. To gain knowledge over multiple reactors with series/parallel configurations. To understand the types of multiple reactions To gain knowledge of non-isothermal and adiabatic reactor performance. 														
	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Remember the concept of stoichiometric equations, order of reaction and chemical kinetic theories							K1							
	CO2: Understand the performance equations of ideal reactors.							K2							
CO3: Apply knowledge of performance studies to compare reactors of different types in series and parallel.							K3								
CO4: Exhibit the mechanism of multiple reactions involved in PFR and MFR.							K4								
CO5: Analyze the performance of reactors under steady state non-isothermal conditions.							K3								
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2		2							3	3	3	2
CO 2	3	2	2	1									3	3	2
CO 3	3	2	2		3								2	2	2
CO 4	3	1	1		2								2	3	2
CO 5	2	2	3		2								3	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															

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Bos Chairman,


Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	FUNDAMENTAL CONCEPTS AND CHEMICAL KINETICS	Periods	9
Chemical Kinetics, Classification of chemical reactions, Rate, rate equation, rate constant, Order and Molecularity, activation energy, Arrhenius theory, collision theory, transition state theory, Types of deal reactors - Variable volume Batch reactor. Elementary and non-elementary reactions, Zero order reaction. Irreversible unimolecular type first order reactions			
Unit - II	SINGLE IDEAL REACTOR DESIGN	Periods	9
Classification of reactors, Batch reactors performance equation, Advantages and disadvantages of Batch reactors, material and energy balance for an element reactor. Simple calculations, CSTR, performance equation, Conversion yield, Space time and space velocity.			
Unit - III	MULTIPLE REACTORS DESIGN	Periods	9
Steady state Mixed flow reactors performance equation, Plug flow reactor Design equation, Mixed flow reactors in series and parallel connection, Plug flow reactors in series and parallel connection, reactors of different types in series. Membrane reactors and steady reactors - modes and operations.			
Unit - IV	DESIGN FOR MULTIPLE REACTIONS	Periods	9
Series reactions , parallel reactions , series-parallel reactions , qualitative discussion about product distribution in mixed flow reactor and plug flow reactor, quantitative treatment of product distribution in mixed flow reactor and plug flow reactor, overall fractional yield ,instantaneous fractional yield, selectivity.			
Unit – V	CONCEPTS OF NON-IDEAL FLOW	Periods	9
Residence time distribution, RTD Measurement. Characteristics of a tracer, E curve, C curve and F curve, relationship between E curve and F curve. Mean residence time, Non flow process equipments early and late mixing of fuels. The RTD in a plug flow reactor State of aggregation of the flowing stream, problems.			
Total Periods			45
Text Books			
1.	H. Scott Fogler, "Elements of Chemical Reaction Engineering" Prentice Hall India Pvt. Ltd., 3rd Ed, 2013.		
2.	O. Levenspiel, "Chemical Reaction Engineering" Wiley Publications, New York, 3rd Ed., 1999.		
References			
1.	Gilbert F . Froment, Kenneth B Bischoff and Juray D Wilde "Chemical Reactor Analysis and Design" Wiley Publication, New York, 3 rd Edition., 2010		
2.	J.M. Smith, "Chemical Engineering Kinetics" McGraw-Hill Publication, 2nd Ed., 1981.		
3.	P.V. Danckwerts, "Gas-liquid reactions" , Sharma and Doraiswamy Vols. I & II Froment and Bischoff.		
E-Resources			
1.	https://nptel.ac.in/courses/103/106/103106116/ .		
2.	https://nptel.ac.in/courses/103/101/103101141/		
3.	https://nptel.ac.in/courses/103/106/103106117/		


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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT623	IMMUNOLOGY	3	0	3	4	50	50	100							
Course Objective	The student should be made ,														
	<ul style="list-style-type: none"> To understand the concepts of immune system and the structure, functions and properties of different cell types and organs that comprise the immune system To gain knowledge on immunoglobulin – types; MHC and its significance To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases To understand transplantation and autoimmunity To learn immunological techniques and their applications in biotechnical industry. 														
Course Outcome	At the end of the course, the students will be able to										Knowledge Level				
	CO1: Remember the concept of immune system structure and functions										K1				
	CO2: Understand the maturation steps of T and B cells and how they work										K2				
	CO3: Understand how cytotoxic T cells kill and the role of helper T cells										K2				
	CO4: Demonstrate the mechanisms involved in control of immune responses and hypersensitivity reactions										K4				
CO5: Apply various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases										K3					
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3		2		2		2	3	3	2	3	3	2	
CO 2	3	2		1		3		1	1		1	2	3	3	2
CO 3	3	2		2		2		2					2	2	2
CO 4	3	2	3	1		1		2					2	3	2
CO 5	2	2	3	2		1		3	1				3	2	2
Pre-requisites	-														
Course Assessment Methods															


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Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION AND OVERVIEW	Periods	12
History of the immune system, Types of immunity- Innate and acquired, Cells and Organs of the immune system, Antigens and their characteristics, classification of antigen, chemical and molecular nature. Practical: Identification of cells in a Blood smear, Preparation of Antigens, immunization and methods of bleeding , Serum separation and storage.			
Unit – II	HUMORAL IMMUNITY	Periods	12
Development, differentiation and maturation of B cells; Structure and Function of immunoglobulin, Immunoglobulin classes and subclasses, Molecular biology of immunoglobulin synthesis, Complement pathways. Practical: ELISA-Quantification of Immunoglobulins , Immunodiffusion-Single Radial Immunodiffusion ,Double Immunodiffusion			
Unit – III	CELL MEDIATED IMMUNITY	Periods	12
Development, differentiation and maturation of T cells; Antigen presenting Cells (APC); Phagocytosis; Major Histocompatibility complex – MHC Class I and II molecules; Antigen processing and presentation; Cytokines; T cell activation Practical: Separation of mononuclear cells by Ficoll-Hypaque			
Unit – IV	SELF AND NON-SELF IMMUNITY	Periods	12
Hypersensitivity reactions – Type I, II, III and IV; Organ transplantation – Graft rejection, evidence and mechanisms of graft rejection, prevention of graft rejection; Cancer immunotherapeutics; immunosuppressive drugs, HLA and disease; Apoptosis, Autoimmune diseases. Practical: Selection and Handling of animals, Widal Test			
Unit – V	IMMUNOLOGICAL TECHNIQUES	Periods	12
Agglutination and Precipitation reactions, Immunofluorescence, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA.Cell sorting- Immuno flow cytometry, confocal microscopy. Active immunization Vaccines, Vaccines and its Types, passive immunization, Hybridoma technology; application of monoclonal & polyclonal antibodies-mice& rabbit. Practical: Precipitin Test, ABO Blood Grouping, Rocket Immunoelectrophoresis			
Total Periods			60
Text Books			
1.	Ivan M.Roitt, “Essential Immunology” Blackwell Scientific Publications, Oxford, London 4th Edition, 2011.		
2.	Abbas AK, Lichtman AH, & Pillai S., “Basic Immunology – Functions and Disorders of the Immune System”, Fifth Edition, Elsevier, 2016.		
3.	Tizard, R.I., “Immunology: An Introduction”, 4th Edition, Brooks/Cole publishers, 2007.		
References			
1.	Richard A.Goldsby, Thomas J.Kindt, Barsara A.Osborne, Janis Kuby, “Immunology” 5th Edition, Freeman & Company, 2007.		



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2.	Ivan M. Roitt, Jonathan Brostoff and David K. Male Glower "Immunology" Medical Publishers, London, 1st Edition., 2011.
3.	Seemi Farhat Basir., "Text Book of Immunology", First edition, PHI Learning Pvt Ltd, New Delhi, 2008.
4.	Goldsby, R.A., Kindt, T.J., Osborne, B.A. and Kerby J., "Immunology", W.H. Freeman, 2003.
5.	Weir, D.M. and Stewart, J., "Immunology", Churchill, Livingstone, 1997.
E-Resources	
1.	https://nptel.ac.in/courses/102103038/
2.	https://nptel.ac.in/courses/102/105/102105083/
3.	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-and-molecular-immunology-fall-2005/lecture-notes/





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Programme	B.Tech		Programme Code	105	Regulation	2023									
Department	Biotechnology				Semester	VI									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT624	Bioprocess Laboratory	0	0	2	1	60	40	100							
Course Objective	The students should be able														
	1. To familiarize students with the kinetics of microbial growth and yield estimation.														
	2. To optimize medium components for enhanced metabolite production using statistical tools.														
	3. To understand enzyme kinetics and the influence of physicochemical parameters on enzyme activity.														
	4. To explore strategies for metabolite production and enzyme immobilization in a bioprocess context.														
	5. To evaluate bioprocess engineering parameters such as heat and mass transfer for scale-up applications.														
Course Outcomes	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Define basic bioprocess terms like biomass, growth rate, enzyme activity, and transfer parameters.										K1				
	CO2: Explain how temperature, pH, and media affect microbial growth and enzyme activity; interpret growth and enzyme kinetics.										K2				
	CO3: Apply Plackett-Burman and RSM for media optimization; perform enzyme immobilization techniques.										K3				
	CO4: Design experiments for metabolite production and use process data for bioreactor monitoring.										K3				
	CO5: Analyze data to estimate heat and oxygen transfer rates in bioprocess systems.										K4				
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2						1		2	3	3	2	
CO2	3	3	2		2				1		2	3	3	2	
CO3	3	3	3	2	2			1	1	2	2	3	3	3	
CO4	3	3	3	3	3			2	2	2	3	3	3	3	
CO5	3	3	2	2	3			1	2	2	3	3	3	3	
Pre-requisites		Nil													




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
Direct		
1. Pre lab and Post lab		
2. Execution of Experiment and Viva-voce		
3. End semester examination		
Indirect		
1. Course - end survey		
List of Experiments		
S.No	Name of the Experiment	Course Outcome
1.	Growth of Bacteria - estimation of biomass, calculation of specific growth rate, yield coefficient	CO1
2.	Growth of Yeast - estimation of biomass, calculation of specific growth rate, yield coefficient	CO1
3.	Medium optimization – i) Plackett Burman design ii) Response surface methodology	CO2
4.	Enzyme kinetics – Estimation of Michelis Menton parameters	CO2
5.	Enzyme activity - effect of Temperature	CO3
6.	Enzyme activity - effect of pH	CO3
7.	Production of microbial metabolites (enzymes) in a bioreactor	CO4
8.	Enzyme immobilization	CO4
9.	Estimation of the overall heat transfer coefficient	CO4
10.	Estimation of K_{La} – sulfite oxidation	CO5
Total Periods		60


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	V										
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks										
		L	T		P	C	CA	ESE	Total						
U23BT625	MINI PROJECT-II	0	0	2	1	100	-	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To understand the process of identifying a relevant research area in biotechnology. To interpret and summarise scientific literature related to the chosen project topic. To develop an appropriate experimental design or prototype based on the identified problem. To analyse experimental results or design data and derive meaningful conclusions. To evaluate the outcomes of the project and document findings with future research scope. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Demonstrate a clear understanding of the selected project problem by explaining its significance, scope, and relevance to the chosen domain.						K2								
	CO2: Conduct a comprehensive literature review to justify the project rationale and formulate specific, measurable research objectives.						K3								
	CO3: Critically analyze the problem and develop an appropriate methodology or design strategy to address it.						K4								
	CO4: Implement the proposed methodology through experiments, modeling, or simulations, and analyze the results using suitable tools and techniques.						K5								
CO4: Evaluate the overall outcomes of the project, compile a comprehensive technical report, and propose future scope or applications.						K6									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)											CO/PSO Mapping			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3					2						3	2	-
CO 2		3		3								2	2	3	-
CO 3			3		2						2		-	2	3
CO 4				3	3				2				-	2	3
CO 5										3	2	2	2	-	3
Course Assessment Methods															
Direct															
1. Project Reviews															
2. End Semester Examinations(Viva Voce)															
Indirect															
1. Course - End survey															


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		L	T	P		C	CA	ESE	Total																																																																																																																																																
U23BT626	Comprehensive Examination	2	0	0	1	100	-	100																																																																																																																																																	
Course Objective	The student should be made to																																																																																																																																																								
	<ul style="list-style-type: none"> Understand microbial diversity, viral classification, immunity, and basic metabolism. Understand core concepts in genetics, cell biology, and molecular biology. Apply principles of biological engineering in bioprocesses and mass transfer. Develop knowledge of bioprocessing and genetic engineering techniques for biotechnology. 																																																																																																																																																								
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level																																																																																																																																														
	CO1: Understand the classification of microorganisms and viruses, microbial interactions, and immunological responses to produce biotechnological solutions including diagnostics, treatments, and microbial engineering.										K2																																																																																																																																														
	CO2: Understand the principles of genetics, cell biology, and molecular biology in biotechnology.										K2																																																																																																																																														
	CO3: Apply the principles of stoichiometry, fluid dynamics, and mass transfer to analyze and optimize microbial growth and product formation in bioreactors.										K3																																																																																																																																														
	CO4: Analyze the principles and applications of enzyme immobilization, bioprocess kinetics, and downstream processing techniques to evaluate and improve bioprocess efficiency.										K4																																																																																																																																														
	CO5: Analyze molecular biology techniques and gene manipulation tools, for applications in genetic engineering and bio sensing by taking the seminar and submitting the assignments .										K4																																																																																																																																														
Pre-requisites	-																																																																																																																																																								
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="12">CO / PO Mapping</th> <th colspan="3">CO/PSO Mapping</th> </tr> <tr> <th colspan="15" style="text-align: center;">(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak</th> </tr> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="3">PSOs</th> </tr> <tr> <th>PO 1</th> <th>PO 2</th> <th>PO 3</th> <th>PO 4</th> <th>PO 5</th> <th>PO 6</th> <th>PO 7</th> <th>PO 8</th> <th>PO 9</th> <th>PO 10</th> <th>PO 11</th> <th>PO 12</th> <th>PSO 1</th> <th>PSO 2</th> <th>PSO 3</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 2</td> <td>2</td> <td>3</td> <td></td> <td>2</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>3</td> <td>3</td> <td>2</td> <td>2</td> </tr> <tr> <td>CO 3</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>2</td> <td>2</td> </tr> <tr> <td>CO 4</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>3</td> <td>3</td> <td>2</td> </tr> <tr> <td>CO 5</td> <td>3</td> <td>2</td> <td>2</td> <td>3</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td>2</td> <td>2</td> <td>3</td> <td>2</td> <td>2</td> </tr> </tbody> </table>													CO / PO Mapping												CO/PSO Mapping			(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															COs	Programme Outcomes (POs)												PSOs			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	CO 1	2	2	2	2	2							2	3	3	3	CO 2	2	3		2	2							3	3	2	2	CO 3	3	3	3	3								2	3	2	2	CO 4	2	2	2	2	3							2	3	3	2	CO 5	3	2	2	3	3					2	2	2	3	2	2
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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	General Science	Periods	9
Bacterial classification and diversity; Microbial interactions; Viruses - structure and classification. Basic concepts and regulation of metabolism of carbohydrates, lipids, amino acids and nucleic acids; Photosynthesis, respiration and electron transport chain. Antibody structure and function; Molecular basis of antibody diversity; T cell and B cell development; Antigen-antibody reaction.			
Unit – II	Genetics, Cell and Molecular Biology	Periods	9
Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extra chromosomal inheritance; Microbial genetics - transformation, transduction and conjugation; Cell cycle and cell growth control; Cell communication; Cell signaling and signal transduction. Nucleic acid - replication, transcription, splicing, translation and their regulatory mechanisms			
Unit – III	Biological Engineering	Periods	9
Stoichiometry of growth and product formation; Degree of reduction, electron balance and theoretical oxygen demand. Newtonian and non-Newtonian fluids, fluid flow - laminar and turbulent; Mixing in bioreactors, mixing time; Molecular diffusion and film theory; Oxygen transfer and uptake in bioreactor, kLa and its measurement			
Unit – IV	Process Biotechnology	Periods	9
Enzyme immobilization, diffusion effects - Thiele modulus, effectiveness factor, Damkohler number; Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models. Centrifugation - high speed and ultra; Cell disruption; Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC and FPLC; Extraction, adsorption and drying.			
Unit – V	rDNA Technology	Periods	9
Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial and yeast artificial chromosomes. Southern and northern blotting; In-situ hybridization; DNA fingerprinting, RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; CRISPR-Cas; Biosensing and biosensors.			
Total Periods			45
Text Books			
1.	M. Agarwal, Akanksha Singhal, Vidhika Goel; "GATE Tutor 2025 Biotechnology" Arihant Publications, 2024		
2.	Pranav Kumar and Usha Mina. "GATE Biotechnology" Pathfinder Publication, 2025		
1.	Pauline M. Doran. "Bioprocess Engineering Principles" Elsevier Science & Technology Books, 1995		
2.	Gardner, Simmons and Snustad. "Principles of Genetics" Wiley; 8 th Edition, 2006		
3.	S.B. Primrose and R.M. Twyman. "Principles of Gene Manipulation and Genomics" Blackwell Publishing, 2006.		
Resources			
1.	https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation		
2.	https://www.ncbi.nlm.nih.gov/books/NBK21128/		
3.	https://www.youtube.com/watch?v=Yh9w_fyvpUk&list=PLwdnzlV3ogoWcRPq0WkGTsi4Wzu8onVfH		

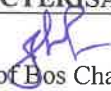

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VERTICAL I


Environmental Biotechnology




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Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV11	Waste Water Treatment	3	0	0	3	40	60	100							
Course Objective	The student should be made, <ul style="list-style-type: none"> To understand the Physical and chemical Characteristics of wastewater and their measurement. To understand the various pollutant treatment techniques. Understand the concepts using biological treatment methods. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Examine the Physical and chemical Characteristics of wastewater and their measurement						K1								
	CO2: Choose the various pollutant treatment techniques in waste water treatment process.						K2								
	CO3: Analyze the concepts using biological treatment methods.						K3								
	CO4: Design the reactors used for various treatment techniques based on the process.						K4								
CO5: Explain the membrane based advanced waste water treatment process						K3									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	1	1	1	-	1	-	1	3	3	3	2
CO 2	3	2	1	1	-	2	-	-	2	-	1	1	3	3	2
CO 3	3	2	2	2	3	1	1	-	1	2	1	2	2	2	2
CO 4	3	1	3	1	3	1	-	-	-	2	2	2	2	3	2
CO 5	2	2	3	2	1	2	1	-	2	2	2	2	3	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	WASTE WATER CHARACTERISATION											Periods	9		


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Terminology – Regulations (TNPCB) – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents, SDG Goals.			
Unit - II	PHYSICAL - CHEMICAL UNIT PROCESSES	Periods	9
Role of unit processes in waste water treatment - Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation–solidification and stabilization–disinfection			
Unit - III	BIOLOGICAL TREATMENT	Periods	9
Objectives of biological treatment– significance–Principles of aerobic and anaerobic treatment–kinetics of biological growth Factors affecting growth – attached and suspended growth –selection of process-reactors			
Unit - IV	AEROBIC AND ANAEROBIC TREATMENT METHODS	Periods	9
Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- - fluidized bed reactors, aerated lagoons, waste stabilization ponds.			
Unit – V	ADVANCED WASTEWATER TREATMENT	Periods	9
Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation-Desalination.Case Studies on wastewater Treatment in India.			
Total Periods			45
Text Books			
1.	Wastewater Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FIBiston, 2018		
2.	S.P. Mahajan, Pollution control in process industries, 27 th Ed. Tata McGraw Hill Publishing Company Ltd., 2019.		
References			
1.	Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2016.		
2.	Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw - Hill,1995.14		
3.	Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2016		
4.	C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2017		
5.	Standard methods for the examination of water and wastewater, 21 st Edition, Washington: APHA., 2012		
E-Resources			
1.	https://nptel.ac.in/courses/105107207		
2.	nptel.ac.in/courses/105/105/105105178/		
3.	nptel.ac.in/noc24_ce53/		




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Programme	B. Tech	Programme Code	105	Regulation	2023																																																																																																																																					
Department	BIOTECHNOLOGY			Semester	-																																																																																																																																					
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks																																																																																																																																				
		L	T	P		C	CA	ESE	Total																																																																																																																																	
U23BTV12	Solid Waste Management	3	0	0	3	40	60	100																																																																																																																																		
Course Objective	The student should be made, <ul style="list-style-type: none"> To know about the solid waste characteristics and its sources. To identify and analyze different methods of treatment of solid waste To understand Industrial practices in solid waste management 																																																																																																																																									
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level																																																																																																																																			
	CO1: Analyze the solid waste characteristics and its sources.						K1																																																																																																																																			
	CO2: Analyze different methods of treatment of solid waste.						K2																																																																																																																																			
	CO3: Analyze the Industrial practices in solid waste management						K3																																																																																																																																			
	CO4: Apply and discuss the process and significance of processing of solid wastes.						K4																																																																																																																																			
CO5: Deliberate the strategy for waste disposal.						K3																																																																																																																																				
Pre-requisites	-																																																																																																																																									
<table border="1"> <thead> <tr> <th colspan="12">CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak</th> <th colspan="3">CO/PSO Mapping</th> </tr> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="3">PSOs</th> </tr> <tr> <th>PO 1</th> <th>PO 2</th> <th>PO 3</th> <th>PO 4</th> <th>PO 5</th> <th>PO 6</th> <th>PO 7</th> <th>PO 8</th> <th>PO 9</th> <th>PO 10</th> <th>PO 11</th> <th>PO 12</th> <th>PSO 1</th> <th>PSO 2</th> <th>PSO 3</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>3</td> <td>3</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>1</td> <td>-</td> <td>1</td> <td>3</td> <td>3</td> <td>3</td> <td>2</td> </tr> <tr> <td>CO 2</td> <td>3</td> <td>2</td> <td>1</td> <td>1</td> <td>-</td> <td>1</td> <td>-</td> <td>-</td> <td>2</td> <td>-</td> <td>1</td> <td>1</td> <td>3</td> <td>3</td> <td>2</td> </tr> <tr> <td>CO 3</td> <td>3</td> <td>2</td> <td>2</td> <td>2</td> <td>3</td> <td>1</td> <td>1</td> <td>2</td> <td>1</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>CO 4</td> <td>3</td> <td>1</td> <td>3</td> <td>1</td> <td>2</td> <td>1</td> <td>-</td> <td>1</td> <td>-</td> <td>2</td> <td>2</td> <td>1</td> <td>2</td> <td>3</td> <td>2</td> </tr> <tr> <td>CO 5</td> <td>2</td> <td>2</td> <td>3</td> <td>2</td> <td>1</td> <td>2</td> <td>-</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>3</td> <td>2</td> <td>2</td> </tr> </tbody> </table>													CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			COs	Programme Outcomes (POs)												PSOs			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	CO 1	3	3	2	2	2	2	2	2	1	-	1	3	3	3	2	CO 2	3	2	1	1	-	1	-	-	2	-	1	1	3	3	2	CO 3	3	2	2	2	3	1	1	2	1	2	1	2	2	2	2	CO 4	3	1	3	1	2	1	-	1	-	2	2	1	2	3	2	CO 5	2	2	3	2	1	2	-	2	2	2	2	2	3	2	2
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Content of the syllabus			
Unit – I	SOURCES AND PHYSICAL CHARACTERISTICS	Periods	9
Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics.			
Unit - II	SOURCE REDUCTION, WASTE STORAGE AND RECYCLING	Periods	9
Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes			
Unit - III	COLLECTION AND TRANSFER OF WASTES	Periods	9
Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.			
Unit - IV	PROCESSING OF WASTES	Periods	9
Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting ; Thermal processing options – case studies under Indian conditions.			
Unit – V	WASTE DISPOSAL	Periods	9
Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill – Dumpsite Rehabilitation			
Total Periods			45
Text Books			
1.	William A. Worrell, P. Anniesland, Solid Waste Engineering, Cengage Learning, 2012.		
2.	John Pitchel Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York, 2014		
References			
1.	Government of India, “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of Urban Development, New Delhi, 2000		
2.	Manser A.G.R. and Keeling A.A.,” Practical Handbook of Processing and Recycling of Municipal solid Wastes”, Lewis Publishers, CRC Press, 1996.		
3.	Tchobanoglous, G., Theisen, H. M., and Eliassen, R. “Solid. Wastes: Engineering Principles and Management Issues”. McGraw Hill, New York, 2016		
4.	Waste: A Handbook for Management, Letcher, T.M., Vallero, D.A, 1 st Ed, Academic Press, USA, 2011.		
5.	Solid Waste Management - Present and Future Challenges, Jagbir Singh, Ramanathan, AL., I.K. International publishing House PVT., Ltd., India, 2011.		
E-Resources			
1.	nptel.ac.in/courses/105/103/105103205/		
2.	nptel.ac.in/courses/120/108/120108005/		
3.	nptel.ac.in/noc23_ce66/preview		


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV13	Bioremediation	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To provide students with a comprehensive understanding of the principles, mechanisms, and applications of bioremediation in addressing environmental pollution. Students will learn about microbial degradation, phytoremediation, biotechnological tools for environmental cleanup Enable students to understand strategies for waste management and sustainability. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand the principles and significance of bioremediation in environmental biotechnology.						K2								
	CO2: Analyze the roles of microorganisms and plants in the degradation of environmental pollutants.						K2								
	CO3: Design strategies for applying bioremediation techniques to various environmental scenarios.						K3								
	CO4: Evaluate the advantages and limitations of different bioremediation approaches.						K3								
CO5: Explore the potential of biotechnological innovations for sustainable environmental management.						K3									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	2	1	3	1	1					2	2	1	2
CO 2	2	2	1	1	3		2					3	1	3	2
CO 3	2	1	2	2	1	1						1	2	2	2
CO 4	1	2		2	3		1	1			1	3	2	1	2
CO 5	2	2		3	1	1					1	2	2	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															



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1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Bioremediation	Periods	9
Definition, scope, and significance of bioremediation. Types of bioremediation: In-situ and ex-situ. Microbial metabolism and pollutant degradation pathways. Factors affecting bioremediation: Environmental and microbial aspects. Case studies: Successful bioremediation applications.			
Unit – II	Microbial Bioremediation	Periods	9
Role of bacteria, fungi, and archaea in pollutant degradation. Microbial degradation of hydrocarbons, pesticides, and heavy metals. Bioaugmentation and biostimulation techniques. Bioreactors for microbial bioremediation. Genetic engineering in microbial remediation.			
Unit – III	Phytoremediation	Periods	9
Role of plants in pollutant removal. Mechanisms: Phytoextraction, phytostabilization, rhizofiltration, and phytodegradation. Selection of plants for remediation: Criteria and case studies. Role of plant-microbe interactions in bioremediation. Applications in contaminated soil, water, and air.			
Unit – IV	Advanced Bioremediation Techniques	Periods	9
Enzymatic bioremediation: Enzymes in pollutant degradation. Nanobiotechnology in environmental cleanup. Bioremediation of e-waste, plastics, and emerging pollutants. Biopolymers and biosurfactants for enhanced remediation. Bioremediation in extreme environments: Case studies.			
Unit – V	Applications and Challenges in Bioremediation	Periods	9
Applications in industrial waste, mining waste, and oil spills. Monitoring and assessment of bioremediation efficiency. Limitations and risks associated with bioremediation. Policy frameworks and regulations for bioremediation projects. Future prospects: Sustainable remediation and green technologies.			
Total Periods			45
Text Books			
1.	Rittmann, B. E., & McCarty, P. L. (2020). Environmental Biotechnology: Principles and Applications (2nd Edition). McGraw-Hill Education.		
2.	Sharma, P. D. (2012). Ecology and Environment. Rastogi Publications.		
3.	Juwarkar, A. A., Singh, S. K., & Mudhoo, A. (2010). Advances in Biodegradation and Bioremediation of Industrial Waste. CRC Press.		
References			
1.	Mohan, S. V., & Nikhil, G. N. (2020). Bioremediation and Sustainable Technologies. Elsevier.		
2.	Vijay, K. M. (2011). Introduction to Bioremediation. Springer Science & Business Media.		
3.	Atlas, R. M., & Philp, J. (2005). Bioremediation: Applied Microbial Solutions for Real-World Environmental Cleanup. ASM Press.		
4.	Singh, A., & Ward, O. P. (2004). Biodegradation and Bioremediation. Springer.		
5.	Ritter, W. F., & Scarborough, R. W. (2002). Principles and Practices of Bioremediation. CRC Press.		
E-Resources			
1.	https://www.edx.org/course/environmental-management		
2.	https://www.coursera.org/learn/environmental-biotechnology		
3.	https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-086-modeling-environmental-complexity-spring-2012/		
4.	https://www.unep.org/		
5.	https://www.epa.gov/		


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Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY		Semester		-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV14	Ecology & Environmental Management	3	0	0	3	40	60	100							
Course Objective	The student should be made, <ul style="list-style-type: none"> To impart knowledge on the principles of ecological engineering that strengthen the functions of ecosystems, restore devastated ecosystems, To impart an understanding of systems approach to Environmental Management as per ISO 14001 To understand the skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement. 														
	At the end of the course, the student should be able to,							Knowledge Level							
Course Outcome	CO1: Understand the principles, concepts and application of ecosystem.							K1							
	CO2: Identify the process and techniques involved in ecosystem.							K2							
	CO3: Knowledge on environmental impact, legal analysis and environmental management programs							K3							
	CO4: Intensify the elements of Corporate Environmental Management systems complying to international environmental management system standards							K4							
	CO5: Develop, Implement, maintain and Audit Environmental Management systems for Organisations							K3							
Pre-requisites	-														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	2	2	1	2	1		1	3	3	3	2
CO 2	3	2	2	2	-	1	-	-	2		1	1	3	3	2
CO 3	3	2	2	2	3	2	2	2	1		1	2	2	2	2
CO 4	3	1	3	2	2	2		1			2	1	2	3	2
CO 5	2	2	3	2	1	2	1	2	2		1	1	3	2	2
Course Assessment Methods															
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Content of the syllabus			
Unit – I	ECOSYSTEMS	Periods	9
Aim, scope and applications of ecology – Development and evolution of ecosystems – Principles and concepts pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems.			
Unit - II	ECOLOGICAL PROCESSES	Periods	9
Self-organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems			
Unit - III	ENVIRONMENTAL MANAGEMENT SYSTEM	Periods	9
Environmental policy – initial environmental review – environmental aspect and impact analysis – legal and other requirements- objectives and targets – environmental management programs - EMAS, ISO 14000 - EMS as per ISO 14001– benefits			
Unit - IV	ENVIRONMENTAL MANAGEMENT STANDARDS	Periods	9
. Environmental Management Principles - National policies on environment, abatement of pollution and conservation of resources - Responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards.			
Unit – V	ENVIRONMENTAL AUDIT	Periods	9
Roles and qualifications of auditors - Environmental performance indicators and their evaluation –Corrective and preventive actions -compliance audits – waste audits and waste minimization planning –Environmental management system audits as per ISO 19011.			
Total Periods			45
Text Books			
1.	Christopher Sheldon and Mark Yoxon, “Installing Environmental management Systems – a step-by-step guide” Earthscan Publications Ltd, London, 2017		
2.	Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, 2015		
References			
1.	ISO 19011: 2002, “Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2015		
2.	Paul L Bishop „Pollution Prevention: Fundamentals and Practice“, McGraw- Hill International, Boston,2018.		
3.	Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York,2009		
4.	ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2014		
5.	Peter O, Muller, Harm J, De Blij, Richard S, Environmental Geography, Oxford university press, USA, 2014		
E-Resources			
1.	nptel.ac.in/courses/120/108/120108004/		
2.	nptel.ac.in/noc23_hs155/preview		
3.	el.ac.in/noc19_ge22/preview		

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Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV15	Air Pollution and Control Engineering	3	0	0	3	40	60	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To understand the nature and characteristics of air pollutants To Identify, formulate and solve air pollution problems using air pollution control devices Understand the knowledge about particulate air pollutants and control devices 														
Course Outcome	At the end of the course, the student should be able to						Knowledge Level								
	CO1: Analyze the nature and characteristics of air pollutants, and basic concepts of air quality management.						K1								
	CO2: Analyse the particulate air pollutants and control devices.						K2								
	CO3: Design and formulate air pollution problems using air pollution control devices to meet applicable standards						K3								
	CO4: Propose suitable air pollution prevention equipment's and techniques for various gaseous and particulate pollutants to Industries						K4								
CO5: Establish the knowledge to control the air pollution in industries using various models.						K3									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
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CO 3	3	2	2	2	3	2	1	2	1	2	1	2	2	2	2
CO 4	3	1	3	2	2	1	-	1	-	2	2	1	2	3	2
CO 5	2	2	3	2	1	2	1	1	1	1	2	2	3	2	2
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Content of the syllabus															


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Unit – I	INTRODUCTION	Periods	9
Structure and composition of Atmosphere – Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation, animals, Effects of air Pollutants on the atmosphere, Soil and Water bodies – Indoor air pollution.			
Unit - II	PREVENTION OF AIR POLLUTION	Periods	9
Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristic sand control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters– Techniques of air pollution control- equipment’s.			
Unit - III	MITIGATION OF GASEOUS POLLUTANTS	Periods	9
Working principle, Design and performance equations of absorption, adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring.			
Unit - IV	MITIGATION OF PARTICULATE AIR POLLUTION	Periods	9
Particle Collection mechanisms – Fluid particle Dynamics – Particle size Distribution – Efficiency–Gravity Settling chambers Cyclones – Electrostatic precipitators and Bag filters.			
Unit – V	AIR POLLUTION MODELLING	Periods	9
Effects of meteorology on Air Pollution stacking - Fundamentals, Atmospheric stability -Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention.			
Total Periods			45
Text Books			
1.	Richardw. Boubeletal., “Fundamentals of Air Pollution”, Academic Press, New York, 2019		
2.	Noel DeNevers, “Air Pollution Control Engg.”, McGraw Hill, NewYork,2018		
References			
1.	David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2019		
2.	Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4 th edn, 2017		
3.	Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons, Inc., 2018		
4.	M.N. Raoetal., “Air Pollution” Tata McGraw Hill,2014		
5.	Rao, C.S., Environmental Pollution Control Engineering. Wiley Eastern Limited, New Age International Limited, New Delhi, 2016		
E-Resources			
1.	nptel.ac.in/courses/105/107/105107213/		
2.	nptel.ac.in/courses/105/102/105102089/		
3.	nptel.ac.in/noc24_ch53/preview		

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV16	Green and Energy Audit	3	0	0	3	40	60	100							
Course Objective	The student should be made to														
	<ul style="list-style-type: none"> Recall the interrelationship between energy, environment, sustainable development, and global and Indian energy scenarios. Explain energy management programs and energy audits to promote efficiency and conservation. Apply strategies for greenhouse gas reduction and green building design principles. Analyze the goals, scope, and procedures of environmental audits and management systems. Analyze energy audit plans and strategies to optimize energy performance. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Recall the relationship between energy, environment, and sustainable development along with global and Indian energy scenarios.							K1							
	CO2: Explain energy management programs and energy audit systems to enhance energy efficiency and conservation.							K2							
	CO3: Apply approaches for greenhouse gas reduction and principles of green building design and rating systems.							K3							
	CO4: Analyze the objectives, scope, and processes of environmental audits and environmental management systems.							K4							
	CO5: Examine energy audit plans, utilizing audit instruments and strategies to optimize energy performance.							K4							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	1	-	2	3	1	-	-	-	2	3	2	1
CO2	2	3	2	2	1	1	2	-	1	2	2	2	2	2	2
CO3	2	2	3	2	3	2	3	1	1	2	-	2	1	3	3
CO4	3	3	2	3	2	2	3	2	1	-	-	3	2	2	2
CO5	3	3	3	2	3	2	3	2	2	3	3	3	1	3	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															


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2. Assignment
3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	ENERGY AND ENVIRONMENT	Periods	9
Introduction to the nexus between energy, environment and sustainable development – Ecosystem an Overview - Energy sources overview and classification - Sun as the source of energy - Classification of Energy – Renewable & Non-renewable energy - Energy production from biomass and wastes - Energy flow in major man-made ecosystems- Carbon Foot Print – Policies & Treaties on Environment, Environmental laws on pollution control - The environmental protection act - Overview of global/India's energy scenario			
Unit – II	PRINCIPLES AND OBJECTIVES OF ENERGY MANAGEMENT	Periods	9
General Philosophy and Need of Energy Audit and Management - Design of Energy Management Programmes - Development of energy management systems & their Importance - Indian Need for Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Monitoring and targeting			
Unit – III	CREATION OF GREEN BUILDINGS	Periods	9
Introduction – Green House Gases (GHG) and its Sources – Measurement of GHG and reduction Strategies - Land Development Practices – Concept of Green Building – Green Construction Materials and Methods – Rating System for Green Buildings - The LEED-NC Rating System – Strength and Weakness of LEED - NC			
Unit – IV	ENVIRONMENT AUDIT	Periods	9
Aims and Objectives of Environment Audit - Scope and Goals of Environment Auditing - Environmental Audit Schemes and their Components - Role of Environmental Audit and Environmental Management System - Target Areas of Environmental Auditing - Steps Involved in the Process of Environmental Audit - Phases of an Environmental Audit			
Unit – V	ENERGY AUDIT CONCEPTS	Periods	9
Need of Energy audit - Types of energy audit – Energy management (audit) approach - understanding energy costs - Benchmarking – Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors - Energy audit instruments - Procedures and Techniques			
Total Periods			45

Text Books

1.	Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean-Philippe; Zaccour, Georges (Eds.), 2005.
2.	De, B. K., Energy Management audit & Conservation, (2nd Edition), Vrinda Publication. 2010


References



1.	Sukhatme S., J Nayak J., Solar Energy: Principles of thermal Collection and Storage, 3 rd Ed., Tata McGraw-Hill Publishing Company Ltd. 2008
2.	General Aspects of Energy Management & Energy Audit, http://www.em-ea.org/gbook11.asp , National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
3.	Energy Performance Assessment for Equipment and Utility Systems, http://www.em-ea.org/gbook14.asp , National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
4.	Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2 nd Edition, John Wiley, 2006.


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5.	Turner, W. C., Doty, S. and Truner, W. C. Energy Management Hand book, 7 th Edition, Fairmont Press. 2009
E-Resources	
1.	https://beeindia.gov.in/en/about-bee
2.	https://onlinecourses.swayam2.ac.in/nou23_es05/preview
3.	https://onlinecourses.nptel.ac.in/noc19_ch26/preview


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Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV17	Environmental Impact & Risk Assessment	3	0	0	3	40	60	100							
Course Objective	The student should be made, <ul style="list-style-type: none"> To understand the concept of environmental Impact assessment To know various components and assessment techniques of EIA To gain knowledge about EIA monitoring studies through various industrial exposure 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Explain the concept of environmental Impact assessment							K1							
	CO2: Summarize the various components and assessment techniques of EIA							K2							
	CO3: Implement understand socio economic assessment plans							K3							
	CO4: Classify the legal requirements of Environmental and Risk Assessment for projects							K3							
CO5: Gain knowledge about EIA monitoring studies through various industrial exposure							K3								
Pre-requisites	-														
CO / PO Mapping													CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	-	1	1	2	1	-	1	3	3	3	2
CO 2	3	2	1	1	-	1	-	-	2	-	1	1	3	3	2
CO 3	3	2	2	2	3	2	1	2	1	2	1	2	2	2	2
CO 4	3	1	3	1	2	2		1		2	2	1	2	3	2
CO 5	2	2	3	2	1	2	1	2	2	1	1	1	3	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															


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Unit – I	INTRODUCTON	Periods	9
Environmental Impact Assessment (EIA) - Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework. Principles of Sustainable Development-			
Unit - II	ENVIRONMENTAL ASSESSMENT	Periods	9
Prediction and Assessment of Impact on land, water, air, noise, flora and fauna -Screening and Scoping in EIA-Expert systems in EIA. Prediction tools for EIA-Cumulative Impact Assessment			
Unit - III	SOCIAL IMPACT ASSESSMENT	Periods	9
Social impact assessment - Relationship between social impacts and change in community - Identification of Project Affected Personal – Rehabilitation and Resettlement Plan			
Unit - IV	ENVIRONMENTAL RISK ASSESSMENT	Periods	9
Environmental risk assessment framework-Hazard identification - Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis			
Unit – V	MONITORING STUDIES AND APPLICATIONS	Periods	9
Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry			
Total Periods			45
Text Books			
1.	Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 2016.		
2.	Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 2019.		
References			
1.	Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2014.		
2.	Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme,2016.		
3.	Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 2008.		
4.	Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2018		
5.	Environmental Management in Practice: Vol 3 - Managing the Ecosystem, Bhaskar Nath, Luc Hens, Paul Compton, Dimitri Devuyt (Editors), Taylor and Francis, 2009		
E-Resources			
1.	nptel.ac.in/noc22_ar07/preview		
2.	nptel.ac.in/courses/124/107/124107160/		
3.	nptel.ac.in/courses/105/107/105107181/		


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Programme	B.Tech.	Programme Code					105	Regulation		2023					
Department	BIOTECHNOLOGY					Semester		-							
Course Code	Course Name		Periods Per Week			Credit	Maximum Marks								
			L	T	P		C	CA	ESE	Total					
U23BTV18	Sustainable product development		3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> • Have a basic knowledge about the characteristics of living microorganisms • Understand the basic concepts of genetics and immune system • Analyze the applications biology in various fields 														
Course Outcome	Students who complete this course successfully are expected to										Knowledge Level				
	CO1: Elucidate the basics of sustainable development, sustainable engineering and its role in Engineering										K1				
	CO2: Application of Sustainable Engineering Concepts and Principles in Engineering										K2				
	CO3: Apply the Principle, and methodology of Life Cycle Assessment Tool to Engineering systems										K3				
	CO4: Understand integration methods of sustainability to Engineering Design										K3				
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
Programme Outcomes (POs)												PSOs			
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	2	1	1	2	2	3	1	2	1	1	2	2	2	2
CO 2	3	1	2	2	3	2	3	2		1	2	1	2	3	3
CO 3	3	1	2	2	1	1	3	1	2	1		1	2	3	3
CO 4	1	2	1		2	1	2	1		1	2	2	2	3	3
CO 5	3	1	2	1	2	1	3	1	2		1	3	3	3	3



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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester Examinations			
Indirect			
1. Course - End Survey			
Content of the Syllabus			
Unit – I	INTRODUCTION	Periods	9
Introduction of Sustainable Development, THE SDFs, Paris Agreement and Role of Engineering, Sustainable Development and the Engineering Profession, Key attributes of the Graduate Engineering, Sustainable Engineering Key Concepts - Factor 4 and Factor 10: Goals of sustainability, System Thinking, Life Cycle Thinking and Circular Economy.			
Unit – II	SUSTAINABLE ENGINEERING	Periods	9
Sustainable Engineering- Concepts, Principles and Frame Work, Green Economy and Low Carbon Economy, Eco Efficiency, Triple bottom Line, Guiding principles of sustainable engineering, Frameworks for sustainable Engineering. Tools for sustainability Assessment - Environmental Management System, Environmental Auditing, Cleaner Production Assessment, Environmental Impact Assessment.			
Unit – III	LIFE CYCLE ASSESSMENT	Periods	9
Life Cycle Assessment (LCA) – Goal, Scope and Life Cycle Inventory, Interpretation and presentation of Results, Iterative Nature of LCA, Methodological Choices, LCI Databases and LCA Softwares, Strength and Limitations of LCA; LCA Applications in Engineering - Environmental Product Declarations and Product Category Rules.			
Unit – IV	ENVIRONMENTAL ECONOMICS	Periods	9
Introduction to Environmental Economics, Valuing the Environment, Market-based Incentives for Sustainability, Command-and-Control versus Economic Instruments, A Simple Model of Pollution Control.			
Unit – V	SUSTAINABILITY IN ENGINEERING DESIGN	Periods	9
Problems Solving in Engineering, Conventional to Sustainable Engineering Design Process, Design for Life Guidelines and Strategies, Measuring Sustainability, Sustainable Design through sustainable procurement criteria, Case studies on sustainable Engineering Design Process.			
Total Periods			45
Text Books			
1.	“Introduction to Sustainability for Engineers”, Toolseeram Ramjeawon, 2020		
2.	“Introduction to Sustainable Engineering”, Rag. R.L and Ramesh Lakshmi Dinachandran, 2016		
References			
1.	“Sustainable development goals: directive principles”, Ajay Ahlawat, 2019		
2.	“Introduction to Sustainable Development”, Martin J. Ossewaarde, 2018		
E-Resources			
1.	https://nptel.ac.in/courses		
2.	https://unesdoc.unesco.org		


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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV19	MARINE BIOTECHNOLOGY	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> • To provide the knowledge about the marine diversity • To know about the marine microbes and the aquatic animals • To impart the biomedical importance of marine organisms. • To learn the bioproducts derived from marine biodiversity • To understand the environmental impacts of the aquatic biotechnology. 														
Course Outcome	At the end of the course, the students will be able to							Knowledge Level							
	CO1: Explain the different habitats of marine biodiversity and its nutrient requirements.							K2							
	CO2: describe the aquaculture related to artificial insemination, eye stalk ablation, transgenic fish technology and the role of probiotic bacteria in aquaculture.							K3							
	CO3: justify the use of bioactive compounds from different marine organisms.							K3							
	CO4: identify the marine source that produces the biopolymers, biomaterials, antifouling compounds and biopotential uses of halophilic bacteria.							K4							
CO5: interpret the bioremediation using microbes, environmental risks and benefits.							K5								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	2	2		3	3		2				3	3	3
CO 2	2	2		3		2	2		2	2	3		3	2	3
CO 3	3	2		3	2	2		2					2	2	3
CO 4	2	3	3	3	3	2	2	2	3	2		3	3	3	2
CO 5	3	3	2	3		2	2		2		3	3	3	3	2
Pre-requisites	Microbiology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															


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3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Marine Biodiversity	Periods	9
Marine microbial diversity: symbiotic, free-living, biofilm, proximity to ocean surface or sediments: Euphotic, Mesopelagic, Bathopelagic, Benthos - concentration of nutrients and growth substrates: Oligotrophic, Mesotrophic, Eutrophic, algal blooms - hydrothermal vents: vent biodiversity - applications of extremozymes.			
Unit – II	Marine aquaculture	Periods	9
Shellfish and crustacean culture: shrimps, edible mussels, pearl oyster, crabs, fish aquaculture: artificial insemination, eye stalk ablation-transgenic fish technology, transgenic fishes with growth hormone(GH) and antifreeze genes, development of healthy fish diets, probiotics bacteria and their importance in aquaculture, vaccines for aquaculture.			
Unit – III	Biomedical importance of marine organisms	Periods	9
Marine pharmacology: pharmaceutical and bioactive natural products - microalgae as a source of bioactive molecules - new antibiotics and medicines from marine organisms – unculturable bacteria, occurrence, characteristics and exploitation.			
Unit – IV	Biomaterials and Bioprocessing	Periods	9
Polymers and biomaterials: properties and production of agarose - agar - alginates - carrageenans - chitin - chitosan - carotene - heparin - marine flavourants - environmentally friendly antifouling compounds, biopotential uses of halophilic organisms.			
Unit – V	Environmental impacts of Aquatic biotechnology	Periods	9
Control of oil spills and bioremediation-Genetically Engineered Marine Organisms- sea weeds for removal of heavy metal pollutants - introduction of coral bleaching - biosphere reserve - Gulf of Mannar, impact of invasive organisms, environmental and economic risks and benefits, Impact of climate in aquatic life system.			
Total Periods			45
Text Books			
1.	Bright Singh I.S, Somnath Pai S., Rosamma Philip and Mohan Das A., “Aquaculture Medicine”, 1 st edition, Paico Printing Press, India, 2003.		
2.	Advances in Biochemical Engineering/Biotechnology- Marine Biotechnology I & II ; Y. Legal, R. Ulber, Springer Verlag Berlin Heidelberg, 2005.		
References			
1.	Y.K. Lee and S. Salminen, “Handbook of probiotics and prebiotics”, 2 nd edition, Wiley, A John Wiley and sons publication, 2009.		
2.	Milton Fingerman and Rachakonda Nagabhushanam, “Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing”, Science Publishers, 2009.		
3.	Proksch and Werner E.G.Muller, “Frontiers in Marine Biotechnology”, Horizon Bioscience, 2006.		
4.	Se-Kwon Kim, “Encyclopedia of Marine Biotechnology”, Wiley publisher, 2020		
E-Resources			
1.	https://onlinecourses.swayam2.ac.in/cec23_bt22/preview		
2.	https://www.classcentral.com/course/swayam-marine-biotechnology-203331		



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VERTICAL II

Food Technology

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV21	FOOD PROCESSING & PRESERVATION TECHNIQUES	3	0	0	3	40	60	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To study about the various components potent role in food processing To introduce various pre-processing techniques in food processing To understand the methods in processing foods To know different techniques used for the preservation of foods. To discuss the materials and types of packaging for foods 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Describe the nutritional aspects, energy value of foods, and the role of food additives in food processing							K2							
	CO2: Demonstrate basic cleaning, separation, sorting, and peeling methods used in food raw material preparation.							K3							
	CO3: Illustrate thermal processing and drying techniques such as blanching, pasteurization, evaporation, and frying used in food processing.							K3							
	CO4: Compare traditional and modern food preservation methods based on their impact on food quality and safety.							K4							
	CO5: Analyze various food packaging techniques, labelling practices, and compare national and international food safety and quality standards.							K4							
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-			2						2	3	3	3
CO 2	3	-	3		2								3	2	2
CO 3	3	-	3	2	2	-							3	2	2
CO 4	3	2	2		-	3	2						3	3	2
CO 5	3	2	2		2	3	3	1					3	2	2
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	NUTRITIONAL VALUES AND ADDITIVES IN FOOD	Periods	9
Constituents of Food, Energy Value of Foods and nutritional aspects of food stuffs, role of food additives, classification of food additives based on their role, dual role of certain additives, Food Colorants – Natural & Artificial, Food Flavors-classification of food flavors; chemical compounds responsible for flavour, use of biotechnology to develop flavors.			
Unit - II	PRE-PROCESSING OPERATIONS	Periods	9
Raw Material Preparation: Cleaning, Air Screen Cleaners, Disk, Indent Cylinder, Spiral, and Specific Gravity, Stone, Inclined Belt, Pneumatic, Aspirator; Separators: Magnetic, Cyclone, Colour Separator, Grading; Sorting; Washing; Peeling-Flash Peeling, Steam Peeling , Knife Peeling , Abrasion Peeling ,Lye Peeling , Flame Peeling			
Unit – III	PROCESSING OPERATIONS	Periods	9
Concepts used in Blanching & its Equipment, Pasteurization: Heat Sterilization; Extrusion; Evaporation, Drying- Freeze Drying, Hot Air Dryer, Contact Dryer, Osmotic Dehydration, Baking and Roasting: Theory And Equipment; Frying and its Equipment			
Unit - IV	PRESERVATION TECHNIQUES	Periods	9
Chilling: theory and equipment, Freezing Equipment, Freeze Drying and its equipment, Freeze Concentration, thawing, Modified Atmospheric Storage(MAS), Controlled Atmospheric Storage (CAS). Chemical preservatives, Preservation by Ionizing Radiations, Ultrasonication, High Pressure Fermentation, Curing, Pickling, Smoking, Membrane technology; Hurdle technology, application of Infra-Red Microwaves; Ohmic heating; Control of Water Activity			
Unit – V	FOOD PACKAGING, SAFETY, AND QUALITY STANDARDS	Periods	9
Coating, Enrobing, Packaging - Modified Atmospheric Packaging(MAP), Controlled Atmospheric Packaging(CAP), Filling, Sealing. Introduction to Food Labelling, Food quality and safety standards: International: Codex Alimentarius, ISO 22000, HACCP, GFSI. National (India): FSSAI, BIS, AGMARK, India Organic Certification			
Total Periods			45
Text Books			
1.	Fellows, P. J. <i>Food Processing Technology: Principles and Practice</i> (5 th ed.). Elsevier, 2022.		
2.	Subbulakshmi, G., & Udipi, S. A. <i>Food Processing and Preservation</i> (2 nd ed.). New Age International Publishers, 2022.		
3.	Barbosa-Cánovas, G. V., & Ibarz, A. <i>Introduction to Food Process Engineering</i> . CRC Press, 2014.		
References			
1.	Ibarz, Albert, and Gustavo V. Barbosa-Canovas, “Introduction to Food Process Engineering”, CRC Press, 2014.		
2.	Sahu, Jatindra Kumar, “Introduction to Advanced Food Process Engineering”, CRC Press, 2014.		
3.	Earle, Richard Laurence, “Unit operations in food processing”, Elsevier, 2013.		
4.	Demam JM, “Principles of Food Chemistry”, New edition, Springer, 2018.		
5.	Gould, G. W. <i>New methods of food preservation</i> . Springer Science & Business Media, 2012.		
E-Resources			



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1.	http://www.fao.org/wairdocs/x5434e/x5434e00.html
2.	https://nptel.ac.in/courses/126105015/
3.	ps://nptel.ac.in/courses/103107088/



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
	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY							Semester							
Course Code	Course Name						Periods Per Week			Credit	Maximum Marks				
							L	T	P		C	CA	ES E	Total	
U23BTV22	Fermented Products						3	0	0	3	40	60	100		
Course Objective	The course aims enable its graduates to														
	<ul style="list-style-type: none"> Excel in the food industry as a technologists capable of ensuring the production, and marketing of safe and quality foods. Importance of Fermented Foods products in the day-to-day life. 														
Course Outcome	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Explain the evolution, principles and procedures in fermented food products.											K2			
	CO2: Identify the metabolism of microbes involved in traditional fermentation processing and maintenance of starter culture.											K2			
	CO3: Describe various fermentation products of vegetable and fruits											K3			
	CO4: Evaluate various concepts, principles and procedures involved in fermented dairy products											K3			
	CO5: practice the manufacture process of fermented meat, poultry and sea food products.											K4			
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O 2	PSO 3
CO 1	3			2		3	3						3	2	3
CO 2	3			2		3	3						3	3	3
CO 3	2	3	2	3	2	3	3					2	2	2	3
CO 4	2	3	2	3	2	3	3					2	3	2	2
CO 5	2	3	2	3	2	3	3					2	3	3	3
Pre-requisites	Microbiology, Basic Industrial Biotechnology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															


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1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO FERMENTED FOODS	Periods	9
Microorganisms in food fermentation - Intrinsic and Extrinsic parameters of foods that affect microbial growth- types of fermented foods and substrates/raw materials, Modern fermented foods industry, Properties of fermented foods, Fermented foods in the twenty-first century, Health benefits of fermented foods.			
Unit – II	TRADITIONAL FERMENTED FOOD PRODUCTS	Periods	9
Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol-based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients			
Unit – III	FERMENTED FRUIT AND VEGETABLE PRODUCTS	Periods	9
Fermented Vegetable products- Introduction, Production principles, Manufacture of Sauerkraut, pickle production, fermented olives, Kimchi, Fermented vegetables and biogenic amines. Fermented Fruit products; Wine, Grape composition, Wine manufacture principles-Harvesting and preparation of grapes, Crushing and maceration, Sulphur dioxide treatment, Separation and pressing, Types of wine, Wine spoilage and defects.			
Unit – IV	FERMENTED DAIRY PRODUCTS	Periods	9
Microorganism in Dairy fermentation -Starter culture, Dairy based fermented products - Cheese, Acidophilus milk, Butter, Yoghurt, Kefir, Kumiss, Cultured butter milk and health benefits of fermented milk and foods products.			
Unit – V	FERMENTED MEAT AND SEA FOOD PRODUCTS	Periods	9
Fermented Meats Sausages, Chicken sausage and Fish sausages- Composition, starter cultures, Principles of fermented sausage manufacturing, - Cutting and mixing, Stuffing, Casing materials, Fermentation, Cooking, drying, and smoking- Defects and spoilage of fermented meats.			
Total Periods			45
Text Books			
1.	Byong H. Lee “Fundamentals of Food Biotechnology” 2nd Edition, Wiley- Blackwell Publishers, USA, 2021.		
2.	Foster G.N “Food Biotechnology” 5th Edition, CBS Publishers and Distributors Pvt. Ltd., New Delhi. 2020.		
References			
1.	Farnworth, Edward R. “Handbook of Fermented Functional Foods” II Edition. CRC Press, 2008.		
2.	Ramesh C. Ray and Didier Montet, “Fermented Foods, Part- II Technological Interventions”, CRC Press, 2017.		
3.	Matthews K.R., Kniel K.E. and Montville T.J “Food microbiology: An Introduction”, 4 th Edn., ASM Press, Washington, DC, 2017.		
4.	Hui Y. H “Handbook of Food and Beverage Fermentation Technology”. Marcel Dekker, 2004.		
5.	B.J. Wood “Microbiology of Fermented Foods” Springer-Verlag New York Inc.; 2nd ed.2011.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc23_ag18/preview		
2.	https://nptel.ac.in/courses/102105058		
3.	https://uomustansiriyah.edu.iq/media/lectures/6/6_2017_09_25!11_14_34_PM.pdf		




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
	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY						Semester		-						
Course Code	Course Name						Periods Per Week			Credit	Maximum Marks				
							L	T	P		C	CA	ESE	Total	
U23BTV23	Dairy Technology						3	0	0	3	40	60	100		
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Provide exposure to variety of technical operations in milk and milk product processing industry and analyse the physico-chemical and functional properties of milk constituents • Apply the technologies for the production of different dairy products • Discover their own professional directions for future development in dairy sector 														
	Course Outcome At the end of the course, the student should be able to,												Knowledge Level		
CO1: Acquire knowledge on the composition of milk and the physical and chemical properties of milk.												K2			
CO2: Be familiar with the essential processes involved in milk collection, transport, and storage.												K2			
CO3: Integrate the milk product processing and packaging methods and its importance in dairy industries.												K3			
CO4: Analyse the process flow for the preparation of different dairy products.												K3			
CO5: Infer Knowledge on the key principles of cleaning and sanitization in dairy production.												K3			
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	2	1	3	1	1					2	2	1	2
CO 2	2	2	1	1	3		2					3	1	3	2
CO 3	2	1	2	2	1	2						1	2	2	2
CO 4	1	2		2	3		1	1			1	3	2	1	2
CO 5	2	2		3	1	1					1	2	2	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION	Periods	9
Overview of dairy industry- Historical development of dairy processing. Milk-Definition, composition, types- Factors affecting composition of milk, physiochemical properties of milk, Nutritive value and properties of Milk, Properties of milk-Colour, Flavour, Specific Gravity, Boiling point, Freezing point, Acidity and pH, Viscosity			
Unit – II	PRE-PROCESSING OF RAW MILK	Periods	9
Raw milk collection , cooling and transportation of raw milk, Reception of raw milk, Microbial inspection of milk, platform tests of raw milk, Filtration and Clarification of raw milk, Bactofugation of raw milk, Cooling and storage of raw milk.			
Unit – III	PROCESSING AND PACKAGING OF MILK	Periods	9
Milk Standardization, Cream Separation, Milk Homogenization, Milk Pasteurization: HTST and LTLT pasteurization, UHT Processing of milk; Processing techniques of milk powder- types; Types of packaging - pouch filling, bottle filling, aseptic filling systems; Modern packaging techniques.			
Unit – IV	MANUFACTURING OF MILK PRODUCTS	Periods	9
Manufacturing process of Cream, Butter and ghee, ice cream; Fermented milk products- Yoghurt, buttermilk, Paneer, cheese; Production of dried milk-whole milk and skim milk powder. Production process of Plant based milk-soy milk, almond milk, oat milk.			
Unit – V	CLEANING AND SANITIZATION OF DAIRY INDUSTRIES	Periods	9
Introduction to Cleaning in- place (CIP) flow system ,types of CIP system, SIP system of dairy plant; cleaning solutions-common dairy detergents and their properties, common dairy sanitizers and their properties; Assessment of effectiveness of cleaning and sanitization.			
Total Periods			45
Text Books			
1.	Sukumar De, "Outlines of Dairy Technology", 46th Edition, Royal Oxford University Press, New Delhi, 2019.		
2.	Robinson R.K., "Modern Dairy Technology: Advances in Milk Products", Volume 2, Springer London Ltd., 2012.		
References			
1.	Murlidhar Meghwal, Megh R Goyal, Rupesh S Chavan, "Dairy Engineering, Advanced Technologies& their application", Apple Academic press Inc, 2017.		
2.	Hui,Y.H., "Dairy Science and Technology Handbook: Applications Science, Technology and Engineering, Volume 3, Wiley, New Delhi ,2014.		
3.	Tufail Ahmad, "Dairy Plant Engineering and Management", Kitab Mahal Publishers, New Delhi, 2016.		
4.	Singh Shivashraya,"Dairy Products and Quality Assurance: Vol.2", New India Publishing Agency,2014.		
E-Resources			
1.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=6100		
2.	https://www.dairyknowledge.in/dkp/section/dairy-technology		
3.	https://www.agrignan.in/p/btechdairy-technology-notes.html		




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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV24	Food additives and Nutraceuticals	3	0	0	3	40	60	100							
Course Objective	To provide deeper insight to students on role of food additives and nutraceuticals on food Product Development.														
Course Outcome	On completion of the course, the students will be able to										Knowledge Level				
	CO1:select appropriate preservatives and antioxidants.										K2				
	CO2:choose suitable food colours, flavours, emulsifiers and stabilizers										K3				
	CO3:relate the safety, regulations and quality standards to food additives in food processing										K3				
	CO4:identify technology to recover nutraceuticals.										K3				
	CO5:identify the effect of nutraceuticals in health promotion and disease prevention										K4				
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	1		3					1		2	2	3	3
CO 2	3	3	2		2			2		1		2	2	3	3
CO 3	3	3	2		2	2		2		2		2	2	1	3
CO 4	3	3	1		1	2				2		2	2	3	3
CO 5	3	3	2		1	2				1		3	3	2	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	FOOD PRESERVATIVES AND											Periods	9		


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ANTIOXIDANTS			
Definition; Types and functions of food additives in food processing. Preservatives: natural preservatives; chemical preservatives; acidulants, organic acids and esters; sulphur dioxide and its salts; nitrites; antibiotics; surface preservation; Permitted preservatives in foods as per FSSAI. Antioxidants: Types; mechanism of antioxidant function; primary and secondary antioxidants; selection and application of antioxidants in foods; permitted antioxidants in foods.			
Unit – II	FOOD ADDITIVES	Periods	9
Natural and synthetic colorants; types and application in food industry; Non permitted colorants - Flavoring agents –concept of flavors in foods; natural flavors & artificial flavoring substances; Emulsifiers and Stabilizers - properties of HLB value; function of emulsifiers and stabilizers in foods; permitted emulsifiers and stabilizers used in foods.			
Unit – III	SAFETY, REGULATION AND QUALITY STANDARDS	Periods	9
Safety limits of Food additives; FSSAI regulations and GRAS additives Risk assessment and risk benefit Indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, teratogenicity, neurotoxicity and behavioral effect, immune toxicity. Limit determination for addition – NOEL – Method of determining toxicity – LD50. FSSAI regulations and GRAS additives			
Unit – IV	FUNCTIONAL FOODS AND NUTRACEUTICALS	Periods	9
Introduction, definition. Difference between functional foods and nutraceuticals. Examples for fortified functional foods. Plant and animal based nutraceuticals. Health benefits of Polyphenols, Flavonoids, Omega-3 Fatty Acids, Carotenoids. Technologies to recover Nutraceuticals compounds: Distillation, ultrahydrostatic pressure treatment, dense carbon-di-oxide treatment, encapsulation of nutraceuticals – materials, mechanical processes and chemical based processes, nano encapsulation.			
Unit – V	HEALTH PROMOTION AND DISEASE PREVENTION	Periods	9
Nutraceuticals in prevention and treatment of gastrointestinal disorder, Probiotics Cardiovascular and Chronic Diseases. End User Market Products with current product updates - supplements forms- tablets, capsules, powders, soft gels, gel caps, liquids; Nutraceuticals currently available in the market, regulation for nutraceuticals.			
Total Periods			45
Text Books			
1.	Wildman, Robert E.C, "Book of Nutraceuticals and Functional Foods", 2 nd Edition, CRC Press, New York, 2006		
2.	John Shi, Chi-Tang Ho and Fereidoon Shahidi "Asian Functional Foods", CRC Press, 2005.		
References			
1.	Belitz H.D., Grosch W. and Schieberle P, "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.		
2.	Clare M. Hasler, "Regulation of Functional Foods and Nutraceuticals: A Global Perspective", 1 st Edition, Wiley, Chicago, 2008.		
3.	Lockwood, Brian, and Rapport, Lisa, —Nutraceuticals: A Guide for Healthcare Professionals, Pharmaceutical Press, 2007.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/126/105/126105013/#		
2.	https://onlinecourses.nptel.ac.in/noc24_ag03/preview		



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV25	Food Quality and Safety Standards	3	0	0	3	40	60	100							
Course Objective	To give insight on food quality, safety and its regulatory standards.														
Course Outcome	On completion of the course, the students will be able to							Knowledge Level							
	CO1:interpret the concepts of quality and safety in food processing							K2							
	CO2: apply principles of quality assurance and safety in food industries							K3							
	CO3: analyze and categorize sampling and statistical quality control techniques							K3							
	CO4: outline suitable food quality and Safety standards							K3							
CO5: classify various regulations for food business operator							K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2– Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	1	3			3		2		1		1	1	2	3
CO 2	3	2	3	2		3		2		1		1	2	2	3
CO 3	3	3	3	3	1	3				2		1	2	3	2
CO 4	3	1	3			3		2		2		2	3	2	2
CO 5	3	2	3			3		2		2		2	3	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	FOOD QUALITY AND SAFETY										Periods	9			
Quality and Safety concepts. Characterization of food hazards – physical, chemical and biological.															


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Food spoilage and food borne infection –sources of food spoilage- microbial aspects in food safety- food toxicants and food poisoning –prevention. Cross contamination.			
Unit – II	QUALITY ASSURANCE IN FOOD INDUSTRY	Periods	9
Objectives, importance and functions of quality control and quality assurance - Quality Control and Assurance procedures, HACCP, Good Manufacturing Practice, Good Laboratory Practices, Good Hygiene Practices.			
Unit – III	SAMPLING AND STATISTICAL QUALITY CONTROL	Periods	9
Sampling- concept, methods and importance. Statistical Process and Quality Control – concept, importance and tools. Control charts: importance, types, design process, Control limits and errors, Process Capability.			
Unit – IV	QUALITY AND SAFETY STANDARDS	Periods	9
Quality Standards – mandatory and optional standards. Mechanism of developing and fixing food standards. Food Safety Systems – ISO 22000, FSSC 22000. National organizations: BIS, CCFS, AGMARK and APEDA. Standards of Weights and Measures. Organic food certification-POP, NPOP. International organizations: ISO, CAC, WTO, USFDA, EIC.			
Unit – V	REGULATIONS FOR FOOD BUSINESS OPERATOR	Periods	9
Food adulteration and food safety, Food laws – Food Safety and Standards Act (FSSAI), Prevention of Food Adulteration Act, Packaged Commodities Rules, Functions of Food Business Operator, QA Audit, IPR and Patents, Issues affecting consumers and industry – Genetically Modified Foods, Fortification, Pesticide Residues, Organic Foods, Food Additives.			
Total Periods			45
Text Books			
1.	Inteaz Alli, "Food Quality Assurance: Principles and Practices", 2 nd Edition, Taylor and Francis, UK, 2014.		
2.	Andres Vasconcellos J. Quality Assurance for the Food industry - A practical approach. CRC press, London, UK. 2005.		
References			
1.	Schmidt, R.H. and Rodrick, G.E, "Food Safety Handbook", 2 nd Edition, John Wiley & Sons Inc, New Jersey, 2005.		
2.	Sara Mortimore and Carol Wallace. HACCP - A practical approach. Third edition. Chapman and Hall, London, 2013.		
3.	Roday, S. Food Hygiene and Sanitation, Tata McGraw-Hill Education, 1998.		
E-Resources			
1.	https://onlinecourses.swayam2.ac.in/cec20_ag06/preview		
2.	https://onlinecourses.nptel.ac.in/noc24_ge65/preview		


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Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY						Semester		-						
Course Code	Course Name					Periods Per Week			Credit	Maximum Marks					
						L	T	P		C	CA	ESE	Total		
U23BTV26	Bakery and Confectionery Products					3	0	0	3	40	60	100			
Course Objective	The main objective of this course is to:														
	<ul style="list-style-type: none"> Understand the basic principles of baking technology and to get familiarize with equipment's for baking. Acquire Knowledge on ingredients in bread baking process and manufacturing of different bakery products. Learn the key aspects of ingredients and technology in production of confectionery products 														
	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Outline the role of ingredients in bakery industry											K2			
Course Outcome	CO2: Select appropriate equipment for baking process and relate the rheological properties of dough											K3			
	CO3: Classify the types of bread making process and chemistry, defects of bread formation											K3			
	CO4: Illustrate the processing techniques for preparation of miscellaneous bakery products											K3			
	CO5: Apply the processing techniques to formulate different confectionery products											K3			
	CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	2	2		2	2	1				1	3	1	
CO 2	3	2	3	2		1	2	2				2	2	2	3
CO 3	3	3	3	2		2	2	1				2	2	2	2
CO 4	3	3	3	2		2	2	2				2	3	2	3
CO 5	3	3	3	1		2	2	1				2	3	2	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															


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3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO BAKING AND ITS INGREDIENTS	Periods	9
Classification of bakery products; Bakery Ingredients-Types and its functions- flour, yeast, sugar, fat, egg, , salt, coloring agents, flavoring agents; Moistening agents- water, milk, milk powder, emulsifiers, leaving agents in bakery products, antioxidants and improvers.			
Unit – II	PRINCIPLES OF BAKING & EQUIPMENTS	Periods	9
Types of equipment used in baking process; Mixing- Bread Dough Mixers, Biscuit Dough Mixers, Cake Mixers, Pastry Mixers, Proving & Retarding, Shaping & Panning- Dividing, Rounding, Sheeting and Laminating; Fermentation enclosures; Ovens and Slicers; Extrusion. Rheology of dough-Farinograph, Amylograph, Alveograph and Extensiograph.			
Unit – III	BREAD MAKING PROCESS	Periods	9
Chemistry of Dough Development. Bread making methods- Straight dough/bulk fermentation, Sponge and dough, Activated dough development, Chorleywood bread process, No time process. Characteristics of good bread- Internal and external characters. Bread defects/faults and remedies. Spoilage of bread.			
Unit – IV	BAKERY PRODUCTS	Periods	9
Production of cookies/biscuits- ingredients and its functions; Types of dough –Developed dough, short dough's, semi-sweet and enzyme modified dough and batters, importance of the consistency of the dough. Production process of Cake making- Ingredients and its function, Icing and decoration for cakes, Egg less cake, Wafers, puff pastry.			
Unit – V	CONFECTIONERY PRODUCTS	Periods	9
Definition, Ingredients, Formulation, Processing method and Types of confectionery products - Candy, Toffees, fudge, caramel; Aerated confectionery- Methods of aeration- Manufacturing process ; Bubble gums and chewing gums; Chocolate Processing –chocolate shells, candy bars; Confectionery product quality parameters, faults and corrective measures. Spoilage of confectionery products.			
Total Periods			45
Text Books			
1.	Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Springer, US, 2008		
2.	W. P. Edwards, "The Science of Bakery Products", United Kingdom: Royal Society of Chemistry, 2015.		
References			
1.	Geoff Talbot, "Science and technology of enrobed and filled chocolate, confectionery and bakery products", Wood head publishing, 2009		
2.	Ferenc A. Mohos, "Confectionery and Chocolate Engineering: Principles and Applications", Wiley Blackwell, UK, 2010.		
3.	Cauvain, Stanley P, and Young, Linda S., "Technology of Bread Making", 2 nd Edition, Aspen publication, Maryland, 1999.		
4.	Weibiao Zhou and Y. H. Hui, "Bakery Products Science and Technology", 2nd Edition, Wiley Blackwell, US, 2014.		
5.	Yogambal Ashok kumar, "Text book of Bakery and Confectionery", 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2012.		
E-Resources			
1.	https://www.cbse.gov.in/publications/vocational/Bakery%20and%20Confectionery/Confectionery%20Final%202.pdf		


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2.	http://ecoursesonline.iasri.res.in/course/view.php?id=647
3.	https://ycmou.ac.in/media/publication/ycmou_book/RVV_YB_130.pdf
4.	https://nios.ac.in/media/documents/bakery/Lesson%201%20Ingredients%20and%20Equipments.pdf



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23BTV27	Food Packaging Technology	3	0	0	3	40	60	100							
Course Objective	The student should be made to														
	<ul style="list-style-type: none"> Recall the types of packaging materials and their characteristics. Explain the different food packaging systems and their requirements based on product characteristics. Interpret the Food Safety and Standards (Packaging) Regulations, 2018, and the required nutritional labeling. Apply advanced packaging techniques such as active and modified atmosphere packaging. Analyze various testing methods for flexible, rigid, and semi-rigid packaging materials. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Recall the different types of packaging materials and describe their characteristics and uses in the food industry.							K1							
	CO2: Explain and demonstrate the application of different food packaging systems based on product characteristics.							K2							
	CO3: Interpret the Food Safety and Standards (Packaging) Regulations, 2018, and summarize the key packaging regulations and labeling requirements.							K2							
	CO4: Apply advanced packaging techniques, such as active and modified atmosphere packaging, to real-world food preservation challenges.							K3							
	CO5: Analyze various testing methods for packaging materials and assess their performance based on different testing criteria.							K4							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	1	-	2	-	1	-	1	-	2	3	2	1
CO2	2	3	2	1	1	1	-	-	1	2	2	2	2	2	2
CO3	2	2	3	2	3	2	-	1	2	2	1	2	2	3	3
CO4	3	3	2	3	2	2	-	2	1	1	1	3	2	2	2
CO5	3	3	3	2	3	2	-	2	2	3	3	3	1	3	3
Pre-requisites	--														
Course Assessment Methods															
Direct															

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1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	FOOD PACKAGING AND USAGE OF MATERIALS	Periods	9
Introduction of Food packaging - Role of packaging in extending the shelf life of foods - Types of packaging materials (paper, glass metal and plastic) characteristics and uses.			
Unit – II	FOOD PACKAGING SYSTEMS	Periods	9
Food packaging systems - Product characteristics and package requirements - Different forms of packaging - Rigid, semi-rigid, flexible forms of packaging - Packaging system for Frozen foods, Dairy products, Meat, Poultry, Seafoods, Fruits and Vegetables.			
Unit – III	PACKAGING AND LABELLING REGULATIONS	Periods	9
Food Safety and Standards (Packaging) Regulations, 2018 - Specific Requirements for Primary food Packaging – Schedule I – Schedule II – Schedule III – Schedule IV - List of suggestive packaging materials mentioned under Schedule IV - Nutritional labelling on packages			
Unit – IV	ADVANCED TECHNIQUES OF PACKAGING	Periods	9
Package accessories and advances in Packaging Technology-Introduction - Active packaging - Modified atmosphere packaging - Controlled Atmosphere Packaging – Gas Packaging – Seal and Shrink Packaging – Retort Pouches - Biodegradable plastics			
Unit – V	TESTING METHODS FOR PACKAGING MATERIALS	Periods	9
Testing methods for flexible materials, rigid materials, and semi-rigid materials - Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test.) - Plastic (thickness, tensile strength, gloss, haze, burning test to identify polymer) - Glass containers (visual defects, colour, dimensions, impact strength, etc.) - Metal containers (pressure test, product compatibility)			
Total Periods			45
Text Books			
1.	Gordon L. Robertson, Food Packaging: Principles and Practice, Third Edition, 2013		
2.	Gordon L. Robertson, Food Packaging and Shelf Life: A Practical Guide, 2010		
References			
1.	Coles, R., McDowell, D., Kirwan, M .J. Food Packaging Technology. Blackwell Publishing Co, 2003		
2.	Mahadevia, M., Gowramma, R.V, Food Packaging Materials. Tata McGraw Hill,2007		
3.	John, P.J, A Handbook on Food Packaging Narendra Publishing House, 2008		
4.	Coles R., McDowell D. and Kirwan, M.J, Food Packaging Technology, Blackwell Publishing Co, 2003		
E-Resources			
1.	https://fssai.gov.in/upload/uploadfiles/files/Compendium_Packaging_Regulations.pdf		
2.	https://onlinecourses.nptel.ac.in/noc23_ge32/preview		



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV28	Food Microbiology	3	0	0	3	40	60	100							
Course Objective	<p>The main objective of this course is to</p> <ul style="list-style-type: none"> Understand the Microbial Role in Food Systems Analyze Factors Influencing Food Spoilage Study Food borne Pathogens and Diseases Explore Food Preservation Techniques Implement Microbial Quality Control in Food Safety. 														
Course Outcome	Students who complete this course successfully are expected to						Knowledge Level								
	CO1: Discuss the role of microorganisms in food systems						K2								
	CO2: Identify and analyze the causes of food spoilage						K3								
	CO3: Recognize and control foodborne pathogens						K3								
	CO4: Apply preservation methods to ensure food safety						K3								
CO5: Implement quality control practices in food processing						K4									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	2	2	2	2	3	3	-	-	1	3	3	2	3
CO 2	3	2	2	2	2	2	3	3	-	-	2	3	3	2	3
CO 3	3	2	2	3	3	2	3	2	-	2	2	3	3	2	3
CO 4	3	3	3	3	3	3	3	2	-	2	2	3	3	2	3
CO 5	3	3	3	3	3	3	3	3	-	-	1	3	3	3	3
Pre-requisites	Microbiology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															

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Unit – I	FOOD MICROBIOLOGY	Periods	9
Quality control in food microbiology: HACCP (Hazard Analysis and Critical Control Points) and GMP (Good Manufacturing Practices) - Rapid detection methods for microbial contaminants: PCR, immunoassays, and biosensors - Development of functional foods. Probiotics, Fermented foods, and the benefits of microorganisms in food.			
Unit – II	MICROORGANISMS IN FOOD: TAXONOMY, SOURCES, AND GROWTH FACTORS	Periods	9
Microbial taxonomy and characteristics of bacteria, yeasts, molds, and viruses associated with food- Sources of microorganisms in food: Raw materials, processing, handling, and storage- Factors affecting microbial growth in food. Food Matrix and Microbial Behavior.			
Unit – III	FOOD SPOILAGE AND CONTAMINATION	Periods	9
Microbial taxonomy and characteristics of bacteria, yeasts, molds, and viruses associated with food- Sources of microorganisms in food: Raw materials, processing, handling, and storage- Factors affecting microbial growth in food. Food Matrix and Microbial Behavior.			
Unit – IV	FOOD BORNE PATHOGENS AND DISEASES	Periods	9
Common foodborne pathogens: <i>Salmonella</i> , <i>E. coli</i> , <i>Listeria</i> , <i>Staphylococcus</i> , and <i>Clostridium botulinum</i> . Emerging foodborne pathogens and toxins - transmission and symptoms of foodborne illnesses. Diagnosis of foodborne pathogens- Preventive measures and outbreak management.			
Unit – V	FOOD PRESERVATION AND CONTROL	Periods	9
Principles of food preservation: Physical, chemical, and biological methods- Thermal processing: Pasteurization, sterilization, and canning –Non-thermal methods: Irradiation, high-pressure processing, and pulsed electric field.- Role of natural antimicrobial agents and preservatives in food safety- Probiotics and bacteriocins in food microbiology.			
Total Periods			45
Text Books			
1.	P. J. Fellows. Food Processing Technology: Principles and Practice, 4 th Edition, Woodhead Publishing, Cambridge, 2021.		
2.	William C. Frazier and Dennis C. Westhoff, Food Microbiology, 5 th Edition, McGraw-Hill Education, New York, 2019.		
References			
1.	James M. Jay, Martin J. Loessner, and David A. Golden, Modern Food Microbiology, 8 th Edition, Springer, New York, 2012.		
2.	M. R. Adams and M. O. Moss, Food Microbiology, 4 th Edition, Royal Society of Chemistry, Cambridge, 2016.		
3.	Vijay K. Juneja and John N. Sofos, Pathogens and Toxins in Foods: Challenges and Interventions, ASM Press, Washington, DC, 2010.		
E-Resources			
1.	https://www.icmsf.org/		
2.	https://www.ift.org/		
3.	https://www.efsa.europa.eu/		


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Programme	B.Tech.	Programme Code	105	Regulation	2023			
Department	BIOTECHNOLOGY			Semester	-			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U23BTV29	FOOD NUTRITION AND HEALTH SCIENCE	3	0	0	3	40	60	100
Course Objective	The student should be made to, <ul style="list-style-type: none"> Understand the role and importance of food and nutrition for the welfare of the community and acquire the skills in planning diet Understand the concept of adequate diet and the importance of nutrients in recommended Dietary Allowances Understand the foundation sciences which underpin therapeutic dietetic practice, the principles of disease prevention and health promotion 							
Course Outcome	the end of the course, the student should be able to,						Knowledge Level	
	CO1: Discuss the role of nutrients, their requirements and the effect of deficiency and excess						K2	
	CO2: Implement Nutrient rich diet in our daily routine						K3	
	CO3: Contrast and evaluate the roles of nutrition within the complex process of pregnancy, lactation, child development and ageing						K3	
	CO4: Recognize the relationship between food, nutrition, health and hygiene						K4	
CO5 Explain about the role of food in human health						K4		
Pre-requisites	-							

COs	CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	2	1	3			1			3				2	2	2
CO 2	3	1	3						2				2	2	2
CO 3	2	2	3	2					2				3	2	1
CO 4	2	2	3	2		1			1			2	3	2	2
CO 5	2	2	3	1		1			2			2	3	2	2


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO NUTRITION	Periods	9
Nutrition, Recommended Dietary Intakes (RDI)- The Indian Nutrition Scenario- FAO/WHO expert committee recommendations- Guidelines for good health- Five food groups and the food pyramid- Malnutrition-Digestion and absorption Process.			
Unit - II	ROLE OF NUTRIENTS	Periods	9
Carbohydrates, Fats, Proteins, Vitamins, Minerals, Water, Electrolyte and Acid-Base balance- Balanced Diet- Menu planning for the family, Energy Balance, BMI, BMR, Factors affecting the BMR.			
Unit – III	NUTRITION DURING NORMAL LIFE CYCLE	Periods	9
Developing good eating habits, Nutritional requirement of different age groups -Nutrition during pregnancy & during lactation, Nutrition during Infancy, Toddlers(1-3 years), Adolescence, Adults, Old age, Parameters of fitness, fitness tests.			
Unit - IV	FOOD SANITATION	Periods	9
Food Borne diseases in food preparation, preservation, processing and service, Cause-Microorganisms, Chemical and Physical ,Safe handling of foods, Food allergy and Food intolerance- Definitions, Symptoms, Risk factors, Diagnosis, Treatment. Prevention, Food additives ,Food Adulteration.			
Unit – V	DIET THERAPY	Periods	9
Indian Dietetic Association(IDA)-Therapeutic Diet and it's types- Nutrition for over weight management and underweight person, General dietary considerations for healthy gut- Dietary modification in infection and fevers.			
Total Periods			45
Text Books			
1.	Shubhangini A Joshi, "Nutrition and dietetics with Indian case studies", McGraw Hill education, 4 th edition 2015.		
2.	B Srilakshmi , "Dietetics", New age international publishers, 2019.		
3.	L Kathleen Mahan et.al, "Krause's food and the nutrition care process", Saunders, 14 th edition 2016.		
References			
1.	B Srilakshmi , "Nutrition Science", New age international publishers, 2021.		
2.	Pooja verma, "Food & Nutritional Science", CBS Publishers, 2020.		
3.	Sumathi R et al, "Fundamentals of foods, Nutrition and diet therapy", New age international publishers, 2020.		
4.	Sunetra roday, "Food science and Nutrition", Oxford university press, 2018.		
E-Resources			
1.	https://onlinecourses.swayam2.ac.in/cec19_ag02/preview		
2.	https://ciet.nic.in/swayam_FNHL.php		
3.	https://www.agmoocs.in/node/299		



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VERTICAL III

Industrial Biotechnology

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Programme	B.Tech	Programme Code				105	Regulation			2023					
Department	BIOTECHNOLOGY					Semester			-						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV31	Basic Industrial Biotechnology	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> • Enable students to understand the fundamental concepts and applications of biotechnology in industrial processes. • It emphasizes the use of microorganisms, enzymes, and biotechnological systems in the production of industrially important products. • Students will gain an understanding of the industrial bioprocessing, fermentation techniques, and downstream processing involved in biotechnology industries. 														
Course Outcome	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Understand the role of biotechnology in industrial processes and applications.											K2			
	CO2: Identify and utilize microorganisms and enzymes for industrial production.											K2			
	CO3: Describe the principles of fermentation technology and bioreactor design.											K3			
	CO4: Analyze the process of downstream processing and product recovery.											K3			
	CO5: Evaluate case studies of industrial biotechnology applications and their global impact.											K3			
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	2	1	3	1	1					2	2	1	2
CO 2	2	2	1	1	3		2					3	1	3	2
CO 3	2	1	2	2	1	1						1	2	2	2
CO 4	1	2		2	3		1	1			1	3	2	1	2
CO 5	2	2		3	1	1					1	2	2	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	Introduction to Industrial Biotechnology	Periods	9
Scope and significance of industrial biotechnology. Role of biotechnology in industries: Biopharmaceuticals, food, and biofuels. Types of industrial microorganisms: Bacteria, fungi, and yeasts. Industrially important enzymes: Amylase, protease, lipase, cellulase.			
Unit – II	Fermentation Technology	Periods	9
Fundamentals of fermentation: Types (batch, continuous, fed-batch). Design and operation of fermenters: Aerobic and anaerobic fermenters. Media formulation for industrial fermentation. Scaling up of fermentation processes.			
Unit – III	Bioreactor Design and Operation	Periods	9
Types of bioreactors: Stirred tank, airlift, fluidized bed, and membrane bioreactors. Monitoring and control of parameters: pH, temperature, aeration, agitation. Process optimization in bioreactors. Bioprocess instrumentation and automation.			
Unit – IV	Downstream Processing	Periods	9
Overview of downstream processing and product recovery. Steps in downstream processing: Cell disruption, filtration, centrifugation, and chromatography. Product purification and formulation.			
Unit – V	Applications of Industrial Biotechnology	Periods	9
Bioplastics, bioethanol, and biodiesel production. Production of organic acids (Citric acid and Acetic acid). Biopharmaceuticals: Insulin, vaccines, and monoclonal antibodies. Environmental biotechnology: Bioremediation and wastewater treatment.			
Total Periods			45
Text Books			
1.	Mukherjee, S., & Ghosh, A. (2020). Industrial Biotechnology: Fundamentals and Applications. CRC Press.		
2.	Satyanarayana, U. (2017). Biotechnology. Books and Allied Pvt. Ltd.		
3.	Dubey, R. C. (2014). A Textbook of Biotechnology. S. Chand & Company.		
References			
1.	Shuler, M. L., & Kargi, F. (2017). Bioprocess Engineering: Basic Concepts (3rd Edition). Pearson Education.		
2.	Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of Fermentation Technology (3rd Edition). Elsevier.		
3.	Crueger, W., & Crueger, A. (2008). Biotechnology: A Textbook of Industrial Microbiology (3rd Edition). Panima Publishing Corporation.		
4.	Glazer, A. N., & Nikaïdo, H. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press.		
5.	Ratledge, C., & Kristiansen, B. (2006). Basic Biotechnology (3rd Edition). Cambridge University Press.		
E-Resources			
1.	https://www.edx.org/course/industrial-biotechnology		
2.	https://www.coursera.org/learn/industrial-biotechnology		
3.	https://ocw.mit.edu/courses/chemical-engineering/10-445-introduction-to-biochemical-engineering/		

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Programme	B.Tech.	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV32	FERMENTATION TECHNOLOGY	3	0	0	3	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> Recognize the overall industrial fermentation process and the process flow sheet. Understand the knowledge on sterilization process. Understand the recovery and purification process. Apply the knowledge for the production of modern biological products. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO 1 :Recall the basics of industrial fermentation and other processes							K1							
	CO 2 :Extend their knowledge on sterilization process							K2							
	CO 3 :Extend their knowledge on design of bioreactor							K3							
	CO 4 : Extend their knowledge on recovery and purification processes in fermentation industries							K4							
CO 5:Support for the commercial production of modern biological products.							K4								
Pre-requisites	Nil														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	3	2	2			3	2			2		3		
CO 2	2	2	3	2	3		2	3			3		2	2	
CO 3	2	3	3		3		2	2			2		3	2	
CO 4	2	2	3	2	2		2				2	1	2		
CO 5	2	3	3	2	3		3	2			2	2	2	2	
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	INTRODUCTION TO FERMENTATION										Periods	9			

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TECHNOLOGY			
Industrial Fermentation, Substrates used for Industrial Fermentation (Carbon and Nitrogen Sources), Methods of Fermentation: Batch, Fed Batch and Continuous, Different stages of fermentation process, Fermentation medium, Isolation and screening of industrially important microorganisms – primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology.			
Unit – II	STERILIZATION PROCESSES & KINETICS	Periods	9
Kinetics of media sterilization, Design of batch and continuous sterilization processes. Calculation of Del factor and holding time. Richard's rapid methods of design of sterilization process. Scale up of batch sterilization process. Methods of air sterilization process. Design of air filters, effects of bed depth and air velocity on filtration.			
Unit – III	DESIGN OF FERMENTOR	Periods	9
Fermentor – basic design – Body construction and components (agitator, baffles, probes and valves) – Design of packed bed reactor, air lift and stirred tank reactor – use of computer in reactor			
Unit – IV	DOWN STREAM PROCESSING	Periods	9
Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis.			
Unit – V	MODERN FERMENTATION TECHNOLOGY	Periods	9
Microbial fungicides and Pesticides, Chemicals and Pharmaceuticals products made by fermentation, Fermented food products – Beer, Wine, - Biopolymers. Microbial leaching, Effluent treatment using microbes, Future of fermentation technology and its products.			
Total Periods			45
Text Books			
1.	Bryce C F A., and Mansi E L., “Fermentation microbiology & Biotechnology”, 3 rd Edition CRC Press, 2011.		
2.	Dubey R C, “A Textbook of Biotechnology” 5 th revised Edition S. Chand Publishing. Ltd, 2014.		
References			
1.	Satyanarayana U, “Biotechnology” Books And Allied (p) Limited, 2013 .		
2.	Presscott S C., and Cecil G Dunn., “Industrial Microbiology”, Agrobios (India), 2005.		
3.	CrugerWulf., and AnnelieseCrueger., “Biotechnology: A Textbook of Industrial Microbiology”, 2 nd Edition, Panima Publishing, 2000.		
4.	Kumar H D, “A Textbook on Biotechnology” 2 nd Edition. Affiliated East West Press Pvt.Ltd, 1998.		
5.	Ratledge Colin and Bjorn Kristiansen, “Basic Biotechnology” 2 nd Edition Cambridge University Press, 2001.		
E-Resources			
1.	https://nptel.ac.in/courses/102105058/		
2.	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/102105064/lec4.pdf		
3.	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/102105058/lec18.pdf		


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


Programme	B.Tech	Programme Code	105	Regulation	2023									
Department	BIOTECHNOLOGY			Semester	-									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks								
		L	T	P		C	CA	ESE	Total					
U23BTV33	Analytical Techniques in Bioindustries	3	0	0	3	40	60	100						
Course Objective	<p>The student should be made to,</p> <ul style="list-style-type: none"> Recall the fundamental principles of microscopy, including image formation, resolving power, and types of microscopy. Explain the principles and applications of colorimetry and spectroscopy techniques. Identify the concepts of radioisotope techniques and methods for detecting and analyzing radioactivity. Analyze electrophoresis techniques and their applications in molecular separation and detection. Examine chromatographic techniques for separation, purification, and analysis of biomolecules. 													
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level						
	CO1: List the basic concepts, principles, and components of microscopy and describe different types of microscopes.							K1						
	CO2: Summarize the working principles and applications of spectroscopy techniques in qualitative and quantitative analysis.							K2						
	CO3: Apply radioisotope techniques and detection methods for analyzing samples in research and diagnostics.							K3						
	CO4: Examine electrophoresis methods to separate, detect, and analyze biomolecules in biological samples.							K4						
	CO5: Dissect chromatographic techniques to evaluate the separation and purification of biomolecules.							K4						
Pre-requisites	-													
CO / PO Mapping												CO/PSO Mapping		
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak														
Programme Outcomes (POs)												PSOs		
COs	PO 1	PO 2	PO 3	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	2	1	2	3	2	1
CO2	3	3	2	2	-	-	-	-	2	2	3	3	3	2

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CO3	3	3	3	2	1	2	-	1	2	2	3	3	3	3
CO4	3	3	3	3	1	2	-	2	3	3	3	3	3	3
CO5	3	3	3	3	1	2	-	1	3	3	3	3	3	3
Course Assessment Methods														
Direct														
1. Continuous Assessment Test I, II & III														
2. Assignment														
3. End-Semester examinations														
Indirect														
1. Course - end survey														
Content of the syllabus														
Unit – I	MICROSCOPY										Periods	9		
Basic Concepts in Microscopy – Absorption, Refraction, Diffraction, Dispersion, Magnification, Interference, Resolution/Resolving Power, Numerical Aperture, Image formation theory, Snells law - Components of microscope – Properties of Objective lens – Types of microscopy – Light (Bright Field, Dark Field, Fluorescence, Phase Contrast) – Electron (Transmission Electron Microscopy(TEM), Scanning Electron Microscopy (SEM), Atomic Force Microscopy(AFM).														
Unit - II	COLORIMETRY AND SPECTROSCOPY										Periods	9		
Properties of electromagnetic radiation - interaction with matter; Beer-Lambert's Law - differences between spectrophotometer and colorimeter - Visible light spectroscopy: Principle, instrumentation and applications, Atomic absorption spectroscopy, Thermogravimetric analysis, Spectrofluorimetry, FTIR, NMR and Mass spectrometry, Matrix-Assisted Laser Desorption/Ionization (MALDI)														
Unit – III	RADIOISOTOPE TECHNIQUES										Periods	9		
Radiation – Radioisotope - History of Radioactivity – Types of Radioactive Decay - Methods of Detecting Radioactivity – Ionization of Gases - Geiger-Müller Counters and Scintillation Counters – Autoradiography – Radioimmunoassay – Applications of Radioisotopes														
Unit – IV	ELECTROPHORESIS										Periods	9		
Theory and applications of electrophoresis – Horizontal Gel Electrophoresis, Native Gel Electrophoresis, Sodium Dodecyl Sulfate (SDS) PAGE, 2D Electrophoresis - Isoelectric focusing, Protein Detection Methods – Pulsed Field Gel Electrophoresis – Immunoelectrophoresis – Capillary Electrophoresis														
Unit – V	CHROMATOGRAPHIC TECHNIQUES										Periods	9		
Introduction to Chromatography, Principles of Chromatography, Size Exclusion, Ion Exchange, Affinity Chromatography- Low Performance Liquid Chromatography – High Performance Liquid Chromatography (HPLC), Gas-liquid chromatography (GLC), GC-MS, LC-MS														
												Total Periods	45	
Text Books														
1.	Friefelder. D., Physical Biochemistry, Application to Biochemistry and Molecular													



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	Biology, W.H. Freeman and Company, San Francisco, 2 nd edition, 1982
2.	Douglas A Skoog, Donald M West, F. James Holler, Stanley R Crouch, Fundamentals of analytical chemistry, Thomson, Brooks/cole, 9 th edition, 2014
References	
1.	Andreas Hofmann and Samuel Clokie, Wilson And Walker's Principles And Techniques of Biochemistry And Molecular Biology, Cambridge University Press, 8 th Edition, 2018
2.	Goutam Bhowmik, Analytical Techniques In Biotechnology, Tata McGraw Hill Education Private Limited, 2010
3.	Seidman and Moore, Basic laboratory methods for biotechnology, Longman, 2 nd Edition, 2009
4.	B.K. Sharma, Instrumental methods of chemical analysis Goel publishing housing, Meerut, 24 th revised and enlarged edition, 2005
E-Resources	
1.	https://nptel.ac.in/courses/102/107/102107028/
2.	https://nptel.ac.in/courses/102/103/102103044/
3.	https://nptel.ac.in/courses/103/108/103108100/
4.	https://archive.nptel.ac.in/courses/102/107/102107028/



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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		I.	T	P		C	CA	ESE	Total						
U23BTV34	Instrumentation and Process Control	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To impart the basic concepts of process control and instrumentation in process industries. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Understand the importance of instrumentation and measurement of temperature in process industries.							K2							
	CO2: Understand the working of various pressure, flow and level measuring instruments.							K2							
	CO3: know of systems and their responses to different input methods.							K3							
	CO4: Understand the principles of controllers and control elements for different applications & to development of block diagram.							K2							
	CO5: Familiarize with the control process using Distributed Control System							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	3	2	2	2	-	-	-	-	-	-	2	2	3	3	2
CO 2	3	2	2	2	-	2	-	-	-	2	-	-	3	3	2
CO 3	3	3	2	3	-	-	-	-	-	-	2	-	3	3	2
CO 4	3	3	2	2	2	2	-	-	2	-	-	-	3	2	2
CO 5	2	2	2	-	-	-	-	2	-	2	-	-	3	2	2
Pre-requisites	Thermodynamics and Heat & Mass Transfer														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															



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Content of the syllabus			
Unit – I	BASIC CONCEPT OF MEASUREMENT AND MEASUREMENT OF TEMPERATURE	Periods	9
Purpose of Instrumentation – Measurement and its aim- Functional elements of Instruments – Static and Dynamic characteristics of Instruments - Signalling and Recording Instruments – Circular and Strip chart-Instrumentation diagram. Temperature - Temperature measuring instruments - Bimetallic Thermometer- RTD - Thermocouples – Temperature Transmitter.			
Unit – II	MEASUREMENT OF PRESSURE, FLOW AND LEVEL	Periods	9
Pressure- Units of Pressure - Pressure measuring instruments - Bellow and Diaphragm pressure sensor. Flow rate - Flow rate measuring instruments –Coriolis flow meter- Electromagnetic flow meter - Ultrasonic flow meter. Level measurement – Radioactive level transmitter- Diaphragm level transmitter.			
Unit – III	BASIC CONCEPT OF PROCESS CONTROL	Periods	9
Laplace transformation and its application in process control. Response of first order systems, Examples of first order systems, Process Dynamics of linear open systems. Second order and first order systems in series higher order systems Transfer Function Step, Ramp, Pulse and Sinusoidal inputs and Linearization			
Unit – IV	AUTOMATIC CONTROL SYSTEM, CONTROLLERS AND FINAL CONTROL ELEMENTS	Periods	9
Automatic control system –significance –Terminology used in control system - open loop system and closed loop system - Feedback control system and Feed forward control system - Ratio control system and Split range control system (Principles and Purposes only). Automatic controllers: controllers- classification; based on control action such as P, I, D, PI, PD, PID (pneumatic system) – Final control element: control valves.			
Unit – V	COMPUTERIZED PROCESS CONTROL	Periods	9
Process control computers: Analog computer system, Digital computer system-Features of both types-application of Distributed Controlled System (DCS) in unit operation unit process and plant control-schematic diagrams for the control of simple unit process-computer supervisory control-simple control flow sheets using computer for Batch reactor and CSTR. Control application in Heat Exchanger - Application of Distributed Controlled System (DCS) and PLC in Distillation column.			
Total Periods			45
Text Books			
1.	Donald R. Coughanowr, Steven E. LeBlanc, Process Systems Analysis and Control, Tata McGraw Hill Company Ltd., New Delhi, 3 rd Edition, 2014.		
2.	S K Singh, Industrial Instrumentation and Control, McGraw Hill Education, 3 rd Edition, 2009 .		
References			
1.	I. Marlin, T. E., Process Control, McGraw Hill, New York, 2 nd Edition, 2000.		
2.	Smith, C. A. and Corripio, A. B., Principles and Practice of Automatic Process Control, John Wiley, New York, 3 rd Edition, 2023.		
E-Resources			
1.	https://nptel.ac.in/courses/103105064		
2.	nptel.ac.in/courses/103/101/103101142		
3.	nptel.ac.in/courses/103/106/103106148		


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ES E	Total						
U23BTV35	Bioreactor Design and Scale Up process	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To impart knowledge about the principles, components, and operation of bioreactors To equip students with skills for designing bioreactors and scaling up bioprocesses. To explore industrial applications and challenges in bioreactor scale-up. 														
Course Outcome	By the end of the course, students will be able to:						Knowledge Level								
	CO1: Strengthen the basic notions of bioreactor design.						K1								
	CO2: Apply engineering principles to design bubble column and Airlift bioreactors suitable for bioprocesses.						K3								
	CO3: Expand knowledge on various modes of operation of industrial bioreactors for microbial, plant and animal cell culture system						K3								
	CO4: Evaluate scale-up criteria and challenges in transitioning bioprocesses from laboratory to industrial scale.						K4								
CO5: Use modelling, simulation tools, and case studies to predict bioreactor performance in large-scale operations.						K3									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	3	2	2	-	-	1	1	-	-	-	-	1	3	2	2
CO 2	3	3	3	2	2	-	-	-	-	-	-	2	3	3	2
CO 3	3	3	3	2	2	1	-	-	-	-	1	2	2	2	2
CO 4	2	3	3	3	2	1	2	-	-	1	1	2	2	2	2
CO 5	3	2	2	3	-	-	-	-	-	-	-	2	2	2	2
Pre-requisites	Basics of Microbiology, Biochemical Engineering, Chemical Reaction Engineering														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															



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Unit – I	INTRODUCTION TO BIOREACTOR DESIGN	Periods	9
Basics and importance of bioreactors- Types of bioreactors-Stirred tank, airlift, packed bed, fluidized bed, Guidelines for bioreactor design-Mechanical aspects of bioreactor design-Requirements for construction of a bioreactor,-Development of bioreactors.			
Unit – II	BUBBLE COLUMN AND AIRLIFT BIOREACTORS	Periods	9
Design and construction of Bubble column fermenter-Airlift bioreactors: Design and construction of the airliftloop reactor ,Hydrodynamics – Three phase flow – Mixing – Oxygen transfer, Design and operation of fluidized bed bioreactor.			
Unit – III	DESIGN OF SPECIFIC BIOREACTOR	Periods	9
Design and Operation of Membrane bioreactor- Design and Operation of Immobilized enzyme bioreactor, Hollow fibre bioreactor, Plant cell bioreactor			
Unit – IV	SCALE-UP PRINCIPLES	Periods	9
Scale-up parameters: Power input, mixing time, shear stress, and kLa. Approaches for scale-up: Geometric similarity, dynamic similarity, and process-specific considerations. Challenges in scale-up: Heat transfer, mass transfer, and contamination control. Case studies: Laboratory to pilot and industrial-scale transitions.			
Unit – V	BIOPROCESS MODELLING AND SIMULATION	Periods	9
Basic mathematical modelling of bioreactors. Dynamic simulations of batch and continuous processes. Modelling biopharmaceutical production- Antibodies and enzymes. Modelling algal bioprocesses for biofuel production.			
Total Periods			45
Text Books			
1.	Shuler, M. L., & Kargi, F., Bioprocess Engineering: Basic Concepts. Prentice Hall. 2 nd Edition, 2015.		
2.	Scrugg. H.,Bioreactors in Biotechnology Ellis Horwood series, 1 st Edition, 1991.		
References			
1.	Panda. T.,Bioreactors: Analysis and Design, McGraw Hill Education (India) Private Limited, 1 st Edition, 2011.		
2.	Riet. K. V., Tramper. J., Basic Bioreactor Design, Marcel Dekker, Inc., New York, 2 nd Edition, 1991.		
E-Resources			
1.	https://link.springer.com		
2.	https://www.elsevier.com		
3.	https://nptel.ac.in		
4.	https://www.coursera.org		
5.	https://www.khanacademy.org		


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Programme	B.Tech	Code Programme							105	Regulation			2023				
Department	BIOTECHNOLOGY							Semester			-						
Course Code	Course Name						Periods Per Week			Credit	Maximum Marks						
							L	T	P		C	CA	ESE	Total			
U23BTV36	Bioprocess Technology						3	0	0	3	40	60	100				
Course Objective	<ul style="list-style-type: none"> To provide foundational knowledge of bioprocessing techniques and their industrial applications. To understand the principles of upstream and downstream processing in bioprocessing. To integrate engineering and biological sciences for innovative bioprocess solutions. 																
Course Outcome	By the end of the course, students will be able to:												Knowledge Level				
	CO1: Explain the fundamental principles and components of bioprocess technology and analyze microbial, enzymatic, and cell culture processes for industrial applications.												K2				
	CO2: Analyze and optimize microbial, enzymatic, and cell culture processes for industrial applications.												K4				
	CO3: Apply downstream processing techniques to purify bioproducts.												K3				
	CO4: Develop process and product of industrial importance												K3				
CO5: Evaluate the economic, environmental, and ethical aspects of bioprocessing.												K3					
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping				
COs	Programme Outcomes (POs)												PSOs				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3		
CO 1	3	2	2	-	-	2	1	-	-	-	-	1	3	3	2		
CO 2	3	3	3	2	-	-	2	-	-	-	-	2	3	3	2		
CO 3	3	3	3	3	-	2	-	-	-	-	1	2	3	2	2		
CO 4	3	3	3	3	-	2	2	-	-	-	2	3	3	2	2		
CO 5	2	2	2	3	-	3	3	2	-	1	2	3	2	2	2		
Pre-requisites	Microbiology, Biochemistry																
Course Assessment Methods																	
Direct																	
1. Continuous Assessment Test I, II & III																	
2. Assignment																	
3. End-Semester examinations																	



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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO BIOPROCESS TECHNOLOGY	Periods	9
Basic principle components of fermentation technology. Types of microbial culture and its growth– Batch, Fedbatch and Continuous culture. Inoculum preparation for bacterial and fungal fermentation processes.			
Unit – II	MEDIA FORMULATION FOR FERMENTATION PROCESS	Periods	9
Natural Media (Conventional); Synthetic media. Variation in sources of components of media and other chemicals required to carry out fermentation process. Strain Improvement: mutation and screening of improved cultures; Strategic screening for production of primary and secondary metabolite production.			
Unit – III	DOWNSTREAM PROCESSING	Periods	9
Definition, cost involved in downstream processing, steps involved in Downstream processing - Criteria for downstream processing. Cell separation techniques - Methods for cell breakage for harvesting intercellular products - Formulation and packaging of bioproducts.			
Unit – IV	APPLICATIONS OF BIOPROCESS TECHNOLOGY	Periods	9
Commercial production of various bioprocess based products (Bioethanol, citric acid, acetic acid) Antibiotics- penicillin, streptomycin, tetracycline. Enzymes, Single cell protein- Types and nature of wastes generated from bioprocesses. Emerging areas-Synthetic biology and personalized medicine.			
Unit – V	BIOPROCESS ECONOMICS AND SUSTAINABILITY	Periods	9
Cost estimation and economic feasibility of bioprocesses. Environmental impact and sustainability in bioprocessing- Resource Consumption- Waste generation and Land Use and Biodiversity Loss - Green Bioprocess Design, Renewable Resources- Circular Economy and Carbon Neutrality - Ethical considerations in biotechnology industries.			
Total Periods			45
Text Books			
1.	Shuler, M. L., & Kargi, F., Bioprocess Engineering: Basic Concepts. Pearson, 3 rd Edition, 2017,		
2.	Doran, P. M., Bioprocess Engineering Principles. Academic Press, 2 nd Edition, 2012.		
References			
1.	Bailey, J. E., & Ollis, D. F. Biochemical Engineering Fundamentals. McGraw-Hill, 2 nd Edition, 2017.		
2.	Lee, J. M. Biochemical Engineering. Prentice Hall, 2 nd Edition, 2021.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc22_bt19/preview		
2.	https://onlinecourses.nptel.ac.in/noc20_bt25/preview		

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester											
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ES E	Total						
U23BTV37	Bioenergy and Biofuels	3	0	0	3	40	60	100							
Course Objective	The student will have an elaborate knowledge on, <ul style="list-style-type: none"> • Bioenergy and Biofuel feedstocks. • Bioenergy and biofuel technologies • Conversion of biomass for energy application. • Sustainability and Economic aspect of bioenergy and biofuel. 														
Course Outcome	By the end of this course, students will be able to:							Knowledge Level							
	CO1: Explain the fundamental concepts of bioenergy and biofuels feedstocks.							K1							
	CO2: Acquire knowledge about Biochemical conversion of biofuels.							K2							
	CO3: Identify and assess the methods of thermochemical conversion of biomass.							K3							
	CO4: Assess the biofuel production technologies from various feedstocks.							K3							
	CO5: Apply modern techniques for improving biofuel production processes and sustainability.							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	3	2	2	2	-	-	-	-	-	-	-	1	3	3	2
CO 2	3	3	2	2	2	1	-	-	-	-	-	2	3	3	2
CO 3	3	3	3	2	2	2	2	-	-	-	1	2	3	2	2
CO 4	3	3	3	3	2	1	1	-	-	1	1	2	3	2	2
CO 5	2	2	2	3	-	2	3	2	1	1	2	2	3	2	2
Pre-requisites	Basics of Microbiology, Biochemistry														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO BIOENERGY AND BIOFUELS	Periods	9
Overview of energy sources and the role of bioenergy. Types of biofuels-First, second, and third generation. Advantages and challenges of bioenergy systems. Classification-Lignocellulosic biomass, algae, agricultural residues, and organic waste. Pre-treatment of feedstocks-Physical, chemical, and biological methods.			
Unit – II	BIOCHEMICAL CONVERSION OF BIOMASS	Periods	9
Introduction to Biomass and Biochemical Conversion- Fundamentals of biochemical conversion processes. Comparison of biochemical vs. thermochemical conversion. Applications of biochemical conversion technologies. Microbial Processes for Biomass Conversion - Integrated Biorefineries- Concept of biorefineries: integration of biochemical processes.			
Unit – III	THERMOCHEMICAL CONVERSION OF BIOMASS	Periods	9
Introduction to Thermochemical Conversion. Applications of thermochemical conversion technologies-Types of thermochemical products: bio-oil, syngas, biochar, and heat. Thermal properties-proximate analysis, ultimate analysis, and calorific value - Fundamentals of biomass combustion. Basics of biomass gasification-partial oxidation and syngas production.			
Unit – IV	BIOFUEL PRODUCTION TECHNOLOGIES	Periods	9
Introduction to Biofuels-production of biofuels. Bioethanol Production-. Biogas Production - Algal biofuels-Biohydrogen Production.			
Unit – V	SUSTAINABILITY. EMERGING TECHNOLOGIES AND APPLICATIONS OF BIOFUELS	Periods	9
Environmental impacts-Carbon footprint and greenhouse gas reduction. Economic and social aspects of biofuel production. Sustainability and environmental impact of biofuels. Case Studies and Applications-Success stories in biochemical conversion of biomass. Industry-scale production of biofuels and biochemical..			
Total Periods			45
Text Books			
1.	Lee, J., & Shah, Y. T., Biofuels and Bioenergy: Processes and Technologies, CRC Press. 1 st Edition, 2012.		
2.	Ayhan Demirbas, A. (2008). Biofuels: Securing the Planet's Future Energy Needs. Springer Science & Business Media, 1 st Edition, 2008		
References			
1.	Kumar, S. Advances in Biofuels Production, Optimization, and Applications, Springer, 1 st Edition, 2010.		
2.	Goldemberg, J. Biofuels for Transport: Global Potential and Implications for Energy and Agriculture. Earthscan, London, 1 st Edition, 2009.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/102/104/102104057/		
2.	https://onlinecourses.nptel.ac.in/noc22_ch28/preview		



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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University Chennai), Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech.		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY						Semester			-					
Course Code	Course Name		Periods Per Week			Credit		Maximum Marks							
			L	T	P	C	CA	ESE	Total						
U23B1V38	Hazard Assessment and Mitigation		3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> To obtain knowledge in safety programmes in industries To analyze the risk analysis and management 														
Course Outcome	Students who complete this course successfully are expected to											Knowledge Level			
	CO1: Remember safety programmes in industries											K1			
	CO2: Explain the safety procedures											K2			
	CO3: Implement the Emergency planning and Risk Management											K3			
	CO4: Demonstrate the hazard identification and safety audits											K3			
CO5: Explain the Hazard and Operability with real time problems											K4				
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak															
Programme Outcomes (POs)												PSOs			
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	2	3	3	2		3	2	3	3	2		1	2	3	2
CO 2	2	3	3	2	1	2	3	3	2	3	1	2	2	2	3
CO 3	1	2	2	1	2	2	2	3	2	2	1	2	3	3	2
CO 4	2	3	3	2	1	3	3	2	2	1		1	3	2	3
CO 5	2	1	2	1		2	2	2				2	3	2	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester Examinations															
Indirect															
2. Course - End Survey															
Content of the Syllabus															
Unit – I	INTRODUCTION										Periods	9			


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Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling.			
Unit – II	SAFETY PROCEDURES	Periods	9
Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety.			
Unit – III	RISK ANALYSIS AND MANAGEMENT	Periods	9
Overall risk analysis-emergency planning-on site & off-site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid 84 and comprehensive risk analysis; Risk due to radiation, explosion due to over pressure, jet fire-fire ball.			
Unit – IV	HAZARD IDENTIFICATION	Periods	9
Hazard identification safety audits, checklist, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fix borough-Mexico-Madras- Vizag Bhopal analysis.			
Unit – V	RECOMMENDATION OF HAZARD ANALYSIS	Periods	9
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.			
Total Periods			45
Text Books			
1.	“Hazard Mitigation Emergency Management” , <u>Tanveer Islam, Jeffrey Ryan</u> , 2015		
2.	“Guidelines for process hazards analysis, hazards identification & risk analysis”, Hyatt N, Dyadem Press, 2004		
3.	“Techniques for Disaster Risk Management and Mitigation”, <u>Prashant K. Srivastava et al</u> , 2020		
References			
1.	“Disaster Management: Hazard and Risk Awareness- A comprehensive approach”, <u>N. V. S. Raju</u> , 2019		
2.	“Principles of Emergency Management”, <u>Michael J. Fagel</u> , 2012		
	“Crisis Management and Emergency Planning”, <u>Michael J. Fagel</u> , 2013		
E-Resources			
1.	https://www.safetynotes.net		
2.	https://www.osha.gov		
3.	https://environmentclearance.nic.in		


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Programme	B.Tech	Programme Code	105	Regulation	2023											
Department	BIOTECHNOLOGY			Semester												
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks										
		L	T	P		C	CA	ESE	Total							
U23BTV39	Bioprocess Economics and Plant Design	3	0	0	3	40	60	100								
Course Objective	<ul style="list-style-type: none"> To introduce the fundamentals of bioprocess plant design and economic analysis. To equip students with knowledge of project evaluation and cost estimation in bioprocess industries. To develop skills for integrating engineering design with business and environmental considerations. To provide practical exposure to designing bioprocess plants using modern tools. 															
Course Outcome	By the end of this course, students will be able to:						Knowledge Level									
	CO1: Understand the principles of bioprocess plant design and layout.						K2									
	CO2: Perform cost estimation and economic analysis for bioprocess industries.						K2									
	CO3: Analyze bioprocess plant operations for profitability and sustainability.						K3									
	CO4: Evaluate safety, environmental, and ethical considerations in plant design and utilities/						K4									
CO5: Apply modern software and tools to model and optimize bioprocess designs.						K3										
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping				
COs	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3	
CO 1	3	3	2	-	2	-	-	2	-	-	-	1	3	3	3	
CO 2	3	3	3	2	3	-	-	-	-	-	-	2	3	3	2	
CO 3	2	2	3	2	3	1	2	2	1	2	2	2	3	2	2	
CO 4	3	3	3	3	3	2	-	-	-	1	1	2	2	2	2	
CO 5	2	2	3	2	-	2	2	2	-	-	2	3	2	2	2	
Pre-requisites	Bioprocess Engineering, Biochemistry, and Basics of Chemical Engineering															
Course Assessment Methods																
Direct																
1. Continuous Assessment Test I, II & III																
2. Assignment																
3. End-Semester examinations																


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO BIOPROCESS ECONOMICS	Periods	9
Importance of economic analysis in bioprocess engineering. Overview of bioprocess industries: Pharmaceuticals, biofuels, and food industries. Economic factors influencing process design.			
Unit – II	CAPITAL AND OPERATING COST ESTIMATION	Periods	9
Fixed and working capital investment. Cost estimation methods: Lang factor and factorial methods. Operating costs: Utilities, labour, raw materials, and waste management.			
Unit – III	ECONOMIC ANALYSIS AND PROJECT EVALUATION	Periods	9
Break-even analysis and profitability analysis. Depreciation, taxes, and cash flow analysis. Project evaluation techniques: NPV, IRR, and payback period.			
Unit – IV	BIOPROCESS PLANT DESIGN	Periods	9
Plant location and site selection criteria. Plant layout design: Equipment placement, workflow, and safety considerations. Design of utilities: Water supply, power systems, and waste disposal.			
Unit – V	SAFETY, ENVIRONMENT, ETHICS IN PLANT DESIGN, SIMULATION TOOLS AND	Periods	9
Safety protocols in bioprocess industries. Environmental impact assessment and waste management strategies. Ethical considerations in bioprocess design and manufacturing. Case studies on plant design using modern software.			
Total Periods			45
Text Books			
1.	Peters, M. S., Timmerhaus, K. D., & West, R. E., Plant Design and Economics for Chemical Engineers. McGraw-Hill, 5 th Edition, 2017.		
2.	Shuler, M. L., & Kargi, F., Bioprocess Engineering: Basic Concepts. Pearson, 3 rd Edition, 2017.		
References			
1.	Aiba, S., Humphrey, A. E., & Millis, N. F., Biochemical Engineering. Academic Press, 2 nd Edition, 2001.		
2.	Towler, G., & Sinnott, R., Chemical Engineering Design: Principles, Practice, and Economics of Plant and Process Design. Elsevier. 3 rd Edition, 2021.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc20_ch31/preview		
2.	https://archive.nptel.ac.in/courses/103/105/103105210/		




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VERTICAL IV

Clinical Biotechnology

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Programme	B.Tech	Programme Code					105	Regulation				2023			
Department	BIOTECHNOLOGY					Semester				-					
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV41	Stem cell Technology	3	0	0	3	40	60	100							
Course Objective	The objective of this course is to														
	<ul style="list-style-type: none"> Familiarize the students with stem cell technology and its applications for betterment of the society Learn about embryonic stem cell isolation, culturing, differentiation techniques, and therapeutic/reproductive cloning and explore factors influencing stem cell differentiation Understand regeneration techniques, experimental methods and stem cell applications in treating diseases and ethical considerations in stem cell research and policy 														
	After completion of this course, the students will be able to														Knowledge Level
	CO1: Summarize stem cell characteristics, classify types, and identify their sources and properties.														K2
Course Outcome	CO2: Demonstrate proficiency in isolating and culturing embryonic stem cells, and understanding differentiation techniques.														K2
	CO3: Demonstrate factors influencing stem cell differentiation and cloning strategies.														K2
	CO4: Apply regeneration techniques and experimental methods to study stem cell behaviour and potential applications in organ transplantation.														K3
	CO5: Infer Knowledge on the ethical implications of stem cell therapy and research, and assess its potential for treating various diseases.														K3
	CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	1	1	2	2	3	3		3	1	1		2	3	2	2
CO 2	1	2	2	2	3	3		3	2	1		1	3	2	1
CO 3	1	2	2	2	3	3		3	2	2		1	3	2	1
CO 4	1	3	2	2	3	3		3	1	2	1	1	2	2	2
CO 5	1	1	2	2	3	3	3	3	2	1		2	2	2	2
Pre-requisites	Cell Biology and Immunology														
Course Assessment Methods															


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Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO STEM CELLS	Periods	9
Stem cells: Definition and basics of stem cells; Classification and types of stem cells- human embryonic stem cells, adult stem cells, Cancer stem cells; Sources of Stem cells-IPSC, Fetal stem cells, Amniotic Stem Cells, Perinatal Stem Cells; Properties of stem cells -self renewel, clonality and plasticity; Stem cell niche- bone marrow microenvironment. Cryopreservation of stem cells-Conventional slow-freezing method and vitrification method			
Unit – II	HEMATOPOIETIC STEM CELLS(HSC) AND EMBRYONIC STEM CELLS	Periods	9
Hematopoietic stem cells(HSC) –Basics, Development and Regulation of HSC; Mesenchymal stem cells(MSC)-Characteristics, differentiation and identification; Human ESCs -Isolation and culturing of hESC's, controlled differentiation of hESC, In vivo and In vitro differentiation of hESC, ESC markers.			
Unit – III	STEM CELLS DIFFERENTIATION AND CLONING	Periods	9
Factors influencing proliferation; Physical, chemical and molecular induced differentiation of stem cells. Therapeutic cloning strategies using ESCs - Derivation and propagation of human embryonic stem cells, Reproductive cloning using ESCs by SCNT, Uses of SCNT.			
Unit – IV	REGENERATION AND ORGAN TRANSPLANTATION	Periods	9
Stem cell therapies in animal models; 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) , green fluorescent protein tagging.			
Unit – V	APPLICATION AND ETHICS IN STEM CELL RESEARCH	Periods	9
Novel Stem Cell Based Gene Therapy ; Stem cell Therapy for neurodegenerative diseases- Parkinson's Disease , Alzheimer's Disease ; Heart disease, muscular dystrophy and orthopedic applications. Stem Cells in Cancer Research; Ethical, Legal, and Social Issues in Stem Cell Research.			
Total Periods			45
Text Books			
1.	Potten.C S., "Stem Cells," Elsevier, 2006.		
2.	Robert Lanza and Antony Atala., "Essentials of stem cell biology" 4 th Edition, Elsevier academic press, 2014		
References			
1.	Quesenberry P., "Stem Cell Biology and Gene Therapy", , WileyLiss, 1998.		
2.	Turksen K., "Embryonic Stem Cells – Protocols", 2 nd Edition, Humana Press, 2002.		
3.	Yanhong Shi, Dennis O. Clegg., "Stem Cell Research and Therapeutics", Springer, 2008.		

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4.	Aditya Bharadwaj., "Global Perspectives on Stem Cell Technologies", Springer International Publishing, 2017.
5.	Bongso A., Lee E.H., "Stem Cells: From Bench to Bedside", World Scientific Publishing Company, 2005.
E-Resources	
1.	https://stemcells.nih.gov/info/basics/stc-basics
2.	https://www.britannica.com/science/regenerative-medicine/Tissue-scaffolds-and-soluble-repair-factors
3.	https://www.nature.com/articles/s41392-022-01134-4



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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University Chennai), Elayampalayam, Tiruchengode – 637 205											 30 JAN 2023 			
	Programme	B.Tech.	Programme Code			105	Regulation		2023						
Department	BIOTECHNOLOGY						Semester		-						
Course Code	Course Name		Periods Per Week			Credit	Maximum Marks								
			L	T	P		C	CA	ESE	Total					
U23BTV42	Clinical Biochemistry		3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> Understand the basic concepts, principle and applications of clinical biochemistry Get a knowledge of basics of chemistry and clinical importance of biomolecules 														
Course Outcome	Students who complete this course successfully are expected to											Knowledge Level			
	CO1: Outline standard values for important constituents in blood and urine											K2			
	CO2: Demonstrate the basic organic reaction mechanisms and chemical kinetics											K2			
	CO3: Analyze the clinical importance of sugars, lipids and proteins											K2			
	CO4: Illustrate the components and functions of blood and lymph											K3			
CO5: Summarize the applications of clinical biochemistry											K3				
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	2	1	1		1	2		2	2		2	1	3	2	3
CO 2	3	2	2	1		2		2		2	1	1	3	2	3
CO 3	1	3	2	1		3	1	1	1	1	2	2	3	3	3
CO 4	2	3	2	2		3	1	2	2	1	2	2	3	2	3
CO 5	1	2	3	2	1	3	1	1		2	1	1	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester Examinations															
Indirect															
1. Course - End Survey															
Content of the Syllabus															


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Unit – I	INTRODUCTION	Periods	9
Basic concepts and principles of Clinical Biochemistry. Standard values for important constituents in blood and urine. Kidney, Liver and thyroid function tests (KFT, LFT, and TFT). Lipid profile. Glucose tolerance tests. Urine and stool examination.			
Unit – II	BASICS OF CHEMISTRY	Periods	9
Basic organic reaction mechanisms; Oxidation-reduction. Redox potential, coupled reactions, Elimination, Isomerization and rearrangements. Dipole-dipole interactions, Hydrogen bonds, vanderwaals forces concepts of acids and bases. Electrophiles and nucleophiles. Chemical kinetics and catalysis; orders of reactions, concepts of activation energy and reaction rates, laws of photochemistry, photochemical reactions. Laws of thermodynamics.			
Unit – III	CLINICAL IMPORTANCE OF BIOMOLECULES	Periods	9
Carbohydrates- Estimation of glucose, glycosuria, GTT's, hyper & hypoglycemia, blood glucose regulation and role of hormones; diabetic coma, Lipids- lipid profile estimation, hypercholesterolemia, hyperlipoproteinemia, atherosclerosis and its risk factors. Proteins -albumin, hypoalbuminemia, hypoproteinemia, Bence Jones proteins, proteins in CSF and their estimation.			
Unit – IV	HEMATOLOGY AND CLINICAL PATHOLOGY	Periods	9
Cell Injury – types and Morphology. Components and functions of blood and lymph. Blood coagulation. Anemia. Inflammation, Mediators of Inflammation, Acute and Chronic Inflammation, Circulatory disturbances – Thrombosis, Infarction. Edema, Shock- definition and pathogenesis.			
Unit – V	APPLICATIONS OF CLINICAL BIOCHEMISTRY	Periods	9
Applications of Clinical Biochemistry. Kidney, Liver and thyroid function tests (KFT, LFT, and TFT). Lipid profile. Glucose tolerance tests. Urine and stool examination.			
Total Periods			45
Text Books			
1.	"Fundamentals of Biochemistry", Voet and Donald, 2006		
2.	"Biochemistry with Clinical correlations", Delvin and Thomas D, 2015		
3.	"Clinical Biochemistry", Samir Fatteh, Sateesh Arja and Sirisha Bala Arja, 2018		
References			
1.	"Biochemistry and Clinical Pathology", Dr. N. Muruges, 2012		
2.	"Practical Clinical Biochemistry: Methods & Interpretations", Ranjna Chawla, 2020		
E-Resources			
1.	https://www.academia.edu		
2.	https://download.e-bookshelf		
3.	https://easybiologyclass.com		

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23BTV43	CANCER BIOLOGY	3	0	0	3	40	60	100							
Course Objective	The goal of this course is to enable the students to														
	<ul style="list-style-type: none"> Understand the basics of cancer and cancerous cells Discuss the significance of carcinogenesis in the development of cancer Interpret the role of oncogenes and their growth factors Make understanding on process of cancer metastasis and their dysregulation factors Gain knowledge on the cancer treatment and design the novel drugs to reduce the effect of carcinogenesis 														
Course Outcome	At the end of the course, the students will be able to							Knowledge Level							
	CO1: Explain the development and proliferation of cancer with specific causes							K2							
	CO2: Describe the influence of carcinogenesis in the cancer development							K3							
	CO3: Identify the pathways and therapeutic targets of cancer							K4							
	CO4: Outline the steps involved in metastasis and tumour cell invasion							K4							
	CO5: Develop novel drugs and technologies for the treatment of cancer							K5							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2		3		3		1		2		2	1	2	1	2
CO 2	3	1	2	1	3		1		3		2	2	1	1	3
CO 3	2	2	2		2	1	2		2		1	2	2	2	1
CO 4	2	2	2		2		2				1	2	1	2	2
CO 5	3	3	3	3	3	2	1	2	3		3	3	3	3	2
Pre-requisites	Molecular Biology and cell biology.														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															



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Unit – I	FUNDAMENTALS OF CANCER BIOLOGY	Periods	9
Introduction, historical perspective, classification carcinogenesis, cancer initiation, promotion & progression, pathways of spread- Epidemiology Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumor suppressor genes, modulation of cell cycle in cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.			
Unit – II	PRINCIPLES OF CARCINOGENESIS	Periods	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	Periods	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.			
Unit – IV	CANCER METASTASIS	Periods	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	Periods	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 Periods			45
Text Books			
1.	Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007		
2.	Hejmadi, M. Introduction to cancer biology, Bookboon publishers. 2014.		
3.	McDonald, F etal., “ Molecular Biology of Cancer” IInd Edition. Taylor & Francis, 2004.		
4.	Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). Oxford textbook of cancer biology. Oxford University Press. 2019.		
References			
1.	Iago Dillion L.C , Jose Cleberson S.S “Advances in Cancer Treatment From Systemic Chemotherapy to Targeted Therapy” Springer Publications 2021.		
2.	Pelengaris, S., & Khan, M. (Eds.). The molecular biology of cancer: A bridge from bench to bedside. 2013.		
3.	Ruddon, Raymond W. “ Cancer Biology” 4 th Edition . Oxford University Press, 2007.		
E-Resources			
1.	https://nptel.ac.in/courses/108108124		
2.	https://onlinecourses.swayam2.ac.in/aic20_ge02/preview		


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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University Chennai), Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech.	Programme Code					105	Regulation			2023				
Department	Biotechnology					Semester			-						
Course Code	Course Name		Periods Per Week			Credit		Maximum Marks							
			L	T	P	C	CA	ESE	Total						
U23BTV44	Biomedical Nanotechnology		3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to														
	<ul style="list-style-type: none"> Understand the basics of nanomaterials Explore DNA, protein, and lipid nanotechnology for drug delivery and diagnostics Study the role of nanomaterials in cancer diagnosis, treatment, and tissue engineering Learn how nanotechnology is used in diagnostics, drug delivery, and antibacterial testing Understand the safety, toxicology, and advanced uses of nanomaterials 														
Course Outcome	Students who complete this course successfully are expected to											Knowledge Level			
	CO1: Understand methods of creating and analyzing nanomaterials											K2			
	CO2: Understand how biomolecules are applied in nanotechnology for medical purposes											K3			
	CO3: Understand how nanomaterials are used in healthcare and disease treatment											K3			
	CO4: Understand the applications of nanomaterials in diagnostics and drug delivery											K4			
CO5: Identify the risks and applications of nanomaterials in biotechnology											K4				
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	3	3	3	3	1	2	1	3	3	2	3
CO 2	3	2	1	1	3	3	3	3		2		2	3	2	3
CO 3	3	2	3	3	3	3	2	3		2		3	3	2	3
CO 4	3	2	3	2	3	3	2	3		2		3	3	2	3
CO 5	3	2	3	2	3	3	3	3	1	2	1	3	3	3	3


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Nanotechnology and Nanomaterials	Periods	9
Overview of Nanotechnology, Nano-Biomimicry, Physical Methods: Ball milling, vapor deposition, laser ablation. Chemical Methods: Sol-gel, hydrothermal synthesis, chemical vapor deposition, Synthesis of Nanomaterials by Biological Methods, Techniques for characterizing nanomaterials: TEM, SEM, X-ray diffraction, FTIR, and UV-Vis spectroscopy.			
Unit - II	Biomolecular Nanotechnology	Periods	9
DNA-based nanostructures: DNA origami, DNA nanorobots, Protein-based nanoparticles, protein folding, and their use in nanomaterials. Liposomes, lipid nanoparticles in drug delivery, and gene therapy, Design, principles, and applications of bio-nanomachines: DNA motors, protein-based motors. Applications in molecular sensing, drug delivery, and diagnostics.			
Unit – III	Nanotechnology in Healthcare and Disease Treatment	Periods	9
Cancer Diagnosis -Imaging: Quantum dots, magnetic nanoparticles, and gold nanoparticles. Early cancer detection. Targeted drug delivery using nanocarriers: Liposomes, dendrimers, micelles. Tissue Engineering and Nano Artificial Cells -Nanomaterials in tissue scaffolds and regeneration. Organ Printing -3D printing technology using nanomaterials.			
Unit - IV	Nanotechnology in Diagnostics and Drug Delivery	Periods	9
Point-of-Care Diagnostics -Portable diagnostic devices. Nanopharmacology & Drug Targeting, Cellular Uptake Mechanisms of Nanomaterials -Endocytosis, phagocytosis, membrane fusion. Factors influencing cellular uptake efficiency of nanomaterials. In Vitro Methods to Study Antibacterial and Anticancer Properties -Screening assays for antibacterial and anticancer activity: MTT assay, disc diffusion, and cell viability assays.			
Unit – V	Safety, Toxicology of Nanotechnology	Periods	9
Nanotoxicology-Use of nanomaterials in biomedical devices and implants. Regulations governing the use of nanomaterials in biotechnology. Ethical considerations related to nanotechnology research and applications. Emerging trends in nanobiotechnology-nanorobotics, personalized medicine, and artificial intelligence.			
Total Periods			45
Text Books			
1.	Jain, K.K., “The Handbook of Nanomedicine”, Humana press. 2008.		
2.	Lamprecht, A., “Nanotherapeutics: Drug Delivery Concepts in Nanoscience”, Pan Stanford Publishing Pte. Ltd. 2016.		
References			
1.	T.Pradeep, Nano: “The Essentials”, McGraw-Hill Education, 2007.		




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2.	Charles P.Poole, Frank J.Owens, "Introduction to Nanotechnology", Wiley Interscience, 2003.
3.	Ralph et al, "Nanoscale Technology in Biological Systems", CRC Press, 2004.
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc19_bt28/preview
2.	https://www.coursera.org/learn/nanotechnology
3.	https://nptel.ac.in/courses/118/107/118107015/




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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV45	Population and Molecular genetics	3	0	0	3	40	60	100							
Course Objective	This course is designed to familiarize in the field of <ul style="list-style-type: none"> • Population genetics and the evolutionary processes • Molecular genetics abstracts evolutionary phenomena to enlighten the variants among the species population • Explore the use of genome editing technologies for various human syndromes 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Develop a thorough understanding of population genetics to comprehend evolutionary processes.						K2								
	CO2: Explore the understanding of genetic polymorphism and variants in genetic demography.						K2								
	CO3: Illustrate the structural organization of human genome and explain the goals of various genome projects.						K3								
	CO4: Appraise the principles of epigenetics.						K3								
CO5: Appraise the strategies of genome imprinting and its principles in identifying the syndromes.						K3									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3 - Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3				3	2				3	3	3	3
CO 2	2	3	3	2	2		2	3				2	3	2	2
CO 3	3	2	3	1	3	3	2	2				2	3	2	3
CO 4	2	2	3	2	2			3	2			1	3	2	2
CO 5	3	2	2	3	3			3				3	3	3	2
Pre-requisites	Molecular Biology, Genetic Engineering														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															


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1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Population genetics	Periods	9
Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg (H-W) principle, heterozygotes, Extension of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies.			
Unit – II	Population variants	Periods	9
Genetic polymorphism, transient and stable and factors responsible stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetics counselling. Genetics origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.			
Unit – III	Human genome Organization	Periods	9
Nuclear genome, mitochondrial genome. Mutations, genetic variations and polymorphisms. Human genome project, HAP Map project, Human Genome Variation, 1000 Genome project. Principles and strategies for identifying human disease genes; Position-independent and positional cloning, mutation screening, testing in animal models			
Unit – IV	Epigenetics	Periods	9
DNA transcription in eukaryotes, chromatin architecture, and modification – chromatin remodelling DNA methylation, post-translational histone, histone modification machinery, histone variants, DNA methylation/imprinting RNA-directed DNA methylation, RNA-based silencing, polycomb repression, epigenetic inheritance, preservation of epigenetic marks during DNA replication, and methylation			
Unit – V	Genomic imprinting syndromes	Periods	9
Genomic imprinting syndrome and its regulation in mammals: 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 Periods			45
Text Books			
1.	John H. Relethford, “Human Population Genetics” Willey-Blackwell Publishers 2022.		
2.	Nei, M. and S. Kumar. “Molecular evolution and phylogenetics” Oxford University Press, Very useful for molecular evolution, 2000.		
References			
1.	Gillespie, J. H. “Population Genetics, a concise guide” 2 nd Edition, The John Hopkins University Press, 2004.		
2.	Hartl, D. L. and A. G. Clark “Principles of population genetics” 3 rd Ed. Sinauer. 1997.		
3.	Anthony Griffiths; John Doebley; Catherine Peichel; David A. Wassarman, “Introduction to Genetic Analysis”, 12 th Edition. Macmillan Learning, 2020.		
4.	Michael Goldberg, Janice Fischer, Leroy Hood and Leland Hartwell, “Genetics: From Genes to Genomes”, 7 th Edition. McGraw Hill Education, 2020.		
5.	Tom Strachan & Andrew Read, “Human molecular genetics” 4 th Edition, Taylor & Francis Group, Garland Science, 2011		
E-Resources			
1.	https://onlinecourses.swayam2.ac.in/cec23_bt04/preview		
2.	https://www.edx.org/learn/genetics/massachusetts-institute-of-technology-genetics-population-genetics-and-human-traits		




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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV46	Basics of Human Physiology and Anatomy	3	0	0	3	40	60	100							
Course Objective	The main objective of this course is to:														
	<ul style="list-style-type: none"> Understand human body basics: cells, tissues, homeostasis, and organization and to explore musculoskeletal system: bones, joints, muscles, and skin functions Study cardiovascular and respiratory systems: blood, heart, and lung functions and acquire knowledge of digestive and urinary systems for physiological understanding Comprehend the intricate regulatory dynamics of nervous and endocrine systems 														
Course Outcomes	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Demonstrate the cellular components and their function and membrane transport mechanisms and tissue types.							K2							
	CO2: Assess different bones and muscles and emphasizing their collective role in maintaining structural integrity.							K3							
	CO3: Illustrate the functioning of cardiovascular system and mechanism of respiration.							K3							
	CO4: Exhibit a thorough comprehension of how the nervous and endocrine systems coordinate to maintain physiological balance.							K3							
CO5: Describe the functioning of digestive system and urinary system.							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	2	2		2	3	1		2			3	2	1
CO 2	3	2	2	2		2	2	2		2			3	2	1
CO 3	3	2	2	2		2	2	2		2			3	2	1
CO 4	3	2	3	2		2	2	1		2			3	2	1
CO 5	3	2	1	2		2	1	2		2			3	2	1
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	BASICS OF HUMAN BODY	Periods	9
Anatomical terms, positions, planes and levels of organization. Cell- Structure and its organelles with functions. Cell Membrane – Transport across Cell Membrane, Membrane Potential – Origin and propagation of potential. Homeostasis. Tissues- Types and functions. Integumentary system.			
Unit – II	SKELETAL AND MUSCULAR SYSTEM	Periods	9
Skeletal System- Structure and types of Bone and its functions, Physiology of Bone formation, Division of Skeleton, Types of joints and functions, Types of cartilage and functions. Muscular System- Types and functions of Muscles, Structure and activity of skeletal muscles, Sliding Filament Theory, Types of muscle contraction.			
Unit – III	CARDIOVASCULAR AND RESPIRATORY SYSTEM	Periods	9
Blood- Composition, Functions, Haemostasis, Blood groups and typing. Cardiovascular System- Structure, Conduction System of heart, Cardiac Cycle, Cardiac output. Blood Vessels – Structure and types, Blood pressure. Respiratory system- Parts of respiratory system, Respiratory physiology, Lung volumes and capacities, Gaseous exchange.			
Unit – IV	NERVOUS , SPECIAL SENSORY AND ENDOCRINE SYSTEM	Periods	9
Nervous System- Cells of Nervous systems, Types of Neuron and Synapses; CSF- Composition and function, Brain- structure and function, Spinal Cord- Tract and Pathways, Reflex Mechanism. Autonomic Nervous systems and its functions. Sense Organs- Eye and Ear. Endocrine Glands- major endocrine glands and their hormonal functions.			
Unit – V	DIGESTIVE AND URINARY SYSTEMS	Periods	9
Digestive System- organization, Organs of Digestive system –liver, pancreas and gallbladder, Mechanism of Digestion and Absorption. Urinary System- Structure of urinary system, Mechanisms of Urine formation, Acid base Regulation by Urinary System, Micturition reflex.			
Total Periods			45
Text Books			
1.	Elaine.N. Marieb , “Essential of Human Anatomy and Physiology”, Eight Edition, Pearson Education, New Delhi 2007		
2.	Ross & Wilson, “Anatomy and Physiology in Health and Illness” 13th Edition, Elsevier, 2018.		
References			
1.	Guyton & Hall, “Medical Physiology”, 13th Edition, Elsevier Saunders, 2015		
2.	Sarada Subramanyam, K.Madhavan Kutty and H.D.Singh - Text Book of 'Human Physiology' S.Chand & Company, 1996.		
3.	Valerie C. Scanlon and Tina Sanders, “Essential of Human Anatomy and Physiology”, Fifth Edition, F.A. Davis Company, Philadelphia 2007.		
4.	Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publishers. 2014		
5.	Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Tenth Edition, Pearson Publishers, 2014.		
E-Resources			
1.	https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology		
2.	https://openstax.org/books/anatomy-and-physiology-2e/pages/1-1-overview-of-anatomy-and-physiology		
3.	https://courses.lumenlearning.com/suny-ap1/		




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
	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester			-							
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV47	TISSUE ENGINEERING	3	0	0	3	40	60	100							
Course Objective	The goal of this course is to enable the students to <ul style="list-style-type: none"> To learn the fundamentals of tissue engineering and tissue architecture To study the biomaterials and its applications To understand the basic concept behind cell mechanism. To acquire knowledge on clinical applications of tissue engineering. 														
	At the end of the course, the students will be able to										Knowledge Level				
Course Outcome	CO1: Illustrate the basic concepts of tissue engineering										K2				
	CO2: Ability to understand the components of the tissue architecture.										K3				
	CO3: Learn the types, properties and application of biomaterials										K4				
	CO4: Outline the recent advancement such as 3D cultures in tissue engineering and use of scaffolds.										K4				
	CO5: summarize the clinical applications of tissue engineering.										K4				
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	2	2	3		3		1		2		2	1	2	1	2
CO2	3	1	2	1	3		1		3		2	2	1	1	3
CO3	2	2	2		2	1	2		2		1	2	2	2	1
CO4	2	2	2		2		2				2	2	1	2	2
CO5	3	3	3	3	3	2	1	2	3		3	3	3	3	2
Pre-requisites	Cell biology and stem cell technology.														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															


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
Unit – I	INTRODUCTION	Periods	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.			
Unit – II	TISSUE ARCHITECTURE	Periods	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	Periods	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	GENERAL ASPECTS OF CELLS IN CULTURE	Periods	9
Transport limits on 3D cultures, Cell-Matrix & Cell-Cell Interactions, cell migration and control of cell migration, Differential cell adhesion & tissue organization, Hormone & Growth Factor Signaling, Growth factor delivery in tissue engineering, Scaffolds & tissue engineering - Basic properties, Basic transplantation immunology, Quantitative analysis of receptor-ligand binding.			
Unit – V	CLINICAL APPLICATIONS	Periods	9
Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy.			
Total Periods			45
Text Books			
1.	The Principles of Tissue Engineering (5th edition), by Robert Lanza, Robert Langer, and Joseph P. Vacanti. Academic Press (AP). 2020.		
2.	Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.		
3.	Samuel E, Lynch L L, and Be Roberts J. Geng, “Tissue Engineering”, Wiley Black well, Singapore, 2010.		
4.	Bernhard O.Palsson, Sangeeta N.Bhatia, ”Tissue Engineering” Pearson Publishers 2009.		
References			
1.	Raphael Gorodetsky, Richard Schafer, Stem cell-based tissue repair. RSC Publishing, 2011.		
2.	J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine” Artech House, INC Publications, 2008.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc19_bt33/preview		
2.	https://www.classcentral.com/course/swayam-tissue-engineering-14337		




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Programme	B.Tech	Programme Code					105	Regulation			2023				
Department	BIOTECHNOLOGY					Semester			-						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV48	Cell culture technologies	3	0	0	3	40	60	100							
Course Objective	The aim of the course is to <ul style="list-style-type: none"> Provide theoretical and practical knowledge, required for dealing with animal cell and tissue cultures in vitro and to prepare students capable to maintain animal cells and tissues under in vitro conditions. Comprehend the Role of Bioreactors in Large-Scale Cultures and able to explore the Development and Maintenance of Cell Lines 														
	At the end of the course, the student should be able to,											Knowledge Level			
Course Outcomes	CO1: Understand the fundamental principles of cell culture, including the types of cultures and their applications in research and biotechnology											K2			
	CO2: Apply the techniques involved in subculturing cells, including detachment methods, passage protocols, and appropriate cell handling.											K3			
	CO3: Assess the characteristics of different cell lines and understand the advantages and limitations of using specific cell lines											K3			
	CO4: Demonstrate knowledge on principles of bioreactor systems, scaling up and automation in cell culture.											K3			
	CO5: Explore emerging technologies in cell culture, microfluidic systems, for advanced applications in disease modeling and drug testing.											K3			
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	1	2		1	2	2	3	1				2	2	1
CO 2	2	2	3	1	2	2	2	2					1	2	3
CO 3	3	2	2		1	3	2	3					2	2	1
CO 4	2		3		2	2	1	2	1		2		1	3	2
CO 5	2	1	2		2	3	2	3					2	1	2
Pre-requisites	Cell Biology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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
Content of the syllabus			
Unit – I	Introduction to Cell Culture Techniques	Periods	9
Introduction to cell culture- concepts, Definition and importance of cell culture, types of cell cultures; Composition and types of media, Media preparation; Types of Specialized Media- stem cell media, cancer cell media; Sterilization techniques-autoclaving, filtration; Aseptic techniques; Equipments-incubators, CO ₂ control, laminar flow hoods, biosafety cabinets, microscopes and imaging techniques.			
Unit – II	Cell Culture Techniques & Handling	Periods	9
Development of primary culture and subculturing (passaging); development of suspension culture; cell detached methods- Trypsinization, mechanical methods; cell counting methods-Haemocytometer, automated counters: cell viability-cytotoxicity assays; Cryopreservation-principle, Uses of cryoprotectants and recovery of Cells			
Unit – III	Cell Line Development and Maintenance	Periods	9
Cell line development-finite and continuous cell lines; Cell line immortalization; Cell line techniques-viral transfection, chemical methods, and genetic modification; Cell line authentication-STR profiling; Common cell culture contaminants; Ethical Issues in Cell Culture and Stem Cell Research; Regulatory Framework-FDA,GMP.			
Unit – IV	Bioreactor Systems and Scaling Up	Periods	9
Introduction to Bioreactors, Types of bioreactors-Batch, fed-batch, and continuous culture systems; scaling up-principle, uses, Monitoring and controlling culture conditions; Cell Culture in Bioreactors for Protein Production; Process development and optimization in cell culture; Automation and Quality Control in Bioreactor Systems			
Unit – V	Applications of cell culture technologies	Periods	9
Stem cell and gene therapy; Drug Discovery and Toxicology Testing; 3D cell culture-spheroids, organoids, bioprinting; Organs-on-Chips and Microfluidics; Emerging tools and techniques in cell engineering-CRISPR.			
Total Periods			45
Text Books			
1.	R. Ian Freshney "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" 7 th Edition, Wiley Blackwell 2016.		
2.	Michael Butler "Animal Cell Culture and Technology" Second Edition, Taylor & Francis Publishers, 2008.		
References			
1.	John R. W. Masters "Cell and Tissue Culture: Laboratory Procedures", 4 th Edition Oxford University Press, 2013.		
2.	John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.		
3.	Martin Clynes, "Animal Cell Culture Techniques", Springer, 2012.		
4.	Cornelia Kasper, Verena Charwat, Antonina Lavrentieva, "Cell Culture Technology" Springer,2018.		
5.	Shalini Mani, Manisha Singh, Anil Kumar, "Animal Cell Culture: Principles and Practice", Springer,2024.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/102/104/102104059/		
2.	https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf		
3.	https://ncert.nic.in/textbook/pdf/lebt108.pdf		
4.	https://www.atcc.org/resources/culture-guides/animal-cell-culture-guide		


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Programme	B. Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY						Semester		-						
Course Code	Course Name		Periods Per Week			Credit	Maximum Marks								
			L	T	P		C	CA	ESE	Total					
U23BTV49	Clinical Trials and Healthcare Policies in Biotechnology		3	0	0	3	40	60	100						
Course Objective	The student should be made <ul style="list-style-type: none"> ➤ To Acquire knowledge on drug discovery and development ➤ To understand the process of clinical trial, its ethics and follow the regulatory framework important for benefit for the society ➤ To prepare the necessary documents required for conducting clinical trials & project management strategies for efficient trials 														
Course Outcomes	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Understand key areas of drug development, clinical research regulations, trial management											K2			
	CO2: Understand the ethical considerations in clinical trials											K2			
	CO3: Apply the guidelines in clinical research											K3			
	CO4: Analyze the necessary documents required for clinical research and Evaluate the clinical trial management process											K4			
CO5: Apply and demonstrate critical analysis skills using tools of CDM											K4				
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2		2		1	2			3	1		2	3	3	3
CO 2	3	3	2	2	3	2				2			2	1	2
CO 3	3	2	3	2	2	2				2			2	2	1
CO 4	1	2	2	3	3	2			2	2		2	3	3	2
CO 5	3	2	2	2	1	1				2			3	1	1
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															


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Unit – I	FUNDAMENTALS OF DRUG DEVELOPMENT AND CLINICAL TRIALS	Periods	9
Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India-The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV-methods, Principles of sampling-Inclusion and exclusion criteria, Termination of trial			
Unit – II	GOOD CLINICAL PRACTICE	Periods	9
Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Research ethics and Bioethics-Principles of research ethics-Ethical issues in clinical trials-Use of humans in Scientific Experiments-the informed consent-Introduction to ethical codes and conduct Introduction to animal ethics-Animal rights and use of animals in the advancement of medical technology			
Unit – III	REGULATIONS IN CLINICAL RESEARCH	Periods	9
History of Regulations in Clinical Research, Patents US Regulatory Structure, Post Drug Approval Activities, PMS, FDA Audits and Inspections EU Regulatory Affairs, EMEA Organization and Function, INDIAN Regulatory system, Indian GCP guidelines (CDCSO guidelines), ICMR Guidelines - Ethical Guidelines for Biomedical Research on Human Subjects Schedule Y, Schedule Y- Rules and Regulations, Health Insurance Portability and Accountability Act (HIPAA).			
Unit – IV	CLINICAL TRIAL MANAGEMENT AND ESSENTIAL DOCUMENTS	Periods	9
Project management in clinical trials-principles of project management- assessment Pharmacovigilance, Project Auditing, Inspection., Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form			
Unit – V	CLINICAL RESEARCH METHODOLOGY AND CLINICAL DATA	Periods	9
Designing of Protocol, CRF, e-CRF, IB, ICF, SOP, Pharmaco-epidemiology, BA/BE Studies, Report writing, Publication, Introduction to CDM, tools for CDM, CDM process, CRF Design, Clinical Data Entry, Electronic Data Capture, Data Validation, Discrepancy Management, Clinical Data Coding, SAE Reconciliation, Quality Assurance & Clinical Data Management.			
Total Periods			45
Text Books			
1.	Lee, Chi-Jen et al., Clinical Trials or Drugs and Biopharmaceuticals. CRC / Taylor & Francis, 2011		
2.	Richard Chamberlain, “Project Management of Clinical Trials” Xlibris Us, 2019		
3.	Abdel-aleem, Salah M., The Design and Management of Medical Device Clinical Trials: Strategies and Challenges. Wiley, 2011		
4.	Friedman, L.M., Furberg, C.D., DeMets, D., Reboussin, D.M., Granger, C.B. Fundamentals of Clinical Trials, springer, 2015		
References			
1.	Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016		
2.	John I. Gallin, M.D, Frederick P Ognibene Principles and Practice of Clinical Research, Academic Press, 3 rd edition 2012.		
3.	Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and Ameet Bakhai. Remedica. 2006.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/127/106/127106137/		
2.	https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ge14/		
3.	https://archive.nptel.ac.in/courses/127/106/127106009/		



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VERTICAL V


Quality and Regulatory Affairs



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Programme	B. Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV51	GOOD MANUFACTURING PRACTICES	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To explain the principles of GLP, GMP and GCP To describe the features of quality by design To discuss the importance of GMP in bioprocess industries To impart fundamental knowledge on various Good Clinical Practices To educate the importance of Biosafety and quality assurance 														
Course Outcomes	After completion of this course, the students will be able to						Knowledge Level								
	Apply GMP principles to ensure the quality and safety of manufactured products.						K2								
	Develop critical thinking skills to identify areas for improvement and implement QBD and DOE strategies						K3								
	Demonstrate proficiency in conducting in-process quality control (IPQC) checks to ensure compliance with regulatory standards and product specifications.						K3								
	Apply principles of laboratory safety to prevent accidents, protect personnel, and maintain a secure research environment.						K4								
	Apply quality assurance principles and practices to ensure compliance with regulatory requirements						K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	3	2	3	3	3	2		2	2		2	2
CO 2	3	3	3	3	2	3	3	3	2		2	2		2	2
CO 3	3	3	3	3	2	3	3	3	2		2	2		2	2
CO 4	3	3	3	3	2	3	3	3	2		2	2		2	2
CO 5	3	3	3	3	2	3	3	3	2		2	2		2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
<ol style="list-style-type: none"> Continuous Assessment Test I, II & III Assignment End-Semester examinations 															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION	Periods	9
GMP, cGMP, GLP, GCP, GDP, QMS. Types of Laboratory, General Rules, Protocols, SOP, Calibration of Instruments, Record Keeping and Interpretation. National and international regulatory authorities and their function. Risk assessment and risk control measures.			
Unit – II	QUALITY BY DESIGN	Periods	9
Principles of quality by design (QBD) Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development. Case studies: Example of QBD and DOE in Process Development, Documentation and records, Audit, goals of Laboratory Quality Audit, Audit tools. Bureau of Indian Standards.			
Unit – III	GOOD MANUFACTURING PRACTICES IN PROCESS INDUSTRIES	Periods	9
Analysis of raw materials, finished products, packaging materials, in-process quality control (IPQC) Developing specification (ICH Q6 and Q3), purchase specifications and maintenance of stores for raw materials. Formulation, Production, Management, Authorization and marketing of drugs, Documentation in Pharmaceutical Industry, Manufacturing Operations and Controls			
Unit – IV	GOOD CLINICAL LABORATORY PRACTICES	Periods	9
Regulation on Clinical and Preclinical Studies, Pre-examination process, examination processes, sample storage/disposal, laboratory safety, ethical considerations, and data management. Guidelines on animal studies, Responsible conduct of research, Ethical review procedures, Informed consent process, Clinical trials of drugs and other interventions, Biological materials, biobanking and datasets			
Unit – V	BIOSAFETY AND QUALITY MANAGEMENT	Periods	9
cGMP guidelines, Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, construction and plant layout, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, Control of contamination, Good Warehousing Practice. Quality Standards- Advantages and Disadvantages, Concept of Quality Control Quality Assurance- Their functions and advantages Quality assurance and quality management in industry			
Total Periods			45
Text Books			
1.	Beg, S., Hasnain, M. S., "Pharmaceutical Quality by Design: Principles and Application", Academic Press, March 2019.		
2.	Cooper, B. N., "Good Manufacturing Practices for Pharmaceuticals: GMP in Practice", CreateSpace Independent Publishing Platform, July 2017.		
3.	Tobin, E. P., "cGMP Starter Guide: Principles in Good Manufacturing Practices for Beginners", CreateSpace Independent Publishing Platform, April 2016.		
References			
1.	Indian Council of Medical Research, New Delhi, "Guidelines for Good Laboratory Practices", 2008.		
2.	Department of Biotechnology (DBT) Star College Scheme, "Life Science Protocol Manual", 2018.		
3.	Singer, D.C., "Laboratory Auditing for Quality and Regulatory Compliance", Vol.150, Drugs and the Pharmaceutical Sciences, 6 th Edition, 2021		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc20_me67/preview		
2.	https://nptel.ac.in/courses/112107077		
3.	https://onlinecourses.nptel.ac.in/noc20_me73/preview		




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
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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV52	Entrepreneurship & IPR	3	0	0	3	40	60	100							
Course Objective	This course will teach the <ul style="list-style-type: none"> Importance of entrepreneurship, and management skills in business practice. Evaluate the effectiveness of bio-business plan. 														
Course Outcomes	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Apply entrepreneurship skills to convert their research ideas into commercial products.							K2							
	CO2: Gained knowledge on legal issues, regulations of starting and operating a venture and capstone presentation on practice venture.							K2							
	CO3: Analyze the functions of bio-business to transfer the technology from laboratory into market.							K3							
	CO4: Evaluate the importance of Intellectual property rights to protect the inventions.							K4							
CO5: Explain patenting process and its strategic tools in business development							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2	2	2	2				3	3	3	3		3	2	2
CO 2	2	2		2	3					1	3		3	3	2
CO 3	2	3		3	2					2	3		2	2	2
CO 4	2	3	2	3	1			3	3	3	2		3	2	2
CO 5	3	1	3		2			3	3	3	2		3	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	ENTREPRENEUR	Periods	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, BUSINESS STRATEGIES AND TECHNOLOGY TRANSFER	Periods	9
General considerations of Business plan – Do’s and don’ts -How to write Business proposal - Checklist for Business proposal writing- Intellectual property in biotech - Licensing, Accessing, University technology, Licensing of Biotechnological invention.			
Unit – III	BIO-ENTREPRENEURSHIP START-UP	Periods	9
Bio entrepreneurship; Indicators of Bio entrepreneurship - Paths for starting new Biotech ventures- History of establishment of pioneer biotechnology companies- Key for success, Mission and Strategy, product selection for new Biotech venture. Opportunities for a start-up company and its approaches through agency-Proposal Writing.			
Unit – IV	INTELLECTUAL PROPERTY RIGHTS	Periods	9
Types of Intellectual property: Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs, IP as a factor in R&D; IPs of relevance to Biotechnology Agreements and Treaties. History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty: Indian Patent Act 1970 and recent amendments			
Unit – V	PATENTING PROCESS	Periods	9
Patents; Types of patent applications, National and Patent Cooperation Treaty filing procedure; Time frame and cost; Status of the Patent applications filed; Precautions while patenting - disclosure/non-disclosure; Financial assistance for patenting, Existing schemes, Patent licensing and agreement Patent infringement.			
Total Periods			45
Text Books			
1.	Heidrun Flaadt Cervini and Jörg Dogwiler, “Bio- and Med- Tech Entrepreneurship: From Start-up to Exit”, Stampfil Verlag, Italy,2020,		
2.	Deepa Goel, Shominiparashar, “IPR, Biosafety and Bioethics”, Pearson, 2013.		
References			
1.	Charles Bamford and Garry Bruton, “ENTREPRENEURSHIP: The Art, Science, and Process for Success”, 2nd Edition, Tata McGrawhill Company, New Delhi, 2016.		
2.	Shreya Sanghvi Malik and Dr. Shiv Kant Shukla “Bio entrepreneurship development” Biotech Consortium India Limited (BCIL), New Delhi, India, 2018		
3.	David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.		
4.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.		
5.	Stephen Key, “One Simple Idea for Startups and Entrepreneurs: Live Your Dreams and Create Your Own Profitable Company” 1st Edition, Tata McGrawhill Company, New Delhi, 2013.		
E-Resources			
1.	Entrepreneurship – SWAYAM https://onlinecourses.swayam2.ac.in/cec19_mg39/preview		
2.	Intellectual Property Rights- India: www.ipindia.nic.in		
3.	www.patentoffice.nic.in		


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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV53	Audit and Regulatory Compliance	3	0	0	3	40	60	100							
Course Objective	This course deals with understanding the process of auditing, documentation, and regulatory compliance perceive in biopharmaceutical industries.														
Course Outcome	At the end of the course, the student should be able to,								Knowledge Level						
	CO1: Appraise the importance of audit and documents pertaining to drugs in pharmaceutical industries								K2						
	CO2: Demonstrate the auditing methodology and prepare the compliance report for approval pharmaceutical products								K3						
	CO3: Design of the vendor auditing process in the pharmaceutical industries								K4						
	CO4: Develop microbial laboratory facility, and utility auditing strategy								K4						
	CO5: Perform and inspect the critical engineering safety measures and maintenance in pharmaceutical manufacturing area								K3						
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2		2	3	2				3		2	2	3	3	3
CO 2	3								2		2	2	3	3	3
CO 3	2	1									3	2	3	3	3
CO 4	3	1		3	3	2	2					2	3	3	3
CO 5	3	3	2	2	3				3			2	3	3	3
Pre-requisites	Biopharmaceutical Technology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	Introduction to Audit										Periods	9			
Audits: Introduction, Definition, Summary, Types of audits, GMP compliance audit, Audit policy, Internal and External Audits, Second Party Audits, External third-party audits, Auditing strategies, Preparation and															



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conducting audit, Auditing strategies, audit analysis, audit report, audit follow up. Auditing/inspection of manufacturing facilities by regulatory agencies. Timelines for audits/inspection.			
Unit – II	Role of Quality Systems and Audits in Pharmaceutical Manufacturing Environment	Periods	9
cGMP Regulations, Quality assurance functions, Quality systems approach, Management responsibilities, Resource, Manufacturing operations, Evaluation activities, Transitioning to quality system approach, Audit checklist for drug industries. Classifications of deficiencies, factory acceptance test (FAT), site acceptance test.			
Unit – III	Auditing of Vendors and Production Department	Periods	9
Vendor certification- Objectives, vendor appraisal, Vendor rating, Assessment of new vendor, vendor preferences, rewards system. Bulk Pharmaceutical Chemicals and packaging material audit, Warehouse and weighing, Dry Production: Granulation, tableting, coating, capsules, sterile production and packaging			
Unit – IV	Auditing of Microbiological Laboratory	Periods	9
Auditing the manufacturing process, Product and process information, General areas of interest in the building raw materials, Water, Packaging materials			
Unit – V	Auditing of Quality Assurance and Engineering Department	Periods	9
Quality Assurance Maintenance, Critical systems: HVAC – Purpose, life cycle, control during routine operation, Required Quality for Water for Pharmaceutical Purposes, Selection of Water for Pharmaceutical Purposes, Equipment and Components for Water System - Purposes of an Air Handling System, verification of air quality Cleanliness.			
Total Periods			45
Text Books			
1.	Karen Ginsbury, Gil Bismuth “Compliance Auditing for Pharmaceutical Manufacturers: A Practical Guide to In-Depth Systems Auditing”, CRC Press BSP Books, 2018		
2.	Erfan Syed Asif “Pharmaceutical Vendors Approval Manual A Comprehensive Quality Manual for API and Packaging Material Approval”, CRC Press, 2021		
References			
1.	Donald C. Singer, Raluca-loana Stefan, Jacobus F. Van Staden “Laboratory auditing for quality and regulatory compliance” CRC Press (2008)		
2.	Carmen Medina “Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics” First Edition, 2019		
3.	Douglas J. Pisano, David Mantus “FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics” 2008		
4.	Shayne Cox Gad “Pharmaceutical Manufacturing Handbook, Regulations and Quality” Wiley-Interscience, A John Wiley and sons, Inc., Publications. 2008		
5.	Rosamund M. Baird, Norman A. Hodges, Stephen P. Denyar “Handbook of microbiological Quality control” CRC Press. 2000		
E-Resources			
1.	https://nptel.ac.in/courses/127106137		



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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV54	Supply Chain Management	3	0	0	3	40	60	100							
Course Objective	This course aims to explain <ul style="list-style-type: none"> The process and functions of supply chain management in industries. The design, appreciate continuous processes through networks, The understand the coordination role in supply chain management. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Describes the fundamental understanding of supply chain management.							K2							
	CO2: Designing of the network distribution in the supply chain management							K3							
	CO3: Appraise to solve the demand problems in supply chain and appreciating forecasting techniques							K4							
	CO4: Develop the uninterrupted transportation of logistics and its information through enterprise architectures							K3							
CO5: Aggregate planning, managing economies of scale and managing uncertainty in supply chain through safety inventory.							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3		3	2				3	3	3	3		3	3	2
CO 2	1	3	3		2	3		3	3		3		3	3	2
CO 3	2		1		3	3		3	3	3	1		2	3	2
CO 4	2	3	2		3	2			3		3	2	2	3	2
CO 5	3		3	2					2		3	3	3	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															



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Unit – I	Introduction to Supply Chain Management	Periods	9
Introduction to Supply Chain Management- Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.			
Unit – II	Designing the Supply Chain Network	Periods	9
Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact – distribution networks in practice – network design in the supply chain – role of network – factors affecting the network design decisions – modelling for supply chain.			
Unit – III	Planning of supply chain strategies	Periods	9
Planning Demand and Supply- Role of forecasting – demand forecasting – approaches – role of IT. Planning and Managing Inventories- Safety inventory and its appropriate level – impact of supply uncertainty, aggregation and replenishment policies.			
Unit – IV	Transportation Networks and Sourcing	Periods	9
Role of transportation – modes and their performance – transportation infrastructure and policies - design options and their trade-offs – Tailored transportation. Sourcing – In-house or Outsource – 3 rd and 4th PLs – supplier scoring and assessment.			
Unit – V	Supply chain Coordination	Periods	9
Coordination in a Supply Chain- Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination – managerial levels – building partnerships and trust – continuous replenishment and vendor-managed inventories – collaborative planning, forecasting and replenishment.			
Total Periods			45
Text Books			
1.	Sunil Chopra and Peter Meindl, “Supply Chain Management – Strategy, Planning and Operation”, PHI, 4 th Edition, 2016.		
2.	Ballou and Samir “Business Logistics Management”, 5th Edition 2014.		
References			
1.	David B. Grant & Chee Yew Wong “Sustainable Logistics and Supply Chain Management: Principles and Practices for Sustainable Operations and Management” 2 nd edition, 2017.		
2.	Donald Bowersox, David Closs & Bixby cooper “Supply chain Logistical Management” McGraw-Hill, 4th Edition, 2013.		
3.	Wisner, Keong Leong and Keah-Choon Tan, “Principles of Supply Chain Management a Balanced Approach”, Thomson Press, 2005.		
4.	Coyle, Bardi, Longley, “The Management of Business Logistics – A Supply Chain Perspective”, Thomson Press, 2006.		
5.	Jeremy F Shapiro, “Modelling the Supply Chain”, Thomson, 2002.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc24_hs128/preview		
2.	https://www.coursera.org/courses?query=supply%20chain		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV55	QA and QC in Biotechnology	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To provide students with a comprehensive understanding of quality assurance and quality control principles and their application in biotechnology industries. Students will gain knowledge about regulatory standards, analytical methods, validation processes, and quality systems required. Understand safe biotechnological product manufacturing. 														
Course Outcomes	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand the principles and significance of QA and QC in biotechnology industries.						K2								
	CO2: Apply Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP) to ensure product quality and safety.						K2								
	CO3: Perform quality control techniques and validation processes in biotechnology.						K3								
	CO4: Analyze regulatory requirements for QA and QC in biotechnology product development.						K3								
	CO5: Evaluate the implementation of quality management systems (QMS) in biopharmaceuticals and biosimilars.						K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	2	1	3	1	1					2	2	1	2
CO 2	2	2	1	1	3		2					3	1	3	2
CO 3	2	1	2	2	1	1						1	2	2	2
CO 4	1	2		2	3		1	1			1	3	2	1	2
CO 5	2	2		3	1	1					1	2	2	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															



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1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to QA and QC in Biotechnology	Periods	9
Overview of QA and QC concepts in biotechnology. Importance of QA/QC in biopharmaceuticals, diagnostics, and industrial biotechnology. Key differences between QA and QC. Case studies on quality failures in biotechnology.			
Unit – II	Good Practices in Biotechnology	Periods	9
Good Laboratory Practices (GLP): Principles, applications, and compliance. Good Manufacturing Practices (GMP): Principles, implementation, and global standards. Good Clinical Practices (GCP): Role in clinical trials and biotechnology products. Documentation: SOPs, batch records, and quality audits.			
Unit – III	Quality Control Techniques and Analytical Methods	Periods	9
Quality control tools and techniques: Process and product testing. Analytical methods: Chromatography, spectroscopy, and bioassays. Validation of analytical methods: Accuracy, precision, and robustness. Role of automation and artificial intelligence in quality control.			
Unit – IV	Regulatory Requirements and Standards	Periods	9
Regulatory authorities: FDA, EMA, WHO, and ICH guidelines. Quality-by-Design (QbD) approach in biotechnology. Risk management and regulatory compliance. Biosafety and bioethics in QA/QC.			
Unit – V	Quality Management Systems and Emerging Trends	Periods	9
Quality Management Systems (QMS): ISO 9001 and ISO 13485 standards. Implementation of total quality management (TQM) in biotechnology. Emerging trends: Data integrity, electronic records, and cloud-based QMS. Case studies on successful QA/QC systems in biotechnology.			
Total Periods			45
Text Books			
1.	Purohit, S. S., & Mathur, S. K. (2013). Biotechnology: Fundamentals and Applications. Agrobios.		
2.	Sharma, S. (2010). Good Manufacturing Practices (GMP) for Pharmaceuticals. CBS Publishers.		
3.	Rathore, A. S., & Sofer, G. K. (2005). Process Validation in Manufacturing of Biopharmaceuticals: Guidelines, Current Practices, and Industrial Case Studies. CRC Press.		
References			
1.	Sharma, R. (2021). Validation Standard Operating Procedures: A Step-by-Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries. CRC Press.		
2.	ICH Guidelines: Q8 (R2) Pharmaceutical Development, Q9 Quality Risk Management, and Q10 Pharmaceutical Quality System		
3.	Nally, J. D. (2016). Good Manufacturing Practices for Pharmaceuticals. CRC Press.		
4.	Friedli, T., Goetzfried, M., & Basu, P. (2010). Leading Pharmaceutical Operational Excellence: Outstanding Practices and Cases. Springer.		
5.	Sarker, D. K. (2008). Quality Systems and Controls for Pharmaceuticals. Wiley-Blackwell.		
E-Resources			
1.	https://www.edx.org/course/good-manufacturing-practices		
2.	https://www.fda.gov/training-and-continuing-education/learning-portal		
3.	https://www.ich.org/page/quality-guidelines		


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Programme	B.Tech	Programme Code		105	Regulation	2023									
Department	BIOTECHNOLOGY			Semester		-									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV56	INDUSTRIAL BIOSAFETY	3	0	0	3	40	60	100							
Course Objective	The objective of this course is to aid each student in making progress in the bio-safety guidelines for industrial safety management.														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Understand the basic concept of necessity of bio-safety.							K2							
	CO2: Explain the overall risk analysis.							K2							
	CO3: Describe the bio-safety guidelines.							K3							
	CO4: Explain the bio-containment and certification.							K3							
CO 5: Illustrate the national and international regulations of bio-safety aspects.							K4								
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs Programme Outcomes (POs)													PSOs		
	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	P O 10	P O 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2	2	2			2		2				2	3	2	3
CO 2	3	3	3			2	3	3				3	2	3	2
CO 3	3	3	3		3	1	2	2				3	2	2	2
CO 4	3	3	1		3	1	1	2				3	2	3	3
CO 5	3	3	3	3	3			3	3	3	3	3	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															
Unit – I	NECESSITY FOR BIOSAFETY										Periods	9			
Introduction; the history and incidence of laboratory-acquired infections (LAI) ,incidents of secondary transmission from the laboratory, types of laboratory accidents leading to LAIs, role of aerosols in LAIs, importance of biosafety and biocontainment in minimizing the risk of LAIs.															
Unit - II	RISK ANALYSIS										Periods	9			
Overall risk analysis–emergency planning-on site & off site emergency planning, risk management ISO 14000,															



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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 – III	BIOSAFETY GUIDELINES	Periods	9
Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including; Cartagena Protocol.			
Unit – IV	BIOCONTAINMENT AND CERTIFICATION	Periods	9
Building a new bio-containment laboratory from conceptualization through to certification. concepts of laboratory programming phase, architectural and engineering bio-containment features, key security features and control systems, commissioning and certification process and their differences.			
Unit – V	NATIONAL AND INTERNATIONAL REGULATIONS	Periods	9
International regulations – OECD (Organisation for Economic Co-operation and Development) consensus documents and Codex Alimentary; Indian regulations – EPA (Environmental Protection Agency) act and rules, guidance documents, regulatory framework – RCGM (The review committee on genetic manipulation), GEAC (Genetic Engineering Appraisal Committee), IBSC (Indian Biomedical Skill Consortium) and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containment – bio-safety levels and category of rDNA experiments; field trails – bio-safety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).			
Total Periods			45
Text Books			
1.	Harding, A.L., and Brandt Byers, K. Epidemiology of laboratory-associated infections. In: Fleming, D.O., and Hunt, D.L. Biological safety: principles and practices. Washington, DC: ASM Press, 2000;35-54.		
References			
1.	Heymann, Control of communicable diseases manual 20 th ed.) 2014.		
2.	NIH guidelines for research involving recombinant or synthetic nucleic acid molecules .2013.		
3.	Guide for the care and use of laboratory animals 8 th ed . (National Research Council) National Academies Press 2011.		
4.	Biosafety in Microbiological and Biomedical Laboratories, 5 th ed. 2009.		
5.	Fleming and Hunt, Biological Safety, Principles and Practices, 4 th ed. ASM Press 2006.		
E-Resources			
1.	www.patentoffice.nic.in www.iprlawindia.org/ - 31k - Cached - Similar page		
2.	http://www.cbd.int/biosafety/background.shtml		
3.	http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm		
4.	http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html		

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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV57	Product Development and Technology Transfer	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> To provide students with a comprehensive understanding of the principles and processes involved in product development in biotechnology Understand the effective transfer of technology from research to commercialization. Enable students to equip with knowledge of regulatory requirements, intellectual property and commercialization strategies. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand the stages of product development in the biotechnology industry, from concept to commercialization..						K2								
	CO2: Demonstrate an understanding of intellectual property rights, patents, and their role in protecting biotechnological innovations.						K2								
	CO3: Apply regulatory and quality standards (e.g., GLP, GMP) to ensure compliance in product development.						K3								
	CO4: Develop strategies for successful technology transfer, including scale-up, licensing, and partnerships.						K3								
	CO5: Analyze case studies of biotechnology products and propose solutions to challenges in development and transfer.						K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	2	2	2	1	3	1	1					2	2	1	2
CO2	2	2	1	2	3		2					3	1	3	2
CO3	2	1	2	2	1	1						1	2	2	2
CO4	1	2		2	3		1	1			1	3	2	1	2
CO5	2	2		3	1	1					1	2	2	3	2
Pre-requisites	-														



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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Product Development	Periods	9
Overview of product development in biotechnology. Steps involved: Idea generation, proof of concept, feasibility analysis, and prototyping. Market analysis and need identification. Case studies: Examples of successful biotech product development			
Unit – II	Intellectual Property and Regulatory Framework	Periods	9
Intellectual property rights (IPR) and patents: Types, filing process, and management. Importance of IPR in biotechnology innovation. Regulatory bodies and guidelines (FDA, EMA, WHO, etc.). Regulatory pathways for biotech products, including drugs, diagnostics, and medical devices			
Unit – III	Quality Management and Compliance	Periods	9
Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Quality assurance and quality control in biotech product development. Risk assessment and management during product development. Ethical considerations in product development and technology transfer			
Unit – IV	Technology Transfer and Commercialization	Periods	9
Fundamentals of technology transfer: Definition, scope, and challenges. Technology transfer models: Academia to industry, licensing, and joint ventures. Scale-up and pilot production. Business strategies: Funding, partnerships, and market entry			
Unit – V	Case Studies and Emerging Trends	Periods	9
Case studies on biotechnology products (e.g., vaccines, biologics, biosimilars, and diagnostics). Challenges in biotech product development and transfer: Scientific, legal, and financial perspectives. Emerging trends: AI in biotech, synthetic biology, and personalized medicine. Future opportunities in biotechnology product development and commercialization			
Total Periods			45
Text Books			
1.	Smith, J. E. <i>Biotechnology: Applications and Research</i> . Cambridge University Press. 2009.		
2.	Rathore, A. S., & Sofer, G. K. <i>Process Validation in Manufacturing of Biopharmaceuticals: Guidelines, Current Practices, and Industrial Case Studies</i> . CRC Press. 2005.		
3.	Murray, T. H., & Mehlman, M. J. <i>Encyclopedia of Ethical, Legal, and Policy Issues in Biotechnology</i> . Wiley-Interscience. 2000.		
4.	Walsh, G., & Murphy, B.. <i>Biopharmaceuticals: Biochemistry and Biotechnology (3rd Edition)</i> .		


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	Wiley. 2013
References	
1.	Shimasaki, C. D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press. 2014.
2.	Stimson, M. J. Intellectual Property in Molecular Medicine. Cold Spring Harbor Laboratory Press. 2018.
3.	Mehta, M. N., & Rathore, A. S. Technology Transfer in Biotechnology: A Global Perspective. Springer. 2021.
4.	International Conference on Harmonisation (ICH) guidelines: ICH Q8 (R2) Pharmaceutical Development, ICH Q9 Quality Risk Management, and ICH Q10 Pharmaceutical Quality System.
5.	Regulatory guidelines: FDA, EMA, WHO, and ISO Standards for Biotechnology and Pharmaceuticals
E-Resources	
1.	https://www.coursera.org
2.	https://www.edx.org
3.	https://www.fda.gov/


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Programme	B.Tech	Programme Code	105	Regulation	2023												
Department	BIOTECHNOLOGY			Semester	-												
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks											
		L	T	P		C	CA	ESE	Total								
U23BTV58	Innovation And Design Thinking For Biotechnologists	3	0	0	3	40	60	100									
Course Objective	The student should be made to, <ul style="list-style-type: none"> familiarize with design thinking concepts and principles practice the methods, processes and tools of design thinking. apply the design thinking approach and have ability to model real world situations. 																
Course Outcome	At the end of the course, the students will be able to							Knowledge Level									
	CO1: Understand and apply the concept of team building activity							K1									
	CO2: Understand Design Thinking and apply the design thinking approach to empathize with situations in real world.							K2									
	CO3: Identify various methods of empathy and define the problem.							K3									
	CO4: Develop creative ideas through design thinking.							K4									
	CO5: Understand benefits of learning through observation, experience and application.							K4									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping					
COs												Programme Outcomes (POs)			PSOs		
	PO 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	P O 10	P O 11	PO 12	PS O1	PS O 2	PSO 3		
CO 1	3	2	1	2	1	-	-	-	-	2	1	2	3	2	1		
CO 2	3	3	2	2	2	-	-	-	1	2	2	3	3	3	2		
CO 3	3	3	3	3	2	1	1	-	1	2	2	3	3	3	3		
CO 4	3	3	3	3	3	1	1	-	2	3	3	3	3	3	3		
CO 5	3	3	3	3	3	1	1	-	1	3	3	3	3	3	3		
Pre-requisites		-															
Course Assessment Methods																	
Direct																	
1. Continuous Assessment Test I,II & III																	
2. Assignment																	
3. End-Semester examinations																	


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	BASICS OF TEAM BUILDING	Periods	9
Introduction – Team Building - Types – 4 C's of Team Building – Levels of Team Building – Benefits of Team Work – Team Building Activity.			
Unit – II	DESIGN THINKING	Periods	9
Introduction to Design Thinking – Purpose of Design Thinking – Design Thinking Framework, Empathy and related case studies in Biotechnology			
Unit – III	PROBLEM STATEMENT	Periods	9
Define : Examine and Reflect on the Biotech problem.			
Unit – IV	IDEATION	Periods	9
Generating Biotech Ideas – Identifying ideas – Bundling the ideas and create concepts – Rapid Prototyping – Idea Refinement.			
Unit – V	APPLICATION OF DESIGN THINKING	Periods	9
Importance & testing the design with people - Retest and redefine results in Biotechnology.			
Total Periods			45
Text Books			
1.	Solving Problems with Design Thinking - Ten Stories of What Works by Jeanne Liedtka 2013.		
2.	Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.		
References			
1.	Design thinking toolbox by Michael Lewrick, Wily 2020		
2.	Design thinking playbook by Michael Lewrick , Wily 2019		
3.	The Design of Everyday Things: by Don Norman 2013		
E-Resources			
1.	https://thisisdesignthinking.net/on-design-thinking/design-thinkingresources/		
2.	https://www.mindtools.com/brainstm.html		



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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV59	Resource Management & Lean start-up Management	3	0	0	3	40	60	100							
Course Objective	The student should be made to <ul style="list-style-type: none"> Understand the classification, distribution, and uses of natural resources and their impacts. Explain resource management approaches to address productivity and sustainability. Identify lean management principles, waste, and stakeholder requirements. Analyze lean tools and TPM to improve equipment effectiveness and efficiency. Examine lean project selection, process mapping, and value stream mapping. 														
Course Outcome	At the end of the course, the student should be able to,					Knowledge Level									
	CO1: Classify, distribute, and analyze the uses of natural resources.					K1									
	CO2: Develop the ability to evaluate and apply resource management approaches.					K3									
	CO3: Identify lean management principles, recognize waste, and understand stakeholder requirements for effective implementation.					K3									
	CO4: Apply lean tools, techniques, and Total Productive Maintenance (TPM) to enhance operational efficiency.					K3									
	CO5: Acquire skills in selecting lean projects, process mapping, and value stream mapping to implement and analyze lean initiatives effectively.					K4									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	3	-	-	1	-	-	-	-	-	-	-	3	1	1
CO 2	-	2	3	-	2	-	-	-	-	-	-	-	3	2	-
CO 3	-	2	-	3	2	2	-	-	2	-	2	2	-	3	2
CO 4	-	-	-	3	3	2	3	2	2	-	3	-	1	3	3
CO 5	-	-	-	3	3	-	-	-	2	-	2	2	-	3	3


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION	Periods	9
Classification of natural resources - Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management.			
Unit – II	APPROACHES IN RESOURCE MANAGEMENT	Periods	9
Ecological approach - Economic approach - Ethnological approach , Implications of the approaches - Integrated resource management strategies , Poverty and implications in Resource Management in developing countries ; Resource Management paradigms - Evolution and history.			
Unit – III	LEAN MANAGEMENT AND LEAN ELEMENTS	Periods	9
Introduction to seven waste and their narration - Evolution of lean; Global competition - Lean Manufacturing, Value flow and Muda- Muri and Mura, Need for LM, Meeting the stake holders requirement, Elements of LM.			
Unit – IV	LEAN TOOLS AND TECHNIQUES	Periods	9
Various tool of LM, Fundamental blocks of Lean, Impact of Seiri Seiton Seiso Seiketsu and Shitsuke - Need for TPM, Pillars of TPM, Implementation of TPM, Overall Equipment Effectiveness (OEE) and its computation.			
Unit – V	PROJECT SELECTION AND LEAN MANAGEMENT	Periods	9
Lean projects: Training, Resource and project selection, Selecting projects, Process mapping, Current and future value stream mapping, project suitable for lean initiatives, selecting the members, preparing project plan, implementation, review.			
Total Periods			45
Text Books			
1.	Maximilian Thundermann, A book of Lean Management for beginners, 2019		
2.	Michael Balle, Daniel Jones, Jacques Chaize and Orest fiume, The Lean Strategy, 2017		
Reference			
1.	Pankaj Goyal, Before You Start-up: How to prepare to make your Startup dream a Reality, 2017.		
2.	Harikesh N Mishra, Managing Natural Resources- Focus on Land and Water. PHI Larning Publication, 2014		
3.	Charron, R., Harrington, H. J., Voehl, F., & Wiggin, H. The lean management systems handbook (Vol. 4). CRC Press, 2014		
4.	Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley &		

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	Sons, 2003
5.	Tapping, D., Luyster, T., & Shuker, T. Value stream management: Eight steps to planning, mapping, and sustaining lean improvements. Productivity Press, 2002
E-Resources	
1.	https://www.techtarget.com/searchcio/definition/Lean-startup/
2.	https://wadhwanifoundation.org/the-lean-startup-model-building-a-successful-business-with-limited-resources/
3.	https://archive.nptel.ac.in/courses/127/105/127105007/



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VERTICAL VI

Computational Biotechnology

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Programme	B.Tech	Programme Code				105	Regulation		2023						
Department	BIOTECHNOLOGY					Semester		-							
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV61	Fundamentals of Protein Chemistry	3	0	0	3	40	60	100							
Course Objective	The student should be made to														
	<ul style="list-style-type: none"> Recall the classification, properties, and structure of amino acids, including their spectroscopic properties and interactions. Explain the primary, secondary, tertiary, and quaternary structures of proteins. Identify the factors that contribute to protein folding and stability. Analyze the types of protein-protein interactions and their significance in regulating cellular processes. Examine the various strategies involved in protein purification and isolation. 														
Course Outcomes	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: List the different classifications of amino acids and describe their physical and chemical properties.											K1			
	CO2: Demonstrate an understanding of the different levels of protein structure and their significance.											K2			
	CO3: Apply the knowledge of protein folding mechanisms to predict protein structure and stability.											K3			
	CO4: Examine the different methods used to study protein-protein interactions and their applications in research.											K4			
	CO5: Dissect the advantages and limitations of different protein purification techniques.											K4			
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	1	2	-	-	-	-	-	-	-	-	-	-	2	3	2
CO 2	1	2	2	1	-	-	-	-	-	2	-	-	2	3	2
CO 3	2	2	3	2	2	2	-	-	-	2	1	-	3	3	3
CO 4	1	3	-	2	-	1	3	1	1	2	1	-	2	2	2
CO 5	2	3	3	2	1	1	-	-	-	2	1	-	3	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															



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3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Classification and Properties of Amino acids	Periods	9
Amino Acids, D-/ L- Isomerism, Classification of Amino Acids, Properties of Amino Acid - Isoelectric point, Amino acid titration, Hydrophobicity, Spectroscopic properties of Amino Acids - Peptide Bond formation, Properties, Geometry, Hydrogen Bonding, Salt Bridges, van der Waals Interactions, Hydrophobic Interactions			
Unit – II	Structure of Amino Acids	Periods	
Primary Structure, Dihedral Angles, Rotamers, Amino Acid Sequencing Methods - Secondary Structure, Torsion Angles, Ramachandran Plot - Tertiary Structure of Protein, Types of interactions in tertiary structure, Fibrous Protein, Globular Protein, Quaternary Structure			
Unit – III	Protein Folding and Structure Prediction	Periods	9
Protein Folding, Models of protein folding, Important elements for protein folding, Molecular Chaperones, Classes of Chaperons - Stability factors of protein folding, Structure Stabilizing Interactions, Factors that disrupt the Native state, Types of Denaturants, Protein Structure Prediction: X-ray and NMR			
Unit – IV	Protein - Protein Interactions	Periods	9
Protein-protein interactions (PPIs) and examples, Types of protein protein interfaces, Properties of interfaces, Binding affinity, Protein-protein binding domains, Regulation of protein-protein interactions, Methods to detect protein protein interactions, Importance of protein-peptide interactions, Specifics of protein – peptide interactions, Peptides as therapeutics			
Unit – V	Protein Isolation and Purification Methods	Periods	9
Isolation of protein from different sources, General strategy of Protein purification, Salt fractionation, Centrifugation, Diffusion and Sedimentation, Isoelectric Focusing, Size Exclusion Chromatography, Affinity Chromatography			
Total Periods			45
Text Books			
1.	Lubert Stryer; Jeremy Berg; John Tymoczko; Gregory Gatto, Biochemistry, 9 th Edition, 2019		
2.	Amit Kessel & Nir Ben-Tal, Introduction to Proteins: Structure, Function, and Motion, 2 nd Edition 2018		
References			
1.	Albert L Lehninger; David L Nelson; Michael M Cox, Principles of Biochemistry, Macmillan International Edition, 6 th Edition, 2013		
2.	Sananda Chatterjee, Protein Chemistry , Discovery Publishing Pvt.Ltd, 1 st edition, 2012		
3.	K.E.van Holde, C. Johnson, P. S. Ho, Physical Biochemistry, Pearson Prentice Hall, 2 nd Edition, 2005,		
4.	Thomas E. Creighton, Proteins: Structures and Molecular Properties, W.H.Freeman & Co Ltd, 2 nd edition, 1992		
5.	Carl Ivar Branden , John Tooze, Introduction to Protein Structure Paperback, 2 nd edition, 1999		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc22_bt62/preview		
2.	https://archive.nptel.ac.in/courses/104/105/104105102/		


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Programme	B.Tech.	Programme Code				105	Regulation			2023					
Department	Biotechnology					Semester			-						
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV62	PROTEIN ENGINEERING	3	0	0	3	40	60	100							
Course Objective	The main objective of this course is to														
	<ul style="list-style-type: none"> • Understand the Fundamentals of Proteins and Peptides • Analyze Protein Architecture and Structure • Analyze Protein Folding and Stability • Examine the Structure-Function Relationship • Develop Knowledge of Proteomics Techniques 														
Course Outcome	Students who complete this course successfully are expected to										Knowledge Level				
	CO1: Recall and Comprehend Protein Chemistry Concepts										K2				
	CO2: Analyze Protein Structures and Sequence										K3				
	CO3: Identify the main methods for determining 3D protein structures										K3				
	CO4: Evaluate Protein Function and Design Applications										K3				
CO5: Apply Proteomics Techniques for Protein Interaction Studies										K4					
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
Programme Outcomes (POs)												PSOs			
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	2	2	3	2	3	1	1	1	1	2	3	2	3
CO 2	3	2	2	2	3	2	3	1	1	1	1	3	3	2	3
CO 3	3	2	2	2	3	2	3	1	1	1	1	3	3	2	3
CO 4	3	3	3	2	3	2	3	1	1	1	1	3	3	2	3
CO 5	3	3	3	2	3	2	3	1	1	1	1	3	3	2	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	INTRODUCTION TO PROTEINS AND PEPTIDES	Periods	9
Amino acids as the building blocks of proteins, Three and single letter codes and their molecular properties (size, solubility, charge, pKa). Different bonds in protein formation: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vanderwaal interactions. Peptides and peptide bonds.			
Unit - II	PROTEIN ARCHITECTURE	Periods	9
Primary structure - peptide mapping, peptide sequencing - Edman degradation method & mass spectrometry; Secondary structure - Alpha, beta and loop structures, Super-secondary structure .			
Unit – III	TERTIARY STRUCTURE	Periods	9
Tertiary structure - Domains, folding, denaturation and renaturation, Cryo-electron microscopy (Cryo-EM). Nuclear Magnetic Resonance (NMR) spectroscopy in protein analysis. X-ray crystallography, Ramachandran plot; Quarternary structure – complex structure formation and characterization.			
Unit - IV	STRUCTURE-FUNCTION RELATIONSHIP	Periods	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, Serine proteases.			
Unit – V	PROTEOMICS	Periods	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.			
Total Periods			45
Text Books			
1.	Haggerty, Lauren M. “Protein Structure: Protein Science and Engineering”. Nova Science Publications, 2011.		
2.	Williamson, Mike “How Proteins Work”. Garland Science, 2012.		
References			
1.	Pennington, S.R and M.J. Dunn, “Proteomics: Protein Sequence to Function”. Viva Books, 2002.		
2.	Liebler, “Introduction to Proteomics” Humana Press, 2002.		
3.	Voet D., Prat W.C., Voet J., “Principles of Biochemistry”, John Wiley and Sons, 4th edition 2012.		
E-Resources			
1.	https://www.classcentral.com/subject/protein-engineering		
2.	https://alison.com/course/understanding-proteomics		
3.	https://www.classcentral.com/subject/proteomics		



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Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY							Semester		-					
Course Code	Course Name						Periods Per Week			Credit	Maximum Marks				
							L	T	P		C	CA	ESE	Total	
U23BTV63	Molecular Modelling and Drug Design						3	0	0	3	40	60	100		
Course Objective	The main goal of this course is to														
	<ul style="list-style-type: none"> gain some knowledge on modern approaches used in molecular modeling. powerful computer-based technology used to identify and design molecules for new medications greatly shortening the discovery phase of drug development by powerful computer-based technology 														
Course Outcome	At the end of the course students will be able to											Knowledge Level			
	CO1: Apply and develop theoretical and software skills to model biomolecules											K3			
	CO2: Apply the concept of molecular model											K3			
	CO3: Analyze new molecules with therapeutic values											K4			
	CO4: Evaluate the development of new biomolecules by modification.											K5			
CO5: Create new lead molecules in drug design											K6				
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3		3	2			2						3	2	2
CO 2	2		3	2	1	1	2						2	3	2
CO 3	2		3	2	1		2					2	2	2	2
CO 4	2		3	1	2	2	2						3	3	2
CO 5	2		3	2	2		2					1	2	3	2
Pre-requisites		-													
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	QUANTUM MECHANICS	Periods	9
Introduction - coordinate systems - potential energy surfaces - introduction to quantum mechanics - postulates - Schrodinger wave equation - hydrogen molecule - Born-Oppenheimer approximation, introduction to computer hardware and software			
Unit – II	MOLECULAR MECHANICS AND ENERGY MINIMIZATION	Periods	9
Empirical force field models - Bond stretching - angle bending - torsional term - nonbonding interactions thermodynamics properties using a force field - derived and non-derived energy minimization method - simplex - sequential univariate method - steepest descent method - conjugate gradient method- Newton-Rapson method.			
Unit – III	MOLECULAR DYNAMICS (MD) SIMULATIONS	Periods	9
Monte Carlo simulation of molecules- Rigid molecules - flexible molecules- polymers- molecular dynamics-thermodynamic properties – Boundaries -Long-range forces - Molecular dynamics using simple models - Molecular dynamics with continuous potentials - Constraint dynamics - Time-dependent properties.			
Unit – IV	CHALLENGES IN MOLECULAR MODELLING	Periods	9
Free energy calculations - free energy differences –enthalpy –entropy - free energy Partitioning - Potential pitfalls - Potentials of mean force - electrostatic contribution -Born and Onsager models - The Langevin dipole model - Methods based upon the Poisson-Boltzmann equation			
Unit – V	APPLICATIONS	Periods	9
Molecular modelling in drug discovery - chemical databases, 2D and 3D database searching - Deriving 3D pharmacophore - Molecular docking -Molecular similarity and similarity searching - Molecular Descriptors - Structure-based de novo ligand design- Quantitative structure-activity relationships - Partial least squares			
Total Periods			45
Text Books			
1.	Drug Discovery and Development: Technology in Transition - Raymond G. Hill, Humphrey P. Rang, 2018		
2.	The Organic Chemistry of Drug Design and Drug Action - Richard B. Silverman, 2015		
References			
1.	Leach Andrew R ,Molecular Modelling: Principles And Applications – (2 nd Ed) – Prentice Hall		
2.	Frenk Jensen , Introduction to Computational Chemistry –3rd Edition – Wiley Publishers		
3.	Tamar Schlick , Molecular Modeling and Simulation: An Interdisciplinary Guide — 2010 ed. Springer Publications		
4.	Riccardo Baron , Computational Drug Discovery and Design - 2012		
5.	Kenneth M. Merz Jr., Dagmar Ringe, Charles H. Reynolds , Drug Design: Structure- and Ligand-Based Approaches - -1 st Ed, Cambridge Publishers		
E-Resources			
1.	https://nptel.ac.in/courses/103103036		
2.	https://onlinecourses.nptel.ac.in/noc21_bt29/preview		


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Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY						Semester								
Course Code	Course Name					Periods Per Week			Credit	Maximum Marks					
						L	T	P		C	CA	ESE	Total		
U23BTV64	Computer Aided Drug Design					3	0	0	3	40	60	100			
Course Objective	The main goal of this course is														
	<ul style="list-style-type: none"> To provide a broad overview of important approaches used in protein and ligand structure based drug design. To state the approaches that are currently applied in drug discovery efforts. To design and produce novel biomolecules. 														
Course Outcome	At the end of the Course, Students will be able to											Knowledge Level			
	CO1: Apply the basic terms in the field of drug designing and drug discovery											K3			
	CO2: Apply pharmacophore modelling methods for drug discovery											K3			
	CO3: Analyze new molecules with therapeutic values based on their structure activity relationship											K4			
	CO4: Evaluate the development of new biomolecules by analyzing their Pharmacology.											K5			
	CO5: Create new lead molecules, antibiotics, antiviral and anticancer drugs											K6			
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	3		3	3					1	3	3	2	3
CO 2	3	3	2	2		3					1	3	2	2	2
CO 3	3	3	2	3		1		1			2	2	3	3	3
CO 4	3	2	1	2	3	2					1	3	3	2	3
CO 5	3	2	3	3	2		1				2	3	2	2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															




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
Unit – I	INTRODUCTION TO DRUG DESIGN AND DISCOVERY	Periods	9
Drug Discovery Therapeutic targets-identification and validation, Drug development process -An outline Discovery of drug candidates. Sources of hits, leads and candidate drugs. Basic principles in lead development and optimization, Membrane penetration-Lipinski Rule of five Stereochemistry in Drug Design and the importance.			
Unit – II	DOCKING AND PHARMACOPHORE MODELLING	Periods	9
Role of X-ray crystallography in structure guided drug design, molecular docking and scoring methods, de novo ligand design, fragment-based drug design. Pharmacophore-based ligand design, pharmacophore concept, basic principles and step by step procedure, pharmacophore elements and their representations, receptor excluded and receptor essential volumes solvation effect. Benzodiazepine site of GABA receptors, 3D-Pharmacophore model.			
Unit – III	STRUCTURE ACTIVITY RELATIONSHIP- QSAR MODELS	Periods	9
Quantitative structure activity relationships and experimental design: Hammett equation, Free Wilson analysis, Hansch analysis hydrophobic correlations, multifactorial correlations physicochemical properties (electronic descriptors hydrophobic parameters, ST descriptors, biological relevance applications of Hansch equations (hydrophobic factors steric factors, electronic factors, ionization constant prediction from equations, blood-brain barrier penetration relations to molecular modeling: 3D-QSAR methodologies, Pharmacophore guided optimization of compounds			
Unit – IV	RECEPTORS, ION CHANNELS AND ENZYMES- PHARMACOLOGY	Periods	9
Receptor structure and function: G-protein coupled receptors, ligand gated ion channel receptors, tyrosine kinase receptors, Nuclear receptors, Receptor pharmacology, Ion channels: Structure and function of ion channels, classification of ion channels, ion channels and diseases. Inhibitors acting at the active site of an enzyme inhibitors acting at allosteric binding sites, uncompetitive and non-competitive inhibitors, transition state analogues, suicide			
Unit – V	DESIGN OF ANTIVIRAL ANTICANCER AND ANTIBIOTICS	Periods	9
Anticancer Agents: Hallmarks of malignant cancer, currently used anticancer agents and their mode of actions. Antibiotics affecting bacterial cell wall formation, cytoplasmic membrane, nucleic acid synthesis, and protein synthesis. Antiviral Drugs and HIV compounds Nucleoside reverse transcriptase inhibitors; nucleotide reverse transcriptase inhibitors; non- nucleoside reverse transcriptase inhibitors, protease inhibitors. Viral entry inhibitors. and HBV compounds, Anti-herpes virus compounds, and influenza virus compounds.			
Total Periods			45
Text Books			
1.	Han, Kamber, and Pel, J. Data Mining: Concepts and Techniques. Publishers. USA, 3 rd edition, 2012		
2.	Voit E. A First Course in Systems Biology. Garland Science, 1/e. ISBN 0815344678, 2012		
References			
1.	Klipp E. Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742, 2009		
2.	Newman MEJ. Networks: an introduction. Oxford Univ. Press. ISBN 9780199206650, 2011		
3.	Bak, P. Brak 5. Bioinformatics: the machine learning approach, MIT Press, 2 edition, 2001		
4.	Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug Action, 3 rd Edition, Academic Press, USA, 2014		


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5.	David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc21_bt29/preview
2.	https://online.vtu.ac.in/course-details/Computer-Aided-Drug-Design




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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV65	Data mining and Machine Learning for Bioinformatics	3	0	0	3	40	60	100							
Course Objective	The main goal of this course is <ul style="list-style-type: none"> To expose the students to data mining and machine learning techniques. To render knowledge of how to perform research in ANN, Bayes classifier biology and synthetic biology. To work in multi-disciplinary teams for big data analyze for biological applications. 														
Course Outcome	At the end of the Course, Students will be able to						Knowledge Level								
	CO1: Apply the problems for machine learning and select the either supervised, unsupervised or reinforcement learning.						K3								
	CO2: Apply cluster analysis methods for machine learning.						K3								
	CO3: Analyze the theory of probability and statistics related to machine learning						K4								
	CO4: Analyze the concept learning, ANN, Bayes classifier, k nearest neighbor						K4								
CO5: Evaluate big data analyze for biological applications.						K5									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	3		3	3					1	3	3	2	3
CO 2	3	3	2	2		3					1	3	2	2	2
CO 3	3	3	2	3		1		1				2	3	3	3
CO 4	3	2	1	2	3	2					1	3	3	2	3
CO 5	3	2	3	3	2		1				2	3	2	2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	OVERVIEW OF MACHINE LEARNING TECHNIQUES	Periods	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	Periods	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	Periods	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 PREPROCESSING AND VISUALIZATION	Periods	9
Overview of data preprocessing, Data cleaning, Data integration, Data reduction, Data transformation and discretization, Visualization- Visualizing a single attribute, visualizing pair of attributes, visualizing several attributes, Visualizing results of machine learning.			
Unit – V	APPLICATIONS OF DATA MINING	Periods	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 data mining tools: Entrez, Blast, sequence retrieval system (SRS).			
Total Periods			45
Text Books			
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.		
References			
1.	Clarke, S. B., Fokoue, E. and Zhang, H. H. 2009 Principles and Theory for Data Mining and Machine Learning.		
2.	Data Mining: Concepts and Techniques by Jiawei Han and Micheline Kamber, 2000		
3.	Data Mining Techniques, A. K. Pujari, University Press, Hyderabad, 2006		
4.	Data mining in bioinformatics by Wang et al, Springer-Verlag, 2005		
5.	Han, Kamber, and Pel, J. Data Mining: Concepts and Techniques. Publishers. USA, 3 edition, 2012.		
E-Resources			
1.	https://www.coursera.org/learn/machine learning		
2.	https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-bt20/		
3.	https://onlinecourses.nptel.ac.in/noc21_bt06/preview		


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23RTV66	System Biology	3	0	0	3	40	60	100							
Course Objective	The main goal of this course is <ul style="list-style-type: none"> To introduce the bottom-up and top-down design and analysis strategies for systems and synthetic biology To expose students to biological networks in cellular process To create deeper understanding of systems biological applications and work in computational and wet-lab projects 														
Course Outcomes	The students should be able to						Knowledge Level								
	CO1: Apply the basic concepts and correlate the importance of Systems biology						K3								
	CO2: Apply the knowledge of biological molecules in network analysis						K3								
	CO3: Analyze the genes and regulatory networks to understand systems biology						K4								
	CO4: Analyze the concepts of systems biology with various tools						K4								
	CO5: Evaluate systems biology modelling and simulation in biological applications						K5								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	1	2				2					3	3	2
CO 2	2	2	1	2	2			2					3	2	2
CO 3	2	2	2	2	2			3				2	3	3	3
CO 4	3	2	1	2	3			2				3	3	2	2
CO 5	3	2	2	1	1			3				3	3	3	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															


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Unit – I	INTRODUCTION TO SYSTEMS BIOLOGY	Periods	9
Overview of System Biology, Mechanisms of gene expression, Metabolic and signal transduction pathways, enzyme kinetics and thermodynamics, Networks and Motifs, Signaling & Experimental methods in systems biology, Robustness and optimality in Biology			
Unit – II	BIOLOGICAL NETWORKS	Periods	9
Biological networks: metabolic, signaling, regulatory, Network alignment and comparisons, network organization, Designing, simulating and building gene circuits, Genome design and synthesis			
Unit – III	GENE REGULATORY NETWORK	Periods	9
Clustering Coordinately Regulated Genes, Discovering Gene Regulatory Signals, Gene Regulatory Modules and Networks, MicroRNA Regulatory Networks, Gene networks			
Unit – IV	TOOLS IN SYSTEMS BIOLOGY	Periods	9
Flux analysis MFA & FBA, Bottom-up approach, Top-down approach, Computer aided design tools for metabolic engineering (Ienera programs, retrosynthesis), Development of a flux theoretical model, correlation of the model with experimental data			
Unit – V	MODELLING AND APPLICATIONS OF SYSTEMS BIOLOGY	Periods	9
Modelling and simulation of biological cells, Stochastic modelling for systems biology, Applications of systems biology in various platforms.			
Total Periods			45
Text Books			
1.	Pengcheng Fu, Sven Panke, "Systems Biology and Synthetic Biology", Wiley-Blackwell Publisher, 2009.		
2.	Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall, 2006.		
References			
1.	Bartocci, E. and Lió, P., Computational modeling, formal analysis, and tools for systems biology. PLoS computational biology, 12(1), p.e1004591. 2016.		
2.	Brückner, A., Polge, C., Lentze, N., Auerbach, D. and Schlattner, U., Yeast two-hybrid, a powerful tool for systems biology. International journal of molecular sciences, 10(6), pp.2763-2788, 2009.		
3.	Voit E. A First Course in Systems Biology. Garland Science, 1/e. ISBN 0815344678, 2012.		
4.	David B. Mount: Bioinformatics. Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York, 2001		
5.	Klipp E, Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742, 2009		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc21_bt16/preview		
2.	https://archive.nptel.ac.in/courses/102/106/102106035/		


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	-										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	FSF	Total						
U23BTV67	Molecular Simulations of Biomolecules	3	0	0	3	40	60	100							
Course Objective	The course enables the students to apply computational methods to study biomolecular structures and dynamics, interpret simulation results, predict molecular behavior, and utilize advanced tools for drug design and protein-ligand interactions. Students will also gain insights into thermodynamic and kinetic properties through molecular modeling.														
Course Outcomes	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand molecular modeling principles and applications in drug discovery.						K2								
	CO2: Gain insights into drug discovery processes and assay development for therapeutic targets.						K2								
	CO3: Understand drug behavior, safety, formulation, delivery methods, and emerging trends in pharmacology.						K3								
	CO4: Understand CADD techniques in protein engineering, design principles, and pharmacophore mapping applications.						K3								
	CO5: Learn QSAR principles, computational modeling, and molecular descriptors for predicting biological activities.						K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3		1		2	3	3						3	2	3
CO2	3		2		3	3	3						3	3	3
CO3	2	3	2	3	2	3	3						2	2	3
CO4	2	3	2	3	2	3	3						3	2	2
CO5	2	3	2	3	2	3	3						3	3	3
Pre-requisites	-														

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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course-end survey			
Content of the syllabus			
Unit –I	APPLICATION OF MOLECULAR MODELING IN DRUG DESIGN	Periods	9
Introduction to Molecular Modelling, Drawbacks of mechanical models as compared to graphical models, Coordinate systems two – matrix, potential energy surface, Molecular modeling in drug discovery - Three dimensional pharmacophores, molecular docking, De-novo ligand designing, structure-based methods - electrostatic and non-electrostatic contribution to free energies, 3D data base searching and virtual screening.			
Unit - II	DRUG DISCOVERY	Periods	9
Drug discovery: targets and receptors identification, Drug Discovery Processes - Medical Needs, Target Identification, Target Validation, Drug Interactions with Targets or Receptors, Enzymes, Receptors and Signal Transduction, Assay Development.			
Unit –III	DRUG DEVELOPMENT	Periods	9
Pharmacodynamics, Pharmacokinetics, Toxicology studies, animal tests, Drug formulations and delivery systems, future perspectives.			
Unit –IV	APPLICATIONS OF CADD	Periods	9
Application and methods of CADD in protein engineering, Protein design principles and examples, Applications in pharmacophores mapping.			
Unit –V	QUANTITATIVE STRUCTURE ACTIVITY RELATIONSHIP (QSAR)	Periods	9
Introduction to QSAR, Analysis of QSAR- computational approaches to chemical libraries lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors.			
Total Periods			45
Text Books			
1.	D. Frenkel and B. Smit, Understanding Molecular Simulation, 2 nd Edition, Academic Press, 2001.		
2.	Rick NG, Drugs: from Discovery to Approval, John Wiley & sons, 2004.		
References			
1.	David W Mount, Bioinformatics, Sequence and Genome analysis, CSHL Press, 2004		
2.	Copeland, Robert A. Enzymes: a practical introduction to structure, mechanism, and data analysis. John Wiley & Sons, 2004.		
3.	Jean-Pierre Doucet and Jacques Weber, Computer-Aided Molecular Design, Theory and Applications. Elsevier Ltd. 1996.		
4.	Andrew R. Leach, Molecular Modelling- Principles and application, Prentice hall, II edition, 1996.		


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E-Resources	
1.	https://www.learntoupgrade.com/s/store/courses/description/Molecular-Modelling
2.	https://ocw.mit.edu/courses/3-320-atomistic-computer-modeling-of-materials-sma-5107-spring-2005/resources/lecture-13-molecular-dynamics-i/
3.	https://nptel.ac.in/courses/104101095




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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV68	Fundamentals of Algorithm for Bioinformatics	3	0	0	3	40	60	100							
Course Objective	The main goal of this course is														
	<ul style="list-style-type: none"> To identify various algorithm design techniques. To impart knowledge on runtime analysis of algorithms. To understand the theory and background of commonly available bioinformatics tools 														
Course Outcome	At the end of the course students will be able to							Knowledge Level							
	CO1: Apply the importance of algorithms for biological applications							K3							
	CO2: Apply the knowledge of bioinformatics in sequence analysis							K3							
	CO3: Analyze the structure of RNA for informatics analysis							K4							
	CO4: Analyze the concepts of clustering methods in biological applications							K4							
CO5: Evaluate the tree algorithms for informatics-based applications							K5								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	2		2								3	2	1
CO 2	2	3	1		2								2	2	2
CO 3	3	3	1	1									2	2	2
CO 4	2	3	1	2									3	2	2
CO 5	2	3	2	1	1								3	2	1
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															
Content of the syllabus															


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Unit – I	STRINGS,GRAPHS AND SEQUENCE COMPARISON ALGORITHMS	Periods	9
Strings: Rabin Karp, finite automata, KMP algorithm, Boyer Moore algorithm and suffix tree. Interval graphs, Mapping-Restriction site mapping algorithms, Partial digest, Double Digest Problem (DDP)-Simulated annealing, circular maps, Fitting data to maps. Radiation hybrid mapping and optical mapping. Longest common substring and longest common subsequence.			
Unit – II	METHODS FOR AIDING ALIGNMENT	Periods	9
Sequence alignment algorithm, Global, local and semi global alignment; affine gaps, time warping. Similar matrices -PAM and BLOSSUM derivation, BLAST algorithm. MSA-scoring MSA methods (global and local)- CLUSTAL W, Muscle. Hidden Markov Model (HMM), Algorithm for HMM. Finding genes with HMM			
Unit – III	PREDICTION OF SITES AND RNA SECONDARY STRUCTURE	Periods	9
Finding instances of known sites, finding instances of unknown sites - Greedy approach, Gibbs sampler, Maximum subsequence problem; RNA secondary structure prediction- approaches to look at changes in the sequence: Minimum free energy and maximum base pair matching, MFOLD predictions, Pseudoknots.			
Unit – IV	CLUSTERING METHODS	Periods	9
Gene expression analysis - Hierarchical clustering, k-means, Clustering and functional analysis of coordinately regulated Genes, gene finding and annotation.			
Unit – V	TREE ALGORITHMS	Periods	9
Evolutionary Models Jukes-Cantor, Kimura, Distance-based tree reconstruction with problems - Reconstruction of trees from additive matrices-Evolutionary trees and hierarchical clustering, Character based tree reconstruction.			
Total Periods			45
Text Books			
1.	Kelly, S.T and Didulo D. Computational Biology: A Hypertextbook. American society for microbiology,2018.		
2.	Sun, H., Construction of Computer Algorithms in Bioinformatics of the Fusion Genetic Algorithm. Mathematical Problems in Engineering, 2022		
References			
1.	Saadeh, H., Al Fayez, R. Q., & Elshqirat, B., Application of K-means clustering to identify similar gene expression patterns during erythroid development. Int J Mach Learn Comput, 10, 452-457, 2020		
2.	Zou, Q., Lin, G., Jiang, X., Liu, X. and Zeng, X., Sequence clustering in bioinformatics: an empirical study. Briefings in bioinformatics, 21(1), pp.1-10., 2020		
3.	Eidhammer, I, Jonassen, I and Taylor, W.R. An Algorithmic approach to sequence and structural analysis. John Wiley and Sons, 2004.		
4.	D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006.		
5.	M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Academic Press, 2010		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc21_bt06/preview		
2.	https://onlinecourses-archive.nptel.ac.in/noc18_bt01/preview		


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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		-								
Course Code	Course Name	Periods Per Wck			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTV69	PROGRAMMING FOR BIOINFORMATICS APPLICATIONS	3	0	0	3	40	60	100							
Course Objective	To understand the history and basics of python. To gain knowledge about the different data types and control flow statements. To impart knowledge about the functions, files, list, set tuples and dictionaries.														
Course Outcomes	At the end of the course, Students will be able to							Knowledge Level							
	CO1: Apply the basics of Linux operating system and the SQL for database creation and management.							K3							
	CO2: Use the Perl data types to construct programs in Perl.							K3							
	CO3: Analyze the various operators, Regular expressions, conditional statements and loops in Perl programs.							K4							
	CO4: Develop and execute Perl subroutines to define reusable code, pass arguments, and return values.							K4							
CO5: Demonstrate the applications of Perl Programming in handling genomics and Proteomics data.							K4								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3		3									3	2	2
CO 2	2	3											3	2	3
CO 3	2	3		3									2	2	2
CO 4	2	3		3	2								3	2	3
CO 5	2	3		3	2								3	2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	INTRODUCTORY CONCEPTS	Periods	9
Introduction to Operating systems, Linux commands, File transfer protocols FTP and telnet, Data life cycle, Database management system models. Structured Query Language (SQL) – Data Definition Language (DDL), Data Manipulation Language (DML) and Query by example.PL/SQL - Stored procedure, Database triggers; Relational Data Base Management system.			
Unit – II	PERL PROGRAMMING	Periods	9
Perl overview, variables and data types, control Structure, loops- while loop, for loop, until loop, File handles - opening and closing files, reading and writing file handles, Library Functions: String specific functions, User defined functions.			
Unit – III	OPERATORS	Periods	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	Periods	9
Simple characters, * special character, . character, character, Grouping with (), anchor characters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl.			
Unit – V	APPLICATIONS OF PERL IN BIOINFORMATICS	Periods	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 Periods			45
Text Books			
1.	James Tisdall, “Beginning Perl for Bioinformatics”, O’Reilly & Associates, 2001		
2.	James Tisdall, “Mastering Perl for Bioinformatics”, O’Reilly, 2003		
References			
1.	Elmasri and Navathe. 2006. Fundamentals of Database Systems. Addison Wesley.		
2.	Cynthia Gibas& Per Jambeck, “Developing Bioinformatics Computer Skills”, O’Reilly & Associates, 2000.		
3.	2. Rex A. Dawyer, “Genomic Perl”, Cambridge University Press 3. Learning Perl, 3rd Edition , Author: Randal L. Schwartz and Tom Phoenix, O’Reilly		
4.	Bassi, S Python for Bioinformatics, Chapman and Hall CRC press, 2nd edition, 2018.		
5.	Guttag, J.V Introduction to computation and programming using python, MIT press, 2nd edition, 2016.		
E-Resources			
1.	https://onlinecourses.swayam2.ac.in/aic20_sp31/preview		
2.	https://www.arraygen.com/bioperl-course.php		
3.	https://script.spoken-tutorial.org/index.php/PERL		



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	Programme	B.Tech.	Programme Code				105	Regulation		2023					
Department	BIOTECHNOLOGY					Semester			V						
Course Code	Course Name		Periods Per Week			Credit	Maximum Marks								
			L	T	P		C	CA	ESE	Total					
U23BTOE1	Biology for Engineers		3	0	0	3	40	60	100						
Course Objective	The main objective of this course is to														
	<ul style="list-style-type: none"> To study about the organelles of prokaryotic and eukaryotic cells To know the types and functions of biomolecules To understand the basic concepts of immunological science To discuss plant and animal system To study the applications of biology in various fields 														
Course Outcome	Students who complete this course successfully are expected to								Knowledge Level						
	CO1: Examine the structure of Prokaryotic and Eukaryotic cells								K2						
	CO2: Highlight the concept of Biomolecules								K2						
	CO3: Illustrating theories of evolution and immune response								K3						
	CO4: Review the classification of plant and animal system								K3						
CO5: Highlight the applications of biology in different areas								K4							
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)											CO/PSO Mapping			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	2	1	1	2	1	3	1			2	1	3	2	3
CO 2	3	1	2			1	2	1				1	3	1	3
CO 3	2	1	2	2	1	1	2	1	2	1		1	3	3	3
CO 4	1	2	1			1	2	1				1	3	2	3
CO 5	2	1	2	1			3	1	2			3	3	3	3
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester Examinations															
Indirect															
1. Course - End Survey															
Content of the syllabus															
Unit – I	INTRODUCTION TO CELL BIOLOGY										Periods	9			


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Definition and scope of cell biology, Historical background – discovery of cell and cell theory, Structure of prokaryotic and eukaryotic cells-cell division-Binary fission, Mitosis and Meiosis.			
Unit – II	BIOMOLECULES	Periods	9
Biomolecules: Carbohydrates-classifications and functions, Proteins- Types and functions, Lipids-Types and functions-Vitamins-Types, Functions and its applications, Enzymes and its industrial importance.			
Unit – III	IMMUNOLOGICAL SCIENCE	Periods	9
Introduction to Immunity, Types of immunity- Innate and acquired, Cells and Organs of the immune system, Antigens and their characteristics, classification of antigen, Structure and Function of immunoglobulin, Immunoglobulin classes and subclasses.			
Unit – IV	PLANT AND HUMAN PHYSIOLOGY	Periods	9
Plant System: basic concepts of plant growth-nutrition-photosynthesis and nitrogen fixation, Human System: elementary study of digestive-respiratory-circulatory-excretory systems and their functions.			
Unit – V	BIOLOGY AND ITS INDUSTRIAL APPLICATION	Periods	9
Introduction to Industrial Biology, Biology in Environmental Applications-Bioremediation, Biodegradation of plastics and heavy metals, Composting, Biology in Dairy Industry- production of Fermented foods: yogurt, cheese and paneer.			
Total Periods			45
Text Books			
1.	"A book of Biotechnology", R.C.Dubey, S. Chand Higher Academic Publications, 2013.		
2.	"A book of Diseases of the Human Body", Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.		
3.	"Biomedical instrumentation, Technology and applications", R. Khandpur, McGraw Hill Professional, 2004.		
References			
1.	"Biology for Engineers", Arthur T. Johnson, CRC Press, Taylor and Francis, 2011.		
2.	"Cell Biology and Genetics", Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.		
3.	"Biotechnology Expanding horizon", B.D. Singh, Kalyani Publishers, 2012.		
E-Resources			
1.	https://vtucircle.com/biology-for-engineers-bboc407/#gsc.tab=0		
2.	https://onlinecourses.nptel.ac.in/noc19_ge31/preview		
3.	https://onlinecourses.nptel.ac.in/noc23_bt25/preview		

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Programme	B.Tech.	Programme Code		105	Regulation	2023									
Department	Biotechnology			Semester		V									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
IJ23BTOE2	Food & Nutrition	3	0	0	3	40	60	100							
Course Objective	The main objective of this course is to <ul style="list-style-type: none"> • Understand the basic principles of food and nutrition • Learn the role of nutrients in maintaining health • Analyze the nutritional needs of different populations • Apply knowledge of food safety and quality control • Explore the impact of diet on disease prevention and overall well-being 														
Course Outcome	Students who complete this course successfully are expected to						Knowledge Level								
	CO1: Understand the role of nutrients in health and disease prevention						K2								
	CO2: Analyze dietary requirements across various life stages						K3								
	CO3: Evaluate energy requirements based on basal metabolic rate (BMR) and physical activity levels						K3								
	CO4: Evaluate the relationship between nutrition and lifestyle diseases						K3								
CO5: Apply principles of food safety and quality in daily life						K3									
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	2	2	3	1	3	1	1	1	2	3	2	3	
CO 2	3	2	2	2	3	1	3	3	1	1	2	3	2	3	
CO 3	3	2	2	2	3	1	3	3	1	1	2	3	2	3	
CO 4	3	3	3	3	3	3	3	3	1	1	3	3	3	3	
CO 5	3	3	3	3	3	3	3	3	1	1	3	3	3	3	
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	Introduction to Food and Nutrition	Periods	9
Definition and Importance of Food and Nutrition, Classification of Nutrients-Macronutrients: Carbohydrates, proteins, and fats.Micronutrients: Vitamins and minerals.Water: Role and importance in nutrition. Dietary Guidelines-Recommended dietary allowances (RDAs). Daily values and food pyramid. Overview of food safety standards and regulations: FSSAI, Codex Alimentarius, ISO.			
Unit - II	Nutrients and Nutrition	Periods	10
Carbohydrates-Functions in the body,Importance of the glycemic index in diet.Proteins-Functions: Building blocks, enzymes, immune support,Consequences of protein deficiency.Fats-Types: Saturated, unsaturated, and trans fats,Role in energy storage and cell function.Vitamins and Key minerals: Calcium, iron, potassium-Deficiency and toxicity effects.Water-Importance in temperature regulation, digestion, and waste elimination,Effects of dehydration on health.			
Unit – III	Digestion, Metabolism, and Energy	Periods	9
Structure and function of the digestive system.Process of digestion and nutrient absorption.Metabolism of carbohydrates, proteins, and fats.Energy requirements and expenditure: Basal metabolic rate (BMR) and physical activity.. Factors influencing nutritional requirements (age, gender, activity level). Nutritional disorders: Obesity, diabetes, and metabolic syndrome.			
Unit - IV	Diet and Health	Periods	8
Role of nutrition in preventing lifestyle diseases: Hypertension, cardiovascular diseases, and cancer. Importance of functional foods and nutraceuticals.Antioxidants and their role in health. Nutritional considerations for specific groups: Athletes and individuals with chronic illnesses. Global hunger and malnutrition: Causes and solutions.			
Unit – V	Food Safety, Quality, and Regulations	Periods	9
Food safety principles: Hygiene, sanitation, and contamination prevention. Food quality indicators: Sensory evaluation and shelf-life. Nutritional labeling: Understanding labels and dietary recommendations. Food adulteration: Detection and effects on health. Role of AI and IoT in improving food quality and safety.			
Total Periods			45
Text Books			
1.	Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Introduction to Human Nutrition, 3rd Edition, Wiley-Blackwell, 2019.		
2.	Paul Insel, Don Ross, Kimberley McMahon, Melissa Bernstein, Nutrition, 6th Edition, Jones & Bartlett Learning, 2020.		
References			
1.	Eleanor Noss Whitney, Sharon Rady Rolfes, Understanding Nutrition, 15th Edition, Cengage Learning, 2021.		
2.	Shubhangini A. Joshi, Nutrition and Dietetics, 4th Edition, McGraw Hill Education, 2021.		
3.	B. Srilakshmi, Nutrition Science, 7th Edition, New Age International Publishers, 2021.		
E-Resources			
1.	https://www.nin.res.in		
2.	https://www.cdc.gov/nutrition		
3.	https://www.who.int/nutrition		


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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTOE3	Biosensors	3	0	0	3	40	60	100							
Course Objective	The course aims enable its graduates to understand the basic principles, design, and optimization of biosensors, including biomolecule immobilization, enzyme kinetics, and performance parameters. It allows the students to explore the applications of biosensors in various fields.														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Learn about different classes of biosensors based on their functioning principles.							K2							
	CO2: Understand the principles and concepts of transducers and their application in biosensor design.							K2							
	CO3: Understand biomolecule immobilization, enzyme kinetics, and optimization of biosensor characteristics.							K3							
	CO4: Understand the fundamentals of diagnostic devices and biomarker testing.							K3							
	CO5: Understand the technical and societal factors involved in point-of-care diagnostics and wearable sensors.							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 - Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO3
CO 1	3					3	3						3	2	3
CO 2	3					3	3						3	3	3
CO 3		3	2	3	2	3	3						2	2	3
CO 4		3	2	3	2	3	3						3	2	2
CO 5		3	2	3	2	3	3						3	3	3
Pre-requisites -															
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															


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1.Course-end survey			
Content of the syllabus			
Unit –I	Introduction to Biosensors	Periods	9
Introduction to biosensor, General components of biosensor, classification of transducing elements and Biological recognition elements. Electrochemical sensors, Thermometric Biosensors, Chemicalfibrosensors, Ionselective FETs, Optical Biosensors, Conductometric, Amperometric, Impedimetric, Piezoelectric Biosensors, Whole Cell Biosensors, Immuno-Biosensors. Overview of biosensor applications in medicine, food, agriculture, water and Environment.			
Unit - II	Biomolecules in Biosensors	Periods	9
DNA, enzyme, antibody, antigen, protein, peptide, aptamer. Case studies and examples of each. Amplification Techniques (PCR), ELISA (enzyme-linked immunosorbent assay). Biomarker testing and detection sensor. Surface plasmon resonance biosensors (Biacore), Catalytic biosensors (glucosensor), Antibodies based biosensors, DNA based biosensors, Nanomaterial in biosensor technology.			
Unit –III	Elements in Biosensors	Periods	9
Biomolecule Immobilization Techniques, Enzyme Kinetics. Optimization of desired characteristics of biosensors: sensitivity, selectivity, stability, detection limit, reliability, response time, reproducibility, range and linearity, safety, simplicity, cost, and parameters like operating conditions, calibration, positive and negative controls. Bio Affinity: Labelled and Label free, whole cell sensing – bacteria, yeast, mammalian cell.			
Unit –IV	Basics of Detection Methods	Periods	9
Fluorescence Spectroscopy, UV-Vis Absorption and Emission, Surface Plasmon Resonance, Magnetic labelling, Electrochemical Detection, redox processes, and electron transfer. Electrochemical cells for measurements, processes at electrode surface, and mass transport of material to the electrode surface. Active DC electrochemical techniques: voltammetry and amperometry, immobilized enzyme-electrodes. Impedance Spectroscopy. Potentiometry for small molecule and ion detection. Fluorescence and colorimetric biosensors.			
Unit –V	Biosensors in Diagnostics	Periods	9
Point-of-care sensing: microfluidics and paper-based diagnostics, Point-of-care sensing: yarn and textile-based sensing. Mobile Biosensors for detection of viruses and bacteria. Microfabricated Sensors and the Commercial Development of wearable Biosensors for health monitoring.			
Total Periods			45
Text Books			
1.	Biosensors by A.E.G Gass, IRL Press, 1990.		
2.	Understanding Smart Sensors by Randy Frank, 2nd Edition, ArtechHouse Publications, 2000.		
References			
1.	Novel Approaches in Biosensors and Rapid Diagnostic Assays by Zvi Liron; Springer US Ed.1		
2.	Biosensors and Bioelectronics by Robert S. Marks, Cullen R. Lowe, and George B. Wilson; Wiley-VCH, 2007.		
3.	Biosensors: Fundamentals and Applications by Anthony P. F. Turner, Isao Karube, and George S. Wilson; Elsevier advanced technology, 1987.		
E-Resources			
1.	https://onlinecourses.nptel.ac.in/noc22_ph01/preview		
2.	https://www.mooc-list.com/tags/biosensors		
3.	https://www.biologydiscussion.com/enzymes/biosensors/biosensors-features-principle-and-types-withdiagram/10240		

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OPEN ELECTIVE-II

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech	Programme Code				105	Regulation			2023					
Department	BIOTECHNOLOGY						Semester			VI					
Course Code	Course Name					Periods Per Week			Credit	Maximum Marks					
						L	T	P		C	CA	ESE	Total		
U23BTOE4	BASICS OF BIOINFORMATICS					3	0	0	3	40	60	100			
Course Objective	The student should be made to,														
	<ul style="list-style-type: none"> • Understand scope of Bioinformatics • Understanding of popular bioinformatics database • Learn Fundamentals of Databases and Sequence alignment • Acquire knowledge on different bioinformatics tools • Gain knowledge of real-time applications of bioinformatics 														
Course Outcome	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Understand the basics of biological data and its acquisition											K1			
	CO2: Know the importance of available biological databases											K2			
	CO3: Acquire knowledge on different data retrieval tools used in biological data retrieval											K4			
	CO4: Understand different approaches in sequence alignment and interpretation											K3			
	CO5: Identify various applications of bioinformatics techniques in biological science											K6			
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3
CO1	2	1			3	3							3	2	3
CO2	2	1			3	3							2	3	2
CO3	2	1			2	3							2	3	3
CO4	2	1			3	3							2	3	3
CO5	2	1			3	2							3	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
<ol style="list-style-type: none"> 1. Continuous Assessment Test I, II & III 2. Assignment & Quiz 3. End-Semester examinations 															

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Indirect			
2. Course - end survey			
Content of the syllabus			
Unit – I	BIOLOGICAL DATA ACQUISITION	Periods	9
The form of biological information – sequences and biological databases - types. Retrieval methods for DNA sequence, protein sequence and protein structure information			
Unit - II	DATABASES	Periods	9
Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence and structure databases, Organism specific databases			
Unit – III	DATA PROCESSING	Periods	9
Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Local versus global. Distance metrics. Similarity and homology. Scoring matrices.			
Unit - IV	METHODS OF ANALYSIS	Periods	9
Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment			
Unit – V	APPLICATIONS	Periods	9
ANN in protein secondary structure prediction; Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis: Comparative genomics, orthologs, paralogs. Genome analysis – Genome annotation			
Total Periods			45
Text Books			
1.	David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.		
2.	Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.		
References			
1.	Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.		
2.	Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003.		
3.	Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002.		
4.	Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.		
5.	Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall, 2001.		
E-Resources			
1.	https://nptel.ac.in/courses/102/106/102106065/		
2.	https://openlab.citytech.cuny.edu/biology/bioinformatics-online-resources/		
3.	https://guides.lib.berkeley.edu/bioinformatics		


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Programme	B.Tech	Programme Code				105	Regulation		2023						
Department	BIOTECHNOLOGY					Semester			VI						
Course Code	Course Name					Periods Per Week			Credit	Maximum Marks					
						L	T	P		C	CA	ESE	Total		
U23BTOE5	HUMAN HEALTH AND NUTRITIONAL DISORDERS					3	0	0	3	40	60	100			
Course Objective	The student should be made to,														
	<ul style="list-style-type: none"> Understand the role of nutrition in different stages of life cycle. Gain experience in planning nutrition for different stages. Analyze the role of various nutrients and vitamins important in maintaining health during pregnancy. Evaluate the roles of nutrition and behavior during Adolescence. Acquire knowledge in management of health through proper diet. 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Understand the basics of nutrition, Nutritional assessment and RDA										K1				
	CO 2: Understand the metabolic and physiological functions of nutrients										K2				
	CO 3: Apply the knowledge in nutrient needs during pregnancy.										K3				
	CO 4: Understand the impact of growth and development in arriving at the nutritional needs of adolescents.										K4				
	CO 5: Analyze the importance of nutrients and diet for maintaining healthy life										K4				
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3
CO1	2					3							3	3	3
CO2	2												3	2	2
CO3	3		2			3				2			3	2	2
CO4	2			1		3							3	3	2
CO5	3									2			3	2	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															




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2. Assignment & Quiz			
3. End-Semester examinations			
Indirect			
3. Course - end survey			
Content of the syllabus			
Unit – I	INTRODUCTION TO NUTRITION	Periods	9
Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, Digestion, Absorption and Transport: Anatomy and physiology of the digestive tract, mechanical and chemical Digestion, Absorption of nutrients.			
Unit - II	METABOLISM, ENERGY BALANCE AND BODY COMPOSITION	Periods	9
Energy Balance; body weight and body composition; health implications; obesity, BMR and BMI calculations; Weight Control: Fat cell development; hunger, satiety and satiation; dangers of unsafe weight loss schemes; treatment of obesity; attitudes and behaviours toward weight control.			
Unit – III	NUTRITION DURING PREGNANCY	Periods	9
Nutritional Requirements; Physiological changes during pregnancy; Importance of Nutrition during pregnancy; Effect of Nutritional status on Pregnancy outcome; Guide for eating during pregnancy. Complications in pregnancy; food and nutritional requirements.			
Unit - IV	NUTRITION IN ADOLESCENCE	Periods	9
Growth and development, body composition, puberty, secondary sexual characteristics, psychological changes, nutritional requirements, nutritional problems, malnutrition due to early marriage, food habits and diet plan. Nutrition to cancer patients (after chemotherapy treatment).			
Unit – V	AN OVERVIEW OF DIETETICS	Periods	9
Dietary recommendations; Balanced diet Planning a Healthy Diet: Diet planning principles, dietary guidelines; Basic Concepts of Diet Therapy; Nutrition Care Process: Definition of MNT, Nutritional Assessment (ABCD); Nutritional Diagnosis, Nutrition Intervention; principle of therapeutic diet, Classification of therapeutic diet			
Total Periods			45
Text Books			
1.	Gropper, Sareen S. and Jack L.Smith , “Advanced Nutrition and Human Metabolism”, Wadsworth Publishing, 5 th Edition, 2008.		
2.	Mann, Jim and Stewart Truswell , “Essentials of Human Nutrition”. Oxford University Press, 3 rd Edition, 2007.		
3.	Krause, M.V. and Hunscher, M.A., “Food, Nutrition and Diet Therapy”, W.B. Saunders, 14 th Edition, 2014.		
4.	Mahtab, S, Bamji, Kamala Krishnasamy, G.N.V. Brahman, “Text Book of Human Nutrition”, Oxford and IBH Publishing Co. P. Ltd, Third Edition, 2012.		
References			
1.	Agarwal, A., & Udipi, S. A, “Text Book of Human Nutrition”, New Delhi: Jaypee Brothers Medical Publishers (P) LTD, 2014.		
2.	Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, “Introduction to Human Nutrition”. 2 nd Edition. Blackwell 2009.		


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3.	Antia, F.P, "Clinical Nutrition and Dietetics", Oxford University Press, Delhi, 2005.
4.	Srilakshmi, B, "Dietetics", New Age International (P) Ltd., New Delhi, 2013.
5.	Dietary Guidelines for Indians, ICMR, National Institute of Nutrition, Hyderabad, 2013.
E-Resources	
1.	https://ciet.nic.in/swayam_FNHL_module07.php
2.	https://onlinecourses.swayam2.ac.in/nce19_sc04/preview
3.	https://onlinecourses.swayam2.ac.in/cec19_ag02/preview


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Programme	B.Tech	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	VI										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTOE6	BIO-BUSINESS	3	0	0	3	40	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> To make the students understand the biotechnology techniques, marketing of bio products. To create the mindset in start of biotech industries. Learn about bioethics issues in developing and marketing biotech products to the public. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Understand the concept of biobusiness.						K2								
	CO 2: Infer knowledge on various ventures for biobusiness.						K2								
	CO 3: Implement the bioproduct production.						K3								
	CO 4: Organizing various supportive organisation for biobusiness.						K5								
CO 5: Attributes of bioethical skills.						K6									
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3
CO1	2		2								2	3	3	1	3
CO2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO3	2	3	2								2	3	3	2	2
CO4	2		2	2					2				3	1	2
CO5	2		3			3		3	2		3		2	3	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment & Quiz															
3. End-Semester examinations															
Indirect															
1. Course - end survey															


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Content of the syllabus			
Unit – I	OVERVIEW OF BIOBUSINESS	Periods	9
Scope, Need, Demand and market potential of Biotechnology Industries in India and abroad- SWOT analysis of Biobusiness- Business planning- budget plan - Bioproducts production design, Marketing Analysis, Product development, transition from R & D to business units.			
Unit - II	NEW VENTURE CREATION-BIOBUSINESS	Periods	9
Aqua culture - Biofertilizer and Vermitechnology- Organic Farming, Mushroom cultivation- Azolla & Spirullin cultivation - Medicinal plants cultivation - horticulture Technology.			
Unit – III	BIOPRODUCT DEVELOPMENT	Periods	9
Fermentation Technology - Value added product development from agro and organic substances – Agriculture through IOT - Product development: Biochips, Bioplastics, Biosensors, Biofuels, etc.			
Unit - IV	BIOBUSINESS PLANNING	Periods	9
Schemes for Women Entrepreneurs in India - Bank loan and finance strategy- licensing and Branding concerns, opportunities, policy and regulatory concerns, opportunities from government & nongovernment organizations.			
Unit – V	IPR, BIOETHICS AND LEGAL ISSUES	Periods	9
IPR and current legal issues. Regulatory affairs in Bio business-regulatory bodies and their regulations - Public education of the process of biotechnology - Ethical concerns of biotechnology research and innovation- Interference with nature, fear of unknown, unequal distribution of risks.			
Total Periods			45
References			
1.	Nicholas, “Project Management for Business & Technology”, Routledge, 2012		
2.	Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001		
3.	R Rallapalli & Geetha Bali “Bioethics & Biosafety” APH Publication, 2007		
4.	Rachana Singh Puri, “Practical Approach to IPR”, IK Intl. Ltd. 2009		
5.	N. Chandrasekhara Rao, Ram Kumar Mishra, “Organised Retailing and Agri-Business”, Springer 2016		
E-Resources			
1.	https://symbiosisonlinepublishing.com/family-business-management/family-business-management19.php		
2.	http://bbb.rcb.res.in/bio-entrepreneurship/		
3.	https://www.the-scientist.com/bio-business		


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
CAREER TRACK COURSE – II

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Course code	Course name	Periods per week			Credit	Maximum Marks								
		L	T	P	C	CA	ESE	Total						
U23CTCE2	Product Innovation, Commercialization, and Finance	2	0	0	1	40	60	100						
Course Objective	The student should be made to,													
	<ul style="list-style-type: none"> To understand the principles of product innovation and its significance in entrepreneurship. To understand the processes involved in scaling and commercializing innovative products. To learn how to assess financial needs, management and secure funding for entrepreneurial ventures. To learn how to maintain financial records and interpret financial statements. To learn effective purchase management techniques to control costs and optimize resources. 													
	At the end of the course, the student should be able to,								KL					
	CO1: Students will be able to explain the significance of product innovation in entrepreneurship.								K2					
	CO2: Students will be able to describe the process of commercializing a new product and create a basic commercialization plan.								K2					
	CO3: Students will be able to apply financial assessment methods to determine the funding needs of a venture.								K3					
CO4: Students will be able to interpret basic financial statements and accounting records.								K2						
CO5: Students will be able to prepare a budget for an entrepreneurial venture and manage purchases effectively.								K3						
Pre-requisites														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak														
COs	Programme Outcomes (POs)												CO/PSO Mapping	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	3	3	3	2	3		3	1	1	2	3	2		
CO 2	3	3	2	1	3		2	1	1	2	3	2		
CO 3	3	3	1	1	2		1	1	1	2	3	2		
CO 4	3	3		1	3		1	1	1	2	3	2		
CO 5	3	3		1	3		1	1	3	2	3	2		


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignments / Seminar/Quiz			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit - I	Product Innovation	Periods	6
Introduction to Product Innovation - Ideation and Concept Development - Market Research and Validation - Product Design and Prototyping - Innovation Management - Case Studies in Product Innovation			
Unit – II	Commercialization Strategies	Periods	6
Introduction to Commercialization- Go-to-Market Strategies - Sales and Promotion Strategies - Marketing and Branding - Pricing Strategies - Commercialization Case Studies			
Unit – III	Entrepreneurial Finance	Periods	6
Introduction to Entrepreneurial Finance - Funding Sources for Startups- Financial Planning and Budgeting - Financial Statements and Analysis- Valuation of Startups- Exit Strategies			
Unit – IV	Accounting for Entrepreneurs	Periods	6
Introduction to Accounting Principles – Book keeping and Record Keeping - Cost Management and Analysis - Taxation and Compliance - Financial Reporting- Auditing and Controls			
Unit - V	Budget and Purchase Management	Periods	6
Introduction to Budgeting-Characteristics of Sound Budget- Fixed Budget-Production Budget-Sales Budget- Flexible-Zero base budget Budgeting and budgetary control- ROI			
Purchase Management: Role of Purchase department- Vendor Selection-Purchase-Document related to purchase-Invoice Generation-material Inward and outward			
Total Periods			30
Text Books			
1.	Thomas N. Duening , Robert A. Hisrich , Michael A. Lechter “Technology entrepreneurship : Taking Innovation to the Marketplace” 3rd edition		
2.	Blank, S., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company		
References			
1.	James. C., Vanhorn, "Fundamentals of Financial Management" PHI, 2012		
2.	R. Kesavan , C. Elanchezhian ,T. Sunder Selwyn “Engineering Economics and Financial Accounting” Laxmi Publications; First Edition (1 January 2016)		
3.	Maheshwari SN “Management Accounting and Financial Control” Sultan Chand & Sons 2015		
4.	Barringer, B. R., & Ireland, R. D. (2015). Entrepreneurship: Successfully Launching New Ventures.		



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E-Resources	
1.	https://asana.com/resources/product-development-process
2.	https://www.xcubelabs.com/blog/the-ultimate-guide-to-product-development-from-idea-to-market
3.	https://mark-bridges.medium.com/50-case-studies-exploring-pricing-strategy-across-various-products-and-industries-2254a7b30c80
4.	https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBAA3011.pdf
5.	https://ncert.nic.in/textbook/pdf/keac101.pdf
6.	https://icmai.in/upload/Students/Syllabus2016/Inter/Paper-10-April-2021.pdf


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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech.	Programme Code	105	Regulation	2023										
Department	BIOTECHNOLOGY			Semester	V										
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA	ESE	Total							
U23CTCG1	History & Culture of India and Indian Geography	2	0	0	1	40	60	100							
Course Objective	The main objective of the course is to														
	* To gain insight into the chronological development of Indian civilization from ancient to modern times.														
	*To appreciate the diverse cultural heritage of India, including art, architecture, literature, and music.														
	*To study the socio-economic structures and changes over different periods.														
	*To explore the evolution of political systems and administrative structures in India.														
Course Outcomes	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Gain an in-depth understanding of the Indus Valley Civilization, including its social, economic, and political structures.							K2							
	CO2: Appreciate the cultural and technological advancements during the Indus Valley Civilization and the Gupta period.							K2							
	CO3: Analyze archaeological evidence and historical records to understand the significance of these civilizations.							K4							
	CO4: Understand the reasons for the decline of these civilizations and their influence on later periods.							K2							
	CO5: Discuss the impact of infrastructure development on regional growth and planning.							K3							
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1		2	2			1			3	2	1
CO 2	3	2				1	2			2			3	1	1
CO 3	3	3		2		2	2			1			3	3	2
CO 4	3	2		1		2	2					2	3	2	2
CO 5	3	2	3	1		2	2					2	2	2	3
Course Assessment Methods															
Direct															
1.Continuous Assessment Test I, II & III															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit –I	HISTORY AND CULTURE OF INDIA-1	Periods	6
Indus Valley Civilization, Guptas			
Unit –II	HISTORY AND CULTURE OF INDIA-2	Periods	6
Delhi Sultans, Mughals and Marathas, South Indian History			
Unit –III	INDIAN GEOGRAPHY-1	Periods	6
Physical Features- Monsoon, rainfall, weather and climate. Water resources rivers			
Unit –IV	INDIAN GEOGRAPHY-2	Periods	6
Soil, Minerals and Natural resources. Forest and Wildlife. Agriculture pattern			
Unit –V	INDIAN GEOGRAPHY-3	Periods	6
Transport. Communication. Population density and distribution in Tamil Nadu and India			
Total Periods			30
Text Books			
1.	G. Venkatesan, Cultural History of India, Varthamanan Pathipagam, 2018 (in Tamil)		
2.	K.L. Khurana, History of India: Earliest times to 1526 A.D., Lakshmi Narain Agarwal, Agra		
3.	L.P. Sharma, History of Ancient India, Konark Pub. Pvt. Ltd., New Delhi, 2008		
4.	R.N Dubey and B.S Negi- Economic and Commercial Geography of India. 13th edition, Kitab Mahal published in 1970		
5.	T.C Sharma and O.Coutinho-Economic and commercial Geography of India Paper, published by Sangam Books Ltd in 1997.		
References			
1.	R.C. Majumdar, et. al., An Advanced History of India, MacMillan, Delhi, 1974		
2.	R.S. Sharma, India's Ancient Past, Oxford University Press, New Delhi, 2017.		
3.	L.P. Sharma, History of Medieval India, 1000-1740 A.D., Konark Pub. Pvt. Ltd., New Delhi, 1997		
4.	Satish Chandra, History of Medieval India, Orient Blackswan, New Delhi, 2017		
5.	Gopal Singh – Geography of India is published by Atma Ram & Sons, 1979.		
E-Resources			
1.	https://www.britannica.com/topic/Gupta-dynasty		
2.	https://www.britannica.com/place/Delhi-sultanate		
3.	https://www.britannica.com/topic/Maratha-people		
4.	https://cwc.gov.in/		
5.	https://www.egyankosh.ac.in/		

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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		V								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23CTCH1	HIGHER STUDIES IN ABROAD & INDIA	2	0	0	1	40	60	100							
Course Objective	<p>The main objective of the course is to</p> <ul style="list-style-type: none"> Gain comprehensive knowledge of the higher education systems, admission processes, and key requirements in both India and abroad. Identify top universities worldwide and understand the financial aspects of overseas education, including costs, funding options, and scholarships. Acquire in-depth understanding of the GRE and GMAT, including their importance. Learn the significance of TOEFL and IELTS for non-native English speakers, assessment patterns, and the key areas of reading, speaking, and writing. <p>Understand the importance, syllabus, and assessment patterns of the GATE exam, including the weightages in different domains and the general aptitude and subject-specific requirements for successful performance</p>														
	At the end of the course, the students will be able to									Knowledge Level					
Course Outcomes	CO1: To categorize the higher education in abroad and India.									K2					
	CO2: Analyze the selection and scholarship in various countries.									K4					
	CO3: Analyze GRE & GMAT Selection process and Assessment.									K4					
	CO4: Analyze TOEFL & IELTS Selection process and Assessment.									K4					
	CO5: Analyze GATE Selection process and Assessment.									K4					
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
Cos	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1								1	1		2				
CO 2								1	1		2				
CO 3	3							1	1		2				
CO 4	3							1	1		2				
CO 5	3							1	1		2				
Pre-requisites	-														


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	OVERVIEW OF HIGHER STUDIES	Periods	6
Higher Education in abroad: Introduction-Admission process- Identification & Procedure - SOP-LORDesirable Characteristics - Introduction to Proficiency test-Higher education in India & Examinations.			
Unit – II	SELECTION & SCHOLARSHIP	Periods	6
Top Universities in world- Cost of overseas education- Funding & Scholarships-Case studies Higher Education in USA, UK, France, Singapore, Germany, Norway, Sweden, Australia & Netherland			
Unit – III	GRE & GMAT	Periods	6
GRE & GMAT: Importance of GRE & GMAT- Syllabus- Assessment pattern- Analytical reasoningQuants-Verbal-Integrated Reasoning-Analytical writing assessment			
Unit – IV	TOEFL & IELTS	Periods	6
Importance of TOEFL & IELTS - Syllabus-Assessment Pattern-Reading-Speaking –Writing			
Unit – V	GATE	Periods	6
Importance of GATE- Syllabus -Assessment Pattern- Weightages in the different domain-General Aptitude- Candidate selected subject			
Total Periods			30
Text Books			
1.	B.S.Warrier, “Studying Abroad”, 1st edition, Tata Mcgraw Hill Education Private Limited, 2011.		
2.	Dr.T.P.Sethumadhavan, “Study abroad”, 1 st edition, I Rank : An Imprint of DC Books publishers, 2013.		
References			
1.	“GATE 2025 General Aptitude & Engineering Mathematics”, Pearson Education, 2024.		
2.	Jandhyala B.G. Tilak, "Higher Education in India: In Search of Equality, Quality and Quantity", 1st edition, Orient Blackswan, 2013.		
3.	ONeal, Anthony, “The graduate survival guide”, Brentwood, Tennessee : Ramsey Press, the Lampo Group, LLC, 2017.		
4.	Christine T. Ennew, David Greenaway, “The Globalization of Higher Education”, 1st edition, Palgrave Macmillan London, 2012.		
5.	Abhishek Kumar, “The Ultimate Guide to Scholarships for Indian Citizens Planning to Study Abroad”, 1 st edition , Abiproduct Pty Ltd, 2016.		
6.	Magoosh, Chris Lele, Mike McGarry, “GRE Prep by Magoosh”, Rtc Publishing, 2016.		
E-Resources			
1.	Websites: Ministry of Education (India), University Grants Commission (UGC), All India		



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	Council for Technical Education (AICTE).
2.	Websites: QS World University Rankings, Times Higher Education, Studyportals, EducationUSA.
3.	Specific to Higher Studies Abroad : StudyPortals (studyportals.com), The Princeton Review (princetonreview.com), IELTS Official (ielts.org), ETS GRE (ets.org/gre)
4.	Specific to Higher Studies in India : Shiksha (shiksha.com), India Education (indiaeducation.net), National Digital Library of India (ndl.iitkgp.ac.in).




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	Programme	B.Tcch			Programme code	105		Regulation				2023			
Department	Bio-Technology					Semester			V						
Course Code	Course Name					Periods per week			Credit	Maximum Marks					
						L	T	P	C	CA	ESE	Total			
U23CTCP4	Leveraging Arithmetic with logic and Codes Snippet					2	0	0	1	40	60	100			
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Develop a Strong Understanding of English Grammar for flawless sentence construction. • Enhance Problem-Solving Skills in Mixture and Allegation, and Probability. • Strengthen Mathematical and Analytical Thinking through Permutation and Combination. • Identify the logic behind code snippets and automate flawless codes. 														
Course Outcome	At the end of the course, the student should be able to,										Knowledge Level				
	CO1: Demonstrate Mastery in Identifying and Correcting Grammatical Errors to maintain grammatical accuracy.										K3				
	CO2: Apply Mathematical Techniques in Mixture, Allegation, and Probability to Solve Real-World Problems.										K3				
	CO3: Solve Problems Using Permutation and Combination Principles for competitive exams.										K3				
	CO4: Develop Proficiency in Programming and Advanced Data Structures.										K4				
CO5: Analyze and Interpret Data for Decision Making and problem solving.										K4					
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1		2	2	2		2	1	2	2	3		2	2		
CO 2		3	2	2		1		1	2			1	2		
CO 3		3	2	2		1		1	2			1	2		
CO 4	3	3	3	3	2	2	2	2	2	1	2	3	3	2	2
CO 5	3	3	2	1	1	2		2	2	3	2	3	3	3	2


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Course Assessment Methods			
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignments / Seminar/Quiz			
3. End-Semester Examinations			
Indirect			
1.Course -end survey			
Content of the syllabus			
Unit -I	SENTENCE CORRECTION	Periods	6
Parallelism, Modifiers, Pronoun – Antecedent Agreement, Comparisons, Tenses, Redundancy, Pronouns, Conjunctions, Choose the Grammatically Correct and Incorrect Sentences.			
Unit–II	MIXTURE AND ALLIGATION AND PROBABILITY	Periods	6
MIXTURE AND ALLIGATION: Mixing two Different Liquids(Criss Cross Method), Mixture- Mixing with and without Replacement(Quantity withdrawn and Replacement are same and not same) (Find Price and Ratio), Profit and Loss Obtained.			
PROBABILITY: Problems on addition and multiplication theorems (dependent and Independent), Problems on coins, dice, deck of cards, balls, Alphabet , Number and Selection Based Model, Independent Events – Application, Conditional Probability , Baye’s Thorem and its Applications, Probability Distribution – (Bernoulli, Binomial, Poisson), Defective, Mensuration and Miscellaneous.			
Unit – III	PERMUTATION AND COMBINATION	Periods	6
PERMUTATION AND COMBINATION: Permutation – Arranging people, digits, numbers, alphabets, letters, and colours(Comes together and never comes together), Picking a person from a group, Picking two favourite colours from a colour brochure, Picking first, second and third place winners(Identical and Non identical). Combination – Selection of menu, food, clothes, subjects, team, Selecting some team members from a group, Picking Some colours from a colour brochure, Picking three winners, Circular Permutation.			
Unit– IV	CODE SNIPPETS	Periods	6
Conditional and control flow based on Array and String, Functions and Recursion based on Array and String, Error Handling: Try-catch, Custom Exceptions, Inheritance, Polymorphism, Encapsulation and Abstraction, Sorting and Searching based on Array, binary and binary search tree, AVL , B and B+ , balanced tree			
Unit-V	DATA INTERPRETATION, CLOCKS, CALENDARS	Periods	6
DATA INTERPRETATION: Tables-Data organized in rows and columns. Charts-Represents data using rectangular bars , Show proportions of a whole, Display trends over time or changes in a variable, Analyzing data presented in a combination of different graph types.			
CLOCKS: Problems based on angle between hands, the time when the hands overlap, finding actual time from reflections, Time gained or lost by a faulty clock.			
CALENDARS: Finding the day of the week for a specific date. Calculating the number of odd days in a given period. Solving questions on leap years and date calculations. Determining the day after or before a certain number of days.			
Total Periods			30
Text books			




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1.	Fast Track Objective Arithmetic by Rajeev Varma, Arihant Publication- 2023-24 edition.
2.	Quantitative Aptitude for CAT - Dinesh k Sinha
3.	Quantitative Aptitude: Permutation and Combination, Probability - <u>Rajnish Mishra (Author)</u> ,Kindle Edition- 2020
4.	A Modern Approach to Logical Reasoning by R.S. Aggarwal, S. Chand & Company Ltd.-2022 edition.
5.	Objective General English by SP Bakshi – Arihant Publication-2023 edition.
References	
1.	R.S. Aggarwal “An Advanced Approach to Data Interpretation for Competitive Examinations” S.Chand Twelfth Edition.
2.	Dinesh Khattar- The Pearson guide to Quantitative Aptitude for Competitive Examinations 3 rd edition.
3.	Arun Sharma, "How to Prepare for Data Interpretation for CAT" McGraw Hill,2025
4.	How to Crack Test of Reasoning by Arihant Experts-2024 edition
5.	A modern Approach to verbal and non-verbal reasoning by R.S. Aggarwal-2023 edition
E-Resources	
1.	Aptitude: https://pt.scribd.com/
2.	Reasoning: https://placement.freshersworld.com
3.	Verbal: https://testbook.com


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CAREER TRACK COURSE – III



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Programme	B.E. / B.TECH			Programme code	105		Regulation	2023						
Department	BIOTECHNOLOGY						Semester	VI						
Course Code	Course Name				Periods per week			Credit	Maximum Marks					
					L	T	P	C	CA	ESE	Total			
U23CTCE3	Intellectual Property Rights				2	0	0	1	40	60	100			
Course Objective	The student should be made to,													
	<ul style="list-style-type: none"> • Know about Intellectual property rights and classification. • Understand about Patents, Registration & Procedure and other information • Learn about Copyrights, Registration & Procedure and other information • Understand about Trademark, Registration & Procedure and other information • Know about other forms of IP, Registration & Procedure and other information 													
Course Outcome	At the end of the course, the student should be able to,										KL			
	CO1: Explain the different types of intellectual property rights and their classifications.										K2			
	CO2: Demonstrate the knowledge of types of inventions that can be patented and the rights conferred by a patent.										K2			
	CO3: Explain the concept of copyright and its importance in protecting creative works.										K2			
	CO4: Demonstrate knowledge of the process for registering a trademark and the legal enforcement of trademark rights										K3			
Pre-requisites											K3			
	CO5: Identify and explain other forms of intellectual property, such as trade secrets, industrial designs, and geographical indications.													
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak														
COs	Programme Outcomes (POs)											CO/PSO Mapping		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	1			3	2			2	1	1		2		
CO 2	1			3	2			2	1	1		2		
CO 3	1			3	2			2	1	1		2		
CO 4	1			3	2			2	1	1		2		
CO 5	1			3	2			2	1	1		2		
Course Assessment Methods														
Direct														
1. Continuous Assessment Test I, II & III														
2. Assignments / Seminar/Quiz														
Indirect														
1. Course - end survey														


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Content of the syllabus			
Unit - I	Introduction	Periods	6
Introduction and need for Intellectual Property Rights- Types of Intellectual Property Rights - Patent, Copyright, Trademark, Design, Geographical Indication- Trade secret.-TRIPS and other treaties.			
Unit – II	Patents	Periods	6
Patents-Elements of patentability: Novelty, Non Obviousness (Inventive Steps), Industrial Application – Non-Patentable Subject Matter- Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents.			
Unit – III	Copyright	Periods	6
Nature of Copyright – Subject matter of Copyright: original literary, dramatic, musical, artistic works; Cinematograph films and sound recordings – Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright.			
Unit – IV	Trademark	Periods	6
Concept of trademarks – Different kinds of trademarks (Brand names, Logos, Signatures, Symbols, Well known marks, certification marks and service marks) – Non Registrable Trademarks – Registration of Trademarks – Rights of holder and assignment and license of marks.			
Unit - V	Other forms of IP	Periods	6
Design: Meaning and Concept of Novel and Original Design - Procedure for Registration- Effect of Registration and term of Protection			
Geographical Indication(GI): Meaning and Difference between GI and trademarks- Procedure for Registration- Effect of Registration and term of Protection- overview of IP laws in India-WIPO			
Total Periods			30
Text Books			
1.	K. V. Nithyananda” Intellectual Property Rights: Protection and Management” Cengage Learning India -2019 ISBN: 9789386668578		
2.	Neeraj Pandey, Khushdeep Dharni “Intellectual Property Rights” PHI Learning Pvt. Ltd., 2014		
References			
1.	Deborah E Bouchoux “Intellectual Property : The Law of Trademarks, Copyrights, Patents and Trade Secrets” Cengage Learning India		
2.	Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013		
3.	Prabuddha Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011		
4.	Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: LexisNexis.		
E-Resources			
1	https://www.nitap.ac.in/storage/pdf/f63d0ea9127821f83a5a4ad9f1531be8-10-04-11of%20IPR.pdf		
2	https://www.copyright.gov.in/Documents/Copyrightrules1957.pdf		
3	https://www.bdu.ac.in/cells/assets/docs/ipr/course/resources/IPR-Course-Chapter2.pdf		
4	https://thelegalschool.in/blog/types-of-trademark		
5	https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf		




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Programme	B.Tech	Programme Code			105	Regulation		2023							
Department	Biotechnology				Semester			VI							
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P	C	CA		ESE	Total						
U23CTCG2	Indian economy and Freedom struggle in India & Tamilnadu.	2	0	0	1	40		60	100						
Course Objective	The main objective of the course is to														
	* Understand the structure and characteristics of the Indian economy.														
	* Identify and categorize the various sources of revenue for the Indian government.														
	* Analyze the challenges and opportunities in the distribution of financial resources.														
	*Explore the concept of National Renaissance in the context of Indian history.														
Course Outcomes	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Understand the processes involved in the formulation and implementation of economic policies in India											K2			
	CO2: Assess the role of the Finance Commission in fiscal federalism and resource distribution.											K4			
	CO3: Evaluate the mechanisms for resolving fiscal disputes between Union and State governments.											K3			
	CO4: Understand the concept of National Renaissance and its significance in Indian history.											K3			
	CO5: Identify key leaders and events from Tamil Nadu that played a significant role in the independence movement.											K2			
Pre-requisites	-														
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	3	1	1		2	1			1	2	1	2	1	2
CO 2	1	3	1	1		2	1			1	2	1	2	1	2
CO 3	1	3	1	1		2	1			1	2	1	2	1	2
CO 4		1	1	1		3	1			1		1	1		1
CO 5		1	1	1		3	1			1		1	1		1
Course Assessment Methods															
Direct															
1.Continuous Assessment Test I, II & III															
2.Assignment															
3.End-Semester examinations															
Indirect															
1. Course - end survey															


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
Content of the syllabus			
Unit –I	INDIAN ECONOMY-1	Periods	6
The nature of Indian Economy-Five-year plan models – an assessment-Planning Commission-Niti Ayog			
Unit –II	INDIAN ECONOMY-2	Periods	6
Sources of revenue – Reserve Bank of India-Finance Commission			
Unit –III	INDIAN ECONOMY-3	Periods	6
Resource sharing between Union and State Governments-Goods and Services Tax			
Unit –IV	FREEDOM STRUGGLE IN INDIA	Periods	6
National Renaissance-Early uprising against British Rule-Indian National Congress			
Unit –V	FREEDOM STRUGGLE IN TAMILNADU	Periods	6
The role of Tamil Nadu in the freedom struggle-Different modes of Agitation in Tamil Nadu and movements			
Total Periods			30
Text Books			
1.	Nitin Singhania, Indian Economy, McGraw Hill, Noida,2022		
2.	Dutt R. & K.P.M. Sundharam, Indian Economy, S. Chand & Company Ltd,2021.		
3.	Mishra &Puri, Indian Economy, Himalaya Publishing House, 2023.		
4.	Bipan Chandra, History of Modern India, Orient Blackswan, New Delhi 2019.		
5.	Bipan Chandra, et al., India’s Struggle for Independence, Penguin Books, New Delhi, 2016.		
References			
1.	Sankaran, S, Indian Economy, Marathi Granth Sangrahalaya, 2022.		
2.	Agarwal,A.N.Indian Economy, Wiley India Pvt. Ltd,2021.		
3.	G. Venkatesan, History of Modern Tamil Nadu 1600-2011, VC Publications, Rajapalayam,2013.		
E-Resources			
1.	https://www.indiabudget.gov.in/economicsurvey/		
2.	https://www.niti.gov.in/		
3.	https://fincomindia.nic.in/commission-reports		
4.	https://www.nipfp.org.in/home-page/		
5.	https://dsal.uchicago.edu/		


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Programme	B.Tech	Programme Code	105	Regulation	2023			
Department	BIOTECHNOLOGY			Semester	VI			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P		C	CA	ESE
U23CTCH2	SOCIAL NETWORKING FOR HIGHER STUDIES	2	0	0	1	40	60	100
Course Objective	The main objective of the course is to:							
	<ul style="list-style-type: none"> • Understand the fundamentals of networking, its benefits, and the distinction between quality and quantity in professional networking for career growth. • Gain practical knowledge of digital networking tools such as LinkedIn, Facebook, Twitter, Google+, and open learning networks to enhance professional connections. • Develop strong interpersonal and communication skills, including empathy, active listening, and networking etiquette, to build meaningful professional relationships. • Learn effective networking strategies, including business communication, emotional intelligence, and copyright considerations, to create a successful networking plan. • Explore the impact of digital footprints, long-term networking strategies, and case studies related to overseas education and scholarships, enabling students to leverage networking for academic and career advancements. 							
Course Outcomes	At the end of the course, the student should be able to						Knowledge Level	
	CO1: To explain the fundamentals of networking, its benefits, and the importance of quality networking in professional and academic growth.						K2	
	CO2: To utilize digital networking tools such as LinkedIn, Facebook, Twitter, and Google+ for professional connections and career opportunities.						K3	
	CO3: To analyze and apply effective listening skills, empathy, and networking etiquette for building strong professional relationships.						K4	
	CO4: To develop interpersonal and business communication skills, understand emotional intelligence, and create a networking plan for career development.						K3	
	CO5: To assess digital footprints, implement long-term networking strategies, and evaluate case studies on overseas education and scholarships.						K3	


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CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping			
Cos	Programme Outcomes (POs)												PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3	
CO 1									1	2		2				
CO 2					3				1	2		2				
CO 3									1	2		2				
CO 4									1	2		2				
CO 5									1	2		2				
Pre-requisites		-														
Course Assessment Methods																
Direct																
1. Continuous Assessment Test I, II & III																
2. Assignment																
3. End-Semester examinations																
Indirect																
1. Course - end survey																
Content of the syllabus																
Unit – I		INTRODUCTION										Periods		6		
Networking, Benefits, Quality vs Quantity in Networking, Networking for new opportunities, Networking for Professional Partnership, Local and In-person networking																
Unit - II		DIGITAL NETWORKING										Periods		6		
Tools for Online Networking – Linkedin, Facebook, Twitter, Google+, LMS, Open Learning Networks.																
Unit – III		EMPATHIZING										Periods		6		
Art of Listening, Empathy, Listening Models, Networking etiquette, Digital Storytelling, Lead Generation																
Unit - III		COMMUNICATION										Periods		6		
Interpersonal Skills, Personality and Emotional Intelligence, Business Communication, Copyrights, Networking Plan																
Unit - V		DIGITAL FOOTPRINTS										Periods		6		
Introverts & Extroverts, Maintain Your Connections, Long-Term Networking Strategies, Case Studies-Scholarship for higher education in various countries –Case study																
													Total Periods		30	
Text Books																
1.		Andrea R Nirenberg"Essentials of Business networking" Tips, Tools and Tactics you can use, Pearson Education														
2.		Miriam Salpter "Social Networking for career success "Learning express, Newyork														
3.		Andrea R Nirenberg "Network like you means it" handbook for business and personal networking														
4.		Elizabeth A Segal "Social Empathy-Art of understanding others" Columbia University press, New York														


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References	
1.	S.P.Bakshi, "Objective English" Arihant Publications.
2.	Peter W Cardon "Business Communication" Tata McGraw Hill Publications, Third edition
E-Resources	
1.	https://www.udemy.com/course/networking101/
2.	https://learndigital.withgoogle.com/digitalunlocked/course/effective-networking
3.	https://www.linkedin.com/learning/professional-networking
4.	https://alison.com/course/personal-business-networking-skills-for-maximum-success
5.	https://www.edx.org/professional-certificate/uwashingtonx-english-for-businessnetworking


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
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Programme	B.E. / B.Tech	Programme code		Regulation	2023										
Department	Bio-Technology			Semester	VI										
Course Code	Course Name	Periods per week			Cre dit	Maximum Marks									
		L	T	P	C	C A	ESE	Total							
U23CTCP5	Integrated Reasoning and Pseudo Code	2	0	0	1	4 0	60	100							
Course Objective	The student should be made to, <ul style="list-style-type: none"> • Develop Proficiency in Verbal Communication and Writing. • Master Mensuration, Geometry, and Coordinate Geometry Concepts. • Apply Pseudo Code in Problem-Solving. • Enhance Logical Reasoning and Analytical Thinking. 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Demonstrate strong Verbal and Written Communication skills.							K3							
	CO2: Apply Mensuration and Geometry Concepts to Solve Real-World Problems.							K3							
	CO3: Design and Implement structure based Pseudo Codes.							K3							
	CO4: Optimize DSA based Pseudo codes for Effective Problem-Solving.							K4							
CO5: Enhance Logical and Analytical Reasoning Skills for Complex Problem Solving.							K2								
Pre-requisites															
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 – Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	1	2	2	2		1		1	1	3		2	1		1
CO 2	3	3	3	3		2			1			1	1		
CO 3	3	3	3	3	2	2		1	2	2		2	2		
CO 4	3	3	3	3	2			1	2	3		2	2		
CO 5	3	3	3	3	3	3		1	2	3		2	2	3	3

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Course	Assessment	Methods	
Direct			
1. Continuous Assessment Test I, II & III			
2. Assignments / Seminar/Quiz			
3. End-Semester Examinations			
Indirect			
1.Course -end survey			
Content of the syllabus			
Unit -I	Verbal Ability	Periods	4
Reading Comprehension, Essay Writing			
Unit-II	Mensuration and Geometry	Periods	8
MENSURATION: 2D - Area and Perimeter – Triangles, Square, Rectangle, Parellelogram, Rhombus, Trapezoid, Circles, quadrilaterals and Polygons. 3D - Surface area and Volume – Cuboids, Cube, Cylinder, Cone, Sphere, Prism and Pyramids.			
GEOMETRY: points, lines, planes, angles and shapes, including triangles, quadrilaterals, and circles and polygons along with topics like congruence, similarity, area and volume, Co-ordinate Geometry.			
Unit – III	Structure based Pseudo code	Periods	6
Pseudo codes: Accenture, Capgemini, TCS , DXC, Hexaware based on string, condition, control, function and recursive			
Unit-IV	DSA based Pseudo code	Periods	6
Pseudo codes on DSA- Sorting and Graph based on array, tree (in order, preorder, post order, binary tree, binary search tree, tree rotation, b and b++, balanced tree,			
Unit-V	Logical Reasoning	Periods	6
Analogy –Number analogy, Alphabet analogy; Inequalities –Comparisons-Logical Deduction-Coded Relationships; Ranking and ordering -Ranking from left/right or top/bottom, Total number of people/objects; Cubes and Cuboids – number of sides painted ,Cutting of cubes vertically & Horizontally, Folding of cubes; Non Verbal – Series, mirror image ,water image, grouping of images, classification, hidden figures, Heights and Distances -Finding the height of an object, Finding the distance between two objects, Finding the distance of an object.			
Total Periods			30
Text books			
1.	Fast Track Objective Arithmetic by Rajeev Varma, Arihant Publication- 2023-24 edition.		
2.	Quantitative Aptitude for CAT - Dinesh k Sinha		
3.	GEOMETRICKS: 356 Short Tricks of Geometry in Math By <u>A.K.VISHWAKARMA</u> (Author), Kindle Edition- 2019		
4.	A Modern Approach to Logical Reasoning by R.S. Aggarwal, S. Chand & Company Ltd.-2022 edition.		
5.	A Complete Book Of Logical Reasoning, Adda247 Publications.		
6.	Objective General English by SP Bakshi – Arihant Publication-2023 edition.		
7.	Industry based Pseudo code		
References			
1.	R.S. Aggarwal “An Advanced Approach to Data Interpretation for Competitive Examinations”		


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	S.Chand Twelfth Edition.
2.	Dinesh Khattar- The Pearson guide to Quantitative Aptitude for Competitive Examinations 3 rd edition.
3.	Arun Sharma, "How to Prepare for Data Interpretation for CAT" McGraw Hill,2025
4.	How to Crack Test of Reasoning by Arihant Experts-2024 edition
5.	A modern Approach to verbal and non-verbal reasoning by R.S. Aggarwal-2023 edition
E-Resources	
1.	Aptitude: https://pt.scribd.com/
2.	Reasoning: https://placement.freshersworld.com
3.	Verbal: https://testbook.com




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SEMESTER VII

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Programme	B. Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		VII								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT727	Downstream Processing	3	0	0	3	40	60	100							
Course Objective	The course aims to understand the separation of bioproduct from a fermented broth using various unit operations involved in the downstream process. This course aid to learn the techniques of isolation, concentration, and purification of bioproducts.														
Course Outcome	At the end of the course the students will be able to							KL							
	CO1: Apply various unit operation principles in the cell-disruption techniques to obtain biological product.							K2							
	CO2: Analyze to design the various filtration and centrifugation techniques for the bioproduct separation.							K3							
	CO3: Analyze to design the adsorption, microfiltration and ultrafiltration techniques for the isolation and extraction of bio-products.							K3							
	CO4: Evaluate the chromatographic separation processes and equipment selection.							K3							
CO5: Apply the different crystallizer and dryers operations for polishing and assessing the stability of biotechnology products.							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O 2	PSO 3
CO 1	3	3			2		3	2			2		2		1
CO 2	2		2	3	2				1				2		
CO 3	3	3	3	1									2		
CO 4	2	2	3	2	3				2		2			3	
CO 5	2	2	2				3							3	
Pre-requisites	Bioprocess Engineering, Microbiology														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to Downstream Processing	Periods	9
Introduction to downstream processing, principles, Range and characteristics of bioproducts, Product quality and market based on demand, Characteristics of fermentation broth, and its pretreatment and stabilization of bio-products. Cell disruption techniques for product release – mechanical, enzymatic and chemical methods.			
Unit – II	Physical Methods of Separations	Periods	9
Filtration- Types of pre-treatment, Theory on filtration rates on incompressible and compressible cakes; continuous rotary filtration, Industrial filters, and Centrifugation – principles and its theory of industrial centrifuges- tubular bowl and disc centrifuge, and scale up; Centrifugal filtration.			
Unit – III	Concentration of Products	Periods	9
Adsorption, -Adsorbents, Isotherms, Design of batch, continuous, and fixed bed adsorption process. Extractive separation: Solvent extraction, Aqueous Two-Phase Extractions, Reverse Micelle Extraction, Super Critical Extraction. Precipitation methods-Salts; Membrane Based Separation: Ultrafiltration; Microfiltration; Nanofiltration; Dialysis and Electrodialysis.			
Unit – IV	Product Purification	Periods	9
Chromatographic Principles: Distribution coefficients, retention parameters, qualitative and quantitative aspects of Chromatography. Size exclusion Chromatography, Ion exchange chromatography, Reverse-phase chromatography, hydrophobic interaction chromatography (HIC), Affinity chromatography, HPLC, FPLC and GC – Operations & application.			
Unit – V	Product Polishing and Formulation	Periods	9
Crystallization, crystallization theory, Methods of super saturation, types of nucleation and crystal growth, yield of crystal. Drying: types of moistures, batch drying process, mechanism of drying, drying time calculation, drying equipment's; Freeze-drying and Spray drying. Bioproduct formulation and its stability analysis.			
Total Periods			45
Text Books			
1.	Belter P.A, Cussler,E.L and Wei-Houhu. (1998). Bioseparations- Downstream Processing for Biotechnology, Wiley Interscience Publications, USA.		
2.	Roger G.Harrison, Paul Todd, Scott R.Ruger and Demetri P. Petrides. (2009). Bioseparation Science and Engineering. Oxford University Press, 2nd ed. NewYork.		
References			
1.	Sivashankar, B ,Bioseparation : Principles and Techniques, Prentice Hall of India, New Delhi, 2005.		
2.	Michael C Flickinger “Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology” John Wiley & Sons, 2010		
3.	Ladisch, M. R, Bioseparations Engineering: Principles. Practice and Economics, Wiley,2001		
4.	Prasad Krishna ,“Downstream Process Technology a New Horizon in Biotechnology”, Prentice Hall of India, New Delhi, 2005.		



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5.	Scopes, R.K., Protein Purification – Principles and Practice, 2nd ed. Narosa Publications, 2005.
E-Resources	
1.	https://nptel.ac.in/courses/102/106/102106022/
2.	https://www.biozeen.com/portfolio/training/biotechnology-training-for-students/downstream-processing-technology/



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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	BIOTECHNOLOGY				Semester		VII								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT728	AI in Proteomics and Genomics	3	0	0	3	40	60	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To understand the genomes, its organization, annotation and its sequence determination To explore the techniques involved in genome analysis To understand the proteomes and techniques used in determination of protein sequence and function To gain insight knowledge on drug development considering the genome To interpret the gene function through analyzing gene expression data 														
Course Outcomes	At the end of the course, the students will be able to										Knowledge Level				
	CO1: Understand the importance of genomes and its functional annotation										K2				
	CO2: Apply the knowledge of genome analysis tools in biotechnology										K3				
	CO3: Apply the knowledge in proteomic approaches for Biotechnology applications										K3				
	CO4: Understand the concept of pharmacogenetics & personalized medicine										K3				
	CO5: Analyze the gene expression data for interpreting the function of genes										K4				
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2		3		3		1		2		2	1	2	1	2
CO 2	3	1	2	1	3		1		3		2	2	1	1	3
CO 3	2	2	2		2	1	2		2		1	2	2	2	1
CO 4	2	2	2		2		2				1	2	1	2	2
CO 5	3	3	3	3	3	2	1	2	3		3	3	3	3	2
Pre-requisites	Molecular Biology, Genetic Engineering.														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															



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1. Course - end survey			
Content of the syllabus			
Unit – I	GENOME & ANNOTATION	Periods	9
Structural organization of genome in Prokaryotes and Eukaryotes; DNA sequencing-First generation Sequencing, Second generation Sequencing, Third generation Sequencing and Next generation Sequencing; Accessing and retrieving genome project information from web resources; Recognition of coding and non-coding sequences and gene annotation.			
Unit – II	TECHNIQUES IN GENOMICS AND AI INTEGRATION	Periods	9
Tools for genome analysis-PCR, DNA fingerprinting techniques; physical and genetic mapping; Identification and classification of microbes using 16S rRNA typing/sequencing; Machine Learning for Genomic Analysis- Supervised Learning and Unsupervised Learning in Genomics.			
Unit – III	PROTEOMICS AND AI INTEGRATION	Periods	9
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2- D electrophoresis of proteins; MALDI-TOF; LC/MS-MS; Peptide fingerprinting; ML/DL for protein identification and quantification; Alpha Fold and structure-based predictions.			
Unit – IV	PHARMACOGENETICS	Periods	9
High throughput screening in genome for drug discovery-identification of gene targets, Steps involved in drug development & Pharmacogenetics – personalized medicine			
Unit – V	FUNCTIONAL GENOMICS AND TRANSCRIPTOMICS	Periods	9
Microarray- Protein and peptide microarray-based technology; Structural proteomics & techniques. Transcriptomics, System Biology, Metabolomics Metagenomics; Epigenomics and Application of AI-an Overview			
Total Periods			45
Text Books			
1.	Arthur Lesk, “Introduction to Genomics”, Oxford University Press,2017,2nd Edition.		
2.	D.C. Libeler, “Introduction to Proteomics: Tools for the New Biology”, Humana Press, 2001		
References			
1.	Bharath Ramsundar, Peter Eastman, Patrick Walters, and Vijay Pande “Deep Learning for the Life Sciences”, Shroff Publishers and distributors Pvt limited,2019		
2.	Debmalya Barh, “Artificial Intelligence in Precision Health-From concept to applications”, Academic Press,2020		
E-Resources			
1.	https://nptel.ac.in/courses/102101055		
2.	https://onlinecourses.nptel.ac.in/noc24_bt40/preview		
3.	https://onlinecourses.nptel.ac.in/noc19_bt26/preview		






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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT729	Principles of Food Processing	3	0	0	3	40	60	100							
Course Objective	The student should be made														
	➤ Understand the basics of food processing														
	➤ Study the methods of food storage.														
	➤ Gain knowledge on principles of food preservation														
	➤ Understand the concept of preservation by uses of chemicals.														
Course Outcome	At the end of the course, the student should be able to,							Knowl edge Level							
	CO1: Explain the basic concepts in processing of foods and its needs							K2							
	CO2: Describe the food product handling and important methods of storage							K2							
	CO3: Identify and apply the suitable food processing methods							K3							
	CO4: Choose the appropriate chemicals to process the foods							K4							
	CO5: Summarize the traditional and recent methods in food processing							K4							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
CO 1	2				2			3			2	3	3	3	
CO 2	3	3		2	3				2			2	1	2	
CO 3	3		3						2			2	2	1	
CO 4		2		3	3	2		2			2	3	3	2	
CO 5	3	2		2					2			3	1	1	
Pre-requisites		-													
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															


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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Introduction to food processing	Periods	9
Historical perspective, traditional technologies used in food processing; Classification and constituents of food; Processing of Foods – Primary, Secondary and Tertiary processing; Food processing need and its significance. Energy value of foods; Causes for food spoilage, Factors affecting food spoilage (temperature, moisture, pH); Food additives in preservation; Food colorants- natural and artificial			
Unit – II	Food products handling and storage	Periods	9
Nature of harvested crop, plant and animal; Storage of raw and cooked food; Processing of cereals- Rice, wheat; Processing of fruits and vegetables storage methods and its importance; effect of cold storage and its importance, Processing of meat, fish, poultry, egg; Processing of milk, Beverages- Tea, Coffee			
Unit – III	Thermal processing Methods	Periods	9
Mode of action and changes in foods; High temperature – Moist and Dry heat methods, Blanching, Dehydration, Concentration, Canning, Sterilization, Pasteurization; Low temperature – Freezing and Refrigeration; Dehydration; Ionizing radiation and microwave heating. Advantages and Limitations of Thermal food processing methods; Traditional methods of food processing – Smoking, Sun drying, Pickling/ Salting, Fermentation.			
Unit – IV	Food Processing by Chemical Methods	Periods	9
Principles, Technological aspects and applications of sugar and salt, antimicrobial agents, biological agent, mold inhibitor, effect of various food processing operations on the nutritive value of foods. Preservation by irradiations, ultrasonic, high pressure, membrane technology; Chemical preservatives, fermentation, curing; Super Critical Technology for Preservation; Hurdle technology			
Unit – V	Food Packaging and Labeling	Periods	9
Basic packaging materials; Types of packaging; Packaging for different types of foods; Packaging Techniques- Retort pouch packing, MAP, Vacuum Packaging, Intelligent Packaging			
Total Periods			45
Text Books			
1.	Norman.N Potter, Joseph H. Hotchkiss “Food science”, 5 th Edition, Springer US, 2012.		
2.	B.Sivasankar, “Food Processing and Preservation”, PHI Learning, 2004.		
3.	Desrosier N W and Desrosier J N (1987) The technology of Food Preservation, 4th Edition, CBS, New delhi.		
References			
1.	P.J. Fellows, “Food Processing Technology “, 2 nd Edition, Taylor& Francis, 2000.		
2.	NIIR Board, “The Complete Technology Book on Processing. Dehydration, Canning, Preservation of Fruits & Vegetables”, 5th Revised Edition, 2019.		
E-Resources			
1.	https://nptel.ac.in/courses/126105015		
2.	https://archive.nptel.ac.in/courses/103/107/103107088/		


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Programme	B.Tech	Programme Code			105	Regulation	2023								
Department	Biotechnology				Semester		VII								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BT730	Downstream Processing Laboratory	0	0	3	1	60	40	100							
Course Objective	The students will get the hands-on learning experience on various unit operations utilized for bioproduct separations and purification used in downstream process laboratory.														
Course Outcomes	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Understand the process of filtration, and centrifugation operations used in bioseparation process.							K2							
	CO2: Apply the physical, chemical method of cell disruption techniques							K2							
	CO3: Analyse and gain the ability to isolate the protein from the broth using salts- Polymers/ solvents.							K3							
	CO4: Analyse and gain the ability to work on different extraction techniques							K3							
CO5: Analyze and ability to design the chromatography technique for purification of specific bioproduct/Compound.							K3								
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
Cos	Programme Outcomes (POs)											PSOs			
	PO 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	PO 8	P O 9	P O 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3					3		3				2	2	1
CO 2	2	3	2						3				2		
CO 3	3	3	3						3				2		2
CO 4	2	2	3						2					3	2
CO 5	2	2	2				3		3					3	2
Pre-requisites		Nil													
Direct															
1. Pre lab and Post lab															
2. Execution of Experiment and Viva-voce															
3. End semester examination															
Indirect															
1. Course - end survey															


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List of Experiments		
S.No	Name of the Experiment	Course Outcome
1.	Separation of the compound using filtration methods.	CO1
2.	Separation of the biomolecules using centrifugation.	CO1
3.	Cell disruption technique using ultrasonication.	CO2
4.	Cell disruption technique using enzymatic and chemical method	CO2
5.	Concentration of protein sample using ammonium precipitation	CO3
6.	Concentration of protein sample using solvent	CO3
7.	Concentration of protein sample using aqueous two-phase extraction.	CO4
8.	Separation of the proteins with suitable chromatography methods - Gel filtration chromatography	CO5
9.	Separation of the proteins with suitable chromatography methods - Affinity chromatography.	CO5
10.	Separation of the proteins with suitable chromatography methods - Ionexchange chromatography.	CO5
Total Periods		60






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
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks										
		L	T		P	C	CA	ESE	Total						
U23BT731	Internship Training cum Project phase- I	0	0	3	3	100	-	100							
Course Objective	The student should be made <ul style="list-style-type: none"> To apply theoretical knowledge in practical settings. To develop professional and technical skills. To enhance communication and teamwork abilities. To understand workplace culture and ethics. To foster research and innovation mindset. 														
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level								
	CO1: Demonstrate the ability to apply academic concepts in a professional environment.						K3								
	CO2: Analyze real-world problems and contribute to solutions through technical or research-based tasks.						K4								
	CO3: Develop effective communication, documentation, and presentation skills relevant to the workplace.						K3								
	CO4: Exhibit professionalism, ethical responsibility, and understanding of workplace dynamics.						K2								
	CO5: Design and implement a summer project using appropriate tools and techniques, and interpret the outcomes.						K5								
Pre-requisites	-														
CO / PO Mapping												CO/PSO Mapping			
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak															
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	2	1	1	1	-	2	2	2	3	3	3	3
CO 2	3	3	2	3	3	3	1	-	2	2	3	3	3	3	3
CO 3	3	3	3	3	1	1	3	1	3	3	2	3	2	1	1
CO 4	2	2	2	1	1	3	2	3	3	2	3	3	2	1	1
CO 5	3	3	3	3	3	1	1	1	2	1	2	3	3	3	3
Course Assessment Methods															
Direct															
1. Project Reviews															
2. End Semester Examinations(Viva Voce)															
Indirect															
1. Course - End survey															


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SEMESTER VIII



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Programme	B.Tech	Programme Code	105	Regulation	2023																																																																																																																																					
Department	BIOTECHNOLOGY		Semester		VIII																																																																																																																																					
Course Code	Course Name	Periods Per Week		Credit	Maximum Marks																																																																																																																																					
		L	T		P	C	CA	ESE	Total																																																																																																																																	
U23BT832	PROJECT PHASE -II	0	0	16	10	60	40	100																																																																																																																																		
Course Objective	The student should be made <ul style="list-style-type: none"> To understand the process of identifying a relevant research area in biotechnology. To interpret and summarise scientific literature related to the chosen project topic. To develop an appropriate experimental design or prototype based on the identified problem. To analyse experimental results or design data and derive meaningful conclusions. To evaluate the outcomes of the project and document findings with future research scope. 																																																																																																																																									
Course Outcome	At the end of the course, the student should be able to,						Knowledge Level																																																																																																																																			
	CO1: Explain the significance of a selected project area and demonstrate a clear understanding of the problem statement.						K2																																																																																																																																			
	CO2: Apply literature review skills to support the project rationale and frame research objectives.						K3																																																																																																																																			
	CO3: Analyze the identified problem and formulate an experimental or design plan to address it effectively.						K4																																																																																																																																			
	CO4: Perform experiments or simulations and interpret results using appropriate analytical tools.						K4																																																																																																																																			
CO5: Evaluate project outcomes, compile a detailed report, and suggest future improvements and applications.						K5																																																																																																																																				
Pre-requisites	-																																																																																																																																									
<table border="1"> <thead> <tr> <th colspan="12">CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak</th> <th colspan="3">CO/PSO Mapping</th> </tr> <tr> <th rowspan="2">COs</th> <th colspan="12">Programme Outcomes (POs)</th> <th colspan="3">PSOs</th> </tr> <tr> <th>PO 1</th> <th>PO 2</th> <th>PO 3</th> <th>PO 4</th> <th>PO 5</th> <th>PO 6</th> <th>PO 7</th> <th>PO 8</th> <th>PO 9</th> <th>PO 10</th> <th>PO 11</th> <th>PO 12</th> <th>PSO1</th> <th>PSO 2</th> <th>PSO 3</th> </tr> </thead> <tbody> <tr> <td>CO 1</td> <td>3</td> <td>2</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td></td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>3</td> <td>3</td> <td>2</td> <td>3</td> </tr> <tr> <td>CO 2</td> <td>3</td> <td>3</td> <td>2</td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> <td>2</td> <td>3</td> <td>3</td> <td>2</td> <td>2</td> </tr> <tr> <td>CO 3</td> <td>3</td> <td>3</td> <td>3</td> <td>2</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 4</td> <td>3</td> <td>3</td> <td>2</td> <td>2</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> <td>2</td> <td>3</td> <td>3</td> <td>3</td> </tr> <tr> <td>CO 5</td> <td>2</td> <td>2</td> <td>3</td> <td>2</td> <td>3</td> <td>2</td> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>3</td> <td>3</td> <td>2</td> <td>3</td> <td>3</td> </tr> </tbody> </table>													CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			COs	Programme Outcomes (POs)												PSOs			PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	CO 1	3	2	2	1	2	2		2	2	2	2	3	3	2	3	CO 2	3	3	2	1	2				1	2	2	3	3	2	2	CO 3	3	3	3	2	3					1	2	3	2	3	3	CO 4	3	3	2	2	3					1	2	2	3	3	3	CO 5	2	2	3	2	3	2		1	2	3	3	3	2	3	3
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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205														
Programme	B.Tech		Programme Code				105		Regulation		2023				
Department	BIOTECHNOLOGY							Semester		VII					
Course Code	Course Name						Periods Per Week			Credit	Maximum Marks				
							L	T	P		C	CA	ESE	Total	
U23BTOE7	FOOD PROCESSING AND PRESERVATION TECHNOLOGY						3	0	0	3	40	60	100		
Course Objective	This course aims to														
	<ul style="list-style-type: none"> • Provide foundational knowledge of food composition, spoilage mechanisms, and processing techniques. • Equip students with an understanding of thermal and non-thermal food preservation methods. • Explore different types of food packaging materials and technologies suited for various food products to ensure quality and extended storage. 														
Course Outcome	At the end of the course, the student should be able to,											Knowledge Level			
	CO1: Explain the composition of food and identify the major factors responsible for food spoilage, including the role of food additives and colorants in preservation.											K2			
	CO2: Describe the various processing methods for cereals, fruits, vegetables, dairy, meat, and beverages											K2			
	CO3: Compare different thermal food processing methods and their effectiveness and limitations in preserving various types of foods.											K3			
	CO4: Discuss non-thermal technologies and hurdle preservation concepts											K3			
	CO5: Identify packaging materials and analyze packaging techniques for various food types											K4			
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2			2	2				2		1	3	2	1
CO 2	3	3	2		2					2		1	3	2	2
CO 3	3	3	2		2	2	1					2	3	3	3
CO 4	3	3	3	2	2	2	2					2	3	3	3
CO 5	3	3	3	2	2	2	2			2		2	3	3	3
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															


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2. Assignment			
3. End-Semester examinations			
Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	Fundamentals of Food Science & Preservation	Periods	9
Constituents of food, energy value of foods; Causes for food spoilage, Factors affecting food spoilage (temperature, moisture, pH); Food additives in preservation; Food colorants-natural and artificial			
Unit – II	Food Processing Techniques	Periods	9
Processing of cereals-Rice, wheat; Processing of fruits and vegetables; Processing of meat, fish, poultry, egg; Processing of milk; Processing of Beverages-Tea, Coffee			
Unit – III	Thermal Food processing Methods	Periods	9
High temperature Processing- Blanching, Pasteurization, sterilization, canning; Low temperature Processing- Refrigeration, freezing, drying; Advantages and Limitations of Thermal food processing methods			
Unit – IV	Non-Thermal Food processing Methods	Periods	9
Preservation by irradiations, ultrasonic, high pressure, smoking, membrane technology; Chemical preservatives, fermentation, curing, pickling ; Super Critical Technology for Preservation; Hurdle technology			
Unit – V	Food Packaging	Periods	9
Basic packaging materials; Types of packaging; Packaging for different types of foods; Packaging Techniques- Retort pouch packing, MAP, Vacuum Packaging, Intelligent Packaging			
Total Periods			45
Text Books			
1.	Norman.N Potter, Joseph H. Hotchkiss “Food science”, 5 th Edition, Springer US, 2012.		
2.	B.Sivasankar, “Food Processing and Preservation”, PHI Learning, 2004.		
References			
1.	P.J. Fellows, “Food Processing Technology “, 2 nd Edition, Taylor& Francis, 2000.		
2.	NIIR Board, “The Complete Technology Book on Processing, Dehydration, Canning, Preservation of Fruits & Vegetables”, 5th Revised Edition, 2019.		
3.	Gordon L. Robertson, “Food Packaging Principles and Practice”, Third Edition, Taylor& Francis, 2013.		
4.	Neelam Khetarpaul, “Food Processing and Preservation.” Daya Publications, 2012.		
E-Resources			
1.	https://ebooks.inflibnet.ac.in/ftp1/		
2.	https://www.intechopen.com/chapters/86251		
3.	https://nptel.ac.in/courses/126105015/		
4.	https://nptel.ac.in/courses/103107088		



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Programme	B.Tech	Programme Code		105	Regulation	2023									
Department	BIOTECHNOLOGY				Semester		VII								
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTOE8	Forensic Technology	3	0	0	3	40	60	100							
Course Objective	<p>The student should be made to,</p> <ul style="list-style-type: none"> To prepare students for entry-level positions in the fields of forensic technology To create a deeper understanding of forensic science To render knowledge of how to perform research in interdisciplinary fields like forensic studies 														
Course Outcome	At the end of the course, the student should be able to,							Knowledge Level							
	CO1: Explain the forensic science and crime investigation process							K2							
	CO2: Apply the principles and operation of analytical instruments in forensic analysis							K3							
	CO3: Analyze various biological samples for forensic studies							K3							
	CO4: Analyze the non-biological samples and characterize							K3							
	CO5: Implement forensic examination in different levels and documentation							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)											PSOs			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	2	3	3	2	2				2		1	3	2	3
CO 2	3	3	2	2	2					2		1	2	3	2
CO 3	3	2	3	2	2	2	1					2	3	2	3
CO 4	3	3	2	2	2	2	2					2	3	2	3
CO 5	3	2	3	2	2	2	2			2		2	2	3	2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
2. Assignment															
3. End-Semester examinations															
Indirect															
2. Course - end survey															

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Content of the syllabus			
Unit – I	BASICS OF FORENSIC SCIENCE	Periods	9
History and Development, Fundamental principles of Forensic science – Frye case and Daubert standard, Crime Scene Management and Investigation- Collection, packaging, preservation and forwarding of physical and trace evidence for analysis; Role in legal and Court procedure pertaining to Expert Testimony.			
Unit – II	FORENSIC TOOLS AND TECHNIQUES	Periods	9
Instrumentation in Forensic Science, Qualitative and quantitative methods of analysis, Microscopy- Polarizing, Fluorescent and Electron microscopes; Spectrophotometry- UV, Visible, IR atomic absorption; Forensic Application of planar chromatography. Mass Spectrometry (MS): Principle and applications.			
Unit – III	ANALYSIS OF BIOLOGICAL SAMPLES	Periods	9
Grouping and typing of fresh blood samples; Analysis of stains of blood and allied body fluids for their groups; Cases of disputed paternity and maternity problems; DNA profiling; Biological evidence - Identification of hair, determination of species origin, sex, site and individual identification from hair; Examination and identification of saliva, Urine and Faecal matter.			
Unit – IV	CHARACTERIZATION OF NON-BIOLOGICAL SAMPLE	Periods	9
Physical analysis - soil, glass, paints, lacquers, cement, inks, paper, tool marks, tyre marks, shoe prints, forensic examination of vehicles in cases of an accident; Identification of individuals from bodily features; Fingerprinting – palm prints, retina, geometry of hand and face. Examination and identification of deceased from skeletal remains.			
Unit – V	FORENSIC EXAMINATION	Periods	9
Method of crime analysis: Fingerprinting – palm prints, retina, geometry of hand and face, Preliminary examination of documents- Identification and characteristics of handwriting, signatures and detection of forgeries; Physical and chemical erasures, obliterations, additions, alterations, indentations, secret writings and charred documents; Inks, papers and their scientific examinations including instrumental analysis.			
Total Periods			45
Text Books			
1.	Rukmani Krishnamurthy, An Introduction to Forensic Medicine, Selective & Scientific Books, 2022		
2.	Rosalind Wolstenholme, Analytical Techniques in Forensic Science, First Edition, Wiley, 2020		
References			
1.	Jane Schober, Forensic Biology, Taylor & Francis, 2021		
2.	Pankaj Shrivastava, Textbook of Forensic Science, Global Edition, Springer, 2023		
3.	B R Sharma, Forensic science in criminal investigation & trials, Universal Law Publishing, 6 th Edition, 2020		
4.	Jaskaran Singh, Crime Scene Management within Forensic Science: A Forensic Science Perspective, 2022		
E-Resources			
1.	https://sites.google.com/site/introductiontoforensicscience/file-cabinet		
2.	https://www.coursera.org/learn/forensic-science/home/welcome		


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3.	https://www.studocu.com/en-us/document/fairleigh-dickinson-university/forensic-science/forensic-science-lecture-notes-1-15/6529798
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Programme	B.Tech	Programme Code		105	Regulation	2023									
Department	BIOTECHNOLOGY			Semester		VII									
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks									
		L	T	P		C	CA	ESE	Total						
U23BTOE9	Organic Farming for Sustainable Agriculture	3	0	0	3	40	60	100							
Course Objective	<ul style="list-style-type: none"> Aims at incurring knowledge on various aspects of organic farming and its importance in present world scenario and its impact on environment and soil health. 														
Course Outcomes	At the end of the course, the student should be able to							Knowledge Level							
	CO1: Explain the principles, ecosystem approaches, and scope of organic farming in the Indian context, including indigenous knowledge systems.							K2							
	CO2: Identify and apply suitable organic fertilizers, biofertilizers, and growth promoters for improving soil fertility and crop productivity.							K3							
	CO3: Evaluate and implement eco-friendly strategies for pest, disease, and weed management using organic and biological methods.							K3							
	CO4: Interpret the organic certification process, labeling standards, and assess the economic and market potential of organic farming in India.							K3							
	CO5: Apply emerging techniques for enhancing productivity, sustainability, and pest-free organic cultivation.							K3							
CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak												CO/PSO Mapping			
COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	3		3	2	2	2			2	3		3
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CO 4	3	3	3	2	2	2	3			2			2	2	3
CO 5	2	2	3	3	3	2							2		2
Pre-requisites	-														
Course Assessment Methods															
Direct															
1. Continuous Assessment Test I, II & III															
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Content of the syllabus			
Unit – I	Introduction to Organic Farming	Periods	9
Organic farming- concepts, principles and its scope in India- organic ecosystem and their concepts. Organic nutrient resources and its fortification. Restrictions to nutrient use in organic farming. Choice of crops and varieties in organic farming. Organic waste recycling methods. Indigenous Technical Knowledge (ITK) in organic agriculture.			
Unit – II	Organic Fertilizers and Growth Promoters	Periods	9
Organic Fertilizers- Farmyard manure, Compost and vermicompost, Green manures, Oil cakes-neem, groundnut. Biofertilizers- Rhizobium, Azolla. Fermented organic formulations- Panchagavya, Jeevamrut. Nutrient content and field application techniques.			
Unit – III	Organic Pest, Disease, and Weed Management	Periods	9
Need for eco-friendly pest and disease control. Botanical Pesticide- Neem oil, Biopesticide- Bacillus thuringiensis, Buttermilk spray, cow urine formulation. Organic Herbicide- Vinegar-based sprays, clove oil, citric acid. Biological agents for weed control.			
Unit – IV	Organic certification and Labelling	Periods	9
Operational structure of NPOP - Certification process and standards of organic farming. Processing – labelling – economic considerations and viability - marketing and export potential of organic products- Initiatives taken by Government (central/state) - NGOs and other organizations for promotion of organic agriculture.			
Unit – V	Emerging Techniques in Organic Farming	Periods	9
Nano-Formulations in Organic Farming, Biochar in Soil Amendment, Organic Hydroponics, Aeroponics and Aquaponics. Vertical Farming with LED Lighting. Greenhouse automation system for pest free organic production.			
Total Periods			45
Text Books			
1.	Palaniappan.S.P. and Annadurai. K, “Organic Farming: Theory & Practice”, Scientific Publishers, 2 nd Edition, 2022.		
2.	Dahama. A. K, “Organic Farming for Sustainable Agriculture”, Agro Bios (India), 2 nd Edition, 2007.		
References			
1.	Jayanthi. C, Devasenapathy.P and Vennila.C, “Farming systems, Principles and Practices”, Sathish Serial publishing house, New Delhi. 1 st Edition, 2007.		
2.	Dilip Nandwani, “Organic Farming for Sustainable Agriculture”, Springer International Publisher, 1 st Edition, 2016.		
3.	Nicolas Lampkin, “Organic Farming”, Old Pond Publishing, 2 nd Edition, 2002.		
4.	Bhattacharyya.P and Chakraborty.G, “Organic Agriculture and Agribusiness”, National Centre of Organic Farming, 1 st Edition, 2005.		
E-Resources			
1.	http://nsdl.niscair.res.in		
2.	https://nptel.ac.in		
3.	http://www.navdanya.org		
4.	http://nsdl.niscair.res.in		




Signature of BoS Chairman

BoS Chairman,
Faculty of Biotechnology,
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Vampalayam, Tiruchengode - 637 205

OPEN ELECTIVES OFFERED BY OTHER DEPARTMENTS

Signature of Bos Chairman

BOS Chairman,
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Vivekanandha College of
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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI)	
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Department of Computer Science and Engineering



UG R2023

LIST OF OPEN ELECTIVE COURSE (OEC)

Course code	Course name	Category	L	T	P	C	CA	ESE	Total
U23CSOE1	Fundamentals of OS	OEC	3	0	0	3	40	60	100
U23CSOE2	Web Designing	OEC	3	0	0	3	40	60	100
U23CSOE3	Multimedia and Animation Basics	OEC	3	0	0	3	40	60	100
U23CSOE4	Software Engineering	OEC	3	0	0	3	40	60	100
U23CSOE5	Mobile Application Development	OEC	3	0	0	3	40	60	100
U23CSOE6	Principles of cloud computing	OEC	3	0	0	3	40	60	100
U23CSOE7	Machine Learning with Python	OEC	3	0	0	3	40	60	100
U23CSOE8	Ethical Hacking	OEC	3	0	0	3	40	60	100
U23CSOE9	Open Source Software	OEC	3	0	0	3	40	60	100

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

OPEN ELECTIVE (OE) OFFERED

DETAILS OF OPEN ELECTIVE (OE) FOR UG COURSE R2023

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P		C	CA	ESE
U23EEOE1	Energy Conservation & Management	3	0	0	3	40	60	100
U23EEOE2	Electrical Safety	3	0	0	3	40	60	100
U23EEOE3	Wind and Solar Energy Systems	3	0	0	3	40	60	100
U23EEOE4	Introduction to Electric Vehicle	3	0	0	3	40	60	100
U23EEOE5	Environment Sustainability	3	0	0	3	40	60	100


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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	B.E.,	Programme Code	103	Regulation	2023				
Department	ELECTRONICS AND COMMUNICATION ENGINEERING			Semester	-				
CURRICULUM (Applicable to the students admitted from the academic year 2023-2024 onwards)									
LIST OF OPEN ELECTIVE									
Course Code	Course Name	Category	Periods / Week			Credit C	Maximum Marks		
			L	T	P		CA	ESE	Total
OPEN ELECTIVE-I									
U23ECO1	Principles of Communication	OE	3	0	0	3	40	60	100
U23ECO2	Basics of VLSI	OE	3	0	0	3	40	60	100
U23ECO3	Industry 4.0 & 5.0	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-II									
U23ECO4	Satellite Communication	OE	3	0	0	3	40	60	100
U23ECO5	4G and 5G Network	OE	3	0	0	3	40	60	100
U23ECO6	Robotic system and control	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-III									
U23ECO7	Industrial Electronics	OE	3	0	0	3	40	60	100
U23ECO8	Sensor and its Applications	OE	3	0	0	3	40	60	100
U23ECO9	Nano Electronics	OE	3	0	0	3	40	60	100



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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN							
	(Autonomous Institution, Affiliated to Anna University, Chennai)							
Elayampalayam, Tiruchengode – 637 205								
Programme	B.Tech.	Programme Code	104	Regulation			2023	
Department	INFORMATION TECHNOLOGY			Semester			-	
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)								
LIST OF OPEN ELECTIVES								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
OPEN ELECTIVE - I								
U23ITOE1	IT Essentials	OEC	3	0	0	3	40	60
U23ITOE2	Machine Learning	OEC	3	0	0	3	40	60
U23ITOE3	Data Science and Analytics	OEC	3	0	0	3	40	60
U23ITOE4	Cyber Threats Intelligence	OEC	3	0	0	3	40	60
U23ITOE5	Offensive Security Essentials	OEC	3	0	0	3	40	60
U23ITOE6	Object Oriented Programming	OEC	3	0	0	3	40	60
U23ITOE7	Creative UX/UI Design	OEC	3	0	0	3	40	60


 Signature of BCS Chairman
BcS Chairman,
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Programme	B.E.	Programme Code	106	Regulation		2023			
Department	BIOMEDICAL ENGINEERING			Semester		OPEN ELECTIVE			
CURRICULUM									
LIST OF OPEN ELECTIVES									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
OPEN ELECTIVE-I									
U23BMOE1	Introduction to Medical Instrumentation	OE	3	0	0	3	40	60	100
U23BMOE2	Telemedicine	OE	3	0	0	3	40	60	100
U23BMOE3	Hospital Engineering and Information Systems	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-II									
U23BMOE4	Advanced Medical Equipments	OE	3	0	0	3	40	60	100
U23BMOE5	Virtual Instrumentation	OE	3	0	0	3	40	60	100
U23BMOE6	Embedded Systems in Medical Applications	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-III									
U23BMOE7	Hospital Management	OE	3	0	0	3	40	60	100
U23BMOE8	Medical Informatics	OE	3	0	0	3	40	60	100
U23BMOE9	Clinical Engineering	OE	3	0	0	3	40	60	100


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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN							
	(Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	B.Tech.	Programme Code	107	Regulation	2023			
Department	COMPUTER SCIENCE AND TECHNOLOGY			Semester	-			
CURRICULUM (Applicable to the students admitted from the academic year 2023 - 2024 onwards)								
LIST OF OPEN ELECTIVES								
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
OPEN ELECTIVE - I								
U23CTOE1	Fundamentals of Artificial Intelligence	OEC	3	0	0	3	40	60
U23CTOE2	Fundamentals of Information Security	OEC	3	0	0	3	40	60
U23CTOE3	Fundamentals of Data Science	OEC	3	0	0	3	40	60
U23CTOE4	Fundamentals of Machine Learning	OEC	3	0	0	3	40	60
U23CTOE5	Fundamentals of Data Visualization	OEC	3	0	0	3	40	60
U23CTOE6	Marketing Analytics	OEC	3	0	0	3	40	60


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**MINOR DEGREE VERTICALS
OFFERED BY OTHER
DEPARTMENTS**

Signature of Bos Chairman



**VIVEKANANDHA COLLEGE OF ENGINEERING FOR
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(AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI)





**DEPARTMENT OF COMPUTER SCIENCE AND
ENGINEERING**

MINOR DEGREE – CYBER SECURITY

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
THEORY									
U23CSV31	Information Security	PEC	3	0	0	3	40	60	100
U23CSV32	Cyber security	PEC	3	0	0	3	40	60	100
U23CSV33	Malware Analysis	PEC	3	0	0	3	40	60	100
U23CSV34	Cyber law and Ethics	PEC	3	0	0	3	40	60	100
U23CSV35	Block chain Technology	PEC	3	0	0	3	40	60	100
U23CSV36	Social Network Security	PEC	3	0	0	3	40	60	100
U23CSV37	Ethical Hacking	PEC	3	0	0	3	40	60	100
U23CSV38	Security and Privacy in cloud	PEC	3	0	0	3	40	60	100
U23CSV39	Digital Forensics	PEC	3	0	0	3	40	60	100


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VERTICALS – V: MINOR IN “ADVANCED ENERGY AND ELECTRONIC SYSTEM”


	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode 637 205								
Programme	B.E.	Programme Code	102	Regulation	2023				
Department	ELECTRICAL AND ELECTRONICS ENGINEERING		Semester		-				
CURRICULUM									
(Applicable to the students admitted from the academic year 2023- 2024 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
THEORY									
U23EEV51	Energy Storage Systems	PEC	3	0	0	3	40	60	100
U23EEV52	VLSI Design	PEC	3	0	0	3	40	60	100
U23EEV53	Digital Signal Processing	PEC	3	0	0	3	40	60	100
U23EEV54	Energy Management and Auditing	PEC	3	0	0	3	40	60	100
U23EEV55	Utilization and Conservation of Electrical Energy	PEC	3	0	0	3	40	60	100
U23EEV56	Biomedical Instrumentation	PEC	3	0	0	3	40	60	100
U23EEV57	Online Course	PEC	3	0	0	3	40	60	100

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**VERTICALS – VII: ELECTRONICS ENGINEERING AND
ADMINISTRATION SYSTEM**

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	B.E.	Programme Code	103	Regulation	2023				
Department	ELECTRONICS AND COMMUNICATION ENGINEERING		Semester		-				
CURRICULUM									
(Applicable to the students admitted from the academic year 2023- 2024 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U23ECV71	Medical Electronics	PEC	3	0	0	3	40	60	100
U23ECV72	Management Quality and Ethical Values	PEC	3	0	0	3	40	60	100
U23ECV73	Remote Sensing	PEC	3	0	0	3	40	60	100
U23ECV74	Industry 4.0 & 5.0	PEC	3	0	0	3	40	60	100
U23ECV75	Automotive Electronics	PEC	3	0	0	3	40	60	100
U23ECV76	Soft Computing	PEC	3	0	0	3	40	60	100
U23ECV77	Principles of Public Administration	PEC	3	0	0	3	40	60	100
U23ECV78	PCB Design and Fabrication	PEC	3	0	0	3	40	60	100
U23ECV79	Rocketry and Space Mechanics	PEC	3	0	0	3	40	60	100


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**VIVEKANANDHA COLLEGE OF ENGINEERING FOR
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(AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI)



DEPARTMENT OF INFORMATION TECHNOLOGY

MINOR DEGREE - IoT & Cloud



Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
THEORY									
U23ITV41	Cloud Computing	PEC	3	0	0	3	40	60	100
U23ITV42	Distributed Systems	PEC	3	0	0	3	40	60	100
U23ITV43	Smart Sensor Technologies	PEC	3	0	0	3	40	60	100
U23ITV44	Software Defined Networks	PEC	3	0	0	3	40	60	100
U23ITV45	Parallel Programming	PEC	3	0	0	3	40	60	100
U23ITV46	Virtualization	PEC	3	0	0	3	40	60	100
U23ITV47	Edge and Fog Computing	PEC	3	0	0	3	40	60	100
U23ITV48	Amazon Web Services	PEC	3	0	0	3	40	60	100

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BoS Chairman,



**Faculty of Biotechnology,
Vivekanandha College of
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Kavampalayam, Tiruchengode - 637 205**

VERTICAL V - HEALTHCARE MANAGEMENT

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	B.E.	Programme Code	106	Regulation	2023				
Department	BIOMEDICAL ENGINEERING			Semester	-				
CURRICULUM (Applicable to the students admitted from the academic year 2023 onwards)									
Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
U23BMV51	Hospital Systems Management	PEC	3	0	0	3	40	60	100
U23BMV52	Database Management Systems	PEC	3	0	0	3	40	60	100
U23BMV53	Biomedical Engineering Entrepreneurship	PEC	3	0	0	3	40	60	100
U23BMV54	Energy Audit and Management for Hospitals	PEC	3	0	0	3	40	60	100
U23BMV55	Quality Assurance and Regulatory Aspects for Medical Devices	PEC	3	0	0	3	40	60	100
U23BMV56	Medical Ethics and Intellectual Property Rights	PEC	3	0	0	3	40	60	100
U23BMV57	Troubleshooting of Medical Devices	PEC	3	0	0	3	40	60	100
U23BMV58	Medical Waste management	PEC	3	0	0	3	40	60	100
U23BMV59	NPTEL/IEEE Online Course	PEC	3	0	0	3	40	60	100



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BoS Chairman,
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**DEPARTMENT OF COMPUTER SCIENCE AND
TECHNOLOGY**

MINOR DEGREE – DATA SCIENCE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P		C	CA	ESE
THEORY									
U23CTV11	Data Warehousing and Data Mining	PEC	3	0	0	3	40	60	100
U23CTV12	Big Data Analytics	PEC	3	0	0	3	40	60	100
U23CTV13	Exploratory Data Analytics	PEC	3	0	0	3	40	60	100
U23CTV14	Social Media Analytics	PEC	3	0	0	3	40	60	100
U23CTV15	Predictive Analytics	PEC	3	0	0	3	40	60	100
U23CTV16	Image and Video Analytics	PEC	3	0	0	3	40	60	100
U23CTV17	Recommender Systems	PEC	3	0	0	3	40	60	100
U23CTV18	Storage Technologies	PEC	3	0	0	3	40	60	100
U23CTV19	Time Series Analysis and Forecasting	PEC	3	0	0	3	40	60	100


 Signature of BoS Chairman
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