VIVEKANANDHA

COLLEGE OF ENGINEERING FOR WOMEN

(An Autonomous Institution Affiliated to Anna University-Chennai

Approved by AICTE – Accredited by NBA New Delhi and ISO 9001:2008 Certified)

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

CURRICULUM

FOR

UG - B.TECH. BIOTECHNOLOGY

REGULATION 2019

(BATCH 2021 & 2022)

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.Tech.**	Programme Code	105	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	**I**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 - 2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA101	Calculus*	BSC	3	1	0	4	40	60	100
U19EN101	English For Communication-I *	HSC	3	0	0	3	40	60	100
U19PH105	Engineering Physics#	BSC	3	0	0	3	40	60	100
U19CS101	Programming for Problem Solving*	ESC	3	0	0	3	40	60	100
U19GE101	Engineering Graphics*	ESC	2	0	3	3	40	60	100
PRACTICAL									
U19PH106	Physics Laboratory#	BSC	0	0	4	2	60	40	100
U19CS102	Computer Practices Laboratory*	ESC	0	0	4	2	60	40	100
MANDATORY COURSES									
	Mandatory Course - I	MC	3	0	0	0	100	-	100
					Total	**20**	**420**	**380**	**800**

BSC - Basic Science Courses, ESC- Engineering Science Courses, PCC- Professional core courses, PEC- Professional Elective courses, OEC- Open Elective courses, MC- Mandatory courses, HS- Humanities and Social Sciences, EEC- Employability Enhancement Courses, SI- Summer Industry Internship, PROJ-IT- Project, CA- Continuous Assessment, ESE - End Semester Examination.

*Common for all branches

#Common for ECE, EEE, BME

Signature of BoS Chairman

BoS Chairman,
Faculty of Biotechnology,
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Programme	**B.Tech.**	Programme Code	105	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	**II**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 - 2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA202	Linear Algebra and Ordinary Differential Equations*	BSC	3	1	0	4	40	60	100
U19EN202	English For Communication-II *	HSC	3	0	0	3	40	60	100
U19CH207	Engineering Chemistry$	BSC	3	0	0	3	40	60	100
U19EE201	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	40	60	100
U19GE202	Basic Civil and Mechanical Engineering*	ESC	3	0	0	3	40	60	100
U19BT201	Cell Biology	ESC	3	0	0	3	40	60	100
U19TA201	தமிழர் மரபு / Heritage of Tamils#	HSC	2	0	0	1	40	60	100
PRACTICAL									
U19CH208	Chemistry Laboratory$	BSC	0	0	4	2	60	40	100
U19GE203	Engineering Practices Laboratory*	ESC	0	0	4	2	60	40	100
MANDATORY COURSES									
	Mandatory Course - II	MC	3	0	0	0	100	-	100
						Total Credits	**23**	**460**	**440**	**900**
						Total Credits#	**24**	**500**	**500**	**1000**

CA- Continuous Assessment, ESE - End Semester Examination.

*Common for all branches

$ Common for ECE, EEE, BME

Applicable to the students admitted in the academic year 2022-2023

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Programme	**B.Tech.**	Programme Code	**105**			Regulation		**2019**		
Department	**BIOTECHNOLOGY**					Semester		**III**		
CURRICULUM (Applicable to the students admitted from the academic year 2019 - 2020 onwards)										
Course Code	Course Name			Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ESE	Total
THEORY										
U19MA303	Transforms and Partial Differential Equations		BSC	3	1	0	4	40	60	100
U19BT302	Essentials of Microbiology		PCC	3	0	0	3	40	60	100
U19GE304	Unit Operations		ESC	3	0	0	3	40	60	100
U19BT303	Introduction to Biochemistry		PCC	3	0	0	3	40	60	100
U19BT304	Industrial Biotechnological products		PCC	3	0	0	3	40	60	100
U19TA302	தமிழரும் தொழில்நுட்பமும்;; / TAMILS AND TECHNOLOGY#		HSC	2	0	0	1	40	60	100
PRACTICAL										
U19BT305	Microbiology Laboratory		PCC	0	0	4	2	60	40	100
U19BT306	Cell Biology Laboratory		PCC	0	0	4	2	60	40	100
U19BT307	Biochemistry Laboratory		PCC	0	0	4	2	60	40	100
MANDATORY COURSES										
	Mandatory Course - III		MC	3	0	0	0	100	-	100
							Total Credits	**22**	**480**	**420**	**900**
							Total Credits#	**23**	**520**	**480**	**1000**

 # Applicable to the students admitted in the academic year 2022-2023

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	**IV**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 - 2020 onwards)

Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA408	Probability and Statistics	BSC	3	1	0	4	40	60	100
U19BT407	Bioprocess Engineering& Technology	PCC	3	0	0	3	40	60	100
U19BT408	Thermodynamics for Biotechnologists	PCC	3	0	0	3	40	60	100
U19BT409	Molecular Biology	PCC	3	0	0	3	40	60	100
U19BT410	Bioinstrumentation	PCC	3	0	0	3	40	60	100
PRACTICAL									
U19BT411	Bioprocess Laboratory	PCC	0	0	4	2	60	40	100
U19BT412	Chemical Engineering Laboratory	ESC	0	0	4	2	60	40	100
MANDATORY COURSES									
	Mandatory Course - IV	MC	3	0	0	0	100	-	100
						Total Credits	**20**	**420**	**380**	**800**

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Programme	**B.Tech**	Programme Code	**105**				Regulation		**2019**	
Department	**BIOTECHNOLOGY**						Semester		**V**	
CURRICULUM (Applicable to the students admitted from the academic year 2019 - 2020 onwards)										
Course Code	Course Name			Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ESE	Total
THEORY										
U19BT513	Computational Biology		PCC	3	0	0	3	40	60	100
U19BT514	Principles of Genetic Engineering		PCC	3	0	0	3	40	60	100
U19BT515	Immunology and Immunotechnology		PCC	3	0	0	3	40	60	100
U19BT516	Heat & Mass Transfer		ESC	3	0	0	3	40	60	100
	Professional Elective - I		PEC	3	0	0	3	40	60	100
	Open Elective – I		PEC	3	0	0	3	40	60	100
PRACTICAL										
U19BT517	Genetic Engineering & Molecular Biology Laboratory		PCC	0	0	4	2	60	40	100
U19BT518	Immunology and Immunotechnology Laboratory		PCC	0	0	4	2	60	40	100
MANDATORY COURSES										
	Mandatory Course - V		MC	3	0	0	0	100	-	100
							Total Credits	**22**	**460**	**440**	**900**

PEC – Professional Elective Course

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Programme	**B.Tech**	Programme Code	**105**	Regulation		**2019**
Department	**BIOTECHNOLOGY**			Semester		**VI**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 - 2020 onwards)

Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19BT619	Plant and Animal Biotechnology	PCC	3	0	0	3	40	60	100
U19BT620	Enzyme Engineering and Technology	PCC	3	0	0	3	40	60	100
U19BT621	Protein Engineering	PCC	3	0	0	3	40	60	100
U19BT622	Chemical Reaction Engineering	ESC	3	0	0	3	40	60	100
	Professional Elective –II	PEC	3	0	0	3	40	60	100
	Open Elective – II	OE	3	0	0	3	40	60	100
PRACTICAL									
U19BT623	Computational Biology Laboratory	PCC	0	0	4	2	60	40	100
U19BT624	Plant & Animal Biotechnology Laboratory	PCC	0	0	4	2	60	40	100
U19EN603	Communication skills laboratory	EEC	0	0	3	1	100	0	100
MANDATORY COURSES									
	Mandatory Course - VI	MC	3	0	0	0	100	-	100
					Total Credits	**23**	**560**	**440**	**900**

EEC – Employability Enhancement Course, OE – Open Elective

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Programme	**B.Tech**	Programme Code	**105**				Regulation	**2019**		
Department	**BIOTECHNOLOGY**						Semester	**VII**		
CURRICULUM (Applicable to the students admitted from the academic year 2019 – 2020 onwards)										
Course Code	Course Name			Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CA	ESE	Total
THEORY										
U19BT725	Downstream Processing		PCC	4	0	0	3	40	60	100
U19BT726	Proteomics and Genomics		PCC	4	0	0	3	40	60	100
U19BT727	Biopharmaceutical Technology		PEC	4	0	0	3	40	60	100
	Professional Elective –III		PEC	4	0	0	3	40	60	100
	Open Elective – III		OE	4	0	0	3	40	60	100
PRACTICAL										
U19BT728	Downstream Processing Laboratory		PCC	0	0	4	2	60	40	100
U19BT729	Internship training & Summer project		EEC	0	0	8	4	100	-	100
						Total Credits	**21**	**360**	**340**	**700**

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Programme	**B.Tech**	Programme Code	**105**			Regulation	**2019**		
Department	**BIOTECHNOLOGY**					Semester	**VIII**		
CURRICULUM (Applicable to the students admitted from the academic year 2019 - 2020 onwards)									
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
	Professional Elective – IV	PEC	3	0	0	3	40	60	100
	Professional Elective – V	PEC	3	0	0	3	40	60	100
PRACTICAL									
U19BT830	Project	EEC	0	0	16	8	60	40	100
						Total Credits	**14**	**140**	**160**	**300**

Cumulative Course Credit: 165

Cumulative Course Credit: 167#

 # Applicable to the students admitted in the academic year 2022-2023

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	-

CURRICULUM

(Applicable to the students admitted from the academic year 2019 - 2020 onwards)

LIST OF OPEN ELECTIVES

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
OPEN ELECTIVE - I								
U19BTOE1	Biology for Engineers	3	0	0	3	40	60	100
U19BTOE2	Biofuels and Bioenergy	3	0	0	3	40	60	100
U19BTOE3	Bio-Business	3	0	0	3	40	60	100
OPEN ELECTIVE –II								
U19BTOE4	Basics of Bioinformatics	3	0	0	3	40	60	100
U19BTOE5	Human Health and Nutritional Disorders	3	0	0	3	40	60	100
U19BTOE6	Waste Management	3	0	0	3	40	60	100
OPEN ELECTIVE –III								
U19BTOE7	Food Processing and Preservation Technology	3	0	0	3	40	60	100
U19BTOE8	Forensic Technology	3	0	0	3	40	60	100
U19BTOE9	Biodiversity and Bioprospecting	3	0	0	3	40	60	100

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LIST OF MANDATORY COURSES

Course code	Course Name	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCFY1	Environmental Science and Engineering	3	0	0	0	100	-	100
U19MCFY2	Indian Constitution and Universal Human values	3	0	0	0	100	-	100
U19MCSY3	Numerical Ability	3	0	0	0	100	-	100
U19MCSY4	Verbal Ability	3	0	0	0	100	-	100
U19MCTY5	Logical Reasoning	3	0	0	0	100	-	100
U19MCTY6	Personality Development	3	0	0	0	100	-	100

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

S.No.	Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V
	Environmental Biotechnology	**Entrepreneurship**	**Clinical Biotechnology**	**Food Technology**	**Industrial Biotechnology**
1	Waste Water Treatment	Principles of Management	Plant Pathogenesis	Food Processing & Preservation Techniques	Fermentation Technology
2	Environmental Biotechnology	Bio-Entrepreneurship	Developmental Biology	Fermentation Products	Analytical Techniques in Bioindustries
3	Bioremediation	Industrial Biosafety	Nanobiotechnology	Dairy Technology	Principles of Biochemical Engineering
4	Ecology & Environmental Management	Bioethics & IPR	Cytogenetics	Food Nutrition & Health Sciences	Instrumentation and process control
5	Solid Waste Management	Bioindustries & Entrepreneurship	Cancer Biology	Confectionary products	Pharmaceutical packaging technology
6	Safety and Disaster Management	Total Quality management	Herbs and drug action	Product development and technology transfer	Bioreactor for recombinant products
7	Air Pollution and Control Engineering	Audit and Regulatory Compliance	Cellular Biochemistry	Chemistry of Natural Products	Stoichiometry and Fluid Mechanics
8	E-waste management	Biobusiness	Phytoconstituents	Food Microbiology	Bioprocess Technology
9	Environmental Impact Assessment	Resource Management & Lean Start-up Management	Clinical Trial Management	Food Quality, Safety Standards and Certification	Metabolic Engineering
10	Mini Project	Mini Project	Stem Cell Technology	Mini Project	Mini Project

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	-		

CURRICULUM

(Applicable to the students admitted from the academic year 2021 - 2022 onwards)

LIST OF VERTICALS

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
Vertical - I Environmental Biotechnology								
U19BTV11	Waste Water Treatment	3	0	0	3	40	60	100
U19BTV12	Environmental Biotechnology	3	0	0	3	40	60	100
U19BTV13	Bioremediation	3	0	0	3	40	60	100
U19BTV14	Ecology & Environmental Management	3	0	0	3	40	60	100
U19BTV15	Solid Waste Management	3	0	0	3	40	60	100
U19BTV16	Safety and Disaster Management	3	0	0	3	40	60	100
U19BTV17	Air Pollution and Control Engineering	3	0	0	3	40	60	100
U19BTV18	E-waste management	3	0	0	3	40	60	100
U19BTV19	Environmental Impact Assessment	3	0	0	3	40	60	100
U19BTV10	Mini Project	3	0	0	3	40	60	100
Vertical - II Entrepreneurship								
U19BTV21	Principles of Management	3	0	0	3	40	60	100
U19BTV22	Bio-Entrepreneurship	3	0	0	3	40	60	100
U19BTV23	Industrial Biosafety	3	0	0	3	40	60	100
U19BTV24	Bioethics & IPR	3	0	0	3	40	60	100
U19BTV25	Bioindustries & Entrepreneurship	3	0	0	3	40	60	100
U19BTV26	Total Quality management	3	0	0	3	40	60	100
U19BTV27	Audit and Regulatory Compliance	3	0	0	3	40	60	100
U19BTV28	Biobusiness	3	0	0	3	40	60	100
U19BTV29	Resource Management & Lean Start-up Management	3	0	0	3	40	60	100
U19BTV20	Mini Project	3	0	0	3	40	60	100
Vertical - III Clinical Biotechnology								
U19BTV31	Plant Pathogenesis	3	0	0	3	40	60	100

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U19BTV32	Developmental Biology	3	0	0	3	40	60	100
U19BTV33	Nanobiotechnology	3	0	0	3	40	60	100
U19BTV34	Cytogenetics	3	0	0	3	40	60	100
U19BTV35	Cancer Biology	3	0	0	3	40	60	100
U19BTV36	Herbs and drug action	3	0	0	3	40	60	100
U19BTV37	Cellular Biochemistry	3	0	0	3	40	60	100
U19BTV38	Phytoconstituents	3	0	0	3	40	60	100
U19BTV39	Clinical and Translational Research	3	0	0	3	40	60	100
U19BTV30	Stem cell technology	3	0	0	3	40	60	100
Vertical - IV Food Technology								
U19BTV41	Food Processing & Preservation Techniques	3	0	0	3	40	60	100
U19BTV42	Fermentation Products	3	0	0	3	40	60	100
U19BTV43	Dairy Technology	3	0	0	3	40	60	100
U19BTV44	Food Nutrition & Health Sciences	3	0	0	3	40	60	100
U19BTV45	Confectionary products	3	0	0	3	40	60	100
U19BTV46	Product development and technology transfer	3	0	0	3	40	60	100
U19BTV47	Chemistry of Natural Products	3	0	0	3	40	60	100
U19BTV48	Food Microbiology	3	0	0	3	40	60	100
U19BTV49	Food Quality, Safety Standards and Certification	3	0	0	3	40	60	100
U19BTV40	Mini Project	3	0	0	3	40	60	100
Vertical - V Industrial Biotechnology								
U19BTV51	Fermentation Technology	3	0	0	3	40	60	100
U19BTV52	Analytical Techniques in Bioindustries	3	0	0	3	40	60	100
U19BTV53	Principles of Biomedical Engineering	3	0	0	3	40	60	100
U19BTV54	Instrumentation and process control	3	0	0	3	40	60	100
U19BTV55	Pharmaceutical packaging technology	3	0	0	3	40	60	100
U19BTV56	Bioreactor for recombinant products	3	0	0	3	40	60	100
U19BTV57	Stoichiometry and Fluid Mechanics	3	0	0	3	40	60	100
U19BTV58	Bioprocess Technology	3	0	0	3	40	60	100
U19BTV59	Metabolic Engineering	3	0	0	3	40	60	100
U19BTV50	Mini Project	3	0	0	3	40	60	100

CA - Continuous Assessment, ESE - End Semester Examination

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VERTICAL II - ENTREPRENEURSHIP
For Minor Degree in Biotechnology

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Programme	**B.TECH.**	Programme Code	105	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	-

CURRICULUM
(Applicable to the students admitted from the academic year 2021- 2022 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19BTV21	Principles of Management	PEC	3	0	0	3	40	60	100
U19BTV22	Bio-Entrepreneurship	PEC	3	0	0	3	40	60	100
U19BTV23	Industrial Biosafety	PEC	3	0	0	3	40	60	100
U19BTV24	Bioethics & IPR	PEC	3	0	0	3	40	60	100
U19BTV25	Bioindustries & Entrepreneurship	PEC	3	0	0	3	40	60	100
U19BTV26	Total Quality management	PEC	3	0	0	3	40	60	100
U19BTV27	Audit and Regulatory Compliance	PEC	3	0	0	3	40	60	100
U19BTV28	Biobusiness	PEC	3	0	0	3	40	60	100
U19BTV29	Resource Management & Lean Start-up Management	PEC	3	0	0	3	40	60	100
U19BTV20	Mini Project	PEC	3	0	0	3	40	60	100

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(Autonomous Institution, Affiliated to Anna University, Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**
Department	**Biotechnology**			Semester	**I**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA101	**Calculus**	3	1	0	4	40	60	100

Course Objective

The Main Objective of the course is to

- Provide the information about Review of limits, continuity and differentiability.
- Understand maxima and minima of functions of two variables.
- Demonstrate Integral calculus.
- Identify the problems based on area, surface and volume.
- To Recognize the Second order linear differential equations.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Apply Mean value theorem and Taylor"s theorem.	K1,K3
	CO2: Analyze Total derivative.	K2,K4
	CO3: Formulate Reduction Formulae.	K3,K5
	CO4: Translate Change of order of integration	K2,K5
	CO5: Apply method of variation of parameters.	K3,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	3	3		2								3	2	
CO 2	3				2								3		
CO 3	3		2										3		
CO 4	3	2											3	2	
CO 5	3				2								3	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	DIFFERENTIAL CALCULUS	Periods	12

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. Physical Applications (Newton's law of cooling – Heat flow problems, Rate of decay of radioactive materials – Chemical reactions and solutions, Ohm's law, Kirchoff's law- Simple electric circuit problems)

Unit - II	FUNCTIONS OF SEVERAL VARIABLES	Periods	12

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 functionsof two variables(excluding proof) – Maxima and minima of functions of two variables .

Unit – III	INTEGRAL CALCULUS	Periods	12

Riemann integral- Fundamental theorem of calculus(excluding proof) - 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 - IV	MUTIPLE INTEGRALS	Periods	12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

Unit – V	ORDINARY DIFFERENTIAL EQUATIONS	Periods	12

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.

	Total Periods	60

Text Books

1.	Stewart, J. Calculus: Early Transcendentals (8th Edition), Cengage Learning, 2015.
2.	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

References

1.	Kreyszig E, Advanced Engineering Mathematics (10th Edition), John Wiley (2015).
2.	Boyce W E and DiPrima R, Elementary Differential Equations (9th Edition), John Wiley (2005).
3.	NishantShukla, Elementary Integral Calculus
4.	Anton H, Calculus: Early Transcendentals, 10th Edition, Wiley (2012).
5.	B V Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Pvt Ltd., New Delhi (2012)

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	2019
Department	**Biotechnology**			Semester	I

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN101	**English for Communication – I**	3	0	0	3	40	60	100

Objective

The main objective of this course is to:

- To make learners listen to audio files and replicate it in speaking contexts.
- To make learners read widely in order to practice writing
- To 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

Outcomes	The students who complete this course successfully are expected to:	Knowledge Level
	CO1: Speak adequately from the inputs they gained through listening.	K2
	CO2: Write appropriately based on the knowledge gained through reading ofa variety of materials	K3
	CO3: Use language through their grammatical acquisition and their knowledge about using right word at the right context.	K3
	CO4: Listen the accents and tones of the language properly.	K2
	CO5: Comprehend and retain the contextual and syntax understanding from reading.	K4

Pre-Requisities	**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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	P O 11	P O 12	PSO 1	PS O 2	PSO3
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: Simulation using tool 3. End-Semester examinations **Indirect** 2. 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,Functional Use of Tenses, 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**- Informal writing -short 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**– Pronunciation Practice (Phonetic sounds - Vowels, Consonants and Diphthongs), 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 Suprasegmental Features-Practicing Stress, Pause and Intonation, **Reading**– Reading for a purpose, Reading Business Documents, Interpreting Charts and Graphs,. **Writing**- Writing Business e-mails, Describing a Process.**Focus on Language** -Synonyms and Antonyms, Common Errors in English.		
	Total Periods	45

Text Books:	
1.	Sumant. s, Pereira Joyce, Shameem.M, Selvarajan.R-English Communication Skills,Vijay Nicole imprints Pvt.Ltd, 2015.
2.	Sokkaalingam, S.RM., The Art Of Speaking EnglishVersatile Publishing House,2018.

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References:	
1.	Dr. Padma Ravindran, Poorvadevi, M. Y. AbdurRazack- English for life, English for work, students Book, Ebek language laboratory pvt ltd, 2011.
2.	DuttRajeevan, 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 BlackswanPvt, 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 Engineers; oxford University Press, 2008.
E-Resources.	
1	http://www.sparknotes.com/lit/the-alchemist/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	2019
Department	Biotechnology			Semester	I

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19PH105	ENGINEERING PHYSICS	3	0	0	3	40	60	100

Course Objective

The student should be made to,
- 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
- 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	Knowledge Level
• understand the elastic properties of the materials	K2
• gain knowledge about the conduction properties of metals	K3
• determine packing factor for various unit cells and understand different types of crystal imperfections	K1
• discuss the basic idea of semiconducting materials and realize the function of modern engineering materials	K1
• learn the optical properties of materials and its uses	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** 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								1		1
CO 3	3	3		3	1										
CO 4	3		2	1	1								2	2	2
CO 5	3			1	2	2							2	2	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	PROPERTIES OF MATTER	Periods	9

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Elasticity: Types of moduli of elasticity - Stress - Strain Diagram – uses. Young's modulus: Experimental determination by non-uniform bending - Twisting couple on a wire – Application: Torsional pendulum. **Viscosity:** Co-efficient of viscosity - Poiseuilles' formula - Experimental determination – uses.			
Unit - II	**ELECTRONS IN SOLID**	Periods	**9**
Classical theory: Classical free electron theory of metals- Expressions for electrical conductivity and Thermal Conductivity of metals – Wiedemann-Franz law (Qualitative) - Success and failures. **Quantum theory:** de Broglie's hypothesis - Schrodinger's time independent and time dependent wave equations (Qualitative) - Particle in a one-dimensional box - Fermi – Dirac Statistics - Density of energy states (Qualitative).			
Unit – III	**CRYSTAL PHYSICS AND ULTRASONICS**	Periods	**9**
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. **Ultrasonics:** Introduction – Magnetostriction and Piezoelectric Oscillator methods – Applications: Sound Navigation and Ranging (SONAR), Non – Destructive Testing (NDT) and Sonogram.			
Unit - IV	**SEMICONDUCTING & MODERN ENGINEERING MATERIALS**	Periods	**9**
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. **Metallic glasses:** preparation, properties and applications - Shape memory alloys (SMA): Characteristics and applications of NiTi alloy.			
Unit – V	**LASER AND FIBER OPTICS**	Periods	**9**
Laser: Characteristics of laser – Derivation of Einstein's A and B coefficients. Types: Nd-YAG laser - Semiconductor laser: Homo junction - Applications. 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: Medical endoscope.			
		Total Periods	**45**

Text Books	
1.	R.K. Gaur and Gupta. S.L, Engineering Physics, DhanpatRai Publishers, 2017.
2.	S.O Pillai., Solid state physics, New Age International Private Limited.
3.	Dr.P.Mani, "Engineering Physics", ShriDhanam publisher, Chennai – 600 042
References	
1.	B.K. Pandey, S. Chaturvedi. "Engineering Physics", 1st Edition, Cengage Learning India Pvt Ltd, (2012).
2.	Fundamentals Of Physics Extended 8/Ed 8th Edition, David Halliday, Robert ResnickJearl Walker, Wiley India Pvt Ltd, 2008.
3.	Lawrence H.Vanvlack, "Elements of materials Science Engineering, 6th Edition, Pearson 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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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	CSE, EEE, ECE, IT & Biotechnology.			Semester	I

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS101	Programming for Problem Solving	3	0	0	3	40	60	100

Course Objective

The main objective of this course is to:

- Learn the fundamentals of computers and acquire problem solving skills
- Understand C programming concepts
- Write the programs using arrays and strings
- Write the programs using functions
- Write the programs using structures.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Write the algorithms and to draw flowcharts for solving problems.	K3
CO2: Analyze the basics of C programming language.	K4
CO3: Implement the C programs using arrays and strings.	K4
CO4: Develop C programs using the functions and pointers.	K3
CO5: Solve the real time problems using Structures and union	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	3		2			3	3	3	3	2	3		
CO 2	3	3	3		2			3	3	3	3	2	3		
CO 3	3	3	3		2			3	3	3	3	2	3		
CO 4	3	3	3	2	2			3	3	3	3	2	3		
CO 5	3	3	3	3	2			3	3	3	3	2	3	3	

Course Assessment Methods

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO PROBLEM SOLVING	Periods	9

Basic Organization of Computer - Programming Languages- Flowchart – Pseudocode - Compilers-Interpreter-Algorithm - Building Blocks of Algorithm - Algorithmic Problem Solving-Simple Strategies for

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Developing Algorithms - Illustrative Problems: Find Minimum value from list of elements, Guess an Integer Number in a Range, Factorial of a given number.			
Unit - II	**C PROGRAMMING**	Periods	**9**
Introduction to C – Features - Data Types – Constants – Variables - I/O Statement - Operators –Expressions - Decision Making and Branching – Looping Statements - Break, Goto, 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.			
Unit - IV	**FUNCTIONS AND STRINGS**	Periods	**9**
Function: 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 AND UNIONS**	Periods	**9**
Structures-Introduction- nested structures- Arrays of Structures - Structures and Functions - Pointers to Structures – Unions- Type Definition – Bitfields- Enumerated Types.			
		Total Periods	**45**
Text Books			
1.	Kernighan BW and Ritchie DM, "The C Programming Language", 2nd Edition, Prentice Hall of India, 2015.		
2.	E. Balagurusamy, Computer Programming, First Edition, McGraw Hill, 2016.		
References			
1.	Herbert Schildt, C: The Complete Reference, McGraw Hill, 4th Edition		
2.	Dr.V.Rameshbabu, Dr.R.Samyutha, M.MuniRathnan, "Computer Programming", VRB Publishers Pvt.Ltd,		
3.	E. Balagurusamy, Programming in ANSI C, Seventh Edition, McGraw Hill, 2017.		
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	**2019**
Department	**Biotechnology**			Semester	**I**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE101	**Engineering Graphics**	2	0	3	3	40	60	100

Course Objective

The main objective of this course is to:

- 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.

Course Outcomes

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.	K1

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** 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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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 isinclined to one reference plane.			
Unit - III	**SECTION OF SOLIDS**	**Periods**	**3+8**
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical positionby 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, cylindersand cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.			
Unit - V	**ISOMETRIC PROJECTIONS, ORTHOGRAPHICVIEWS 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:	
T1.	BasantAgrawal and C.M Agrawal ,"Engineering Drawing ",Tata McGraw Hill ,Third Edition,2019
T2	Jain and Gautam ,"Engineering Graphics & Design ",Khanna Publishing House, 2018
Reference Book :	
R1.	Dr.P.Kannan and Dr.J.Bensam Raj, "Engineering Graphics", JBR Tri Sea Publishers Pvt. Ltd,2018.
R2.	K.V Natarajan, "Engineering Drawing and Graphics", M/s. N.Dhanalakshmi, Chennai,2014.
R3.	K.Venugopal and V. Prabhu Raja, "Engineering Graphics"New Age International Publishers,2011.
R4.	N.S Parthasarathy and Velamurali, " Engineering Graphics", Oxford University, New Delhi,2015
R5.	Bhatt N.D and Panchal V.M, "Engineering Drawing", Charotar Publishing House,50th Edition,2010
e-RESOURCES:	
E1.	http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. NiharRanjanPatra , IIT Kanpur
E2.	http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr.Velamurali
E3.	http://link.springer.com/ "Engineering Graphics"-Springer Nature.

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Programme	**B.Tech**				Regulation		**2019**	
Department	Bio Technology (BT)				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19PH106	**PHYSICS LABORATORY**	0	0	4	2	60	40	100

Course Objective

- 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	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

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**	**PS O 3**
CO 1	3	1													
CO 2	3	3	1	2	2										
CO 3	3	2			2										
CO 4	3	3		1											
CO 5	3	1	1		1										

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Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1.Course - end survey

Content of the syllabus

PHYSICS

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	45

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.

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Elayampalayam, Tiruchengode – 637 205

Programme	B.Tech	Programme Code	105	Regulation	2019
Department	CSE, EEE, ECE, IT & Biotechnology			Semester	I

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS102	Computer Practices Laboratory	0	0	4	2	60	40	100

Course Objective

The Main Objective of the course is to

- Make the students to learn the programming language
- Understand the basic programming constructs and articulate how they are used
- Develop a program with a desired runtime execution flow
- Articulate where computer programs fit in the provision of computer based solutions to real world problems

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Prepare document using word processor	K3
CO2: Sketch flow of execution of C programs using algorithm and flowcharts	K3
CO3: Write the simple C Programs using decision and looping statements	K3
CO4: Demonstrate code reusability with the help of user defined functions and pointers.	K4
CO5: Write programs that perform operations using derived data types.	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	3	1				3	3	3	3	3	3	1	
CO 2	3	3	3	1				3	3	3	3	3	3	1	
CO 3	3	3	3	1				3	3	3	3	3	3	1	
CO 4	3	3	3	3				3	3	3	3	3	3	1	
CO 5	3	3	3	3				3	3	3	3	3	3	1	

Course Assessment Methods

Direct

1. Prelab and post lab test
2. End-Semester examinations

Indirect

1. Course - end survey

SUGGESTED LIST OF EXPERIMENTS

1. Design an algorithm and flowchart using word processor that reads the customer number and power consumed and prints the amount to be paid by the customer. An electric power distribution company charges its domestic consumers as follows

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Consumption Units	Rate of Charge
0-200	Rs.0.50 per unit
201-400	Rs.100 plus Rs.0.65 per unit excess 200
401-600	Rs.230 plus Rs.0.80 per unit excess of 400.

2. Design an algorithm and flowchart for a simple calculator program using word processor for performing various arithmetic operations such as

   "+" - Addition
   "-" - Subtraction "*"
   - Multiplication
   "/" - Division
   "%" - Modulus

3. Design and develop a C program to accept a number from the user and check whether it is a palindrome or not.
   Palindrome number : (a number is a Palindrome which when read in reverse order is same asread in the right order)
   Example: Palindrome :11, 101, 151 Not
   a Palindrome:123 , 100
4. Develop a C program to find the sum of the digits of an integer and the number of digits inthe integer that is given as input by the user.
   Test Case:
   Sample Input: 15390
   Sample Output:
   Sum of the digits=18
   No. of digits = 5
   For an incorrect choice, an appropriate error message should be displayed.
5. Develop a program to perform the following operations using two dimensional or multi-dimensional matrices:
   a. Addition of two matrices (3x3)
   b. Subtraction of two matrices (2x2)
   c. Multiplication of two matrices using dynamic memory allocation.
6. Write a program to find the maximum and minimum element in a set of inputs using one dimensional array.
7. Write a program to count the total number of vowels and consonants in a string. For exampleInput string: I am proud to be an Indian
   Output: Total vowels – 10 and Total consonants - 10
8. Develop a program to perform the following string manipulations without using string functions:

   d. String copy
   e. String Concatenate
   f. String length
   g. String Compare
9. The Fibonacci numbers are defined recursively as follows:

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F1=1
F2=1
Fn= Fn-1 + Fn-2, n>2
Write a function that will generate and print the first n Fibonacci numbers.Test the function for n=5,10,15

10. Write a function using pointers to exchange the values stored in two locations in the memory.Test Case :
    Input : A=10 , B=-5
    Output : A= -5 , B=10
11. Develop a program to build a database of students with the following attribute: Roll no, Name, Course, Stream, Percentage, and Division. Take input for each student in all fields except division. Calculate division of each student such that those students having percentage >=60% are belongs to first division. Similarly, for second and third division students having conditions 50 %< =percentage<60% and 35 %< =percentage<50% respectively. If any student has percentage less than 35% then write "fail" in division field. After building the database display the database of the students. Hint: create database using structure.

Total Periods	**45**

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	2019
Department	**Biotechnology**			Semester	I

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCFY1	**Environmental Science and Engineering**	3	0	0	0	100	0	100

Objective	The main objective of this course is to: • Familiarize basics of ecosystem and creating environmental awareness. • Congregate quality and standards requirement of water. • Contrast water management procedures. • Acquire knowledge on air pollution and its control. • Summarize Solid waste and its prevention methods.	
Outcomes	The students who complete this course successfully are expected to:	Knowledge Level
	CO1: Distinguish the types of Ecosystem and implicit the knowledge.	K1
	CO2: Recognize quality, standard and control strategies of polluted water.	K3
	CO3: Infer and express air pollution and its control.	K3
	CO4: Acquire Knowledge about Radioactive pollution and disposal method	K3
	CO5: Aweraness about population growth, human rights and Environment	K2
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** 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	1			2	3				1	2	2		
CO 2	1	2	2			2	3					3	3		2
CO 3	2	2	1			3	3				1	2	3		2
CO 4	1	1	1			2	3				1	2	3		2
CO 5	1	2	1			2	2				1	3	2		

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	Course Assessment Methods
	Direct
	1. Continuous Assessment Test I, II & III 2. Assignment : Simulation using tool 3. End-Semester examinations
	Indirect
	1. Course - end survey

	Content of the syllabus		
Unit - I	**Introduction to Environmental Science and Engineering**	Periods	9
Nature and scope of environmental education- Natural Resources – (Forest, Water, Food, Energy &Land Resources) problems and remedial measures, Ecosystem and Biodiversity- Ecosystem-Structure, Characteristics and functions of ecosystem (in general)- Biodiversity – Definition – Conservation of Biodiversity (in-situ and Ex-situ)- Environmental awareness and sustainable development			
Unit - II	**Water pollution and Waste water treatment process.**	Periods	9
Water pollution-causes, effects and control measures of water pollution- case study- Waste water treatment process- Primary, Secondary , Tertiary and desalination -Water quality parameters- Hardness, Alkalinity, DO, COD, BOD-Water quality standard- WHO and BIS.			
Unit - III	**Air Pollution and its Control**	Periods	9
Air Pollution – Types of Air pollutants-CO_2,SO_2, NO_2, PAN etc Sources- causes, effects (Acid rain, Green house effect, Ozone layer depletion and global warming)- control measures (Electro static precipitator, Gravitational settling chamber, Baghouse filter, Wet Scrubber and cyclone separator).			
Unit - IV	**Radioactive Pollution and Solid waste management**	Periods	9
Radio active pollutants-sources, effects , Nuclear Energy – Nuclear Fusion –Nuclear Fission-Nuclear power plant- Light water nuclear power plant- Diagram- illustration- working – pollution- impacts-and control measures- case study- solid waste-definition-Types of solid waste- Disposal method and its problem in solid waste management-Significance for prevention of hazardous waste management.			
Unit - V	**Human population and the environment**	Periods	9
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 (GIA), Environmental impact Analysis (EIA) and Human health			
		Total Periods	**45**

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
Reference books	
1.	Linda Williams- "Environmental Science"-Tata McGRAW – Hill Edition. Edition-I-2008
2.	T.G.MillerJr-"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"-JaicoPubl, House Edition-4-2007
E-Resourses	
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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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**Biotechnology**			Semester	**II**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA202	**Linear Algebra and Ordinary Differential Equations**	3	1	0	4	40	60	100

Course Objective	The Main Objective of the course is to • Understand Eigen values and Eigen vectors and its role in the system of equations. • Proficiently understand the vector differential calculus. • Demonstrate vector integral calculus. • To know about Cartesian and Polar co-ordinates and also transformations. • 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 Reduction of a quadratic form.	K3, K4
	CO2: Identify vector differential calculus.	K2, K3
	CO3: Apply Green's , Stoke's and Gauss Divergence theorems	K1, K5
	CO4: Identifying the analytic functions	K2, K5
	CO5: Recognize the Laplace transform of unit step and unit impulse functions.	K5, 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	3										3		
CO 2	3				2								3		
CO 3	3		2										3	2	
CO 4	3	3											3	2	
CO 5	3				2								3	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	**MATRICES**	Periods	**12**

Characteristic equation – Eigenvalues and Eigenvectors of a real matrix –Properties of Eigenvalues and

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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 2x2 matrix.			
Unit - II	**VECTOR DIFFERENTIAL CALCULUS**	Periods	**12**
Vector Differentiation: Vector and Scalar Functions- Derivatives- Curves, Gradient of a Scalar FieldDirectional Derivative -Divergence of a Vector Field - Curl of a Vector Field – Tangents and Normals.			
Unit – III	**VECTOR INTEGRAL CALCULUS**	Periods	**12**
Line, Surface and Volume integrals, Green"s theorem in a plane(excluding proof), Gauss Divergence theorem(excluding proof), Stokes theorem (Excluding proof) - simple applications involving rectangular parallelepipeds and spheres.			
Unit - IV	**ANALYTIC FUNCTIONS**	Periods	**12**
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 – V	**LAPLACE TRANSFORMS**	Periods	**12**
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	**60**
Text Books			
1.	T.Veerarajan, Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd-2012		
2.	Ravish R Sing , Mukul Bhatt, "Engineering Mathematics", McGraw Hill Education Pvt. Ltd-2018		
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.	YunusA.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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Programme	**B.Tech**	Programme code	105	Regulation	2019
Department	**Biotechnology**			Semester	II

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN202	**English for Communication – II**	3	0	0	3	40	60	100

Objective

The main objective of this course is to:

- To providesuitable listening tasks to develop communicative ability foracademic and professional progress
- To inculcate channelized reading to make learners proficient in the chosenprofessional writing contexts.
- To improve learners" vocabulary and grammar to supplement their languageuse at professional contexts
- Assist students in the development of intellectual flexibility, creativity, andcultural literacy so that they may engage in life-long learning.
- Identify and begin to apply the language features of academic andprofessional writing and speaking

Outcomes	The students who complete this course successfully are expected to:	Knowledge Level
	CO1: Acquire sufficient command over language to speak at an academic or professional context through continuous exposure to similar listening tasks.	K2
	CO2: Write technically well at a professional contexts through exposing them tosimilar readings.	K3
	CO3: Use language at length at technical and professional situations through the enrichment of vocabulary and strengthening of grammatical knowledge.	K3
	CO4: Students should be able to ethically gather, understand, evaluate and synthesize information from a variety of written and electronic sources.	K2
	CO5: Students should be proficient in oral communication and writing.	K4
Pre-requisites	**Nil**	

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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 O 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 & III
2. Assignment: Simulation using tool
3. End-Semester examinations

Indirect

1. Course – end survey

Content of the syllabus

Unit - I		Periods	9

Listening- Listening forCultural Awareness, Listening to ProfessionalConversations, 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	9

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 Articlesin 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 Transformationof Sentences.

Unit - III		Periods	9

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.**Focus on Language**– Pronouns,Phrasal verbs, Restrictive and Non - restrictive clauses.

Unit - IV		Periods	9

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 forIndustrialvisits.**Focus on Language**– Countable, Uncountable nouns, Recommendations, Discourse Markers and Comparative and Contrastive Connectives, Imperatives.

Unit - V		Periods	9

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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, InterpretingReports. **Writing**- Writing Proposals, Agenda, Minutes of the Meeting.**Focus on Language**– British and American Vocabulary, Editing, Error Detection, and Punctuation.		
	Total Periods	**45**
Text books		
1.	Sumant.S,Pereira Joyce, English for Communication, Vijay Nicole Imprints Pvt.Ltd., 2014.	
2.	Sokkaalingam, S.RM., The Art Of Speaking EnglishVersatile Publishing House,2018.	
Reference books		
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.	
4.	S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient BlackswanPvt, 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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Programme	**B.Tech**	Programme code	105	Regulation	2019
Department	**BIOTECHNOLOGY**			Semester	II

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CH207	**ENGINEERING CHEMISTRY**	3	0	0	3	40	60	100

Objective

The main objective of this course is to:
To recognize the basic technology requirements in water treatment
To gain knowledge in Polymeric materials towards engineering application.
To Enrich the Knowledge of the students with the basics of Nano materials, their properties and applications.Familiarize about the renewable energy and different types of batteries in the engineering application.
Gain knowledge in destruction of metals and protection for engineering applications.

Outcomes

The students who complete this course successfully are expected to:	Knowledge Level
CO1: Implement innovative solutions in **wastewater** treatment process..	K3
CO2: Identify the application of a specific polymer in the field of engineering.	K2
CO3: Forecast the information of Nanoparticles and their industrial applications	K2
CO4: Recognize the renewable energy devices **for** sustainable energy.	K3
CO5: Identify the rate of corrosion of a metal in a given environment and **find out** appropriate control techniques to avoid corrosion.	K3

Pre-Requisities

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		2	2				1	2	1	1	2
CO 2	3	2	2	1		2	2				1	1	2	2	2
CO 3	3	2	3	2	1	2	1				1	1	1	1	1
CO 4	3	3	2	2	2	3	3				1	2	3	2	2
CO 5	3	3	2	2	1	3	2				2	2	1	1	2

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	Course Assessment Methods **Direct** Continuous Assessment Test I, II & III Assignment : simulation using tools End-Semester examinations **Indirect** 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, Problems due to hard water in boilers - 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, 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, properties of polymers, Tacticity, Tg, molecular weight - number and weight average method. Types of polymerizations: Addition, condensation and copolymerization. Mechanism of polymerization: Addition - Free radical, cationic and anionic polymerization). Preparation, properties and applications of PE, PMMA, PC, nylon6, nylon 66, 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: Sol-gel, Precipitation, Thermolysis - hydrothermal, solvothermal, Electro deposition, Spray Pyrolysis, Chemical Vapour deposition, Laser ablation; Properties and applications of nano materials in medical and electronic devices.			
Unit - IV	**RENEWABLE ENERGY AND STORAGE DEVICES**	Periods	9
Renewable energy and its sources - Solar Energy - Photo voltaic cells, Importance of Solar cells - p-n junctions in Solar cells - Working of Photovoltaic cell, Recent advances in solar cell materials, Wind energy - Types of Wind Power Plants (WPPs), Components and working of WPPs, Tidal energy - Types of Tidal power plants (TPPs), Barrage and Non-Barrage Tidal power systems. Batteries and fuel cells: Types of batteries - Dry cells-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), Electro less plating (Ni).			
		Total Periods	45

Text Books:

1. O.G.Palanna, "Engineering Chemistry "Tata McGraw Hill PVT, Ltd. Second Edition -2017
2. Dr.S.Vairam, Dr.S.Mageswari, Dr.K.Balachandran, Engineering Chemistry : First Edition, Wiley publication, Reprint-2016

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References:	
1.	Engineering Chemistry: Jain & Jain, Dhanpat Rai Publishing Company Edition- 16- 2015.
2.	**ArunBahl, B.S. Bahl, G.D. Tuli,Essentials of Physical Chemistry, Published by S. Chand & Company Ltd, 2014**
3.	Puri, Sharma and Pathnia, Physical Chemistry-II, Vishal Publishers,.Edition- 2019.
4.	Engineering Chemistry: Sashi Chawla, Dhanpat Rai& Co (pvt.)ltd. Edition- 5- 2013.
5.	Dr.S.Vairam ,Dr.Suba Ramesh, Engineering Chemistry: First Edition, Wiley publication,Reprint-2016
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
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Elayampalayam, Tiruchengode – 637 205

Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	Common to CSE,IT,ECE,BT branches			Semester	II

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EE201	Basic Electrical and Electronics Engineering	3	0	0	3	40	60	100

Course Objective

The students should made to
- Learn the basic concepts of electrical parameters and electrical machines
- Learn the electrical wiring methods
- Learn the basics about semiconductor families and digital logics

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 integrated circuits.	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	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2										3	3		2	
CO 2	3	2										3	3		2	
CO 3	3											3	3		3	
CO 4	3	2										3	3		2	
CO 5	3	2										3	3		2	

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 OF ELECTRICAL CIRCUITS**	Periods	**9**
Definition of Voltage, Current, Power, Energy, Power factor, Circuit parameters, Ohm"s law, Kirchoff"s law. Concepts of AC Circuits- RMS value, Average value, Form and Peak factors, Concept of real and reactive power. Introduction to three phase systems - types of connections, relationship between line and phase values. Concept of DC circuits			
Unit - II	**INTRODUCTION OF ELECTRICAL MACHINES AND MEASUREMENTS**	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 -Working principle and construction of Transformer- Introduction to electrical measuring instruments – Analog and Digital Instruments **(Qualitative)**			
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 –UPS – SMPS.			
Unit – V	**DIGITAL FUNDAMENTALS**	Periods	**9**
Number systems - Boolean Theorems – De Morgan's Theorem - Logic gates -Implementation of Boolean Expression using Gates - Introduction to Operational Amplifier.			
		Total Periods	**45**
Text Books			
1.	D.P. Kotharti and I.J Nagarath, Basic Electrical and Electronics Engineering, McGraw Hill, Third Edition, 2016.		
2.	M.S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronics Engineering, Oxford, 2016.		
References			
1.	S.B. LalSeksena and KaustuvDasgupta, Fundaments of Electrical Engineering, Cambridge, 2016		
2.	Mittle,Mittal, Basic Electrical Engineering‖, 2nd Edition, Tata McGraw-Hill Edition, 2016.		
3.	S.K.Sahdev, Basic of Electrical Engineering, Pearson, 2015.		
4.	John Bird, —Electrical and Electronic Principles and Technology, Fourth Edition, Elsevier, 2010.		
5.	K Murugesh Kumar, 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		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	Biotechnology			Semester	II

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE202	**Basic Civil and Mechanical Engineering**	3	0	0	3	40	60	100

Course Objective

The main objective of this course is to:

- Familiarize the materials and measurements used in Civil Engineering.
- Provide the exposure on the fundamental elements of civil engineering components and structures.
- Impart basic knowledge of power plants, pumps & boilers.
- Study the various types of IC engines and understand the features of IC engine.
- Enable the students to distinguish the components and working principle of refrigeration and air conditioning system.

Course Outcomes

At the end of the course, the student should be able to	Knowledge Level
CO 1: Explain the usage of civil engineering materials and measure the location of pointsin surveying	K2
CO 2: Identify the nature of building components, structures and material qualities.	K1
CO 3: Classify the various types of power plant, pump, turbine & boiler	K2
CO 4: Compare spark ignition and compression ignition of two stroke and four stroke engine.	K2
CO 5: Elaborate the working principle of refrigeration and air conditioning system.	K3

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	3	3	3	2	3	-	-	-	-	-	-	-	3	2	-
CO	3	3	3	2	3	-	-	-	-	-	-	-	2	-	-
CO	3	2	2	-	2	-	-	-	-	-	-	-	2	3	-
CO	3	3	2	-	2	-	-	-	-	-	-	-	2	-	-
CO	3	2	2	-	2	-	-	-	-	-	-	-	3	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			
Unit – I	**CIVIL ENGINEERING MATERIALS AND SURVEYING**	**Periods**	**9**
Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel sections. **Surveying**: Introduction to Surveying & Leveling.			
Unit - II	**BUILDING COMPONENTS AND STRUCTURES**	**Periods**	**9**
Foundations: Site selection, Foundation – Types – Requirement of good foundations. **Superstructure:** Brick masonry – Stone masonry – Beams – Columns – Lintels – Roofing – Flooring - Plastering.			
Unit - III	**POWER PLANT ENGINEERING**	**Periods**	**9**
Introduction, Classification of Power Plants – Boiler - Working principle of steam , Gas , Diesel , Hydro-electric, Solar, Wind and Nuclear Power plants – Merits and Demerits – Pumps and turbines – Working principle of reciprocating pumps (single acting and double acting) – Centrifugal Pump.			
Unit - IV	**IC ENGINES AND AUTOMOTIVE VEHICLES**	**Periods**	**9**
Internal combustion engines as automotive power plant – Four stroke and two stroke cycles – Working of SI and CI engines - Comparison of four stroke and two stroke engines - Introduction to Electric vehicles.			
Unit - V	**REFRIGERATION AND AIR CONDITIONING SYSTEM**	**Periods**	**9**
Terminology of refrigeration and air conditioning. Principle of vapour compression and vapour absorption refrigeration system – Layout of typical domestic refrigerator – Window and split type room air conditioner.			
		Total Periods	**45**

Text Book:	
T1.	Dr.P.Kannan, "Basic Mechanical Engineering", JBR Tri Sea Publishers Pvt. Ltd., 2019.
T2	Pravin Kumar, "Basic Mechanical Engineering", Pearson Publishers, New Delhi, 2013.
Reference Book :	
R1.	Dr.S.Ramachandaran, " Basic Civil and Mechanical Engineering " Air Walk Publication,2016
R2.	R.Gupta, "Basic Civil Engineering", RPH Publication, 2016.
R3.	Mrs.V.Valarmathi, Mr.K.Rajasekar & Mr.T.Satheeskumar,"Basic Civil Engineering", JBR Tri Sea Publishers Pvt. Ltd., 2017.
R4.	G.Shanmugam and M.S Palanichamy, "Basic Civil and Mechanical Engineering ",Tata McGraw Hill Publishing Company Limited, New Delhi,2014
R5.	S.Seetharaman, " Basic Civil Engineering ",Anuradha Agencies,2005
e-RESOURCES:	
E1.	https://nptel.ac.in/downloads/105105104/
E2.	https://nptel.ac.in/courses/112107216/
E3.	http://link.springer.com/ "Basic Civil and Mechanical Engineering"-Springer Nature.

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Programme	**B.Tech.**	Programme Code		**105**	Regulation		**2019**	
Department	**Biotechnology**				Semester		**II**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BT201	**Cell Biology**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective

The student should be made to,

- Familiarize students with the cell structure and functions of both Prokaryotes and Eukaryotes.
- Recall basics of heredity, inheritance and genetics.
- Acquire basic fundamental knowledge on cell cycle and cell cycle.
- Analyze the cell signaling pathways and signal transduction.
- Understands the basic of cell culturing techniques of different cell types.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Describe the basic structure and functions of all the cell organelles.	K2
CO2: Discuss clearly about the mechanisms and control of cell division and cell cycle.	K3
CO3: Describe the transport across cell membranes and cell receptors.	K3
CO4: Understands the regulation of signal transduction at various levels.	K5
CO5: Articulate applications of cell propagation techniques in biotechnology.	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** 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					3							2	3	2
CO 3	3	2	3			2							2	3	3
CO 4	3					3							2	3	3
CO 5	2					3		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

Content of the syllabus

Unit – I	**CELL STRUCTURE AND FUNCTIONS OF ORGANELLES**	Periods	**9**

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Eukaryotic and prokaryotic cells, principles of membrane organisation, membrane proteins, cytoskeleta proteins, and organelles - structure and function.			
Unit - II	**CELL DIVISION AND CELL CYCLE**	Periods	**9**
Types of cell division, details of cell cycle and molecules that control cell cycle, cell cycle and cancer, Oncogenes, growth hormones and their roles, apoptosis and programmed cell death.			
Unit – III	**TRANSPORT ACROSS CELL MEMBRANES AND RECEPTORS**	Periods	**9**
Passive & active transport, permeases, various pump mechanism, co transport, endocytosis and exocytosis,entry of viruses and toxins into cells, cytosolic, nuclear and membrane bound receptors, examples & models of action; quantitation and characterization of receptors.			
Unit - IV	**ION CHANNELS AND SIGNAL TRANSDUCTION**	Periods	**9**
Types of Ion-channels; Neurotransmitters- mechanism of action, action potential, depolarization, nerve conduction. Ion-channel - agonists and antagonists, defects; Actin, myosin, excitation - contraction coupling, relaxation; Different models of signal amplifications; Second messengers.			
Unit – V	**CELL CULTURE**	Periods	**9**
Techniques for the propagation of eukaryotic and prokaryotic cells. Cell line-generation, maintenance of stock cells, characterization of cells, immunochemistry, ex-plant cultures primary cultures, contamination, differentiation, three dimensional cultures, role of matrix in cell growth.			
		Total Periods	**45**

Text Books	
1.	Darnell J, Lodish H, Baltimore D, "Molecular Cell Biology", W.H.Freeman;
2.	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P,"MolecularBiology of the Cell", Garland Science., New York, 2002
References	
1.	James D.Watson, "Molecular Biology of the Cell".
2.	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
3.	Nelson D.L and M.M. Cox. Lehninger Principles of Biochemistry, (7th Edn.) W. H. Freeman and Company, New York, USA. p.1328, 2017
4.	Meyers, R. A, "Molecular Biology and Biotechnology" A comprehensive desk reference VCH Publishers Inc., New York, 1995
5.	Krebs, J. E, Goldstein, E. S, Kilpatrick, S.T. Lewin"s Genes XII. Jones and Bartlett Publishers, Inc., p.838, 2017
E-Resources	
1.	https://di.uq.edu.au/community-and-alumni/sparq-ed/cell-and-molecular-biology-experiences/introduction-cell-biology
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.E/B.TECH	Programme code		105	Regulation		2019
Department	**B.TECH-BT**				Semester		II
Course code	Course name	Periods per week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19TA201	**தமிழர் மரபு** ∴ ர்நசவையபந ழக வுயஅடைள	2	0	0	1	40	60	100
	ஊழவெநவெ ழக வாந ளலடடயடிரள							
அலகு 1	மொழி மற்றும் இலக்கியம்				**Periods**		**3**	

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் திருக்குறளில் மேலாண்மைக் கருத்துக்கள் தமிழ்க் காப்பியங்கள் தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு 2	**மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**	**Periods**	**3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை. யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவல்களின் பங்கு.

அலகு 3	**நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:**	**Periods**	**3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு 4	**தமிழர்களின் திணைக் கோட்பாடுகள்:**	**Periods**	**3**

தமிழகத்தின் தாவரங்களும், விலங்குளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

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அலகு 5	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:	Periods	3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.			
		Total Periods	15

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Programme	B.E/B.TECH	Programme code	105	Regulation	2019
Department	B.TECH-BT			Semester	II

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19TA201	தமிழர் மரபு / Heritage of Tamils	2	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 Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modem literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE	Periods	3

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

UNIT III	FOLK AND MARTIAL ARTS	Periods	3

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

UNIT IV	THINAI CONCEPT OF TAMILS	Periods	3

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

UNIT V	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	Periods	3

Contribution of amils 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.

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Text cum-Reference Books	
1	தமிழக வரலாறு – மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை -ஆற்றங்கரை நகரிகம்.(தொல்லியல் துறை வெயளியீடு)
5	SocialLifeofTamils(Dr.K.K.Pillay)AjointpubhcatlonofTNTB&ESCandRMRL
6	Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: hternational Institute of TamilStudies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamarnan, Dr.K.D.Thirunavukkarasu) (Published by: International Institute of TamilStudies}.
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathl) (Published by. hternational Institute of Tamil Studies.)
9	eeladi - 'Sangam City Civilization on the banks of river Vaigai' (Joi tly Pubhshed by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, TamilNadu)
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pllay) (Publishedby: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu TextBookand Educational Services Corporation,TamilNadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Elayampalayam, Tiruchengode – 637 205

Programme	**B.Tech**	Programme code	105	Regulation	2019
Department	**Biotechnology**			Semester	II

Course code	Course Name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CH208	CHEMISTRY LABORATORY	0	0	4	2	60	40	100

Objective

The main objective of this course is to:

- 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.
- Quote iron forms complex with thio cyanate.
- 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.

Outcomes

The students who complete this course successfully are expected to:	Knowledge Level
CO1: Infer knowledge on neutralization reaction between acid, acid mixture with baseand identify the concentrations.	K3
CO2: Spot the concentration of sample solution through potential of hydrogen and redox reaction.	K3
CO3: Estimate Iron by complexation reaction spectrometrically.	K5
CO4: Determine hardness and dissolved oxygen present in domestic water supply.	K5
CO5: Identify alkalinity and available chlorine present in the given sample.	K5

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		
	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	3		2	2	1	1					2	2	2	2
CO2	3	3		2	1							1	2	1	2
CO3	3	3		2	1								1	2	2
CO4	3	3	1	2	2	2	2					2	2	2	
CO5	2	3	1	2	2	2	2					2	2	2	

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1. Estimation of HCL using NaOH by Conductometric titration	CO1
2. Estimation of Mixture of acid using NaOH by Conductometric titration.	CO1
3. Estimation of Barium chloride using sodium sulphate by Conductometric precipitation titration	CO1
4. Estimation of ferrous iron by Potentiometric titration	CO2
5. Determination of HCL using NaOH by pH metry	CO1
6.Estimation of Ferric ion by Spectrophotometry	CO3
7. Determination of Total, temporary and permanent hardness of water by EDTA method.	CO4
8. Estimation of Dissolved Oxygen content in water by Winkler's method	CO4
9. Estimation of alkalinity in water sample.	CO5
10. Estimation of available chlorine in bleaching powder.	CO5
Total Periods	45

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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Elayampalayam, Tiruchengode – 637 205

Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**
Department	**Biotechnology**			Semester	**II**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE203	**Engineering Practices Laboratory**	0	0	4	2	60	40	100

Course Objective

The main objective of this course is to:

The students should made to

- Know the plumbing line assemblies.
- Weld lap joint, butt joint and T-joint.
- Learn the assembling and dismantling methodology of home appliances.
- Learn the resistor value identification through colors coated on resistor.
- Learn the basics of signal generation in CRO.
- 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 andquantify 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	3	2	3	2	2	-	-	-	2	-	-	-	2	3	-
CO	3	2	3	2	2	-	-	-	2	-	-	-	2	-	-
CO	3	2	2	3	2	2	-	-	2	-	-	-	2	-	-
CO	3	2	2	3	2	2	-	-	2	-	-	-	2	3	-
CO	3	2	3	3	2	2	-	-	2	-	-	-	2	-	-

Course Assessment Methods

Direct

1.Pre lab and Post lab test
2.Record mark
3.End- Semester Examinations

Indirect

1.Course –End survey

Content of the Syllabus

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GROUP A **(CIVIL & MECHANICAL ENGINEERING)**	
(CIVIL ENGINEERING PRACTICE)	
Plumbing : 1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers and elbows in household fittings.	CO2
2. Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components	CO2
Carpentry: 3. Study of the joints in roofs, doors, windows and furniture.	CO2
4. Hands-on-exercise: Wood work, joints by sawing, planning and cutting.	CO2
MECHANICAL ENGINEERING PRACTICE	
Welding: 5. Preparation of arc welding of butt joints, lap joints and tee joints.	CO1
6. Gas welding practice	CO1
Basic Machining: 7. Turning and Facing.	CO1
8. Drilling Practice	CO1
Sheet Metal Work: 9. Forming & Bending	CO1
10. Model making – Tray and Basket.	CO1
4.Demonstration on: (a) Foundry operations like mould preparation for gear and step cone pulley. (b) Fitting – Exercises – Preparation of square fitting and vee – fitting models. **5. Study of Air Conditioner & Centrifugal Pump.**	
GROUP B **(ELECTRICAL & ELECTRONICS ENGINEERING)**	
III. ELECTRICAL ENGINEERING PRACTICE	
1. Residential house wiring and stair case wiring using switches, fuse, indicator & lamp.	CO3
2. Fluorescent lamp wiring.	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
6. Measurement of illumination to earth of electrical equipment.	CO3
7. Study of batteries.	CO3

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IV. ELECTRONICS ENGINEERING PRACTICE	
1. Study of Electronic components and equipments – Resistor, colour coding.	CO4
2. Study of 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 :

R1.	Dr.P.Kannan, Mr.T.Satheeskumar & Mr.K.Rajasekar, "Engineering Practices Laboratory" Manual. First Edition, 2017.
R2.	Mr.T.Jeyapoovan, Mr.M.Saravana Pandian, "Engineering Practices Lab" Manual, Vikas Publishing House Pvt Ltd, 2017.

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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	**2019**	
Department	**Biotechnology**				Semester	**II**	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCFY2	**Indian Constitution and Universal Human Values**	3	0	0	0	100	0	100

Course Objective	The main objective of this course is to: i) To know about Indian constitution. ii) To know about central and state government functionalities in India iii) To know about Indian society.

Outcome Course	At the end of the course, the student should be able to,	Knowledge level
	• Understand the functions of the Indian government	K1
	• Understand and abide the rules of the Indian constitution	K1
	• Understand and appreciate different culture among the people	K1
	• Understanding human being as a co-existence of the sentient „I" and thematerial	K1,K2
	• Ability to utilize theprofessional competence for augmenting universal human order and Ability to identify the scope and characteristics of people-friendly andecofriendly Production systems.	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		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
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						

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect

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1. Course - end survey			
Content of the syllabus			
Unit – I	**INTRODUCTION**	Periods	**9**
Historical Background – Constituent Assembly of India – Fundamental Rights – Citizenship – Constitutional Remedies for citizens			
Unit - II	**STRUCTURE AND FUNCTION OF CENTRAL**	Periods	**9**
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India			
Unit – III	**STRUCTURE AND FUCTION OF STATE**	Periods	**9**
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts			
Unit - IV	**Universal Human Values**	Periods	**9**
Course Introduction - Need, Basic Guidelines, Content and Process for Value Education			
Unit – V	**OPTOEL Universal Human Values - Professional Ethics ECTRONICS**	Periods	**9**
Understanding Harmony in the Human Being - Harmony in Myself and society.			
		Total Periods	**45**
Text Books			
1.	Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.		
2.	Tanushukla,Human Values and professional Ethics, Cengagepublications.		
References			
1.	R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi		
2.	Indian polity, M.Laksmikanth,Tatamchrawhill publications		
3.	R R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2		
E-Resources			
1.	https://mhrd.gov.in/		
2.	https://niti.gov.in/content/niti-aayog-library		
3.	www.drishtiias.com/		

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SEMESTER III

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Programme	B.E/B.Tech	Programme Code		Regulation	2019
Department	ECE/EEE/BT			Semester	III

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA303	**Transforms and Partial Differential Equations**	3	1	0	4	40	60	100

Course Objective

The Main Objective of the course is to

- To introduce the basic concepts of PDE for solving standard partial differential equations
- To solve boundary value problems by using Fourier series..
- 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 how to solve the given standard partial differential equations.	K2,K4
CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.	K3,K4
CO3: Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	K3,K5
CO4: Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.	K2,K5
CO5: Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	K1,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 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	
CO 2	3				2								3	3	
CO 3	3		2										3	2	
CO 4	3	3											3	2	
CO 5	3				2								3	3	

Course Assessment Methods

Direct

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1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool	
3. End-Semester examinations	
Indirect	
1. Course - end survey	

Content of the syllabus

Unit – I	**FOURIER SERIES**	Periods	**12**
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	**12**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Singular integral - 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	**12**
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	**12**
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	**12**
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z-transform: Partial fraction method – Residue method –Initial and Final value theorem- Convolution theorem – Applications of Z-transforms: Solution of difference equations.			
		Total Periods	**60**

Text Books

1.	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2.	Churchill, R.V. and Brown, J. W., Fourier series and boundary value problems.(8th 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 McGraw Hill Publishing Company Limited, New Delhi, 2008.
4.	P.R.Vittal, "Differential equations Fourier and Laplce Transforms", Margham Publishers, 2nd Edition, 1999.
5.	Ray Wylie. C and Barrett.C, " Advanced Engineering Mathematics " Tata McGraw 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	2019
Department	Biotechnology			Semester	III

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT302	Essentials of Microbiology	3	0	0	3	40	60	100

Course Objective

The main objective of this course is to

- 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
- Outline the production process of primary, secondary metabolites and their industrial applications

Course Outcome	Students who complete this course successfully are expected to	Knowledge Level
	1.Basic knowledge about historical perspective of microbiology	K2
	2.Understand the concepts of Identification and multiplication of microorganism	K3
	3.Demonstrate the microbial requirements, growth and its metabolism	K3
	4.Control of microorganisms by physical, chemical and biological methods	K5
	5.Apply the basic knowledge on microbiology for Social welfare	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	PSO 1	PSO 2	PSO 3
CO 1	2	2	2		2	3		2	3			2	3	3	3
CO 2	2		2		2			1					3	2	2
CO 3	3	3	2		3	3		2	3	2			3	2	2
CO 4	2	3	2	1	3	3		2	3			3	3	3	2
CO 5	3	3	2		3			3	3	2		3	3	2	2

Direct

1. Continuous Assessment Test I, II & III
2. Assignment & Quiz

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION	Periods	8

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History of microbiology, Classification and nomenclature of microorganism, Principle and applications of Microscope: 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, Colony morphology study on bacteria, viruses, algae, fungi, bacteriophage (TMV), actinomycetes and mycoplasma			
Unit – III	**MICROBIAL NUTRITION, GROWTH RATE AND METABOLISM**	Periods	**9**
Nutritional requirements of different media used for bacterial culture; growth curve, growth kinetics of bacteria. Factors affecting growth and different methods to quantitative bacterial growth. Host-microbe interactions, Preservation techniques and strain improvement studies			
Unit - IV	**CONTROL OF MICROORGANISMS**	Periods	**9**
Physical and chemical control of microorganisms-Sterilization and disinfection- Dry heat, Moist heat, Filtration, Pasteurization, Radiation and Various chemical agents. Antimicrobial drugs - mode of action and drug resistance			
Unit – V	**APPLICATION OF MICROBIOLOGICAL APPROACH**	Periods	**9**
Production of Bio-fertilizers and bio-pesticides; bioremediation; leaching of ores by microorganisms; Clinical microbiology; preservation of food. microorganisms and pollution control; Interaction between microorganisms – Synergism, Mutualism (symbiosis)			
		Total Periods	**45**
Text Books			
1.	DarnellJ., Lodish H and Baltimore D. Molecular Cell Biology, (4thEdn.) W.H. Freeman and Company, New Tork, USA, 2000		
2.	Prescott L.M., Harley J.P and Klein D.A. Microbiology, Wm. C. Brown Publishers, 2004		
References			
1.	Michael J. Pelczar and Chan E.C.S. Microbiology (An Application Based Approach), (1stEdn.) Tata McGraw Hill, 2010.		
2.	Ray B and BhuniyaA. Fundamental Food Microbiology, (5thEdn.) CRC Press, USA, 2013.		
3.	Talaron K.,Talaron A. Casita., Pelczar and Reid, Foundations in Microbiology, W.C.Brown Publishers, 2005.		
4.	Purohit S.S. Microbiology: Fundamentals and Applications, (6thEdn.) Agribios, 2001.		
5.	Cruger,Wulf and AnnelieseCrueger, Biotechnology: A Textbook of Industrial Microbiology, (2ndEdn)Panima Publishing, 2000.		
E-Resources			
1.	https://microbiologysociety.org/		
2.	https://www.britannica.com/science/microbiology		
3.	https://microbiologyonline.org/about-microbiology		

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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	**2019**
Department	**Biotechnology**			Semester	**III**

Course Code	Course Name	Periods Per Week		Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE304	**Unit operations**	3	0	0	3	40	60	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,	Knowlede Level
	1. Understand the concept of basic stochiometric 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	K5
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	3	3		3		2	1	1	3	2	2	2	3	3
CO 2	3	2	1	2	2	1	2	2	2			2	3	2	2
CO 3	3		2			2	2	3	3	3	2	2	2	1	3
CO 4	3	2	3		2	2	3	1	2	2	3	2	3	2	2
CO 5	3		2	3	2	2	2	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

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Content of the syllabus

Unit – I	Importance of units and Basic Calculation	Periods	9
Conversion factors-Atomic, molecular & equivalent weights-Molar concept-moles, mole fraction, weight fraction, mixtures and solutions. Morality, molality and normality-density, specific gravity. Ideal gas law-Ideal mixtures and solution-Dalton law of additive volumes, Concept of Simpson rules and its application			
Unit – II	**Mass and Energy Balance**	Periods	**9**
Laws of conservation of mass-meaning of material balance and its applications-distillation, evaporation, crystallization, filtration, drying. Material balance with Chemical reactions, limiting and excess reactant, recycle, bypass and purging, problems. Conservation of energy- Meaning of energy balance and its applications			
Unit – III	**Fluid mechanics**	Periods	**9**
Nature of fluids – properties of fluids-Types of fluids, fluid static"s- pressure measurements- Dimensionless analysis and similitude- Velocity potential, continuity and mechanical energy equations, velocity profile and friction factor for smooth and rough surface pipes, Heads losses for various stations.			
Unit – IV	**Fluid flow measurement**	Periods	**9**
Measurements of fluid flow– orifice meter, venturimeter, Pitot tube, Rotameter, wires and notchs. Flow controls –gate valve, needle valve, butterfly valve, globe and ball valve. Fluidization- mechanism, types, it s application. Friction factor for packed beds, Ergun equations.			
Unit – V	**Transportation of Fluid**	Periods	**9**
Transportation of fluids–fluids moving machinery performance, Selection and specification, Airlift and diaphragm pumps positive displacement pumps, reciprocating pumps, centrifugal pumps, pump characteristics. Concepts of compressors, fans and blowers.			
		Total Periods	**45**

Text Books	
1.	Holman, J. P., Heat Transfer, 9th Edition, McGraw Hill, Singapore, 2002
2.	Donald Q. Kern, Process Heat Transfer, Tata McGraw Hill, New Delhi, 1997.
References	
1.	McCabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition,2004
2.	Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003
3.	GK Ray ., Heat and mass Transfer solved problems, Tata McGraw Hill, New Delhi
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	III

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT303	**Introduction to Biochemistry**	3	0	0	3	40	60	100

Course Objective

The student should be made to,
- Familiarize different types of bio molecules, classifications and its structure
- Acquire knowledge in molecular structures and metabolic reactions.
- Generalize theory nitrogen metabolisms.
- Recognize the concepts and mechanism of contractile Proteins.
- 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 different types of biomolecules and its structures.	K1
CO2: Understand the pathway of various metabolisms related to carbohydrate and lipids.	K2
CO3: Identify different types amino acids and its interconnection pathways	K3
CO4: Compare the structural properties and mechanism of different proteins.	K4
CO5: Evaluate the yield of high energy compounds for many metabolic reactions.	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	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

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 BIOMOLECULES**	Periods	**9**
Types of functional groups, water, pH & buffers. Classification, functions and reactions of biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids			
Unit - II	**METABOLISM OF CARBOHYDRATES & LIPIDS**	Periods	**9**
Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt, glyoxalate shunt, fatty acid synthesis and oxidation. Biosynthesis and degradation of Starch and Glycogen. Biosynthesis, degradation and regulation of Lipids.			
Unit – III	**METABOLISM OF AMINO ACIDS**	Periods	**9**
Nitrogen metabolism, Biosynthesis and degradation of all Amino acids, nucleotides. Metabolic disorders and important molecules derived from amino acids, Interconnection of pathways and metabolic regulation.			
Unit - IV	**STRUCTURAL PROTEINS & PROTEIN TRANSPORT**	Periods	**9**
Contractile proteins, Actin, myosin, mechanism of myosin ATPase activity, excitation- contraction coupling and relaxation, microtubules, microfilaments and their role in organelle movements.			
Unit – V	**BIOENERGETICS**	Periods	**9**
High energy compounds, electronegative potential of compounds, respiratory chain, 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 Biochemsitry", 4th Edition, W.H. Freemen & Co., 2005.
2.	Stryer L, "Biochemsitry", 4th Edition, W.H. Freeman & Co., 2000.
References	
1.	Berg J. M, Tymoczko J. L and LubertStryer, "Biochemistry", W H Freeman and Company, New York, 2002.
2.	Voet D, Voet J. G and Pratt C. W, "Fundamentals of Biochemistry- Life at the Molecular level", John Wiley & Sons, New Jersey, 2008
3.	McKee T. and McKee J. R, "Biochemistry- The Molecular Basis of Life", Oxford University Press, London, 2008.
4.	Zubay G L, "Biochemistry", WCB/McGraw-Hill publishers, Iowa, 1998
5.	Palmer T, "Enzymes: Biochemistry, Biotechnology and Clinical Chemistry", East West Press, New York, 2008.
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	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**III**		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT304	**Industrial Biotechnological Products**	3	0	0	3	40	60	100

Course Objective	The student should be made to, • Understand the overall industrial fermentation process and the process flow sheet. • Interpret the knowledge on production of commercially important primary metabolites. • Interpret the knowledge on production of commercially important secondary metabolites. • Understand the production process of modern biological products. • Analyse and apply the knowledge on science for the production of therapeutic products.

	At the end of the course, the student should be able to,	Knowledge Level
Course Outcome	CO 1 :Recall the basics of industrial fermentation and other processes	K1
	CO 2 :Extend their knowledge on commercial production of primary metabolites	K2
	CO 3 :Extend their knowledge on commercial production of antibiotics	K3
	CO 4 :Compare the production of enzyme from bacterial and fungal species	K4
	CO 5: Support for the commercial production of modern biological products.	K5
Pre-requisites	Nil	

CO / PO 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	PSO3
CO 1	2			2			3	2			2		3		
CO 2	2		3		3		2	3			3		2	2	
CO 3	2		3		3		2	2			2		3	2	
CO 4	2		3		2		2				2	1	2		
CO 5	2		3		3		3	2			2	2	2	2	

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
1. Assignment
2. End-Semester examinations

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Indirect			
1. Course - end survey			
Content of the syllabus			
Unit – I	**INTRODUCTION TO INDUSTRIAL BIOPROCESS**	Periods	9
Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology – A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams,			
Unit – II	**PRODUCTION OF PRIMARY METABOLITES**	Periods	9
Primary Metabolites- Production of commercially important primary metabolites like organic acids (citric acid, acetic acid, lactic acid) amino acids (L- cysteine, L- Tryptophan and L-phenylalanine), alcohols (ethanol, butanol, propanol)			
Unit – III	**PRODUCTION OF SECONDARY METABOLITES**	Periods	9
Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics natural and semisynthetic penicillin, chloramphenicol, Erythromycin, macrolides and Steroids – transformation process and its biological significance.			
Unit – IV	**PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS**	Periods	9
Production of Industrial Enzymes (protease and lipase), Biopesticides, Biofertilizers, Bio preservatives (Nisin), Biopolymers (PHA, PHB and Xanthaan Gum) Biodiesel – production process, characteristics, merits and demerits, Production process of Cheese, Beer, SCP & Mushroom culture.			
Unit – V	**PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS**	Periods	9
Production of recombinant proteins having therapeutic and diagnostic applications (Insulin, Interferon, Interleukins and Growth stimulating Hormone), Vaccines – Subunit vaccine, recombinant vaccine advantages and disadvantages. Bioprocess strategies in Plant Cell and Animal Cell culture.			
		Total Periods	**45**
Text Books			
1.	Satyanarayana U, "Biotechnology" Books And Allied (p) Limited, 2013 .		
2.	Dubey R C, "A Textbook of Biotechnology" 5th revised Edition S. Chand Publishing. Ltd, 2014.		
References			
1.	BryceC F A., and MansiE L., "Fermentation microbiology & Biotechnology", 3rd Edition CRC Press, 2011.		
2.	Presscott S C., and Cecil G Dunn., "Industrial Microbiology", Agrobios (India), 2005.		
3.	CrugerWulf., and AnnelieseCrueger., "Biotechnology: A Textbook of Industrial Microbiology", 2nd 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.E/B.TECH	Programme code	-	Regulation	2019
Department	Biotechnology		Semester		

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19TA302	தமிழரும் தொழில்நுட்பமும்;; / TAMILS AND TECHNOLOGY	2	0	0	1	40	60	100

Content of the syllabus

அலகு 1	நெசவு மற்றும் பானை தொழில்நுட்பம்	Periods	3

சங்ககாலத்தில் நெசவுத்தொழில் – பானை தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு 2	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	Periods	3

சங்ககாலத்தில் **வடிவமைப்பு மற்றும்** கட்டுமானங்கள் ரு சங்ககாலத்தில் வீட்டுப் பொருட்களில் **வடிவமைப்பு** - சங்ககாலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடைஅமைப்பு பற்றிய விவரங்கள் - மாமல்லபுர சிற்பங்களும்இ கோவில்களும் – சோழர் காலத்து பெருங்கோவில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் கால கோவில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல்இ மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள்– பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ -சாரோச்செனிக் கட்டிடக்கலை.

அலகு 3	உற்பத்தித் தொழில் நுட்பம்	Periods	3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல்இ எஃகு – வரலாற்றுச்சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல்– மணி உருவாக்கும் தொழிற்சாலைகள்– கல்மணிகள்இ கண்ணாடி மணிகள்– சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு 4	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	Periods	3

அணைஇ ஏரிஇ குளங்கள் இ மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – **வேளாண்மை** மற்றும் **வேளாண்மை** சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத் துக்குளித் தல் – பெருங்கடல் மற்றும் பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு 5	அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	Periods	3

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அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.		
	Total Periods	15

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Programme	B.E/B.TECH	Programme code	-	Regulation	2019
Department	**Biotechnology**		Semester		

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19TA302	**தமிழரும் தொழில்நுட்பமும்;;** / TAMILS AND TECHNOLOGY	2	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 Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.			
UNIT V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**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.			

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Text cum-Reference Books	
1	தமிழக வரலாறு – மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை -ஆற்றங்கரை நாகரிகம்.(தொல்லியல் துறை வெயளியீடு)
5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL
6	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.Subatamarnan, 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 & TamilNadu TextBook and Educational Services Corporation, TamilNadu)
10	Studies in the History of India with Special Reference to TamilNadu (Dr.K.K.P1llay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & TamilNadu TextBook and Educational Services Corporation, TamilNadu)
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	2019
Department	BIOTECHNOLOGY			Semester	III

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT305	MICROBIOLOGY LABORATORY	0	0	4	2	60	40	100

Objective

The main objective of this course is to

- Learn to follow experimental procedures and become proficient at laboratory skills
- Transfer living microbes using aseptic techniques
- Visually recognize and explain the macroscopic and microscopic characteristics of Bacteria and Fungi
- Learn how to make careful observations, collect and analyze the obtained data
- Understand and explain environmental factors that influence microbes

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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				2						3	3	2
CO 2	2	2	2				2						2	3	3
CO 3	3	3	1				1						3	3	2
CO 4	3	3	3				2						2	2	3
CO 5	3	3	2				2						3	3	2

LIST OF EXPERIMENTS

	Course Outcomes
1. Preparation of culture media using nutrient broth and nutrient agar	CO1
2. Isolation of microorganisms from different sources (Soil and water) using Serial Dilution Technique	CO1
3. Culturing of microorganisms – Broth and Plates (Pour plates, Streak plates, Spread plate)	CO1
4. Growth curve observation on bacteria	CO2
5. Grams Staining Technique	CO3
6. Acid Fast Staining, Capsular Staining and Endospore Staining	CO3
7. Biochemical Analysis 1 - i) Carbohydrate Fermentation test ii) Triple Sugar Ion Test iii) Hydrogen Sulphide Test	CO4
8. Biochemical Analysis 2 - IMVIC Test	CO4
9. Biochemical Analysis 3 - i) Urease Activity Test ii) Catalase Activity test iii) Oxidase activity test iv) Starchhydrolysis test	CO4
10. Antibiotic sensitivity assay	CO5

Total periods : 60

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Outcomes:

Students who complete this course successfully are expected to

1. Using selective techniques to enrich and isolate microorganisms
2. Describe the physiology and growth requirements of bacteria
3. Properly stain bacterial cultures using staining techniques and identify the microorganisms
4. Identify microorganisms and their properties using various methods
5. Control the growth of bacteria using antimicrobial agents

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Programme	**B. Tech**	Programme code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**III**		

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT306	**CELL BIOLOGY LABORATORY**	**0**	**0**	**4**	**2**	**60**	**40**	**100**

Objective

The main objective of this course is to

- Develop skills to work with cells
- Understand the working of different microscopy
- Identify cells & their structure using different staining methods
- To study the basics of permeability of the cell
- To know about the different stages of cells during cell division

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	1	2			3		3	2				3	2	3
CO 2	2	2	2			3		3	3				2	3	2
CO 3	1	2	2			3		3	2				3	2	3
CO 4	2	3	3			3		3	3				2	2	2
CO 5	3	2	2			3		3	3				3	2	3

LIST OF EXPERIMENTS

	Course Outcomes
1. Introduction to principles of sterile techniques and cell propagation	**CO1**
2. Microscopy principle & identification of given plant, animal and bacterial cells	**CO2**
3. Gram's Staining	**CO3**
4. Leishman Staining	**CO3**
5. Giemsa Staining	**CO3**
6. Thin Layer Chromatography	**CO1**
7. Separation of Peripheral Blood Mononuclear Cells	**CO4**
8. Osmosis and Tonicity	**CO4**
9. Trypan Blue Assay	**CO3**
10.Staining for different stages of cell division	**CO5**
Total periods : 60	

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Outcomes:

This practical course will facilitate the students

- To understand the basic techniques to work with cells
- To demonstrate working principles of Microscopy
- To understand and perform cell staining techniques
- To understand the tonicity in cell environment
- To identify the various stages of cell division

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Programme	B. Tech	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	III

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT307	BIOCHEMISTRY LABORATORY	0	0	4	2	60	40	100

Objective

The main objective of this course is to:

- Learn the principles behind the qualitative and quantitative estimation of Biomolecules.
- Collect data required for analysis of the same in the body fluids.

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

	Course Outcomes
1. pH measurements & Preparation of buffers	CO1
2. Qualitative test for Carbohydrates	CO2
3. Distinguishing reducing & non-reducing sugars	CO2
4. Using ninhydrin for distinguishing Imino & Amino acids	CO2
5. Protein estimation by Biuret & lowry's method	CO3
6. Protein estimation by Bradford colorimetric methods	CO3
7. Enzymatic assay of Phosphate	CO4
8. Extraction of lipids & analysis by TLC	CO4
9. Estimation of Cholestrol by Zak's methods	CO5
10. Estimation of nucleus end by absorbance at 260nm & hyperchromicity	CO5
Total Periods: 60	

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Course Outcomes: The students will be able to :

- Prepare different buffers
- Calculate amount of biomolecules present in the given sample
- Estimate the amount of protein present in the sample
- Estimating the presence of phosphate and lipids
- Estimate the amount of cholesterol and DNA present in the sample

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**Biotechnology**			Semester	**III**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCSY3	**NUMERICAL ABILITY**	3	0	0	-	100	-	100

Content of the syllabus

Unit – I	**NUMBER SYSTEMS**	Periods	**6**
Number Properties – HCF – LCM - Square root – Cube root – Simplification – Averages.			
Unit - II	**DIRECT PROPORTIONAL PROBLEMS**	Periods	**8**
Percentage - Profit & Loss –. Ratio & Proportions – Mixture & Allegations - Problem on Ages			
Unit – III	**INDIRECT PROPORTIONAL PROBLEMS**	Periods	**8**
Time & Work – Pipes & Cisterns - Time, Speed& Distance – Boats & Streams – Races & Games of Skills .			
Unit - IV	**BANKER'S PROBLEMS**	Periods	**4**
Simple Interest – Compound Interest – Logarithms – Partnership - Discounts.			
Unit – V	**MISCELLANEOUS PROBLEMS**	Periods	**4**
Mensuration: Area & perimeter – Volume & Surface Area – Geometry-Trigonometry.			
		Total Periods	**30**

Text Books

1.	Dinesh Khattar- The Pearson guide to Quantitative Aptitude for Competitive Examinations 3rd edition.

References

1.	R.S. Aggarwal - Quantitative Aptitude for Competitive Examinations

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SEMESTER IV

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**Biotechnology**			Semester	**IV**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA408	**Probability and Statistics**	3	1	0	4	40	60	100

Course Objective

The main objective of the course is to

- Proficiently understand the expected value, variance, and higher-order moments of random variables (for both discrete and continuous types).
- Analyze and interpret statistical data using appropriate probability distribution
- Know and differentiate between one dimensional and Two dimensional random variables.
- Identify and demonstrate suitable sampling and data collection process.
- Identify testing of hypothesis for all size of samples.

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Translate the density and distribution functions for discrete and continuous variables.	K1,K3
CO2: Enable to identify various probability distributions.	K2,K3
CO3: Use the central limit theorem to compute probabilities.	K1,K5
CO4: Apply appropriate modern technology to explore probability/statistical concepts.	K3,K4
CO5: Ability to test the hypothesis using suitable statistical test.	K3,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** 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		
CO 2	3	3											2		
CO 3	3	3											2		
CO 4	3	3											2		
CO 5	3	3											2		

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment: Simulation using tool
3. End-Semester examinations

Indirect

1. Course - end survey

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Content of the syllabus			
Unit – I	**RANDOM VARIABLES**	Periods	**12**
Introduction to probability, random variables, Probability mass function, Probability generating function, moments, moment generating function, Chebyshev inequality.			
Unit - II	**SPECIAL DISTRIBUTIONS**	Periods	**12**
Special discrete and continuous distributions: Binomial, geometric and Poisson distributions, Uniform, Gaussian, Exponential and Gamma distributions.			
Unit – III	**TWO DIMENSIONAL RANDOM VARIABLE**	Periods	**12**
Function of a random variable. Joint distributions, Marginal and Conditional distributions, Transformation of random variables, correlation and regression - central limit theorem.			
Unit - IV	**ESTIMATION THEORY**	Periods	**12**
Sampling distributions, point estimation, unbiasedness, consistency, maximum likelihood estimation, Confidence intervals for parameter in one sample from normal population.			
Unit – V	**TESTING OF HYPOTHESIS**	Periods	**12**
Basic Definitions:- (Population, Sampling, Tests of Significance, Testing a Hypothesis, Null Hypothesis, Alternative Hypothesis, Level of Significance, Types of Errors) – Testing of Hypothesis using : 't'-Test , 'F'-Test , Chi Square Test (ψ^2) - Test for Independence of Attributes & Goodness of Fit.			
		Total Periods	**60**
Text Books			
1.	Montgomery, D.C. and Runger, C.G., Applied Statistics and Probability for Engineers, 6th Edition, Wiley Students Edition, Wiley, 2016.		
2.	Ravichandran, J., Probability and statistics for Engineers, 1st Edition, Wiley India Ltd, 2012.		
References			
1.	Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, 1st Edition, Sultan an Sons, 2001.		
2.	Devore, J.L., Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2011.		
3.	Johnson, R.A., Miller, I. and Freund, J., Miller & Freund's Probability and Statistics for Engineers 8th Edition, Pearson Education, 2010.		
4.	Ronald E.Walpole; Raymond H.M.yers; Stiaron L. Myers,"Probability and Statistics for Engineering and the Scientists",Pearson Publishers, 7th Edition,2004		
5.	Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd 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	**2019**			
Department	**BIOTECHNOLOGY**			Semester	**IV**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT407	**Bioprocess Engineering & Technology**	3	0	0	3	40	60	100

Course Objective	The student should be made to, • learn different types of bioreactors and their components • understand microbial growth kinetics in batch, fed-batch and continuous mode • Interpret the kinetics and mechanism of microbial growth. • study the basics of scale-up criteria for bioreactors • study the major classes of interactions in mixed cultures	
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.	K1
	CO2: Explain the sterilization kinetics of medium and equipment.	K3
	CO3: Apply the scale-up criteria of bioreactors	K2
	CO4: Describe batch, fed-batch and continuous cultivation and their kinetics.	K4
	CO 5: Perform competently chemical and bioprocess industries.	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		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

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	**TYPES OF BIOREACTOR AND MEDIA OPTIMIZATION**	Periods	**9**
General requirements, basic design and construction of fermenters and ancillaries.Types of bioreactors; batch, PFR, CSTR, bubble-column reactor; packed & fluidized bed reactor; air-lift reactor;Simple and complex media; medium formulation for optimal growth and product formation; medium optimization methods: Plackett-Burman design, simplex 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**
Aeration and agitation in bioreactors; Rheology of fermentation fluids; Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale-up criteria for bioreactors; Major factors involved in scale-up; Scaling-up of mixing systems; Scale-up of aeration/agitation regimes in stirred tank reactors. Scale-up of air-lift reactors.			
Unit – IV	**MODELLING AND SIMULATION OF BIOPROCESSES**	Periods	**9**
Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth: Monod model; Growth of filamentous organisms and yeast, Product formation kinetics; Leudeking-Piret models, compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model.			
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 in Immobilized cell.			
		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.
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.	http://users.ox.ac.uk/~dplb0149/publication/NPRBiocatalysisRev.pdf
3.	http://link.springer.com/book/10.1007%2F978-1-4684-0324-4

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**IV**		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT408	**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 equipments

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	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	U19CH205-Chemistry for Biotechnology	

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		3	2			2		3		1
CO 2	3				3		2	3	1		3			2	
CO 3	2				3		2	2			2		3	2	
CO 4	2	2		2	2		2				2	1	2		
CO 5	2				3		3	2			1	2		2	

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
Generalised 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 (NADH and ATP) Thermodynamics of Oxidation-reduction reaction, Energetics of DNA- Protein Interaction, Protein folding and receptor- ligand binding			
		Total Periods	**45**
Text Books			
1.	Sandler S.I, "Chemical And Engineering Thermodynamics", John Wiley,4th 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", 6th Edition, McGraw-Hill, 2001.		
2.	Narayanan K.V, "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall India, 2001.		
3.	Nag P K, "Engineering Thermodynamics"", 3rd Edition, Tata McGraw-Hill, 2005.		
4.	Rathakrishnan E, "Fundamentals Of Engineering Thermodynamics ,2nd Edition, PHI Learning Pvt. Ltd, 2005.		
5.	Christiana D. Smolke, The Metabolic Pathway Engineering Handbook Fundamentals, CRC Press Taylor & Francis Group, 2010		
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/couses/104105040 , " Chemistry and Biochemistry" IIT Kharagpur		

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Elayampalayam, Tiruchengode – 637 205

Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	Biotechnology			Semester	IV

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT409	**Molecular Biology**	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- Analyze the function of the genes at molecular level.
- Recall basics of heredity, inheritance and genetics.
- Acquire basic fundamental knowledge and explore skills in molecular biology.
- Understands the molecular mechanism of DNA replication, repair, transcription, and protein synthesis and gene regulation in various organisms.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them.	K2
CO2: Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.	K3
CO3: Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.	K3
CO4: Understands the regulation of gene expression at various levels.	K5
CO5: Articulate applications of molecular biology in the modern world.	K6

Pre-requisites U19BT201 – Cell Biology

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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					3							2	3	2
CO 3	3	2	3			2							2	3	3
CO 4	3					3							2	3	3
CO 5	2					3		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

Content of the syllabus

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Unit – I	GENOME STRUCTURE AND ORGANIZATION	Periods	9
Introduction and historical development of molecular biology. DNA structure-primary structure, Secondary structure-base pairing and base stacking, Tertiary structure Supercoiling, Quaternary structure. Genome organization- Structure of prokaryotic and eukaryotic nuclear and organelle genome. Repetitive DNA, sequence architecture in repetitive DNA and its classification. Gene-definition and concepts.			
Unit - II	**MOLECULAR EVENTS OF REPLICATION**	Periods	**9**
Central dogma of Molecular Biology. DNA replication- Origin of replication, Enzymes of replication-DNA polymerases, reverse transcriptases, topoisomerases, ligases. Concurrent synthesis and termination-Details in phages, bacteria, and eukaryotes. Polymerase Chain Reaction-Principles and Applications.			
Unit – III	**MOLECULAR EVENTS OF TRANSCRIPTION AND RNA PROCESSING**	Periods	**9**
Transcription-prokaryotic RNA polymerase, sigma, promoters, promoters recognition - elongation and termination. Transcription in eukaryotes-enhancers, initiation-transcription factors, elongation and termination. Post transcriptional modifications - rRNA, tRNA processing. Molecular structure of mRNA, introns, exons-mRNA end modifications – molecular events - 5' Cap formation, 3' polyadenylation - mRNA splicing, alternative splicing, RNA editing.			
Unit - IV	**MOLECULAR EVENTS OF TRANSLATION**	Periods	**9**
Genetic code - codons and its properties, Wobble hypothesis - molecular structure of tRNA, Ribosomes - structure, morphology and organization-Translation-initiation –Elongation termination-Post translational modifications in prokaryotes and eukaryotes. Proteins primary, secondary and tertiary structures. Classification of proteins.			
Unit – V	**GENE EXPRESSION & REGULATION**	Periods	**9**
Gene expression – prokaryotes – operon concept- *lac* and trp operon. Regulation of gene expression in eukaryotes. 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.	Allison, L .A. Fundamentals of Molecular Biology. (2nd Edition) John Wiley and Sons, 2011
2.	Watson JD, Baker TA, Bell SP, Gann A Levine M, Losick R. Molecular Biology of the Gene. 7th Ed. Pearson Education International, 2013
References	
1.	Krebs, J. E, Goldstein, E. S, Kilpatrick, S.T. Lewin"s Genes XII. Jones and Bartlett Publishers, Inc., p.838, 2017
2.	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
3.	Nelson D.L and M.M. Cox. Lehninger Principles of Biochemistry, (7th Edn.) W. H. Freeman and Company, New York, USA. p.1328, 2017
4.	Raineri, D. Introduction to Molecular Biology. Blackwell Science, Inc., 190p, 2001
5.	Robert Weaver. Molecular Biology. (5th Edn.). McGraw Hill Inc., 890p, 2011
E-Resources	
1.	www.dnalc.org
2.	www.hhmi.org/biointeractive/dna-collection
3.	www.johnkyrk.com

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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	IV

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT410	**Bioinstrumentation**	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- Recall about application of electromagnetic radiation in optical instruments.
- Understand the principles and working procedure of various types of spectroscopy.
- Summarize the x-ray diffraction, NMR and its application.
- Distinguish the various type separation techniques applied in biomolecules.
- Compare and check for the availability of various types of electrode and microscopes.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: recognize the application of electromagnetic radiation in optical instruments	K1
CO2: Discuss and compare principle and working procedure of spectroscopy	K2
CO3: Illustrate and demonstrate the application of x-ray diffraction and NMR.	K3
CO4: infer about the various methods used for purification process.	K4
CO5: Asses and validate the various types of electrode and microscopes.	K5

Pre-requisite

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	3		3						2	2	2		
CO 2	3				2							2	2		
CO 3	3		2									2	2		
CO 4	3	2		2	3						2	2	2		2
CO 5	3				2							2	2		2

Course Assessment Methods

Direct

7. Continuous Assessment Test I, II & III
8. Assignment
9. End-Semester examinations

Indirect

3. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO SPECTROMETRY	Periods	9

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Properties of electromagnetic radiation- wave properties, components of optical instruments. Signal process and read outs – signal to noise ratio, sources of noise, Enhancement of signal to noise. Types of optical instruments.			
Unit – II	**SPECTROSCOPY**	Periods	**9**
SOURCES General design and components of spectroscopy, Principles, Instrumentation and applications of colorimetry, UV – Visible – IR- Raman spectroscopy –NMR spectroscopy, Auger electron and Atomic absorption spectroscopy (AAS), – Principle of Fourier Transform optical Measurements.			
Unit – III	**X- RAY DIFFRACTION AND MAGNETIC RESONANCE**	Periods	**9**
Thermo-gravimetric methods, Differential thermal analysis, Differential scanning calorimetry. X-ray sources, absorption of X-rays, X-ray diffraction, X-ray detectors. Theory of NMR, environmental effects on NMR spectra, chemical shift- NMR spectrometers – applications of ^{1}H and ^{13}C NMR.			
Unit – IV	**SEPARATION AND PURIFICATION TECHNIQUES**	Periods	**9**
Principles and Instrumentation of centrifugation, Paper and column chromatography, Ion exchange, Size exclusion, Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Gas chromatography , Electrophoresis of Nucleic acid and protein..			
Unit – V	**ELECTRO ANALYSIS AND SURFACE MICROSCOPY**	Periods	**9**
Electrochemical cells- Electrode potential cell potentials, potentiometry- reference Electrode, ion selective and molecular selective electrodes, Instrument for potentiometric studies. Voltametry – Cyclic and pulse voltametry- Applications of voltametry. Study of surfaces – Scanning probe microscopes – AFM and STM, SEM & TEM.			
		Total Periods	**45**
Text Books			
1.	Douglas A. Skoog., James Holler F., and Stanley R., "Principles of Instrumental Analysis" 6th Edition, Thomson Brooks, 2014.		
2.	ChatwalG.R, and Anand Sham K., "Instrumental Methods of Chemical Analysis" 5th Edition, Himalaya Publishing House, 2016.		
References			
1.	Willard H.H., Merrit J.A., Dean L.L. and Setlle, F.A., "Instrumental Methods of Analysis" CBS Publishers and Distributors 1986.		
2.	Dinesh Kumar C., and Prahlad Singh M., "Instrumental Methods of Analysis in Biotechnology". I K International Publishing House, 2012.		
3.	Sivasankar B., "Instrumental methods of analysis" Oxford University Press , 2012		
4.	Khandpur R.S., "Handbook of Analytical instruments" 2 edition, McGraw Hill Education; 2006.		
5.	Robert D. Braun., " Introduction to instrumental analysis" 2nd edition, Kindle publisher, 2012		
E-Resources			
1.	https://www.britannica.com/science/spectroscopy		
2.	https://link.springer.com/book/10.1007/978-94-011-1812-5		
3.	https://en.wikipedia.org/wiki/Chromatography		

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Programme	B. Tech.	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	IV

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT411	**Bioprocess Laboratory**	0	0	4	2	60	40	100

Objective

The main objective of this course is to

- Provide hands-on training on the operation of fermenters
- familiarize the students with microbial growth kinetics
- know mass/heat transfer in fermenters
- learn about the production of metabolites
- Optimize growth medium and parameters influencing it.

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

1. Growth of Bacteria - estimation of biomass, calculation of specific growth rate, yield coefficient
2. Growth of Yeast - estimation of biomass, calculation of specific growth rate, yield coefficient
3. Medium optimization – i)Response surface methodology ii) PlackettBurman design
4. Enzyme kinetics – Estimation of MichelisMenton parameters
5. Enzyme activity - effect of Temperature
6. Enzyme activity - effect of pH
7. Production of microbial metabolites (enzymes / antibiotics) in bioreactor
8. Enzyme immobilization
9. Estimation of overall heat transfer coefficient
10. Estimation of KLa – power correlation / sulfite oxidation / dynamic gassing method

Total Periods: 60

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Outcomes

Students who complete this course successfully are expected to

- Solve complex bioprocess engineering problems
- Applying skills of reactors in chemical and bioprocess industries
- Develop bio separation techniques
- Design reactors for plant and animal cell culture
- learn the importance of medium formulation and optimization of medium for their role in the economy of the process

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Programme	B.Tech	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	IV

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT412	Chemical Engineering Laboratory	0	0	4	2	60	40	100

Objective

The main objective of this course is to
1. Outline the fluid properties for biochemical processes.
2. Recall laws controlling motion of particles through fluids.
3. Investigate mechanism of momentum transfer.
4. Outline heat transfer properties used in industrial processes
5. Recall absorption, distillation and related equipments.

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

1. Estimation of Discharge coefficient
2. Determination of Darcy"s friction factor
3. Experiment on Fluidization techniques and determination ofMinimum fluidization velocity
4. Calibration of a Rotameter
5. Shell and Tube Heat Exchanger
6. Rotary drum filter (with and without filter aids)
7. Steam Distillation
8. Determining average particle size and screening efficiency
9. Drying Studies
10. Adsorption Studies

Total Periods: 60

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Outcomes

Students who complete this course successfully are expected to

1. Ability to apply the skill of unit process of Fluid Mechanics
2. Ability to analyses the principles of fluid mechanics and its application of biological perspectives
3. Design and working principles of fluid moving machinery and transport phenomenon
4. Characterize adsorption phenomenon.
5. Develop distillation and drying equipments.

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Programme	B.E./ B.TECH.	Programme Code		Regulation	2019
Department	CSE, EEE, ECE, IT & BT			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCSY4	VERBAL ABILITY	3	0	0	-	100	-	100

Course Objective

The main objective of the course is to:

- To help the student understand the importance of having his language skills kept ready for effective use
- To provide a host of varied opportunities for the student to hone his acquired language skills basic components, namely, Grammar, Vocabulary, Spelling and Comprehension.

Course Outcome

At the end of the course, the student will be able to,	KL
CO1:, Identify the verb and tense in a sentence by circling and labeling	K1
CO2: State the definition of an article	K1
CO3: Develop their awareness of correct usage of English grammar in writing and speaking ·	K3
CO4: Tests a vocabulary power and skill to follow the logic of sentences	K4
CO5: Discuss how word root based extends vocabulary	K2

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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

Content of the syllabus

Unit – I	TENSES	Periods	6

Purpose and rules of tenses and its keywords (focus should be given to present continuous, future continuous, present perfect, future perfect, present perfect continuous, past perfect continuous, future perfect continuous with more examples) - Direct and Indirect Speech – Voices.

Unit - II	ARTICLES	Periods	6

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Purpose of Articles: Indefinite Article: If you want to say about ANY item, you should use the articles A / An. **A :** A European, A One Eyed beggar, A University, A Useful Website. Name of professions, Expression of quantity, To make a Proper noun a Common noun, With certain numbers, used before the word 'Half' when it follows a whole number. **Exceptions: Choosing A or An** There are a few exceptions to the general rule of using a before words that start with consonants and an before words that begin with vowels. The first letter of the word honor, for example, is a consonant, but it"s unpronounced. In spite of its spelling, the word honor begins with a vowel sound. Therefore, we use an. **Example.**

The Definite Article:

Where to use the Definite Article -A specific item, a particular person or thing, Before superlative forms, Before double comparatives, Before musical instruments, Before rank or title, Before name of the political parties, armed forces, physical positions, Before a Proper noun when used as a Common noun, Before some adjectives to make them nouns, Before Ordinal numbers, Before the names of Oceans, Seas, Rivers, Canals, Deserts, Groups of Mountains and Groups of Islands, Before the names of the Things, which are unique in nature, Before the names of Planets and Satellites, Before Holy Books, Before the names of News Papers, Before the names of some countries, measuring expressions beginning with by. **Omission of articles**:

Before Plural countable noun, Before proper noun, Before languages, a single item of uncountable noun, Before name of the meals except adjective usage, Double expressions – with wife and fork, with hat and folk, from top to bottom, With the names of meals such as Breakfast, Before predicative nouns denoting a unique position, After type of / kind of / sort of / post of / title of / rank of / articles are not used. Ex. He is not that sortof man, Articles are not used with material nouns, After di-transitive verb articles should not be used except when it is used as mono transitive verb, Before the names of meals no article should be used in a general way except in particular causes.

Repetition of the articles

1. When two or more adjectives qualify the same noun, the article is used before the first adjective only; but when they qualify different nouns, expressed or understood, the article is used before each adjective.

PREPOSITIONS

a. Prepositions Of Time-On, In, At, Since, For, Ago, During, Before, After, Until, Till, To/Past, From/To, By
b. Prepositions Of Place- In, At, On, Off, By, Beside, Under, Over, Below, Above, Up And Down, Ago
c. Prepositions Of Directions/ Movements Across, Through, To, Into, Out Of, Onto, Towards, From
d. Other Prepositions- Of, By , About, For, With
e. Prepositions Usage with Its Context

Unit – III	SENTENCE CORRECTION	Periods	6

ENTENCE CORRECTION

a) In each of the following sentences, four options are given. You are required to identify the best way of writing the sentence in the context of the correct usage of standard written English. While doing so, you have to ensure the message being conveyed remains the same in all the cases.

b) For each of the following questions, a part or the whole of the original sentence has been underlined. You have to find the best way of writing the underlined part of the sentence.

c) In the following questions, you have to identify the correct sentence/s. For each of the following questions, find the sentence/s that are correct.

d) In each of the following questions, one or more of the sentences is/are incorrect. You have to identify the incorrect sentence/s.

SENTENCE IMPROVEMENT

a. Subject-Verb Agreement
b. Parallelism
c. Redundancy: The error of repeating the same thing.
d. Modifier
e. Comparisons

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RULE: (a) When comparative degree is used with than, make sure that we exclude the thing compared from the rest of class of things by using the

f. Confusing words

i) Few and Less

ii) Few and A few

iii) Little and A Little

A little tact would have saved the situation(some tact).

Lay and Lie Lay, laid

Unit - IV	SENTENCE COMPLETION	Periods	6

SENTENCE COMPLETION: Purpose and usage of proper words. **SPOTTING ERRORS:**

a. Errors on conjunctions
b. Errors on „if" clauses
c. Errors on adverbs
d. Errors on adjectives
e. Errors on prepositions
f. Errors on determiners
g. Errors on verbs
h. Errors on nouns
i. Errors on modifiers
j. Errors on degrees of comparison
k. Errors on subject-verb agreement
l. Errors on infinitives
m. Errors on pronouns
n. Errors on tenses
o. Redundancy errors
p. Errors on articles
q. Error on complex sentences

Unit – V	VOCABULARY	Periods	6

Synonyms: Root Based Word, Suffix Based Word. Antonyms - Contextual Vocabulary - Verbal Analogy

Total Periods	30

Text Books

1.	Objective General English by SP Bakshi – Arihant Publication

References

1.	A modern Approach to verbal and non-verbal reasoning by R.S. Agarwal
2.	Word power made easy by Norman Lewis

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SEMESTER V

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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**
U19BT513	**COMPUTATIONAL BIOLOGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The student should be made to, • 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	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**	**PS O1**	**PS O 2**	**PSO 3**
CO 1	2	1			3	3							3	2	3
CO 2	2	1			3	3							2	3	2
CO 3	2	1			2	3							2	3	3
CO 4	2	1			3	3							2	3	3
CO 5	2	1			3	2							3	3	2

Course Assessment MethodsDirect

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	**Basics of Bioinformatics**	Periods	**9**
Basic terms and nomenclature in bioinformatics, Molecular sequences, Biological databases: Protein and Nucleotide databases, Sequence Alignment - Pairwise, Dynamic Programming, Local and Global Alignment, BLAST, FASTA algorithm, Functional Annotation, Multiple sequence alignment, Applications.			
Unit - II	**Machine Learning**	Periods	**9**
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 o machine learning in bioinformatics.			
Unit – III	**Phylogeny**	Periods	**9**
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.			
Unit - IV	**Protein structure and analysis**	Periods	**9**
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.,			
Unit – V	**Tools for Analysis in Bioinformatics**	Periods	**9**
Molecular Docking basics and applications, Molecular dynamics simulations, Microarrays and Clustering techniques for microarray data analysis, introduction to Genomics and Proteomics, sequencing, assembly of genome, next generation sequencing techniques.			
		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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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205						
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
U19BT514	**PRINCIPLES OF GENETIC ENGINEERING**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The student should be made to, • 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.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Describe the basics of genetic engineering.	K2
	CO2: Discuss clearly about the mechanisms and control of recombinant molecules.	K3
	CO3: Describe the gene cloning and expression.	K3
	CO4: Understands the regulation of molecular techniques at various levels.	K5
	CO5: Articulate applications of genetic engineering cell techniques in biotechnology.	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**	**PS O1**	**PS O 2**	**PS O 3**
CO 1	3	3	2	2	2	3	2		2	2	2	2	3	2	3
CO 2	3					3						2	2	3	2
CO 3	3	2	3		2	2	2	2	2				2	3	3
CO 4	3	2	2	2	2	3	2		2			2	2	3	3
CO 5	2	2	2	2	2	3	2	2	2	2	2	2	3	3	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	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 transformatio 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; Calciumchloride 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 cDNAlibraries, 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-application, DNA fingerprinting using molecular markers, DNA sequencing-Maxum-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, gene editing tools – CRISPR-cas9, Zinc finger technique.

		Total Periods	**45**

Text Books

1.	Old, R. W. and Primrose, S. B., "Principles Of Gene Manipulation: An introduction To Genetic Engineering", Blackwell Science. 7th edition,2006
2.	Clark DP and Pasternick NJ, Biotechnology: Academic Cell Updates, Academic Press, Elsevier, 2012.

References

1.	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications,1st Ed, 2014
2.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science Ltd,2006

E-Resources

1.	https://di.uq.edu.au/community-and-alumni/sparq-ed/cell-and-molecular-biology-experiences/introduction-cell-biology
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		**2019**	
Department	**BIOTECHNOLOGY**				Semester		**V**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT515	**IMMUNOLOGY AND IMMUNOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The student should be made , • 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 student should 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

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	2	3	3	3	2
CO 2	3	2		1		3		1	1		1	2	3	3	2
CO 3	3	2											2	2	2
CO 4	3	2	3	1		1							2	3	2
CO 5	2	2	3	2		1		3	1				3	2	2

Course Assessment Methods

Direct

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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 AND OVERVIEW**	Periods	**9**
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.			
Unit - II	**HUMORAL IMMUNITY**	Periods	**9**
Development, differentiation and maturation of B cells; Structure and Function of immunoglobulin, Immunoglobulin classes and subclasses, Molecular biology of immunologlobulin synthesis, Complement pathways.			
Unit – III	**CELL MEDIATED IMMUNITY**	Periods	**9**
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;			
Unit - IV	**IMMUNITY TO SELF AND NON – SELF INFECTION**	Periods	**9**
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.			
Unit – V	**IMMUNOLOGICAL TECHNIQUES**	Periods	**9**
Agglutination and Precipitation reactions, Immunofluorescence, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA.Cell sorting- Immuno flow cytometry, confocal microscopy. Active immunization Vaccines, Vaccine production, passive immunization, Hybridoma technology; application of monoclonal & polyclonal antibodies-mice& rabbit.			
		Total Periods	**45**
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, BarsaraA.Osborne, Janis Kuby, "Immunology" 5th Edition, Freeman & Company, 2007.		
2.	Ivan M. Roitt, Jonathan Brostoff and David K.Male Glower "Immunology" Medical Publishers,London, 1st Edition., 2011.		
3.	SeemiFarhatBasir., "Text Book of Immunology", First edition, PHI LrarningPvt Ltd, New Delhi,2008.		
4.	Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J., "Immunology", W.H. Freeman, 2003.		
5.	Weir, D.M. and Stewart, J., "Immunology", Cheerchill, Linvstone, 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	2019
Department	BIOTECHNOLOGY			Semester	V

Course Code	Course Name	Periods Per Week		Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT516	HEAT & MASS TRANSFER	3	0	0	3	40	60	100

Course Objective

The student should be made to,
1. Describe heat transfer operations with relevance to bioprocess engineering
2. Explain the concepts of mass transfer in bioprocess engineering

Course Outcome

At the end of the course student will be able to:	Knowledge Level
CO1 : Outline the modes of heat of transfer	K3
CO2 : Explain the applications of heat transfer in bioprocess industries	K2
CO3 : Illustrate the principles of diffusion and apply the concepts of interphase mass transfer in bioreactor	K3
CO4 : Describe the concept of gas-liquid operations in bioprocess industries	K4
CO5 : Explain vapour liquid operations and its application in bioprocess industries	

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	2	3	2	2	1	2	1		2		2	2	2	3
CO 2	3	2	2	2	3		2	3	1	2	3	1	3	3	2
CO 3	3	2	3	3	2	2	3	2		3		3	3	2	3
CO 4	3	3	2	2	1		3	1	2	2	3		2	2	2
CO 5	3		3	3	2		1	3	3		2	2	2	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	HEAT TRANSFER	Periods	9
Modes of heat transfer; Conduction: Fourier's law, Thermal conductivity of biological materials, Conduction through plane wall, hollow cylinder and hollow sphere, Individual and Overall heat transfer coefficients, Natural and forced convection, Combined Conduction, convection and radiation in bioprocess industries.			
Unit – II	**HEAT TRANSFER EQUIPMENTS**	Periods	**9**
Heat Exchangers: Design of heat exchanger, Shell & Tube Heat Exchanger, Mechanism of condensation and boiling; Evaporators: Single & Multiple effect evaporator.			
Unit – III	**DIFFUSION AND MASS TRANSFER**	Periods	**9**
Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients;Analogies in mass transfer operations, mass transfer theory, concurrent & counter current operation.			
Unit – IV	**GAS LIQUID& EXTRACTION OPERATIONS**	Periods	**9**
Gas absorption: Types and principle; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts. Liquid-liquid equilibria; solvent characteristics; various types of extractors.			
Unit – V	**VAPOUR LIQUID & ADSORPTION OPERATIONS**	Periods	**9**
V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCABE-THIELE Principles; HETP Concepts. Adsorption equilibria; nature of adsorbants; various types of adsorbers.			
		Total Periods	**45**

Text Books	
1.	Holman, J. P., Heat Transfer, 9th Edition, McGraw Hill, Singapore, 2002
2.	K. A. Gavhane MassTransfer Operations.12th Edition, 2014.
References	
1.	McCabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6TH Edition,2004
2.	Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003
3.	GK Ray ., Heat and mass Transfer solved problems, Tata McGraw Hill, New Delhi
4.	K. A. Gavhane Heat Transfer Operations. Niraliprakashan publication, 18th Edition, 2017.
5.	Treybal, Robert Ewald, and E. Treybal Robert. *Mass-transfer operations*. Vol. 3. New York: McGraw-Hill, 1968.
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
U19BT517	GENETIC ENGINEERING & MOLECULAR BIOLOGY LABORATORY	0	0	4	2	60	40	100

Objective: To impart knowledge of various aspects of gene cloning, electrophoresis and application of genetic engineering

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

1. Agarose gel electrophoresis
2. Isolation of bacteria, plant and animal DNA.
3. Isolation of RNA
4. Elution of DNA from agarose gel using silica column.
5. PCR amplification of DNA fragment
6. Restriction enzyme digestion
7. Ligation of digested DNA
8. Competent cells preparation
9. Transformation and screening for recombinants
10. SDS PAGE gel electrophoresis

Total Periods: 60

Outcomes

1. Ability to express about gene amplification and methods for analysis of DNA
2. Usage of genetic and biotechnological techniques to manipulate genetic materials and their application
3. Understanding the main principles of DNA in various organisms
4. Ability to conduct the experimental method of DNA extraction from plants and animal source
5. Understand the transformation and screening of recombinants

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Programme	B. Tech	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	V

Course code	Course name	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT518	IMMUNOLOGY AND IMMUNOTECHNOLOGY LABORATORY	0	0	4	2	60	40	100

Objective

The students should be able to develop their skills
1. Isolation of antibodies
2. Purification of antibodies
3. Immunoelectrophoresis

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

1. ABO Blood Grouping
2. Widal slide test
3. Antigen antibody reactions and quantitation:
   (a) Slide Agglutination
   (b) Precipitin test
   (c) Immunoelectrophoresis – Rocket Electrophoresis
4. Selection of animals and handling (mouse, rat etc.)
5. Preparation of antigens, immunization and method of bleeding, Serum separation and storage.
6. Separation of leucocytes by dextran method and Separation of mononuclear cells by Ficoll-Hypaque
7. Direct and Indirect immunofluorescence
8. Identification of cells in a blood smear.
8. Radial Immunodiffusion
9. Ouchterlony Double Diffusion – Antibody titration
10. ELISA – Quantification of Immunoglobulins
11. Rapid diagnostics test, Immuno affinity chromatography assay.

Total Periods : 60

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Outcomes

CO1: Awareness of immune system cells and tissues

CO2:Knowledge on microbial and clinical tests

CO3:To know the techniques in isolation of lymphocytes and Leucocytes

CO4:Identify the presence of antigen and antibody in the sample and their related functions based on immune diffusion technique

CO5: Understand the binding of antigens and antibodies and their interaction through the ELISA Technique

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**Biotechnology**			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCTY5	**Logical Reasoning**	2	0	0	-	100	-	100

Content of the syllabus

Unit – I	**VERBAL REASONING**	Periods	**6**

Coding – Decoding(Letter Coding, Direct Letter Coding, Number/Symbol Coding, Deciphering Message – Word coding and Numeral coding, Substitution Coding, Crypt coding – crypt addition, subtraction, Information Arrangement Coding) , **Analogy** (Direct and Simple Analogy, Completing the Analogues pair, Choosing the Analogues pair, Choosing the similar word, Number Analogy, Alphabet Analogy), **Classification**(Choosing the odd words, Choosing the odd pair of words, Choosing the odd letter group, Choosing the odd number and odd pair of numbers), **Alphabet** Test(Arrangement according to dictionary, Alpha-Numeric sequence, Letter word problems, Rule detection), Word Formation (Using letters from a given word, By unscrambling words)

Unit - II	**SITTING ARRANGEMENT & SENSE TEST**	Periods	**6**

Sitting Arrangement (Arrangement in a line, Arrangement around of a circle, square and rectangle, Arrangement around pentagonal and hexagonal, **Direction Sense Test**[(Main, Cardinal and Shortest Direction)Final Detection, Displacement, Direction and Displacement], N**umber, Ranking, Time sequence Test** (Number Test, Ranking Test, Time Sequence Test), Puzzles (Based on classification, Based on placing and comparison, Family Based problems)

Unit – III	**NUMBER AND LETTER SERIES**	Periods	**6**

Number and Letter Series[(Number Series: To find a missing term, Find the number that does not follow the pattern, Miscellaneous pattern of the series (Based on addition / subtraction of consecutive odd / even no"s, Based on addition / subtraction of prime numbers, Multiplication and Division, Based on addition / subtraction of squares of natural numbers, Based on addition / subtraction of cubes of natural numbers) , Letter Series (Alphabet Series, Continuous pattern of series)], **Inserting the missing character, Age, Blood** (Jumbled up descriptions, Relation puzzles, Coded Relations), **Clock and calendar** (Mathematical operations and Notations- Problem of solving by substitution, Interchanging signs and numbers, Deriving the appropriate conclusions), **Logical order of words, Clerical aptitude** (Question based on address, Question based on issues)

Unit – IV	**LOGICAL AND ANALYTICAL REASONING**	Periods	**6**

Logical venn diagrams (Universal positive, Universal Negative, Universal Affirmative or Negative, Miscellaneous, Geometrical Figures on Venn Diagrams), **Eligibility test, Syllogisms, Statement and Assumptions, Statement and Conclusions, Statement and Arguments, Statement and Course of Action, Verification of Truth of the Statement, Data Sufficiency.**

Unit – V	**DATA INTERPRETATION & FLOW CHART**	Periods	**6**

Input – Output (Shifting, Arranging),**Data Interpretation** (Table chart, Bar chart, Pie chart, Miscellaneous chart, Mixed chart), **Cube**(no of sided painted, Full cube, cutting cube), **Flow chart** (Description flow chart, Value updating flow chart), **Quantitative reasoning, Logical deduction, Deductive reasoning, Binary logic**

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	Total Periods	**30**
Text Books		
1.	How to crack Test of Reasoning - Jai kishan and Prem kishan -arihant publication	
References		
1.	How to prepare logical reasoning for CAT – Arun Sharma – Mc Graw Hill Publication	

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SEMESTER VI

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	**VI**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT619	**PLANT & ANIMAL BIOTECHNOLOGY**	3	0	0	3	40	60	100

Course Objective

The objective of this course is to introduce students to cutting edge biotechnologies that can be used for plant, animal and human health and research.
To provide the basics of *Agrobacterium* and applications of plant Biotechnology
In this course students will analyze and discuss the primary literature on plant tissue culture and animal tissue culture.
This course will cover basic cellular and molecular biology techniques and their applications in a real world research.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the various media used in plant cell culture	K2
CO2: Identification of plant transformation techniques	K4
CO3: Gain the knowledge of therapy in animal cell culture	K3
CO4: Understand the concepts of micro manipulation technology	K3
CO5: Application of knowledge in concepts of transgenic plant & animal technology	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	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	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
2. Assignment
3. End-Semester examinations

Indirect

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1. Course - end survey			
Content of the syllabus			
Unit – I	**PLANT TISSUE CULTURE TECHNIQUES**	Periods	**8**
Introduction-Lab Facilities, sterilization methods and nutritional requirements. Protoplast culture,Callus induction, proliferation, shoots differentiation and rooting- Pathways-organogenesis and embryogenesis. Synthetic seeds. Micropropagation-methods, applications and successful examples. Bioreactors for micro propagation. National certification system for TC plants. Cell cultures for production of secondary metabolites. Bioreactors for plant cell cultures.			
Unit – II	**PLANT TRANSFORMATION TECHNIQUES**	Periods	**10**
Introduction- Direct (particle bombardment, PEG mediated transformation, electroporation, silicon carbide fibres) and Indirect gene transfer methods -*Agrobacterium* mediated gene transfer –Ti-plasmid- process of T-DNA transfer and integration- co-integrative and binary vectors, codon optimization, promoters and terminators, selectable markers, reporter genes - analysis and confirmation of transgenic plants -clean gene technology.			
Unit – III	**ANIMAL CELL CULTURE TECHNIQUE**	Periods	**10**
Media for culturing cells and tissues - Chemically defined and serum free media for cell culture; Sterilization of various equipments and apparatus - Cell culture substrates – Animal cell culture; types and methods - Development of cell lines; Development, Maintenance, Preservation and Characterization of animal cells , Scaling up of animal cell cultures – Cell culture as source of valuable products-Protein production by genetically engineered mammalian cell lines, Stem cells and their applications			
Unit – IV	**ANIMAL GENE TRANSFER METHODS**	Periods	**8**
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- Bt crops. Manipulation of Growth hormone; Somatotropic hormone and Probiotics as growth promoters; Ideal characteristics of probiotics; Mode of action and uses of probiotics- Manipulation of lactation -Lactogenesis- galactopoiesis, wool growth and rumen microbial digestive system.			
		Total Periods	**45**

Text Books	
1.	Ramadoss, P., Animal Biotechnology: Recent Concepts and Developments, MJb Publishers, Chennai, 1st Edition, 2017.
2.	Davis, D., Animal Biotechnology, National Academic Press, Washington, 1st Edition, 2002.
3.	Chawla, H.S., Introduction to Plant Biotechnology, Science Publishers, 3rd Edition, 2009.
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://nptel.ac.in/courses/102/102/102102033/
2.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**BIOTECHNOLOGY**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT620	**ENZYME ENGINEERING AND TECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The student should be made • 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

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	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

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect

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2. Course - end survey			
Content of the syllabus			
Unit – I	**INTRODUCTION TO ENZYMES**	Periods	**9**
Nomenclature and classification of enzymes, Enzyme units - Katal, IU, Principles of catalysis - collision theory, transition state theory, Measurement of enzyme activity - two point assay, kinetic assay, Mechanism and Specificity of Enzyme Action, Active site - Determination of active site amino acids - chemical probe, affinity label.			
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, Eisenthal and Cornish - Bowden plot. Kinetics of multi substrate enzyme catalysed reactions - Ping-pong bi-bi, random order and compulsory order mechanism, Kinetics of Allosteric enzymes - MWC model, KNF 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 AND CHARACTERIZATION 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.			
Unit – V	**APPLICATIONS OF ENZYMES IN VARIOUS INDUSTRY**	Periods	**9**
Lactase in Dairy Production, Pectinase in Fruit Juice production, Proteolytic enzymes in leather industry, Xylanase in detergent Production, Cellulase in Paper Production, Streptokinase as thrombolytic agents, Protease in Brewing Process, Collagenase in Skin aging process.			
		Total Periods	**45**
Text Books			
1.	Malcolm Dixon, Edwin C. Webb, "Enzymes ", Elsevier, 3rd edition, 1980.		
2.	Klaus Buchholz, Volker Kasche, Uwe Theo Bornscheuer, "Biocatalysts and enzyme technology", John Wiley & Sons, 2nd 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, "Understanding Enzymes", Prentice Hall, 1995.		
3.	Alan Wiseman, "Handbook of Enzyme Biotechnology", 3rd 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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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**VI**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BT621	**PROTEIN ENGINEERING**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	The student should be made to, • Identify the importance of protein molecules. • Realize the structure-function relationships in proteins • Know the role of functional proteins in various field of study. • Practice the latest application of protein science in their research. • Investigate database resources on protein	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Analyze the various bonds and interactions in protein structure	K2
	CO2: familiarize with different levels of protein structure	K3
	CO3: Understand various structure and functional relationship exist among different molecules	K3
	CO4: Acquire basic knowledge in the field of proteomics and methods associated with analyzing the proteome	K4
	CO5: Use different online tools available to exploit the protein sequence and its structural data	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	3	2		2	3							3	2	3
CO 2	3					3							2	3	2
CO 3	3	2	3			2							2	3	3
CO 4	3					3							2	3	3
CO 5	2					3		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

Content of the syllabus

Unit – I	**INTRODUCTION TO PROTEINS AND PEPTIDES**	Periods	**9**

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Amino - 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 and methods to determine, Alpha-turn-alpha, beta-turnbeta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.			
Unit – III	**TERTIARY STRUCTURE**	Periods	**9**
Tertiary structure - Domains, folding, denaturation and renaturation, basics of methods to determine 3D structures, 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 and Photosynthetic reaction center, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate- assisted catalysis, other commercial applications.			
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.		
Reference			
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.		
4.	Alberghina L., "Protein engineering in Industrial Biotechnology" CRC Press, 1st edition, 2000.		
5.	Branden C.Tooze J., "Introduction to protein structure", Garland Publishing, NY, USA 2nd edition, 1999.		
E-Resources			
1.	https://www.britannica.com/science/protein		
2.	https://www.khanacademy.org/science/biology/macromolecules/proteins-and-amino-acids/a/introduction-to-proteins-and-amino-acids		
3.	https://nptel.ac.in/courses/104/105/104105040/		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	VI

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT622	CHEMICAL REACTION ENGINEERING	3	0	0	3	40	60	100

Course Objective

The student should be made ,

- 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 rectors with series/parallel configurations.
- To understand the types of multiple reactions
- To gain knowledge of non-isothermal and adiabatic reactor performance.

Course Outcome

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

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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									3	3	3	2
CO 2	3	2		1									3	3	2
CO 3	3	2			3								2	2	2
CO 4	3	1											2	3	2
CO 5	2	2	3										3	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	**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, 3rd 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	2019		
Department	BIOTECHNOLOGY			Semester	VI		

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT623	COMPUTATIONAL BIOLOGY LABORATORY	0	0	4	2	60	40	100

Objective

The main objective of this course is to make students,

- Understand the basics of perl programming
- Develop skills to retrieve data from biological databases
- Perform and analyze the results of sequence alignment
- Analyze and evaluate the protein structure model created using modeling software and tool
- Interpret phylogenetic relationships among different organisms using molecular phylogeny tools

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

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LIST OF EXPERIMENTS

1. Basic Linux OS commands
2. Perl programming and applications to Bioinformatics.
   - Basic scripting.
   - Regular expressions.
   - File i/o & control statement.
   - Subroutines & functions.
   - Writing scripts for automation.
3. Important Biological Databases and resources
   - Genbank.
   - Protein Data Bank.
   - Uniprot.
   - BOLD (Barcode of life database)
4. Sequence Analysis Tools
   - Pairwise Sequence Alignment using BLAST
   - Pairwise sequence alignment using FASTA
   - Aligning Multiple Sequences with CLUSTAL W
   - Use of EMBOSS.
5. Phylogenetic Analysis
   - Phylogenetic Analysis using PHYLIP - Rooted trees
   - Phylogenetic Analysis using PHYLIP - Unrooted trees
6. Molecular Modeling
   - Homology Modeling – Swiss modeller.
   - Open Source Software - Modeller
7. Demonstration on Molecular docking and Molecular Dynamics Simulation

Total Periods : 60

Outcomes

Students who complete this course successfully are expected to

1.Develop basic scripts as bioinformatics tools with perl programming
2.Applying skills of computational approach for biological perspectives
3. Construct evolutionary tree by calculating phylogenetic relationship
4. Develop molecular 3-D structures for novel or putative proteins
5. Understand the application of bioinformatics tools in drug discovery and structural analysis

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Programme	B. Tech	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	VI

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT624	PLANT AND ANIMAL BIOTECHNOLOGY LABORATORY	0	0	4	2	60	40	100

Objective
The students should be able to
1. Understand explicitly the concepts
2. Develop their skills in the plant tissue culture techniques

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

Plant Biotechnology

1. Preparation of Media
2. Surface sterilization and inoculation of explants for callus induction
3. Protoplast isolation and viability staining.
4. Multiplication of plant through Micro propagation-Rose, chrysanthemum
5. Preparation of synthetic Seed
6. Sub culturing, shoot elongation rooting and hardening
7. Agro bacterium mediated gene transformation

Animal Biotechnology

1. Media Preparation for animal tissue culture.
2. Primary cell culture-Chick Embryo Fibroblast
3. Viability checking (Trypan Blue) and cell counting by Hemocytometer

Total periods : 60

Outcomes
1.Understanding the preparation of media and sterilization technique
2.Understand the plant cell structure and functions
3.Learn the nitrogen fixation mechanism and significance of viral vectors
4.Ability to gain the knowledge for development of therapeutic products
5.Will gain knowledge in animal cell culture technique and cell viability

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Programme	B.TECH	Programme code	105	Regulation	2019
Department	**BIOTECHNOLOGY**			Semester	VI

Course code	Course Name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN603	**Communication Skills laboratory**	0	0	3	1	100	-	100

Objective

- Equip with effective Soft skills in English.
- Enhance them with intrapersonal skills.
- Effective management of time and stress.

Outcomes

The students who complete this course successfully are expected to:	Knowledge Level
CO1: Able to communicate, present, describe and discuss fluently in English.	K1
CO2: Equipped for an easy transition from studying to working atmosphere.	K1
CO3: Accomplished with planning and corporate Managerial skills.	K2
CO4: To attain professional correspondence and execute the same in professional manner.	K4
CO5: To employ the professional needs and accomplishments at global standards.	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	3	-	3	-	-	-
CO 2	-	-	-	-	-	2	-	-	2	3	-	3	-	-	-
CO 3	-	-	-	-	-	2	-	-	2	2	-	3	-	-	-
CO 4	-	-	-	-	-	2	-	-	3	3	-	3	-	-	-
CO 5	-	-	-	-	-	2	-	-	3	3	-	3	-	-	-

English Language Proficiency: Listening Comprehension, Reading Comprehension, Common Errors in English, Diction and its usage, Framing sentences – Idiomatic Expressions.

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Resume – Structuring and Drafting the resume – Cover letter- Writing Professional Letters		
Group Discussion: Introduction – Topic Analysis – Thematic Expressions-Objective and content of discussion – Persuasion – Discussion – Controlling Emotions - Presentation of the group – Offering support – Use of functional Language - Summary and conclusion		
Presentation skills: Making Self Introduction effectively-Elements of effective presentation – Structure of presentation - Presentation tools – Voice Modulation – Audience analysis - Body language – Accents analysis – Stylistics.		
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 - Innovation, Creativity and Lateral thinking – Flexibility - Personality Traits and Soft Skills for future Career Advancement-Personality and Soft Skills for career growth- Time management.		
	Total Periods	45
Lab Manuals suggested:		
1.	Anderson, P.V, **Technical Communication**, Thomson Wadsworth, Sixth Edition, New Delhi, 2007.	
2.	John Seely, **The Oxford Guide to Writing and Speaking**, Oxford University Press, New Delhi, 2004.	

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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	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCTY6	PERSONALITY DEVELOPMENT	3	0	0	-	100	-	100

Content of the syllabus

Unit – I	NUMERICAL ABILITY	Periods	8

Number Properties – Time & Work – Pipes & Cisterns - Time, Speed & Distance – Ratios & Proportions – Mixtures & Alligations – Averages – Percentages – Profit & Loss – Simple & Compound Interest – Problems on Ages – Partnership – Mensuration – Geometry - Miscellaneous

Unit - II	LOGICAL REASONING	Periods	8

Coding Decoding – Blood Relations –Direction Sense Test – Seating Arrangement – Number Series – Syllogisms – Venn Diagrams – Statements – Data Interpretation – Data Sufficiency – Clocks & Calendars - Miscellaneous

Unit – III	SOFT SKILLS & VERBAL ABILITY	Periods	8

Resume Preparation – Mock GD – Interview Etiquette – Mock Interview – Reading Comprehension – Essay Writing

Unit - IV	TECHNICAL SKILLS I	Periods	8

Recap of C – Variables & Datatypes – Console IO Operations – Operators & Expressions – Control Flow Statements – Working with Functions – Working with Arrays

Unit – V	TECHNICAL SKILLS II	Periods	8

Pointers – String Handling – Structures & Unions – File Handling – Pre Processor Directives – Command Line Arguments & Variables – Searching & Sorting – Stack – Queue – Linked List - Trees

Total Periods 40

REFERENCES:

1. Quantum CAT by Sarvesh Verma – Arihant Publications
2. Quantitative aptitude by R.S. Aggarwal
3. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Aggarwal
4. Word Power Made Easy by Norman Lewis
5. Let us C By Yashavant P Kanetkar
6. Programming in ANSI C By E. Balaguruswamy

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SEMESTER VII

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	VII

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT725	DOWNSTREAM PROCESSING	3	0	0	3	40	60	100

Course Objective

The course aims to
- understand the fundamentals of biological product recovery , isolation separation purification and formulation
- acquire in depth knowledge and hands on training on design and optimization of Downstream process operations and equipment

Course Outcome	At the end of the course the students will be able to	Knowledge level
	CO1: understand the physicochemical properties of biotechnological products and economics of downstream processing	K1,K3
	CO2: analyze equipment selection and design of mechanical separation process for recovery of biotechnological products	K2,K3
	CO3: identify and optimize the suitable bio product isolation process at laboratory and pilot scale	K1,K5
	CO4: evaluate the chromatographic separation processes and equipment selection	K4
	CO5: assessing the stability of biotechnology products and analyze the formulation and stabilization for enhanced shelf-life	K4,K5

Pre-requisites: Bioprocess Engineering and Technology, Microbiology, Biochemistry

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	3		3								3	2	
CO 2	3				2								3	2	
CO 3	3		2										3	2	
CO 4	3	2											3	3	
CO 5	3												3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignments
3. End-Semester examinations

Indirect
1. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION TO DOWNSTREAM PROCESSING	Periods	9

Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell

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disruption for product release – mechanical, enzymatic and chemical methods. Pre-treatment and stabilisation of bio-products.			
Unit - II	**PHYSICAL METHODS OF SEPARATION**	Periods	9
Unit operations for solid-liquid separation - filtration and centrifugation. centrifugation-based methods for separation of the cell organelles and biomolecules (DNA, RNA, Proteins and secondary metabolites), Separation of different types of DNA from cells, Separation of the different types of RNA from biological samples			
Unit – III	**CONCENTRATION OF PRODUCTS**	Periods	9
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, Rotating membrane in bioseparation, polymer beads for immobilization of biomolecules, magnetic beads for bio-separation, cell sorting, microfluidics based separation, precipitation of proteins by different methods.			
Unit - IV	**PRODUCT PURIFICATION**	Periods	9
Chromatographic Principles: Distribution coefficients, retention parameters, qualitative and quantitative aspects of chromatography-Column Efficiency, Selectivity and Resolution. Chromatography – instruments and practice, adsorption, reverse phase, ion- exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques. TLC for separation of the lipids			
Unit – V	**FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS**	Periods	9
Crystallization, crystallization theory, Methods of super saturation, types of nucleation and crystal growth,yield of crystal. Drying – Theoretical Consideration, batch drying process, drying time calculation, and drying equipment and different types of formulation procedure. Analysis of the final product - Protein-based contaminants, Microbial and viral contaminants, Viral assays, Miscellaneous contaminants, Validation studies.			
		Total Periods	**45**
Text Books			
1.	Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing for Biotechnology", John Wiley, 1988		
2.	Ghosh, Raja "Principles of Bioseparations Engineering". World Scientific, 2006.		
3.	Roger G. Harrison, Paul W . Todd, Scott R. Rudge, and Demetri P. Petrides "Bioseparations Science and Engineering " Oxford University Press 2006		
References			
1.	Michael C Flickinger "Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology" John Wiley & Sons 2010		
2.	Michael R Ladisch "Bioseparations Engineering" John Wiley & Sons 2001		
3.	Sivasankar B. Bioseparations: Principles and Techniques PHI Learning, 2005		
4.	Prasad Krishna Downstream Process Technology a New Horizon in Biotechnology, PHI Learning, 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	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**VII**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BT726	**PROTEOMICS AND GENOMICS**	3	0	0	3	40	60	100

Course Objective

The student should be made

- 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 Outcome	At the end of the course, the student should 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	K2
	CO5: Analyze the gene expression data for interpreting the function of genes	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	3	2	1	3	1	2		3	2	2	2	1
CO 2	2	2	2		1	3	2	2	3	3		2	2	3	2
CO 3	2	2	2	2	3	2	3	2	2		1	3	2	1	2
CO 4	3	2	3	3	2	2			2		2		2	2	3
CO 5	3	2	3	3	1	3	2	1	1	2	2	2	2	3	2

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

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2. Course - end survey			
Content of the syllabus			
Unit – I	**GENOME & ANNOTATION**	Periods	9
Structural organization of genome in Prokaryotes and Eukaryotes; DNA sequencing-principles and translation to large scale projects; Microbes, plants and animals; Accessing and retrieving genome project information from web resources; Recognition of coding and non-coding sequences and gene annotation.			
Unit – II	**TECHNIQUES IN GENOMICS**	Periods	9
Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping. Comparative genomics, Identification and classification of microbes using 16S rRNA typing/sequencing, ESTs and SNPs.			
Unit – III	**PROTEOMICS**	Periods	9
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.			
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 PROTEOMICS**	Periods	9
Microarray - analysis of microarray data & Normalization; Protein and peptide microarray-based technology; Structural proteomics & techniques. Transcriptomics, System Biology, Metabolomics Metagenomics.			
		Total periods	**45**
Text Books			
1.	Peter Sudbery, Human Molecular genetics, Benjamin-Cummings Publishing Company, 2010		
2.	D.C. Libeler, Introduction to Proteomics: Tools for the New Biology, Humana Press, 2006		
References			
1.	T.A. Brown, Genomes 3, Garland Science, 2007.		
2.	Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007		
3.	Arthur M. Lesk, Introduction to Protein Science- Architecture, Function and Genomics, Oxford University Press, 2004.		
E-Resources			
1.	https://nptel.ac.in/courses/102/103/102103017/		
2.	https://nptel.ac.in/courses/102/104/102104056/		
3.	https://nptel.ac.in/content/storage2/courses/102101040/downloads/Handouts/Lec-22.pdf [Microarray]		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	VII

Course Code	Course Name	Periods Per Week		Credit	Maximum Marks			
		L	T	P	C	CA	ESE	Total
U19BT727	BIOPHARMACEUTICAL TECHNOLOGY	3	0	0	3	40	60	100

Course Objective

The student should be made

- To gain knowledge on biopharmaceuticals and biosimilars.
- To understand the method of drug discovery and development.
- To understand the different materials used in dosage forms of drugs.
- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.
- To analyze the role of different therapeutic compounds in treatment of various disorders.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the difference between chemical and bio-based pharmaceuticals.	K2
CO2: Infer knowledge on the drug development, manufacture process and Regulatory practices.	K4
CO3: Acquire knowledge on different substances used for pharmaceutical products and their applications in therapeutic and diagnostic fields.	K4
CO4: Understand the various methods for formulation of biopharmaceuticals and its preservation.	K2
CO5: Understand the therapeutic applications of various bioactive substances for their use in treating diseases.	K2

Pre-requisites: Cell Biology, Biochemistry, Microbiology, Molecular Biology, Bioprocess Engineering & Technology, Immunology

CO / PO 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	1	2	1	2	1		1	2	1	2	2	3	2
CO 2	2	2	2	2	2	3	2	3	3	3	3	2	3	3	3
CO 3	3	2	2	2	2	3	1		2	2	3	2	2	3	3
CO 4	2	2	2	2	2	3	1	2	3	2	2	2	2	3	3
CO 5	3	2	2	2	2	3		2	3	2	3	2	2	3	3

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	**INTRODUCTION TO BIOPHARMACEUTICALS**	Periods	**9**
Drug - Definition, Classification - Physiochemical properties - Basic Terminologies in Drug – Agonist, Antagonist, Biopharmaceuticals – Biosimilar – 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, Clinical Trial Phases, FDA- India & US guidelines and approvals-Patenting-Drug and Cosmetics Act-Introduction to animal ethics-Animal rights and use of animals in research for testing of drug-Toxicity Studies-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 - Compartment Modelling - 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 – Antitumour drugs, Diabetes, Role of pharmaceuticals in Gene therapy, Nutraceuticals for Cancer, Vaccine – Definition & Its Types, Vaccines for COVID-19 - COVAXIN, Mode of action of Laxatives, Analgesics, Contraceptives, 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, 5th Edition,2011.
2.	Gary Walsh, "Biopharmaceuticals: Biochemistry and Biotechnology", John Wiley & Sons, Inc., 2nd Edition, 2003.

References

1.	Katzung,B., Masters, S., Trevor, A., "Basic and Clinical Pharmacology (LANGE Basic Science)", McGraw-Hill Medical, 11th edition, 2009.
2.	Ansel H.C,"Pharmaceutical dosage forms and drug delivery systems", Lippincott Williams & Wilkins, 8th edition, 2007.
3.	Gary Walsh, "Pharmaceutical Biotechnology: Concepts and Applications", John Wiley & Sons, Inc., 2007.

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4.	Manohar A. Potdar and Ramkumar Dubey, "cGMP Current Good Manufacturing Practices for Pharmaceuticals", Pharmamed Press / Bsp Books, Second Edition, 2018.
5.	Lee, Chi-Jen et. al, "Clinical Trials or Drugs and Biopharmaceuticals." CRC/Taylor & Francis, 2011.
6.	Ansel, H.C. "Pharmaceutical Dosage Forms and Drug Delivery Systems", 11th Edition, Lippincott Williams &Wilkins, 2018.
7.	Misra, Ambikanandan, Shahiwala, Aliasgar "Novel Drug Delivery Technologies", 1st Edition, Springer, 2019
8.	Lieberman, H.A. "Pharmaceutical Dosage Forms: Tablets". Vol.1-3, 2nd Edition, Marcel Dekker, 2005.
9.	Vyas S.P, Khar K.R. " Targeted & Controlled Drug Delivery -Novel Carrier Systems", 1st Edition, CBS Publishers, 2012.
10.	Surendra Nimesh, Ramesh Chandra, Nidhi Gupta."Nanotechnology for the Delivery of Therapeutic Nucleic Acids". 1st Edition, Woodhead Publishing, 2017.
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://nptel.ac.in/courses/102/108/102108077/
4.	https://medcraveonline.com/JMEN/natural-useful-therapeutic-products-from-microbes.html
5.	https://www.bharatbiotech.com/covaxin.html

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Programme	B. Tech	Programme code	105		Regulation	2019		
Department	BIOTECHNOLOGY				Semester	VII		
Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BT728	DOWNSTREAM PROCESSING LABORATORY	0	0	4	2	60	40	100
Objective	To develop skills of students perform in various purification techniques used in separation of biomolecules							

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	3			3		3	2				2	3	2
CO 2	1	3	2			3		3	3				3	3	2
CO 3	2	2	3			3		3	2				2	2	3
CO 4	3	2	1			3		3	3				3	2	2
CO 5	3	2	2			3		3	3				3	2	2

LIST OF EXPERIMENTS

1. Isolation of the biomolecules using filtration methods.
2. Isolation and separation of the biomolecules using centrifugation
3. Isolation and separation of the biomolecules using ultrasonication cell disruption techniques
4. Isolation and separation of the biomolecules using enzymatic cell disruption method
5. Concentration of protein from bacterial sample using Precipitation methods (ammonium sulphite precipitation, solvent precipitation)
6. Concentration of protein from bacterial sample using aqueous two phase extraction.
7. Separation of the proteins with suitable chromatography methods (affinity chromatography, ion exchange chromatography, gel filtration chromatography)

Total periods : 60

Outcomes

- Understanding of different stages of downstream processing.
- Illustrate the solid-liquid unit operation involved in downstream processing.
- Knowledge of principles and working of different unit operations for the isolation and extraction of bio-products.
- Describe the various methods of chromatography used in protein purification.
- Knowledge of different methods and industrial equipments used for the concentration, purification and final polishing of bio-products at the industrial level

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Verticals -1
Environmental Biotechnology

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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV11	WASTE WATER TREATMENT	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- To know the nature and source of raw wastewaters, and treatment objectives
- To understand the fundamental, scientific basis governing the design and performance of the treatment technologies
- To apply their knowledge of the principles of water and wastewater treatment to the design of each unit process

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Recognize water quality standards and fundamental principles of wastewater treatment	K2
CO2: Acquire knowledge about wastewater analysis and various treatment regulations	K4
CO3: Understand the conventional processes involving pollutant removal from the wastewater	K3
CO4: Awareness about the importance of biological methods of wastewater remediation	K4
CO5: Identify the advance technologies associated with the wastewater treatment mechanisms	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	PSO 2	PSO 3
CO 1	3	2	1		1	3	3	2		2		2	3	2	2
CO 2	3	2	2		1	3	3	2	1	3	2	1	2	3	2
CO 3	3	3	3	1	2	3	3	3	2	2	3	3	3	3	3
CO 4	3	3	3	2	2	3	3	2	2	1	2	2	3	3	3
CO 5	3	1	3	2	3	3	3	3	3	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

Content of the syllabus

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Unit – I	**QUALITY OF WATER AND BASIC TREATMENT TECHNOLOGIES**	Periods	**9**
Water Quality– physical, chemical, and biological parameters of water– water quality requirement – potable water standards – wastewater effluent standards – Water purification methods– physical processes– chemical processes and biological processes– primary, secondary, and tertiary treatment.			
Unit – II	**WASTEWATER TREATMENT PROCESS ANALYSIS AND REGULATIONS**	Periods	**9**
Components of wastewater – industrial water treatment, Environmental regulations, and technology– Regulator Concerns, Technology; Laws, regulations and permits- Air, Water, Solid Waste, Environmental Auditing National Environmental Policy act, Occupational Safety and Health Act (OSHA)			
Unit – III	**CONVENTIONAL TREATMENT METHODS**	Periods	**9**
Adsorption – activated carbon treatment – removal of color – iron andmanganese removal – aeration, oxidation, ion exchange and other methods – effects of fluorides –fluoridation and defluorination – desalination– corrosion prevention and control			
Unit – IV	**BIOLOGICAL TREATMENT**	Periods	**9**
Biological oxidation –lagoons and stabilization basins– activated sludge process – Biofilm process considerations; Trickling Filters and Biological Towers; Rotating Biological Contactors - Up Flow Anaerobic Sludge Blanket (UASB).			
Unit – V	**ADVANCED TECHNOLOGIES**	Periods	**9**
Technologies used in advanced treatment–advanced oxidation process – sludge handling and disposal –Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis& other miscellaneous treatment technologies.			
		Total Periods	**45**

Text Books	
1.	Metcalf and Eddy, "Wastewater Engineering", 5th ed., McGraw Hill Higher Edu., 2013
2.	C.S. Rao, "Environmental Pollution Control Engineering", New Age International, 2007.
References	
1.	W. Wesley Eckenfelder, Jr., "Industrial Water Pollution Control", 2nd Edn., McGraw Hill Inc., 1989.
2.	Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann.
E– Resources	
1.	http://www.fao.org/3/t0551e/t0551e05.htm
2.	https://www3.epa.gov/npdes/pubs/bastre.pdf
3.	https://www.intechopen.com/books/wastewater-treatment-engineering/biological-and-chemical-wastewater-treatment-processes

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**		
Department	**Biotechnology**			Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV12	**ENVIRONMENTAL BIOTECHNOLOGY**	**3**	**0**	**0**	**3**	40	60	**100**
Course Objective	To make the students aware of the basic concept and techniques of environmental biotechnology and its application							

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the role of biotechnology in Environment	K2
	CO2: Implement the concept of biotechnology in waste water treatment	K3
	CO3: Acquire knowledge on pollutant and its bioremediation.	K3
	CO4: Implementation of biotechnology in value added products.	K3
	CO5: Investigate different hazardous substance in environment and monitor it to control	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	3	3	1	3
CO 2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2		2	2					2				3	1	2
CO 5	2		3			3		3	2		2		2	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	**Concept of Environmental Biotechnology**	Periods	9

Definition - concept and scope - Application of biotechnology - Role of microbial systems - Principles - Characteristics - Genetically engineered organisms - Merits and demerits - Bio tools for environmental monitoring - Role of biotechnology in environmental protection.

Unit - II	**Biotechnology and pollution abatement**	Periods	9

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Biotechnology of wastewater treatment - Bioreactors - Microbial system in waste water stabilization - Biofilms - immobilization technology in waste water treatment - Microbial metabolism and growth kinetics - oil degradation - biodecolourization - Reed bed technology - Rhizosphere engineering.			
Unit – III	**Bioremediation**	Periods	**9**
Bioremediation - Principles - Biodegradation of agro chemicals and other organic compounds - Biotransformation of xenobiotic compound - Role of GEMS in degradation of xenobiotics; Bioscrubbers - Biomining of metals - Biopulping.			
Unit - IV	**Environmental Monitoring**	Periods	**9**
Polluted environment - Short and long term monitoring of remediated sites - Biodegradable plastics - Environmental implications – Biofiltration - Bioindicators - Biomarkers – Biosensors – Mass based Biosensor, optical based Biosensor, electrochemical biosensor – Biomonitoring.			
Unit – V	**Biotechnology and value addition**	Periods	**9**
Production of value added products from waste - Single Cell Protein (SCP), ethanol, methane and hydrogen, amino acids, vitamins -Enzyme production from wastes - Biotechnology of Microbial composting - Biofertilizers- Biopesticides			
		Total Periods	**45**
Text Books			
1.	Chatterji. A.K., 2003. Introduction to Environmental Biotechnology. Printice Hall of India Pvt. Ltd., New Delhi.		
2.	Miller Jr. G. T., 2004. Environmental Science. Tenth Edition. Thompson Brooks/Cole. United States.		
References			
1.	Kumar H.D., 1998. A text book on biotechnology. II Edition, Affiliated east west press Pvt.		
E-Resources			
1.	http://dbtindia.gov.in/schemes-programmes/research-development/energy-environment-and-bio-resource-based-applications-0		
2.	https://www.nature.com/subjects/environmental-biotechnology		
3.	https://www.biologydiscussion.com/biotechnology/environmental-biotechnology/environmental-biotechnology-meaning-applications-and-other-details/8528		

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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTV13	**BIOREMEDIATION**	3	0	0	3	40	60	100

Course Objective	The student should be made to • Understand the nature and importance of bioremediation. • Know the influence of site characteristics to bioremediation rates. • Have knowledge of the impacts of contaminant. • Characteristics to bioremediation process.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: To understand the bioremediation concepts	K1
	CO2: To analyse bioremediation, mechanisms, types, success stories& monitoring strategies.	K2
	CO3: To focus the advance molecular techniques to facilitate bioremediation technology.	K4
	CO4: Acquire knowledge on nuclear remediation program.	K3
	CO5: To apply the concepts of bioremediation technology to the real time problems.	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** 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	1	3	2	3	3							3	2	3
CO 2	2	1	2	3	3	3							2	3	2
CO 3	2	1	2	3	2	3							2	3	3
CO 4	2	1	1	1	3	3							2	3	3
CO 5	2	1	3	1	3	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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Unit – I	Introduction to Bioremediation	Periods	9
Introduction to Bioremediation: Types of Bioremediation, Factors affection Bioremediation Bioremediation Mechanisms. Limitations of Bioremediations. Microbes for Bioremediation: Essential Chararcteristics of Microbes for Bioremediation, Microbial Adapadation for Adverse conditions. Microbes involved in Bioremediation. Metabolic process involved in bioremediation. Bioremediation Techniques: Insitu & Exsitu bioremediation techniques. Phytoremediation			
Unit - II	**Specific bioremediation technologies**	Periods	9
Environment of Soil Microorganisms; Soil Organic Matter and Characteristics; Soil Microorganisms Associatio with Plants; Pesticides and Microorganisms; Petroleum Hydrocarbons and Microorganisms; Industrial solvents ar Microorganisms; Biotechnologies for Ex-Situ Remediation of Soil; Biotechnologies for in-Situ Remediation of Soil Phytoremediation Technology for Soil Decontamination			
Unit – III	**Bioremediation of chlorinated compounds and molecular techniques in bioremediation**	Periods	9
Bioremediation of phenols, chlorinated phenols, chlorinated aliphatic compounds, heterocyclic compounds, cyanides, dyes; Rhizoremediation: a beneficial plant-microbe interaction; Molecular techniques in bioremediation- Enhanced biodegradation through pathway engineering; Biodegradation of polyhalogenated compounds by genetically engineered bacteria.			
Unit - IV	**Bioremediation of Metals**	Periods	9
Spent fuel characterization, storage and disposal; Partitioning, transmutation and conditioning; Measurement of Radioactivity in the environment; Basic actinide research.			
Unit – V	**Heavy metal and oil spill bioremediation**	Periods	9
Heavy metal pollution & sources; Microbial interactions with heavy metals - resistance & tolerance; Microbial transformation; Accumulation and concentration of metals. Biosorption of heavy metals by microbial biomass and secondary metabolites – Biosurfactants. Advantages of biosurfactants over chemical surfactants. Biotechnology and oil spills; Improved oil recovery.			
		Total Periods	**45**

Text Books	
1.	Bruce E. Rittmann, Perry L. McCarty, "Environmental Biotechnology: Principles and Applications" McGraw-Hill, 2001.
2.	S. K. Agarwal, "Environmental Biotechnology", APH Publishing, 2000
References	
1.	Bioremediation: Desk Manual for the Environmental Professional (Advances in environmental control technology)" by R Dennis
2.	Bioremediation Technology: Recent Advances" by M H Fulekar
3.	Biofilms in Bioremediation: Current Research and Emerging Technologies" by Gavin Lear
E-Resources	
1.	http://learnbioremediation.weebly.com/introduction-to-bioremediation.html
2.	http://clu-in.org/products/citguide/#flyer

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV14	ECOLOGY & ENVIRONMENTAL MANAGEMENT	3	0	0	3	40	60	100

Course Objective	To impart an understanding of systems approach to Environmental Management as per ISO 14001 and skills for environmental performance in terms of legal compliance, pollution prevention and continual improvement.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Appreciate the elements of Corporate Environmental Management system complying to international environmental management system standards	K2
	CO2: Lead pollution prevention assessment team and implement waste minimization options.	K1
	CO3: Develop, Implement, maintain and Audit Environmental Management systems for Organizations	K1
	CO4: Explain the role of environmental audit.	K1
	CO 5: Illustrate the applications.	K4
Pre-requisites	Knowledge of basic biology and environmental biology.	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2												3	2	3
CO 2	3	3	3									3	2	3	2
CO 3	3	3	3		3							3	2	2	2
CO 4	3	3	1		3							3	2	3	3
CO 5	3	3	3	3	3				3	3	3	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
1. Assignment
2. End-Semester examinations

Indirect
1. Course - end survey

Content of the syllabus

Unit – I	ECOLOGY & ENVIRONMENTAL MANAGEMENT STANDARDS	Periods	9

Unique Characteristics of Environmental Problems - Systems approach to Corporate environmental management - Classification of Environmental Impact Reduction Efforts -Business Charter for Sustainable Production and

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Consumption – Tools, Business strategy drivers and Barriers - Evolution of Environmental Stewardship – Environmental Management Principles - National policies on environment, abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking.			
Unit - II	**PREVENTIVE ENVIRONMENTAL MANAGEMENT**	Periods	**9**
Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification –Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries – Preventive Environmental Management over Product cycle.			
Unit – III	**ENVIRONMENTAL MANAGEMENT SYSTEM**	Periods	**9**
EMAS, ISO 14000 - EMS as per ISO 14001– benefits and barriers of EMS – Concept of continual improvement and pollution prevention - environmental policy – initial environmental review – environmental aspect and impact analysis – legal and other requirements- objectives and targets – environmental management programs – structure and responsibility – training awareness and competence- communication – documentation and document control – operational control – monitoring and measurement – management review.			
Unit – IV	**ENVIRONMENTAL AUDIT**	Periods	**9**
Environmental management system audit as per ISO 19011 – Roles and qualifications of auditors - Environmental performance indicators and their evaluation – Non conformance – Corrective and preventive actions -compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit.			
Unit – V	**APPLICATIONS**	Periods	**9**
Applications of EMS, Waste Audits and Pollution Prevention opportunities in Textile, Sugar, Pulp & Paper, Electroplating, Tanning industry, Dairy, Cement, Chemical industries, etc.			
		Total Periods	**45**
Text Books			
1.	Philipp Weir and Jörg Bentlage, Environmental Management Systems and Certification, Baltic University Press, Uppsala 2006.		
References			
1.	Lennart Nilsson, Per Olof Persson Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene, Cleaner Production-Technologies and Tools for Resource Efficient Production, Baltic University Press, Uppsala, 2007.		
2.	Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earth scan Publications Ltd, London, 1999.		
3.	ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organization for Standardization, 2004		
4.	ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002		
E -Resources			
1.	https://nptel.ac.in/courses/102/102/102102033/		
2.	http://www.nptelvideos.in/2012/11/.html		
3.	https://onlinecourses.swayam2.ac.in/cec20_bt20/preview		

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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV15	SOLID WASTE MANAGEMENT	3	0	0	3	40	60	100

Course Objective

To impart knowledge and skills relevant to minimization, storage, collection, transport, recycling, processing and disposal of solid and hazardous wastes include the related regulations, engineering principles, design criteria, methods and equipment.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Explain the various functional elements of solid and hazardous waste management.	K1
CO2: Apply the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes.	K2
CO3: waste minimization, storage, collection, transport, recycling, processing and disposal.	K3
CO4: Select appropriate methods for processing and disposal of solid and hazardous wastes	K4
CO5: Conduct research pertinent to solid and hazardous waste management.	K4

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** 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
CO 2	3	2		2									2	3	2
CO 3			3										2	3	3
CO 4					3	3							2	3	3
CO 5		2	3	2	3	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

Content of the syllabus

Unit – I	WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS	Periods	9

Sources and types of solid and hazardous wastes - need for solid and hazardous waste management – salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries – elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated

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solid waste management planning.			
Unit - II	**WASTE COLLECTION**	Periods	**9**
Door to door collection of segregated solid wastes - analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes – principles and design of transfer and transport facilities - hazardous waste transport and manifests - mechanical processing and material separation technologies – Size reduction – size separation - density separation - magnetic separation – compaction – principles and design of material recovery facilities – physico chemical treatment of hazardous wastes - solidification and stabilization – case studies on waste collection and material recovery.			
Unit – III	**WASTECHARACTERIZATIONAND RECYCLING**	Periods	**9**
Waste sampling and characterization plan - waste generation rates and variation – physical composition, chemical and biological properties –hazardous characteristics–ignitability, corrosivity and TCLP tests source reduction, segregation and onsite storage of wastes – waste exchange extended producer responsibility - recycling of plastics, C wastes and E waste.			
Unit - IV	**BIOLOGICAL AND THERMAL PROCESSING OF WASTES**	Periods	**9**
Biological and thermo chemical conversion technologies – composting – biomethanation – incineration – pyrolysis- plasma arc gasification –principles and design of biological and thermal treatment facilities - MSW processes to energy with high-value products and specialty BY- Products - operation of facilities and environmental controls - treatment of biomedical wastes – case studies and emerging waste processing technologies.			
Unit – V	**WASTE DISPOSAL**	Periods	**9**
Sanitary and secure landfills - components and configuration– site selection - liner and cover systems - geo synthetic clay liners and geo membranes - design of sanitary landfills and secure landfills- leachate collection, treatment and landfill gas management – landfill construction and operational controls - landfill closure and environmental monitoring – landfill bioreactors – rehabilitation of open dumps and biomining of dumpsites- remediation of contaminated sites- Case studies.			
		Total Periods	**45**

Text Books

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. CPHEEO, "Manual on Municipal Solid waste management,Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016

References

1. William A. Worrell, P. Aarne Vesilind, Christian Ludwig, Solid Waste Engineering - A Global Perspective, 3rd Edition, Cengage Learning
2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York
3. John Pitchtel, Waste Management Practices, CRC Press, Taylor and Francis Group, 2014.

E-Resources

1. https://www.bbau.ac.in/Docs/FoundationCourse/TM/Lecture%2010%20Integrated%20waste%20management.pdf
2. https://www.youtube.com/playlist?list=PLwdnzlV3ogoXAap_BHeApkcF7M8nt13hv

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Programme	**B. Tech**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV16	**Safety and Disaster Management**	3	0	0	3	40	60	100

Course Objective

The student should be made,

- To understand the principle of safety management
- To gain knowledge over safety audit and write audit reports
- To learn about various function and activities of safety department
- To know the source of information for safety promotion and training
- To familiarize the students with evaluation of safety performance

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: To know the trades and procedures of safety engineering department.	K1
CO2: To convey out a safety inspection and frame a report for the audit.	K2
CO3: To formulate an accident investigation report	K3
CO4: To evaluate the safety concert of an organization from accident records	K4
CO5: To Provide basic conceptual understanding of disasters.	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		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	3	2	3	3	3	3	3	2	3	3	3	2
CO 2	3	2	3	1	1	2	2	2	1	3	3	1	3	3	3
CO 3	3	2	2	3	3	2	1	3	2	2	3	3	3	2	3
CO 4	3	1	1	2	1	3	1	3	2	3	1	3	2	3	3
CO 5	2	2	3	1	2	2	3	2	3	1	3	2	3	2	3

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	**CONCEPTS AND TECHNIQUES**	Periods	**9**
Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity, safety-budgeting for safety - safety policy, safety sampling, evaluation of performance of supervisors on safety.			
Unit - II	**SAFETY AUDIT**	Periods	**9**
Components of safety audit, types of audits, audit methodology, review of inspection, remarks by government agencies, safety records formats – implementation of audit indication, check list – identification of unsafe acts of workers.			
Unit – III	**ACCIDENT INVESTIGATION AND REPORTING**	Periods	**9**
Concept of an accident, reportable and non-reportable accidents, and principles of accident prevention – accident investigation and analysis – records for accidents, documentation of accidents – role of safety committee cost of accident.			
Unit - IV	**SAFETY PERFORMANCE MONITORING**	Periods	**9**
Recommended practices for compiling and measuring work injury experience – permanent total disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, incident rate, accident rate safety			
Unit – V	**DISASTERS AND ITS TYPES**	Periods	**9**
Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.			
		Total Periods	**45**
Text Books			
1.	Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 3 rd Edition 2010		
2.	"Accident Prevention Manual for Industrial Operations", N.S.C. Chicago, 13th Edition 2011		
ferences			
1.	Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 2001		
2.	Modh S, "Managing Natural Disasters," Mac Millan publishers India LTD, 2010		
3.	John Ridley, "Safety at Work", Butterworth and Co., London, 2013		
Resources			
1.	https:// nptel.ac.in/noc20_mg43/preview		
2.	https:// https://nptel.ac.in/courses/110105094		
3.	https:// nptel.ac.in/courses/110/105/110105094		

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Programme	**B. Tech**	Programme Code		**105**	Regulation		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV17	**Air Pollution and control Engineering**	3	0	0	3	40	60	100

Course Objective	The student should be made, • To understand the basic concepts of structure and Composition of Atmosphere. • To learn the Effects of meteorology, Atmospheric Diffusion Theories and dispersion models • To gain knowledge over Control of Particulate Contaminants. • To understand the working principle of control of gaseous contaminants equipment's. • To gain knowledge of indoor air quality management.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Remember the concept of composition of Atmosphere and Air Quality Emission standards.	K1
	CO2: Understand the fundamentals of atmospheric stability, inversion, wind profiles and stack plume patterns	K2
	CO3: Apply the design knowledge of control of particulate contaminants equipment's	K3
	CO4: Exhibit the mechanism of air process control and monitoring equipment's	K4
	CO5: Analyze the performance of measurement, standards, control and preventive measures indoor air quality management	K4
e-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		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	2	1	3	3	3	2	2	2	2	3	3	3	2
CO 2	3	2	3	2	1	2	3	3	1	1	3	2	3	3	2
CO 3	3	2	3	3	2	3	2	2	1	2	3	1	2	2	2
CO 4	3	1	2	3	3	1	3	2	2	1	1	2	2	3	2
CO 5	2	2	3	2	3	3	1	3	1	3	3	1	3	2	2

Course Assessment Methods

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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**
Structure and composition of Atmosphere - Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, Ambient Air Quality and Emission standards.			
Unit - II	**METEOROLOGY**	Periods	**9**
Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise			
Unit – III	**CONTROL OF PARTICULATE CONTAMINANTS**	Periods	**9**
Factors affecting Selection of Control Equipment - Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators			
Unit - IV	**CONTROL OF GASEOUS CONTAMINANTS**	Periods	**9**
Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.			
Unit – V	**INDOOR AIR QUALITY MANAGEMENT**	Periods	**9**
Sources, types and control of indoor air pollutants, sick building syndrome and building related illness - Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.			
		Total Periods	**45**
Text Books			
1.	Rao, CS, "Environmental pollution engineering: Wiley Eastern Limited, New Delhi, 1 st January 2018.		
2.	Noel de Nevers, "Air Pollution Control Engineering", Waveland press, Inc 2017.		
ferences			
1.	S. P. Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2016		
2.	G. T Miller, Environmental Science: Working with the Earth, 11th Edition, Wadsworth Publishing Co., Belmont, CA, 2011		
3.	E. C Wolfe, Race to Save to Save Planet, Wadsworth Publishing Co., Belmont, CA 2006		
Resources			
1.	https:// nptel.ac.in/noc23_ce14/preview		
2.	https:// nptel.ac.in/courses/105/104/105104099/		
3.	https:// nptel.ac.in/courses/123/105/123105001/		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV18	E-Waste Management	3	0	0	3	40	60	100

Course Objective

The student should be made to

- To know the basics and effects of E-waste.
- To understand the concepts and technological approaches of E-waste management.
- To acquire knowledge in regulations and laws of E-waste.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Explain the sources, properties and effects of E-waste	K2
CO2: Aware of technologies in recycle and recovery of E-waste	K4
CO3: Understand the fact of E-waste hazardous on global trade	K2
CO4: Analyze the control of e-waste at source	K4
CO5: Perform case study of E-waste mitigation with regulations	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	2			2		1		1	2	3	3
CO 2	2	2		2	2			2		1		2	2	2	2
CO 3	2	3	3	2	2	3		3	3	3	3	3	3	3	3
CO 4	3	2	3	2	2	2		3	3			2	3	1	2
CO 5	3	3		2	2			2	3	1		3	3	3	3

Pre-requisites -

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations
Indirect
3. Course - end survey

Content of the syllabus

Unit – I	INTRODUCTION	Periods	9

E-waste – composition and generation - E-waste pollutants - hazardous properties - Effects on human health and surrounding environment – Domestic E-waste disposal. Global context in E-waste.

Unit – II	E-WASTE HAZARDOUS ON GLOBAL TRADE	Periods	9

Essential factors in global waste trade economy – Waste trading as a quint essential part of electronic recycling - Free trade agreements as a means of waste trading- Import of hazardous e-waste in India – Import of e-waste

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permissions - Estimation and recycling of e-waste in metro cities of India.			
Unit – III	**E-WASTE MANAGEMENT**	Periods	**9**
Basic principles of E-waste management - component of E-waste management - Technologies for recovery of resources from electronic waste - Steps in recycling and recovery of materials from E-waste.			
Unit – IV	**E-WASTE CONTROL MEASURES**	Periods	**9**
Reduction of waste at source – Extended Producers Responsibility (EPR) – Producer-Public-Government cooperation in E-waste control – Administrative controls and Engineering controls.			
Unit – V	**E-WASTE LAWS AND REGULATIONS**	Periods	**9**
Need for stringent health safeguards and environmental protection laws in India - E-waste (Management and Handling) Rules, 2011 – E-waste management Rules, 2016 – The international legislation – The Basel convention and case studies.			
		Total Periods	**45**
Text Books			
1.	Dr. Suresh Kumar and Dr. Jatindra Kumar Pradhan, E-waste: Management and Procurement of Environment, 2021.		
2.	Dr. Suresh Kumar, E-waste in India (Management, Challenges & Opportunities), Volume 1, 2021.		
References			
1.	Shastri S.C, Environmental Law, Eastern Book Company,2022		
E-Resource			
1.	https://news.mit.edu/2013/ewaste-mit		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV19	**Environmental Impact Assessment**	3	0	0	3	40	60	100

Course Objective

The student should be made
- To understand the concept of an EIA in real time project.
- To predict the impact and mitigation measures of any project on natural environment.
- To prepare an EIA report for executing the newly developed project

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Speak about the basic principles of EIA.	K1
	CO2: Analyse the methods of EIA with case studies.	K4
	CO3: Predict the impact on natural environment.	K5
	CO4: Suggest options for the mitigation of impact on environment.	K3
	CO5: Prepare an EIA report for infrastructure projects.	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	3	3	3			1		3	2		1	2	3	2
CO 2	2	2	3	2			2		3	3		1	2	2	3
CO 3	3	2	3	2			3	2	3	2		2	2	3	2
CO 4	1	3	2	3			3	2	3	2		3	2	2	3
CO 5	2	2	3	3			3	2	3	3		3	2	1	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	**BASICS OF EIA**	Periods	9

Environmental Impact Assessment (EIA) – Environmental Impact Statement – Environmental Risk Assessment – Legal and Regulatory aspects in India – Types and limitations of EIA – Terms of references in EIA – Issues in EIA – National – Cross sectoral – social and cultural.

Unit – II	**METHODOLOGIES**	Periods	9

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Methods of EIA – Check lists – Matrices – Networks – Cost benefit analysis – Analysis of alternatives – Case studies.			
Unit – III	**PREDICTION AND ASSESSMENT**	Periods	**9**
Assessment of Impact on land, water, air, noise, social, cultural flora and fauna – Mathematical models- Public participation – Rapid EIA.			
Unit – IV	**ENVIRONMENTAL MANAGEMENT PLAN**	Periods	**9**
Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna – Addressing the issues related to the Project Affected People – ISO 14000.			
Unit – V	**CASE STUDIES**	Periods	**9**
EIA for infrastructure projects – Bridges – Stadium- Highways – Dams – Multistorey Buildings – Water Supply and Drainage Projects.			
		Total Periods	**45**

Text Books	
1.	Raman N.S, Ghajbhiye A.R and Khandeshwar S.R., Environmental Impact Assessment, Wiley India, 2019.
2.	Eccleston C.H, Environmental Impact Assessment, CBS Publisher, 2023.
3.	Shrivastava A.K., Environmental Impact Assessment, A.R.H Publishing Corporation, 2003.
References	
1.	John Glasson, Riki Therivel and Andrew Chadwick, Introduction to Environmental Impact Assessment, U.C.L Press, 2005.
2.	Murthy D.B.N, Environment Planning and Management, Deep and Deep Publications, 2005.
E-Resources	
1.	https://www.iitr.ac.in
2.	https://archive.nptel.ac.in/courses
3.	http://ndl.ethernet.edu.et

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Verticals – 2

Entrepreneurship

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV21	PRINCIPLES OF MANAGEMENT	3	0	0	3	40	60	100

Course Objective

- To gain a basic understanding of principles of management including planning, organizing and controlling.
- To gain a basic understanding of concepts for managing people including human resources, motivation, leading, and communications.
- To improve your ability to examine managerial issues and problems and to develop feasible alternatives that can result in better decision-making.
- To develop an awareness of multiple approaches that can be used to resolve managerial issues and problems.

Course Outcome

	Knowledge Level
CO1: Understand the concepts of Management & organization	K1
CO2: Evaluate the global context for taking managerial actions of planning, organizing and controlling.	K2
CO3: Assess global situation, including opportunities and threats that willimpact management of an organization.	K2
CO4: Can integrate management principles into management practices.	K2
CO 5: Able to assess managerial practices and choices relative to ethical principles and standards.	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		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Course Assessment Methods

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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 TO MANAGEMENT AND ORGANIZATIONS	Periods	9
Definition of Management – Science or Art – Manager Vs Entrepreneur – types of managers -managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization – Sole proprietorship, partnership, company-public and private sector enterprises – Organization culture and Environment – Current trends and issues in Management.			
Unit - II	**PLANNING**	Periods	**9**
Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.			
Unit – III	**ORGANISING**	Periods	**9**
Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design – Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management			
Unit – IV	**DIRECTING**	Periods	**9**
Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership –communication – process of communication – barrier in communication – effective communication –communication and IT.			
Unit – V	**CONTROLLING**	Periods	**9**
System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.			
		Total Periods	**45**

Text Books	
1.	Koontz, "Principle of Management Essentials of management".
References	
1.	Theo Haiman , "Management theory and Practice".
2.	DruckerP.F , "Management-Task and Responsibility".
3.	Drucker P.F, "The Practice of Management".
4.	Newman, "Process of Managements".
E-Resources	
1.	https://nptel.ac.in/courses/110/105/110105146/
2.	https://onlinecourses.nptel.ac.in/noc21_mg30/preview
3.	https://nptel.ac.in/courses/110/107/110107150/

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV22	BIO-ENTREPRENEURSHIP	3	0	0	3	40	60	100

Course Objective

- To inculcate the habit of becoming entrepreneur
- To build a winning strategy, how to shape a unique value proposition, prepare a business plan
- To enable the students to understand the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for bio entrepreneur ship and innovation.
- To know the financing, growth and new venture & its problems
- To impart practical knowledge on business opportunities

Course Outcome	he end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the methods and strategies to become entrepreneur.	K1
	CO2: Apply the entrepreneurial tools in creating a business plan for a new innovative venture.	K2
	CO3: Identify the major steps and requirements in order to estimate the potential of an innovative idea as the basis of an innovative project.	K3
	CO4: Students will know the legal and financial conditions for starting a business venture	K4
	CO5: Create the solutions via an iteration of a virtually endless stream of world changing ideas and strategies, integrating feedback, and learning from failures along the way.	K5

Pre-requisites: Should have a basic knowledge on startups in biotechnology

CO/POMapping (3/2/1 indicates strength of correlation) 3-Strong, 2–Medium, 1-Weak

COs	Programme Outcomes(POs)												CO/PSO Mapping PSOs		
	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	2	2	2	2	3		2	2	1	3		2	3	3	3
CO 2	2	2	2	1	3		2		2		2	2	1	3	1
CO 3	3	2	2	2	2		1	2		1	3		2	3	3
CO 4	2	2	3	2	1		2	1	2	2		3	3	2	3
CO 5	2	2	2	1	1	2		1	2		3	3	3	2	2

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	BASICS OF BIOENTREPRENEURSHIP	Periods	10
Introduction to bio entrepreneurship – Biotechnology in a global scale, Scope in Bio entrepreneurship, Importance of entrepreneurship. Meaning of entrepreneur, function of an entrepreneur, types of entrepreneur, and advantages of being entrepreneur. Innovation – types, out of box thinking, opportunities for Bio entrepreneurship. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup and Make in India).			
Unit - II	**BUSINESS OPPORTUNITY AND BUSINESS PLAN**	Periods	**8**
Business ideas, methods of generating ideas, and opportunity recognition, Idea Generation Process, Feasibility study, preparing a Business Plan: Meaning and significance of a business plan, components of a business plan.			
Unit –III	**INNOVATIONS**	Periods	**9**
Innovation and Creativity - Introduction, Innovation in Current. Environment, Types of Innovation, School of Innovation, Analysing the Current Business Scenario, Challenges of Innovation, Steps of Innovation Management, Experimentation in Innovation Management, Participation for Innovation, Co-creation for Innovation, Proto typing to Incubation.			
Unit –IV	**FINANCING & LAUNCHING THE NEW VENTURE**	Periods	**9**
Importance of new venture financing, types of ownership, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks. Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and formation of the new venture.			
Unit –V	**STRATEGY OF ENTREPRENEUR**	Periods	**9**
Characteristics of high growth new ventures, strategies for growth, and building the new ventures. Managing Rewards: Exit strategies for Entrepreneurs, Mergers and Acquisition, Succession and exit strategy, managing failures – bankruptcy.			
		Total Periods	**45**

Text Books	
1.	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.
2.	Charles Bamford and Garry Bruton, "ENTREPRENEURSHIP: The Art, Science, and Process for Success", 2nd Edition, Tata McGrawhill Company, New Delhi, 2016.
References	
1.	Philip Auerswald, The Coming Prosperity: How Entrepreneurs Are Transforming the Global Economy, Oxford University Press, 2012.
2	Janet Kiholm Smith; Richard L. Smith; Richard T. Bliss, Entrepreneurial Finance: Strategy, Valuation, and Deal Structure, Stanford Economics and Finance, 2011.
3	Edward D. Hess, Growing an Entrepreneurial Business: Concepts and Cases, Stanford Business Books, 2011.
4.	Howard Love, The Start-Up J Curve: The Six Steps to Entrepreneurial Success, Book Group Press, 2011.
E-Resources	
1.	Entrepreneurship – SWAYAM https://onlinecourses.swayam2.ac.in/cec19_mg39/preview

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV23	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.	K1
	CO3: Describe the bio-safety guidelines.	K1
	CO4: Explain the bio-containment and certification.	K1
	CO 5: Illustrate the national and international regulations of bio-safety aspects.	K4
Pre-requisites	Knowledge of basic biology and safety management will be essential.	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2					2		2					3	2	3
CO 2	3	3	3			2	3	3				3	2	3	2
CO 3	3	3	3		3			2				3	2	2	2
CO 4	3	3	1		3			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, 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.

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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; Cartegana 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.	Control of communicable diseases manual 20th ed. (Heymann) 2014.
2.	NIH guidelines for research involving recombinant or synthetic nucleic acid molecules (2013).
3.	Guide for the care and use of laboratory animals 8t ed . (National Research Council) National Academies Press 2011.
4.	Biosafety in Microbiological and Biomedical Laboratories, 5th ed. 2009.
5.	Biological Safety, Principles and Practices, 4th ed. (Fleming and Hunt) 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		**2019**	
Department	**BIOTECHNOLOGY**				Semester		-	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV24	**Bioethics & IPR**	3	0	0	3	40	60	100

Course Objective	**The main objective of this course is to:** • Emphasize on IPR issues and need for Knowledge in patents in biotechnology. • Provide Understanding on biosafety and risk assessment of products, ethical issues in biological research • Make students to learn various agreements and treaties on IPR.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Analyze Ethical aspects related to biological, healthcare and biotechnology research.	K2
	CO2: Recall National and International IP rules and Agreements	K2
	CO3: Gain Awareness about IPR to make measurefor protecting their Ideas and Utilize different patent search Engines.	K3
	CO4: Summarize various aspects of Intellectual Property Rights in context with technological advancements	K4
	CO5: Distinguish Knowledge of biosafety and risk assessment of products from research and environmental release of GMOs, and international regulations.	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	2	1	2		1	2	3					2	3	2
CO 2	3				2	2		3		2			2	1	1
CO 3	3	3	2		3	2		3	1	2	1		3	3	3
CO 4	3	1	2		2	2		3			1		3	1	2
CO 5	2					3	2	1					2	2	1

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	BIOETHICS	Periods	9
Ethical issues in Genetic engineering, cloning, genetic testing & screening; Ethical issues in healthcare; Biotechnology & social responsibility; the legal & socio economic impact of the product & techniques in Biotechnology; public acceptance issue in Biotechnology- issue of access, ownership, monopoly, traditional knowledge, public versus private funding.			
Unit – II	**INTERNATIONAL ORGANIZATIONS & IPR**	Periods	9
Overview of WTO, History of GATT& TRIPS agreement; International conventions-Madrid Agreement; Hague Agreement; WIPO treaties; Budapest treaty; PCT; Indian patent Act 1970& recent amendments.			
Unit – III	**PATENTING**	Periods	9
Patent- basic principle & requirements; Patent application types: Ordinary, PCT, conventional, Divisional and patent of Addition; Patent filing procedure- National& PCT filing procedure; status of patent application filed; Precautions while patenting- disclosure/Non disclosure; Patent databases- USPTO, esp@cenet(EPO), PATENTScope (WIPO).			
Unit – IV	**INTELLECTUAL PROPERTY RIGHTS**	Periods	9
Concepts of IPR, Types of IP: Patents; Trademarks, Copyright& Related Rights, industrial design, traditional Knowledge, geographical indications; Farmers rights, IP as a factor in R&D and of relevance to biotechnology			
Unit – V	**BIOSAFETY**	Periods	9
International dimensions in Biosafety- Cartagena protocol on Biosafety; Bioterrorism& conventions on biological weapons; Biosafety regulatory framework for GMOs at international level.			
		Total Periods	**45**

Text Books	
1.	"Bioethics& Biosafety" ,by Sateesh MK,IK International publications(2008).
2.	"IPR, Biosafety and Bioethics", DeepaGoel,Shominiparashar, Pearson (2013).
References	
1.	"Indian Patent Law: Legal and Buisness Implications", by AjitParulekar, Sarita D'Souza Macmillan India publication (2006).
2.	"Bioethics and Biosafety in Biotechnology", V.Shree Krishna, New Age International Pvt. Ltd, Publishers (2g007).
3.	"BAREACT, Indian Patent Act 1970 Acts & Rules", Universal Law Publishing Co. Pvt. Ltd(2007).
E-Resources	
1.	Intellectualproperty India: www.ipindia.nic.in
2.	USPTO Web Patent Databases at: www.uspto.gov/patft
3.	Government of India's Patents Website: patinfo.nic.in
4.	http://www.wipo.int/portal/index.html.en
5.	www.patentoffice.nic.in

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV25	BIOINDUSTRIES & ENTREPRENEURSHIP	3	0	0	3	40	60	100

Course Objective: At the end of the course, the students would have learnt about entrepreneurship and starting a small business.

Course Outcome	At the end of the course, students will be able to	Knowledge Level
	CO1:Understandthe basic concepts of Entrepreneurship & bioindustries	K2
	CO2:Explain the Entrepreneurship related to waste utilization	K3
	CO3:Describe Budgeting Project business plan Preparation	K3
	CO4:Explain the small business launching and management	K4
	CO5:Explain Management of small Business and bioentrepreneurship	K4

Pre-requisites: -

CO/POMapping (3/2/1 indicates strength of correlation) 3-Strong, 2–Medium, 1-Weak

COs	Programme Outcomes(POs)												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2	3	3	3			2	3	3	3
CO2	3	3		2	3			3		2	3		2	3	2
CO3	3	3	3	3			3	3	3	2	3		2	2	3
CO4	3	2	3	3	3	2		3	2		3	2	3	3	2
CO5	3	2	3	2			3	3	3	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 ENTREPRENEURSHIP & BIO INDUSTRIES	Periods	9

Entrepreneurship concept, Entrepreneurship as a Career, Entrepreneur, Personality Characteristics of Successful Entrepreneur, Knowledge and Skills Required for an Entrepreneur. Bioindustry- concepts and recent trends in the development of bioindustries; scope and status of bioindustries – dairy, poultry, floriculture, aquaculture, horticulture, mushroom and textile. Concepts of green entrepreneurship

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Unit - II	GREEN ECONOMY	Periods	9
Composting, vermicomposting – methods, materials and advantages. Pulping (mechanical and pulping), municipal waste – segregation and uses, biobased plastics and fibres, biomass as energy, biogas production, biofuels – concepts and classification. Concept of bio-villages and biotechnological parks.			
Unit –III	**BUSINESS ENVIRONMENT & BUSINESS PLAN PREPARATION**	Periods	9
Business Environment –Role of Family and Society-Prefeasibility Study-Criteria for Selection of Product-Ownership-Capital Budgeting Project Profile Preparation-Matching Entrepreneur with the Project-Feasibility Report Preparation and Evaluation Criteria.			
Unit –IV	**LAUNCHING AND MANAGEMENT OF SMALLBUSINESS**	Periods	9
Finance and Human Resource Mobilization Operations Planning-Market and Channel Selection-Growth Strategies-Product Launching. Agricultural finance in India: Importance types or requirements; sources: non-institutional and institutional:existing rural credit delivery system(multi-agency approach); Monitoring and Evaluation of Business-Preventing Sickness and Rehabilitation of Business Units. Effective Management of small Business.			
Unit –V	**ENTREPRENEURSHIP DEVELOPMENT IN BIOINDUSTRY**	Periods	9
Entrepreneurship Development Training and Other Support Organisational Services-Central and State Government Industrial Policies and Regulations-International Sources of Product for Business. Self employment schemes in relation to bioindustries, status and scope and establishing biobased small scale industries.			
		Total Periods	**45**
Text Books			
1.	Hisrich, Entrepreneurship, Tata McGrawHill, NewDelhi, 2001.		
2.	S.S.Khanka, Entrepreneurial Development, S.ChandandCompany Limited, New Delhi, 2001.		
References			
1.	Bloxham: Scion. 8. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.		
2	Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. 9. 10. 11.		
3	Onetti, A., &Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.		
E-Resources			
1.	https://nptel.ac.in/courses/127/105/127105007/		
2.	https://nptel.ac.in/courses/110/107/110107094/		
3.	https://nptel.ac.in/courses/110/106/110106141/		

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Programme	B. Tech	Programme Code		105	Regulation	2019
Department	BIOTECHNOLOGY				Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV26	TOTAL QUALITY MANAGEMENT	3	0	0	3	40	60	100

Course Objective

The student should be made,

- To Understand the meaning of quality and its importance.
- To Know the principles of total quality management and peculiarities of their implementation.
- To Develop in-depth knowledge on various tools and techniques of quality management.
- To Learn the applications of quality tools and techniques in both manufacturing and service industry.
- To Develop analytical skills for investigating and analysing quality management issues in the industry.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the meaning of quality and its importance	K1
CO2: Implement the principles of total quality management and address the peculiarities in it.	K2
CO3: Assess various tools and techniques of quality management	K3
CO4: Apply quality tools and techniques in both manufacturing and service industry	K4
CO5: Analyze quality management issues in the industry and suggest solutions to those issues	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** 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	2	2		
CO 2	3			2								2	2		
CO 3	3		2									2	2		
CO 4	1	2		2							2	2	2		2
CO 5	1			2								2	2		2

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	**QUALITY PRINCIPLES AND CONCEPTS**	Periods	9
Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs, Basic concepts of Total Quality Management, Historical Review. Principles of TQM, Leadership – Concepts, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation			
Unit - II	**TQM PRINCIPLES AND STRATEGIES**	Periods	9
Customer satisfaction – Customer Perception of Quality, Customer Complaints, Customer Retention, Employee Involvement, Performance Appraisal, Benefits. Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership, Supplier Selection, Supplier Rating, Relationship Development			
Unit – III	**TQM PROCESS CONTROL TOOLS**	Periods	9
The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.			
Unit - IV	**STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY**	Periods	9
Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, Poka Yoke			
Unit – V	**QUALITY SYSTEM ORGANIZING AND IMPLEMENTING**	Periods	9
Need for ISO 9000 and Other Quality Systems, ISO 9000:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, Introduction to TS 16949, QS 9000, ISO 14000, ISO 18000, ISO 20000, ISO 22000			
		Total Periods	**45**
Text Books			
1.	Besterfield, Dale H. et al., "Total Quality Management", 3rd Edition (Revised), Pearson Education, 2011.		
2.	Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008		
References			
1.	Suganthi L. and Samuel A. Anand, "Total Quality Management", PHI Learning, New Delhi, 2011		
2.	Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill, New Delhi, 2004		
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	**2019**		
Department	**BIOTECHNOLOGY**			Semester			

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV27	**Audit and Regulatory Compliance**	3	0	0	3	40	60	100

Course Objective	This course deals with the understanding the process for auditing and the methodology involved in the auditing process of different in pharmaceutical industries.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Perform the auditing in pharmaceutical industries	K3
	CO2: Demonstrate the different auditing process and prepare the compliance report for approval pharmaceutical products	K3
	CO3: Design and develop the check list for vendor auditing and inspection of the pharmaceutical industries	K4
	CO4: Design and develop process in checking the microbial laboratory facility	K4
	CO5: Perform and verify the critical engineering systems in pharmaceutical manufacturing area	K3

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	2	2				2	2		2	3	3	3
CO 2	3	3	3	3	2				2	2		2	3	3	3
CO 3	3	2	3	2	2				2	2		2	3	3	3
CO 4	3	3	3	3	3	2	2		2	2		2	3	3	3
CO 5	3	3	3	3	3				2	2		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**	Periods	**9**

Objectives, Management of audit, Responsibilities, Planning process, information gathering, administration, Classifications of deficiencies, factory acceptance test (FAT), site acceptance test.

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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			
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.	Compliance Auditing for Pharmaceutical Manufacturers: A Practical Guide to In-Depth Systems Auditing by Karen Ginsbury, Gil Bismuth, CRC Press BSP Books, 2018
2.	Pharmaceutical Manufacturing Handbook, Regulations and Quality by Shayne Cox Gad. Wiley-Interscience, A John Wiley and sons, Inc., Publications. 2008
3.	Handbook of microbiological Quality control. Rosamund M. Baird, Norman A. Hodges, Stephen P. Denyar. CRC Press. 2000
References	
1.	Laboratory auditing for quality and regulatory compliance. Donald C. Singer, Raluca-loana Stefan, Jacobus F. Van Staden. CRC Press (2008)
2.	Pharmaceutical Vendors Approval Manual A Comprehensive Quality Manual for API and Packaging Material Approval by Erfan Syed Asif, CRC Press, 2021

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**Biotechnology**			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTV28	**BIO-BUSINESS**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective

- To make the students to understand about 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
	CO2: Infer knowledge on various ventures for biobusiness	K2
	CO3: Implement the bioproduct production.	K3
	CO4: Organizing various supportive organisation for biobusiness.	K5
	CO5: Attributes of bioethical skills.	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** 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	3	3	1	3
CO 2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2		2	2					2				3	1	2
CO 5	2		3			3		3	2		2		2	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

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

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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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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester			

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV29	**Resource Management & Lean start-up Management**	3	0	0	3	40	60	100

Course Objective

The student should be made

- To know the importance of resource management
- To make difference in lean start-up and traditional start up approaches.
- To aware the concept of lean strategy in sustainable growth

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Remember the availability and uses of natural resources.	K1
	CO2: Analyze different approaches in resource management.	K4
	CO3: Aware the basic knowledge in lean methodology.	K2
	CO4: Develop lean strategies in product development.	K3
	CO5: Apply the lean start-up process in manufacturing and waste minimization.	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	2
CO 2	2	2	3	2	3		2	2	2	1	2		3	3	3
CO 3	3				2		3	2	2				2	2	2
CO 4	3			3	3		2	2	3	2		3	3	3	3
CO 5	3	3	2	3	3		1	2	2	2	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

Unit – I	**INTRODUCTION**	Periods	9

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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	**METHODOLOGY**	Periods	**9**
Lean start up - History, Definition, Ideas and Characters; Lean start-up Vs Traditional start-up approaches; Lean methodology and waste – The Build – Measure – Lean loop – Role of pivot in lean start up process.			
Unit – IV	**LEAN STRATEGIES**	Periods	**9**
Lean strategies – Evolution – History of lean product development – Minimum Viable product (MVP) – Waterfall approach and Water fall model of Product Development.			
Unit – V	**MANAGEMENT TECHNIQUES**	Periods	**9**
The lean start-up process - lean start up Management techniques – Principles of lean start-up – Cohort analysis – Pivot – Principles of lean management – Advantages of lean-start-up management – case study: Lean techniques used in manufacturing and waste minimization.			
		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.		
E-Resources			
1.	https://www.techtarget.com/searchcio/definition/Lean-startup		
2.	https://www.slideserve.com/glen/lean-startup-concepts-powerpoint-ppt-presentation		

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Verticals – 3

Clinical Biotechnology

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV31	**PLANT PATHOGENESIS**	3	0	0	3	40	60	100

Course Objective	The goal of this course is to introduce the subject of Plant Pathology, its conceptsand principles.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the history & basic concepts of Plant Pathology and its principles.	K1
	CO2: Explain the structure, virus-vector relationship, biology and management of plant viruses.	K4
	CO3: Describeplant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.	K2
	CO4: Explain the nomenclature, classification and characters of fungi.	K4
	CO 5: Illustrate thetraining on various methods/techniques/instruments used in the study of plant diseases/pathogens.	K3
Pre-requisites	Knowledge of basic biology, molecular biology and genetics will be essential	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	3
CO 2	3	3	3									3	2	3	2
CO 3	3	3	3									3	2	2	2
CO 4	3	3	1									3	2	3	3
CO 5	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

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Unit – I	INTRODUCTION TO PLANT PATHOLOGY	Periods	9
Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies-oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.			
Unit - II	**PLANT VIROLOGY**	Periods	**9**
History of plant viruses, shape, size, composition, structure and physical properties of viruses; Symptomatology of important plant viral diseases, transmission, virus vector relationship; Mycoviruses, phytoplasmaarbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Mechanism of resistance, genetic engineering and management of plant viruses.			
Unit – III	**PLANT BACTERIOLOGY**	Periods	**9**
History and introduction to phytopathogenic prokaryotes, viz., bacteria, MLOs, spiroplasmas and other fastidious prokaryotes. Importance of phytopathogenic bacteria. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic bacteria. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Prokaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.			
Unit – IV	**PLANT MYCOLOGY**	Periods	**9**
Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology; Fungal biodiversity, reproduction in fungi, Concepts of nomenclature and classification; The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: i) Chytridiomycota ii) Zygomycota, iii) Ascomycota, iv) Basidiomycota, v) Deuteromycota. vi)Oomycota. Lichens types and importance, Mycorrhiza, types and importance.			
Unit – V	**DETECTION AND DIAGNOSIS OF PLANT DISEASES**	Periods	**9**
Plant diseases: Bacterial- Aster yellows, Bacterial wilt, Blight, Canker, Crown gall, Rot, Scab; Fungal- Anthracnose, Black knot, Blight, Canker, Clubroot, Damping-off, Dutch elm disease, Ergot, Fusarium wilt, Leaf blister, Mildew, Oak wilt, Rot, Rust, Scab, Smut, Snow mold, Sooty mold, *Verticillium wilt*; Viral- curly top, Mosaic, Psorosis, Spotted wilt. Methods to prove Kochís postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, spectrophotometer. In vitro evaluation of fungicides, bactericides etc.			
		Total Periods	**45**

Text Books

1.	Stephen B & Sarah B,Plant Pathology. 1st Ed. Garland Science, 2018.

References

1.	Gibbs A & Harrison B, Plant Virology - The Principles. Edward Arnold, London, 2018.
2.	Hull R, Mathewís Plant Virology. 4th Ed. Academic Press, New York, 2002.
3.	Jayaraman, Jayashree, and Jeevan Prakash Verma, Fundamentals of plant bacteriology,Kalyani, 2002.
4.	Jayaraman J &Verma JP, Fundamentals of Plant Bacteriology. Kalyani Publ., Ludhiana, 2002.
5.	Dijkstra, Jeanne, and Cees de Jager. Practical plant virology: protocols and exercises. Springer Science & Business Media, 2012.

E-Resources

1.	http://ecoursesonline.iasri.res.in/course/view.php?id=143
2.	https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236
3.	https://sites.google.com/a/uasd.in/ecourse/plant-pathology

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**BIOTECHNOLOGY**			Semester				
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV32	**DEVELOPMENTAL BIOLOGY**	3	0	0	3	40	60	100
Course Objective	The goal of this course is to introduce students to the very broad field of developmental biology.							

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the history & basic concepts of developmental biology	K1
	CO2: Explain the early development in invertebrate /vertebrate models	K2
	CO3: Describe the late development in invertebrate /vertebrate models	K2
	CO4: Distinguish the overview of plant development	K4
	CO 5: Apply the medical implications of developmental biology	K3
Pre-requisites	Knowledge of basic biology, molecular biology and genetics will be essential	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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			3			2	3	3	3
CO 2		3	1		2					2		3	2	1	2
CO 3			1		2					2		3	2	2	1
CO 4		2	1		2				2			2	3	3	2
CO 5		2	1		2				3	2		3	3	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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Unit – I	**HISTORY & BASIC CONCEPTS OF DEVELOPMENTAL BIOLOGY**	Periods	**9**
Modern era of developmental biology - stages of development- zygote, blastula, gastrula , neurula, cell fate &commitment -potency- concept of embryonic stem cells, differential gene expression, terminal differentiation,lineages of three germ layers, fate map, Mechanisms of differentiation-cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development, Pattern formation-- axis specification, positional identification (regional specification), Morphogenetic movements.			
Unit - II	**Early Development in invertebrate /vertebrate models**	Periods	**9**
Six groups of invertebrates,History and Highlights of Invertebrate use in Research- Model organisms - *Drosophila, C.elegans, Xenopus,* Mouse/ human: Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates - **invertebrate /vertebrate models for aging and biomedical research**			
Unit – III	**Late Development in invertebrate /vertebrate models**	Periods	**9**
Organogenesis- development of ectodermal organs, mesodermal organs, endodermal organs, vulval formation in *C.elegans*, fly serves as a model for vertebrate blood cell development, genome scale analysis evaluating the involvement of genes in tissue development			
Unit – IV	**Overview of plant development**	Periods	**9**
Life cycle of an Angiosperm – characteristics of plant growth development- molecular genetics of plant development, root & shoot development, vascular development, SAM maintenance, organogenesis, leaf development, flowering, cell-cell communication during plant development -Germ cell specification& migration			
Unit – V	**Medical implications of developmental biology**	Periods	**9**
Infertility, Assisted Reproduction Technology (ART), In Vitro Fertilization, Intracytoplasmic sperm injection (ICSI), hybridization, gametogenesis -genetic errors/ teratogenesis/ stem cell therapy, gene therapy- somatic, Germline gene therapy- developmental cancer therapy.			
		Total Periods	**45**

Text Books

1.	Gilbert, S.F. 2020. *Developmental Biology*. 12th Edition. OUP USA

References

1.	Browder, L.W., Erickson, C.A. and Jeffery, W.R. 1991. *Developmental Biology*. Third Edition. Saunders College Publishing. Philadelphia.
2.	Shostak, S. 1991. *Embryology. An Introduction to Developmental Biology*. HarperCollins. New York.
3.	Wolpert, L., Beddington, R., Brockes, J., Jessell, T., Lawrence, P. and Meyerowitz, E. 1998. *Principles of Development*. Current Biology. London.
4.	Kalthoff, K. 1996. *Analysis of Biological Development*. McGraw-Hill. New York.

E-Resources

1.	https://nptel.ac.in/courses/102/107/102107075/
2.	https://nptel.ac.in/courses/102/106/102106084/
3.	http://people.ucalgary.ca/~browder/virtualembryo/dev_biol.html

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**			
Department	**BIOTECHNOLOGY**			Semester	-			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTV33	**NANOBIOTECHNOLOGY**	**3**	**0**	**0**	**3**	40	60	**100**

Course Objective	The student should be made to, • Acquire the fundamentals of nanotechnology in biological and biomedical research • Understand how nanomaterials can be used for a diversity of analytical and medicinalrationales • Understand the synthesis of nanomaterials and the impact of nanomaterial on environment.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the essential features of biology and nanotechnology that are converging to create the new area of bionanotechnology	K2
	CO2: Recognize the structural and functional principles of bionanotechnology	K1
	CO3: Apply bionanomaterials for analysis and sensing techniques	K3
	CO4: Understand and explain the biomedical applications of nanotechnology	K2
	CO5: Interpret the applications of various types of nanostructured materials	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	1	1			2							2	3	1	1
CO 2	3	3	3	2	3	2	2	3			3	2	3	3	1
CO 3	2	1	1	2	3	3		2			1	2	1	1	3
CO 4	2	1	1	2	3	3		2			1	2	2	1	3
CO 5	1	3	2	2	3	1	2	3			3	2	3	1	2

Course Assessment

MethodsDirect

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 TO NANOPARTICLES**	Periods	**9**
From Biotechnology to Nanobiotechnology, Top down and bottom-up approach for building nanomaterials, Classification of nanomaterials, Dimensionality & size dependent phenomena – surface to volume ratio, Nano-biomimicry, Characterization Techniques.			
Unit - II	**NANOMATERIAL SYNTHESIS**	Periods	**9**
Synthesis & Processing, Method of nanostructured materials preparation – mechanical grinding, wet chemical synthesis – sol-gel processing, gas-phase synthesis, gas condensation processing, chemical vapour condensation nanocomposite synthesis, Nanomaterials synthesis by biological methods.			
Unit – III	**BIOMATERIAL BASED NANOSTRUCTURES**	Periods	**9**
DNA Nanotechnology -Use of DNA molecules in nanomechanics, Protein & glycol nanotechnology, Lipid nanotechnology, Nanomaterial based biosensors, Bio-nanomachines, Carbon nanotube and its bio-applications.			
Unit - IV	**NANOTECHNOLOGY & TISSUE ENGINEERING**	Periods	**9**
Importance of scaffolds in tissue engineering – Structure & function of natural extracellular matrix – Application of nanotechnology in developing scaffolds for tissue engineering — Electrospinning, Nano artificial cells, Nanotechnology in organ printing.			
Unit – V	**APPLICATION OF NANOBIOTECHNOLOGY**	Periods	**9**
Applications of nanobiotechnology in early diagnostics, drug targeting, drug delivery, nanosurgery, Application in optical detection methods, Nanotechnology in agriculture – fertilizer and pesticides, Nanotoxicology Challenges.			
		Total Periods	**45**

Text Books	
1.	Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2.	Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2007).
3.	Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co. (2005).
4.	Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2016).
5.	Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008)
References	
1.	T.Pradeep,Nano: "The Essentials",McGraw-Hill education,2007.
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://nptel.ac.in/courses/102/107/102107058/
2.	https://nptel.ac.in/courses/118/107/118107015/
3.	https://nptel.ac.in/courses/118/104/118104008/

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week		Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV34	CYTOGENETICS	3	0	0	3	40	60	100

Course Objective

The student should be made
- To gain knowledge on Mendel"s experiment.
- To understand about chromosomal organization.
- To understand the difference between linkage and crossing over.
- To gain knowledge in biotherapeutics.
- To analyze techniques in cytogenetics.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the difference between segregation – monohybrid cross.	K2
CO2: Infer knowledge on structure and organization of chromosomes.	K4
CO3: Acquire knowledge on linkage and crossing over.	K4
CO4: Understand the process of formulation and preservation in biotherapeutics.	K2
CO5: Understand the various techniques in cytogenetics.	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	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

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	MENDELIAN GENETICS	Periods	9
Mendel"s experiments- cross-breeding experiments, Law of Dominance - Law of Segregation- Law of independent assortment. Principles of segregation – monohybrid cross – Independent Assortment, Gene interaction, multiple alleles.			
Unit – II	**CHROMOSOME STRUCTURE AND ORGANIZATION**	Periods	**9**
Chromosome structure and organization in prokaryotes and eukaryotes, Giant chromosomes and its types– polytene and lampbrush – sex determination and sex linkage in X chromosome.			
Unit – III	**LINKAGE AND CROSSING OVER**	Periods	**9**
Genetic Linkage, chromosomal crossing over – cytological basis of crossing over, chromosome mapping – two and three factor cross – interference, somatic cell hybridization.			
Unit – IV	**VARIATION IN CHROMOSOME STRUCTURE AND NUMBER**	Periods	**9**
Rational for formulation of biotherapeutics, formulation excipients - solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants, methods to enhance shelf- life of protein based therapeutics, preservatives and packaging techniques			
Unit – V	**TECHNIQUES IN CYTOGENETICS**	Periods	**9**
Recent trends in Human chromosome techniques (karyotyping)- Fluorescence In-Situ Hybridization (FISH). Transformation, Transduction, Conjugation-mapping, fine structure mapping in merozygotes-plasmids and episomes.			
		Total Periods	**45**

Text Books

1.	Principles of Genetics by Gardner, Simmons, Snustad, 8th edition – John Wiley and Sons, Inc., 2003.

References

1.	Monroe W. Strickberger, "Genetics," 3rd edition – Phi Learning, 2008

Resources

1.	https://onlinelibrary.wiley.com/doi/book/10.1002/9780470259818
2.	https://nptel.ac.in/courses/102/108/102108077/

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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV35	CANCER BIOLOGY	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- To impart basic concepts of cancer biology, various stages in carcinogenesis, molecular cell biology of cancer, cancer metastasis, and cancer therapy.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand fundamental concepts cancer and its causes	K2
CO2: Understand the various stages in carcinogenesis and the involvement of signaling cascades in cancer	K2
CO3: Explain the molecular basis of cancer and carcinogenesis	K3
CO4: Explain about the pathogenesis of cancer metastasis and mechanism of invasion	K3
CO5: Compare and contrast probable treatment and diagnostic modalities for treating cancer	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** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	2				2			1	2	3	3	2
CO 2	3	2	3	2				2			1	3	2	3	2
CO 3	3	3	3	2				2			1	2	3	3	2
CO 4	3	3	3	2				2			1	2	2	3	3
CO 5	3	3	3	2				2			2	3	3	2	3

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	FUNDAMENTALS OF CANCER BIOLOGY	Periods	9

Regulation of Cell cycle, Mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, Modulation of cell cycle-in cancer, Different forms of cancers, Diet and cancer.

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Unit - II	PRINCIPLES OF CARCINOGENESIS	Periods	9
Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation Carcinogenesis.			
Unit – III	**PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER**	Periods	9
Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Oncogenes / Proto Oncogenes activity. Growth factors related to transformations.			
Unit - IV	**PRINCIPLES OF CANCER METASTASIS**	Periods	9
Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, Three step theories of invasion, Proteinases and tumour cell invasion.			
Unit – V	**CANCER DETECTION & THERAPY**	Periods	9
Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.			
		Total Periods	**45**

Text Books	
1.	Robert A. Weinberg, The Biology of Cancer Garland Science; 2nd edition, 2014
2.	John Mendelsohn, Peter M. Howley, Mark A. Israel, Joe W. Gray, Craig B. Thompson. The Molecular Basis of Cancer, Saunders; 4 edition, 2014
References	
1.	Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, Oxford University Press; 3 edition, 2012
2.	King R.J.B., Cancer Biology, Addision Wesley Longmann Ltd, U.K., 1996.
3.	Ruddon.R.W., Cancer Biology, Oxford University Press, Oxford, 1995.
4.	McDonald, F et al., "Molecular Biology of Cancer" 2nd Edition. Taylor & Francis, 2004.
E-Resources	
1.	https://www.edx.org/course/introduction-to-cancer-biologyzhong-liu-sheng-wu-x
2.	https://www.coursera.org/learn/cancer?specialization=cancer-biology
3.	https://www.oncolink.org/healthcare-professionals/oncolink-university/general-oncology-courses/an-introduction-to-the-nature-of-cancer/the-biology-of-cancer

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Programme	B.Tech.	Programme code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course code	Course name	Periods per week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV36	HERBS & DRUG ACTION	3	0	0	3	40	60	100

Course Objective	To familiar with plant derived value added compounds and its functions To provide knowledge on biotechnology based production of herbal medicines To apply the skills in formulation of therapeutic compounds To understand the mechanism and role of phyto compounds in combating disease To gain knowledge on separation of therapeutic compounds	
Course Outcome	At the end of the course, the students would be able to,	**KL**
	CO1: To gain knowledge on production of drugs from natural origin	K3
	CO2:To understand the fundamentals of phyto chemicals and its functions	K2
	CO3:Toacquire knowledge for the development of therapeutic compounds	K2
	CO4 :To apply the knowledge of phyto compounds in treating disease	K3
	CO5 : To understand the separation techniques of herbal compounds and its analysis	K4
Pre-requisites	Plant Biotechnology	

CO/PO Mapping
(3/2/1 indicates strength of correlation) 3 – Strong, 2- Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	1	2	3
CO1	3	3	3	1	1	3	3	3	3	2	3	3	3	3	2
CO2	2	3	3	1	-	3	3	3	3	2	3	3	3	3	2
CO3	3	3	3	1	1	3	3	3	3	2	3	3	3	3	2
CO4	3	3	3	1	1	3	3	3	3	2	3	3	3	3	2
CO5	2	2	3	1	-	2	2	3	3	2	3	3	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

Content of the syllabus

Unit– I	HERBS AS RAW MATERIALS	Periods	9

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Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation source of herbs selection, identification and authentication of herbal materials, processing of herbal raw material.			
Unit–II	**BIODYNAMIC AGRICULTURE**	Periods	**9**
Good agricultural practices in cultivation of medicinal plants including organic farming. Pest and pest management in medicinal plants. Biopesticides/Bioinsecticides.			
Unit–III	**HERBAL EXCIPIENTS & FORMULATION**	Periods	9
Significance of substances of natural origin as excipients- colourants, sweeteners, binders, diluents, viscosity builders and disintegrants. conventional formulation like syrups, mixtures and tablets and novel dosage forms like phytosomes.			
Unit–IV	**PHYTOMEDICAL TREATMENT**	Periods	**9**
Medicinal Plants for Development of Phytomedicine and Use in Primary Health Care– Immunostimulants and adaptogen from Plants –Polyphenols for Atherosclerosis and Ischemic Heart disease –Cancer Chemopreventive agents –Lipidoxidation nitrogen Radicals– Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease			
Unit– V	**SEPARATION TECHNIQUES AND STRUCTUR ANALYSIS**	Periods	**9**
Thin layer chromatography– HPTLC– Column chromatography – GC-MS – LC-MS –HPLC – Partition chromatography – Gas chromatography – FT-IR – UV- NMR (1D&2D) – X-ray diffraction – QSAR and Molecular Modeling			
		Total Periods	**45**

Text Book	
1.	Ahamed, I., Aqil, F. and Owais, M.,"Modern Phytomedicine",Turning medicinal Plants into drugs. WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
2.	Rasooli, I, "Bioactive compounds in Phytomedicine" , Intech Open access Publishers , 1st Edition, 2011
3.	Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press, 2002.
References	
1.	Arnason, J.T., Arnason, J.E. and Arnason, J.T.,"Phytochemistry of Medicinal Plants", Kluwer Academic Publishers, 1995.
2.	Bidlack, W.R., Omaye, S.T., Meskin, M.S.andTopham, D.K.W.," Phytochemicals as Bioactive Agents", 1 st Edition, CRC Press, 2000.
E-Resources	
1.	https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl#:~:text=Medicinal%20plants%20such%20as%20Aloe,their%20day%20to%20day%20life.
2.	https://archive.nptel.ac.in/courses/104/105/104105120/

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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV37	**CELLULAR BIOCHEMISTRY**	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- Learn the fundamentals of Biochemical processes and Biomolecules.
- Understand the chemical basis which allows biological molecules to give rise to the process.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: understand the basics of biomolecules.	K2
CO2: understand the structure and properties of biomolecules.	K2
CO3: illustrate the metabolism of carbohydrates through various anabolic and catabolic pathways.	K4
CO4: categorize different biosynthesis pathways of biomolecules.	K4
CO5: explain different aspects of protein transport and degradation.	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	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	2	3	2	1	1		3	3	3	3
CO 2	2	2	3	2	2	2	2	2		2		3	2	2	3
CO 3	2	3	2	3	2		2	1		2		1	2	3	2
CO 4	2	3	3	2	2		3		1	2		2	2	2	3
CO 5	3	3	3	2	2		2	1	2	1		2	2	2	3

Pre-requisites | Nil

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 BIOMOLECULES	Periods	9

The cell, organelles, membrane composition, macromolecules introduction: proteins, carbohydrates, nucleic acids and triglycerides; physical and chemical foundation: osmosis, functional groups, water and noncovalent

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interactions, acids, bases and buffers, pH and pI, Energy and thermodynamics, ATP and its energy, redox reactions. Amino acids and proteins: properties and functions.			
Unit – II	**STRUCTURE AND PROPERTIES OF BIOMOLECULES**	Periods	**9**
Enzymes and coenzymes: properties, reactions and regulation. Carbohydrates classification and reactions. Glycoconjugates and blood types. Nucleic acids: DNA and RNA fundamentals. Cloning single genes, PCR. Lipids: storage triglycerides, membrane lipids and sphingolipids. Steroids, eicosanoids, isoprenoids and oleo-soluble vitamins. Biological membranes composition and membrane transport: diffusion, facilitated transport and active transport. Signal transduction			
Unit – III	**CARBOHYDRATE METABOLISM**	Periods	**9**
Biochemical reactions. Glycolysis, gluconeogenesis and the pentose phosphate pathway. Glycogen metabolism, citric acid and glyoxylate cycles. Fatty acid and amino acid catabolism. The urea cycle. Oxidative phosphorylation and photophosphorylation.			
Unit – IV	**INTERMEDIARY METABOLISM AND REGULATION**	Periods	**9**
Carbohydrate biosynthesis. Biosynthesis of fatty acids, eicosanoids and steroids. Biosynthesis of some amino acids. Introduction to hormones and hormonal regulation. DNA, RNA and protein synthesis.			
Unit – V	**PROTEIN TRANSPORT AND DEGRADATION**	Periods	**9**
Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.			
		Total Periods	**45**
Text Books			
1.	Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017		
2.	Murray, R.K., etal "Harper's Illustrated Biochemistry", 31 st Edition, McGraw-Hill, 2018.		
3.	Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.		
References			
1.	Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.		
2.	Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/104/105/102105034/		
2.	https://archive.nptel.ac.in/courses/102/106/102106096/		
3.	https://archive.nptel.ac.in/courses/102/105/102105089/		

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Programme	**B.Tech.**	Programme code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	-		
Course code	Course name	Periods per week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV38	**PHYTOCONSTITUENTS**	3	0	0	3	40	60	100

Course Objective	The students should be made ➢ To familiar with plant derived value added compounds and its functions ➢ To provide knowledge on biotechnology-based production of herbal medicines ➢ To apply the skills in formulation of therapeutic compounds ➢ To determine the mechanism and role of phytocompounds in combating disease ➢ To infer knowledge on characterization of phytocompounds	
Course Outcome	At the end of the course, the student should be able to,	**KL**
	CO1: To relate the knowledge on production of drugs from natural origin	K1
	CO2: To understand the fundamentals of phytochemicals and its methods to identify the different compounds.	K2
	CO3: To implement the concepts and knowledge in development of therapeutic compounds	K3
	CO4 :To apply the knowledge of phytocompounds in treating disease	K3
	CO5 : To analyze the different separation techniques of herbal compounds and its role	K4
Pre-requisites	Plant Biotechnology	

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	1					1	1	1	1	1	1
CO 2	2	1	2	2	2	1	2	1		3		1	3	1	2
CO 3	3	2	2	2	2	2	2		2	2	2	2	2	3	3
CO 4	3	2	2	2	2	2	2	2	3	2	2	2	3	3	3
CO 5	2	2	1	3	2				3	2	2	2	2	3	2

Direct
1 .Continuous Assessment Test I, II & III 1. Assignment **2.** End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**MEDICINAL PLANTS AND ITS IMPORTANCE**	Periods	9
Cultivation and Collection of drugs of natural origin- Factors influencing cultivation of medicinal plants- Plant hormones and their applications - Polyploidy, mutation and hybridization with reference to medicinal plants-Conservation of medicinal plants			
Unit – II	**HERBAL DRUGS**	Periods	9
Phytochemicals and their classification–Phytochemical screening –Physiochemical tests — Macroscopic and microscopic techniques –Traditional plant and Herbal remedies — Herbal drugs WHO guidelines– Standardization of Herbal Drugs Derivatives			
Unit – III	**PHYTOCOMPOUNDS**	Periods	9
Plant extract used to Bacterial, Fungal and Parasitic infection – Biological and Toxicology Properties of plant extract –Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides– Anti microbial and targeted screening of Plant extract – Antioxidant and antitumor Plant metabolites (fruits and vegetables)– Bioactive compounds as food			
Unit – IV	**PHYTOFORMULATION**	Periods	9
Medicinal Plants for Development of Phytomedicine and its Use – Immunostimulants and adaptogen from Plants –Polyphenols for Atherosclerosis and Ischemic Heart disease –Cancer Chemo preventive agents – Lipid oxidation nitrogen Radicals– Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease			
Unit – V	**CHARACTERIZATION OF PHYTOCOMPOUNDS**	Periods	9
Thin layer chromatography– HPTLC– Column chromatography – GC-MS – LC-MS –HPLC – Partition chromatography – Gas chromatography – FT-IR – UV- NMR (1D&2D) – X-ray diffraction – QSAR and Molecular Modeling			
		Total Periods	**45**

Text Book	
1.	Ahamed, I., Aqil, F. and Owais, M.,"Modern Phytomedicine",Turning medicinal Plants into drugs. WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
2.	Rasooli, I, "Bioactive compounds in Phytomedicine" , Intech Open access Publishers , 1st Edition, 2011
3.	Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press, 2002.
References	
1.	Arnason, J.T., Arnason, J.E. and Arnason, J.T., "Phytochemistry of Medicinal Plants", Kluwer Academic Publishers, 1995.
2.	Bidlack, W.R., Omaye, S.T., Meskin, M.S.and Topham, D.K.W.," Phytochemicals as Bioactive Agents", 1 st Edition, CRC Press, 2000.
E-Resources	
1.	https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl#:~:text=Medicinal%20plants%20such%20as%20Aloe,their%20day%20to%20day%20life.
2.	https://archive.nptel.ac.in/courses/104/105/104105120/

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV39	**CLINICAL TRIAL MANAGEMENT**	3	0	0	3	40	60	100

Course Objective	• Understand the basic terms of clinical trials • Ability to widen the knowledge related to clinical research skills • Understand database management for the lifelong learning of clinical research	
Course Outcome	At the end of the course the students will gain knowledge on basic aspects of clinical trials and management.	Knowledge Level
	CO1: Different phases of drug development and clinical trials	K1
	CO2: Regulations involved in clinical trials and procedure followed	K2
	CO3: Major protocols followed in practicing clinical trials	K2
	CO4: Management of clinical trial data	K2
	CO 5: Ethical issues – national and international prospects	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	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

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
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1. Course - end survey

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Content of the syllabus			
Unit – I	**DEVELOPING NEW DRUGS, BIOLOGICS, AND DEVICES**	Periods	9
The Drug Development Process - Pre-Clinical Studies - Clinical Trial Phases - Application to Market New Drugs and Biologics - FDA Review Groups - Developing New Devices – Post marketing Surveillance of Drugs, Biologics, and Devices - Direct Reporting Based on observations			
Unit - II	**GOOD CLINICAL PRACTICE AND THE REGULATIONS**	Periods	9
Guidelines - Local Laws - Principal Investigator Responsibilities - Sponsor Responsibilities - Sponsor-Investigators - FDA Guidance Documents - Online Resources - Informed Consent and the Regulations - Institutional Review Boards - Monitoring, Audits, and Inspections, Indian regulations in clinical trials.			
Unit – III	**PROTOCOL, FEASIBILITY AND ACTIVITY STUDIES, AND DOCUMENTATION**	Periods	9
Common Components of a Protocol - Study Organization - Objectives/Endpoints – Study Design - Study Population and treatment plan - Safety Assessment, Management, and Reporting - Statistical Aspects - Subject Data and Record Retention , Monitoring - Reviewing a Specific Protocol - Study Start-up Phase - Study Maintenance Phase – Study Completion and Close-Out Phase - Documents at Study Start-Up - Documents While the Study is in Progress - Documents at Study Close-out - Maintaining Site Study File- Management of Study Drugs, Biologics, and Devices.			
Unit – IV	**MANAGING CLINICAL TRIAL DATA**	Periods	9
HIPAA, the Privacy Rule, and Clinical Trial Data - Guidelines and Regulations Regarding Clinical Trial Data - Study Site Responsibilities Regarding Clinical Trial Data – Source Document Verification of Clinical Trial Data - Release of Protected Medical Information - Confidentiality of Clinical Trial Data - Endpoint Adjudication			
Unit – V	**GLOBAL HEALTH AND INTERNATIONAL TRIALS**	Periods	9
International Clinical Trials - Ethnic and Racial Differences - Ethical Issues and Cultural Sensitivities - Importance of International Trials - HIV/AIDS , Malaria , Tuberculosis , Polio - International Regulations - Future Efforts			
		Total Periods	**45**
Text Books			
1.	Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.		
References			
1.	Gallin, J.I. and Ognibene, F.P. Principles and Practice of Clinical Research, Academic Press,2012		
E-Resources			
1.	https://www.jli.edu.in/course/professional-diploma-in-clinical-trial-management/		
2.	https://www.iths.org/ctms/about/what-is-a-clinical-trial-management-system/		
3.	http://www.clinicaltrialsmgt.com/		

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester			

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV30	**Stem Cell Technology**	3	0	0	3	40	60	100

Course Objective

The course aims to make the students to

- Get familiarize with stem cell technology and its applications
- To give a broad view of mammalian stem cells, different types and how they are cultured.
- Cover the basic biology of these stem cells as well as bioengineering and application of these stem cells.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the basics of stem cell technology.	K2
	CO2: classify the different types of stem cells with their application	K3
	CO3: Demonstrate the therapeutic applications of stem cells	K3
	CO4: Analyse the Clinical applications of stem cells	K4
	CO5: Evaluate the Ethical and regulatory affairs in Stem cell research	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**	**PS O1**	**PS O 2**	**PSO 3**
CO 1	2	2	3	2	2	2		2				2	3	2	2
CO 2	3	3	2	2	1	2		2				2	3	2	2
CO 3	3	2	3	2	2	2		2				2	3	2	2
CO 4	2	2	3	2	1	2		2				2	3	2	3
CO 5	2	2	2	2	1	1		3				2	3	2	3

Pre-requisites	Cell culture technology, cell biology,

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 Stem Cell Technology**	Periods	**9**
Stem cells- Definition, properties, proliferation, culture of stem cells, potency of stem cells- pluripotent, toitopotent, multipotent, unipotent, Sources - blood, bone marrow, umbilical cord blood, adipose tissue, menstrual blood, skin, teeth, placental tissue mesenchymal stem cells, umbilical cord stem cell and iPSC.			
Unit – II	**Classification of Stem cell**	Periods	**9**
Embryonic stem cells (ES) – Origins of mouse embryonic stem cells, derivation of embryonic stem cells, factors influencing ES cell derivation and uses of embryonic stem cells. Adult Stem Cells-Sources, isolation, identification, characterization, maintenance and culture methods - Cloning of stem cells - Therapeutic cloning and Reproductive cloning.			
Unit – III	**Stem cell biology and therapy**	Periods	**9**
Therapeutic applications of stem cells Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors, Failures and successes with gene therapy and future prospects,			
Unit – IV	**Clinical applications of stem cells**	Periods	**9**
Stem cells and Human diseases – Diagnosis, treatment and prevention. Role of stem cells -spinal cord injury, myocardial infarction and heart failure, Role of stem cells in basic research, role of stem cell in Transplantation, bone marrow replacement, treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease			
Unit – V	**Ethical and regulatory system in Stem cell research**	Periods	**9**
Regulations of stem cell therapy – current regulatory system in India and permissive regulations in other countries, Stem cell ethics – religious and other ethical issues Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.			
		Total Periods	**45**
Text Books			
1.	Daniel Marshak, Richard L. Gardener and David Gottlieb, Stem Cell Biology, Cold Spring Harbour Laboratory Press,2013		
2.	Booth C ,Stem cell biology and gene therapy,, Academic Press,2015		
3.	Alexander Battler,Jonathan Leo ,Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, , Springer,2017		
References			
1.	Quesenberry PJ, Stein GS ,Stem Cell Biology and Gene Therapy., Wiley,2003		
2.	Amita Sarkar, Embryonic stem cells. Discovery Publishing House Pvt. Ltd. 2019.		
3.	Stem Cells Handbook Stewart Sell, Humana Press; Totowa NJ,2013		
E-Resources			
1.	https://stemcellres.biomedcentral.com/articles/10.1186/s13287-019-1165-5		
2.	https://www.slideshare.net/drashutoshtiwari/stem-cell-therapy-36963348		
3.	https://www.slideshare.net/ChanderKNegi/current-status-of-stem-cell-therapy		

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Verticals -4
Food Technology

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV41	**FOOD PROCESSING & PRESERVATION TECHNIQUES**	3	0	0	3	40	60	100

Course Objective

The student should be made

- 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 scope of food processing	K2
	CO2:explain various pre-cleaning techniques in food processing	K4
	CO3: demonstrate different types of high temperature processing operations	K3
	CO4:categorize several low temperature processing and preservation techniques	K4
	CO5:summarize various post -processing operations	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	2					3						2	3	3	3
CO 2	2												3	2	2
CO 3	3		2			3				2			3	2	2
CO 4	2			1		3							3	3	2
CO 5	3									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	**NUTRITIONAL VALUES AND ADDITIVES IN FOOD**	Periods	**9**

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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 flavours; chemical compounds responsible for flavour, use of biotechnology to develop flavours.			
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: Blanching & its equipment, pasteurization: heat sterilization; extrusion; evaporation, Drying- Freeze drying, Direct and Indirect methods of determination, 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, Frozen storage – Freezing Characteristics, thawing; Modified atmospheric storage(MAS)-Sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; Natural and Synthetic preservatives, preservation of Jam, jelly, Marmalade, 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	**POST PROCESSING OPERATIONS**	Periods	**9**
Coating, enrobing, Processing and Packaging- Modified atmospheric packaging (MAP), controlled atmospheric packaging (CAP), Vacuum packaging, filling, sealing, Recent Trends in Food Processing, Regulatory bodies for marketing of foods,HACCP -Introduction and Principles, Introduction to Food Labelling.			
		Total Periods	**45**
Text Books			
1.	Fellows, Peter J., "Food processing technology: principles and practice", Elsevier, 2009.		
2.	Subbulakshmi, G., and Shobha A. Udipi.(2006) .Food Processing and Preservation. New Age Publications.		
3.	Barbosa-Canovas, G. V., &Ibarz, A. (2014). Introduction to food process engineering. CRC Press.		
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.	Deman JM, "Principles of Food Chemistry", New edition, Springer, 2018.		
5.	Gould, G. W. New methods of food preservation. Springer Science & Business Media, 2012.		
E-Resources			
1.	http://www.fao.org/wairdocs/x5434e/x5434e00.html		
2.	https://nptel.ac.in/courses/126105015/		
3.	https://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		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV42	**FERMENTATION PRODUCTS**	3	0	0	3	40	60	100
Course Objective	• Impart knowledge and skills related to process technologies in fermented food products • Learn about the different equipment used for the production of various fermented food products.							

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the concepts, principles and procedures in fermented products.	K1
	CO2: Identify the metabolism of microbes involved in fermentation and maintenance of starter culture.	K2
	CO3: Describe malting, brewing, winemaking spirit from raw materials to final products	K3
	CO4: Evaluate various concepts, principles and procedures involved in fermented cereal and legume products	K4
	CO5: Analyze the principles and manufacture of fermented meat products.	K5
Pre-requisites	-	

CO/POMapping
(3/2/1indicates 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**
CO1	3	2	2	3	2	2	3	2	2	3	1		3	3	3
CO2	2	2	3	1		2		3	1	3	2	2	3	1	2
CO3	2	3	2	2	3		3		2	1	3	2	3	2	2
CO4	3	3	3	1	3	2	2	1		2	2		2	2	1
CO5	2	2	2	2	3			2	3	2	1	2	1	2	2

CO/PSO Mapping

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**

History of food fermentations; types of fermented foods and substrates/raw materials used, traditional fermented foods, major biotransformation of raw materials during fermentation, Modern fermented foods industry, Properties of

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fermented foods, Fermented foods in the twenty-first century, Health benefits of fermented foods and beverages.			
Unit - II	**FERMENTATIVE METABOLISM AND STARTER CULTURES**	Periods	**9**
Fermentation and metabolism basics, Sugar metabolism, Protein metabolism, Other metabolic systems of bacteria, yeast and molds. Starter cultures History, Starter culture microorganisms- bacteria, yeast and mold starter cultures, Strain identification, Culture composition, Manufacture of starter cultures, Evaluation of culture performance, Usage of starter cultures, Starter culture maintenance.			
Unit –III	**FERMENTED FRUIT AND VEGETABLE PRODUCTS**	Periods	**9**
Fermented Vegetable products- Introduction, Production principles, Manufacture of Sauerkraut, Principles of pickle production, fermented olives, Kimchi, Fermented vegetables and biogenic amines. Fermented Fruit products; Wine Basics, 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 CEREAL AND LEGUME PRODUCTS**	Periods	**9**
Introduction to Fermented Cereal Products, Biochemical changes during cereal fermentation, Rice based product- Idli batter method of preparation, Physicochemical and microbiological changes during fermentation. Fermented Legumes- Major legumes used for fermentation, biochemical changes during fermentation, Soy based products- Soy sauce, Miso, Natto and Tempeh Manufacturing steps.			
Unit –V	**FERMENTED MEAT PRODUCTS**	Periods	**9**
Fermented Meat product Sausages- History and evolution of the fermented meats industry, Meat composition, Fermentation principles, Meat starter cultures, Principles of fermented sausage manufacture, Manufacture of fermented sausage- Cutting and mixing, Stuffing, Casing materials, Fermentation, Cooking, drying, and smoking, Mold-ripening, Flavour of fermented meats, Defects and spoilage of fermented meats.			
		Total Periods	**45**
Text Books			
1.	Joshi, V. K. "Biotechnology Food Fermentation" Volume 1. Educational Publishers&Distributors, 2004.		
2.	Robert W. Hutkins. "Microbiology and Technology of Fermented Foods", 2nd Edition, Blackwell, 2006		
3.	Hui Y. H "Handbook of Food and Beverage Fermentation Technology". Marcel Dekker, 2004.		
4.	B.J. Wood "Microbiology of Fermented Foods" Springer-Verlag New York Inc.; 2nd ed.2011		
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	N.R. Reddy, "Legume based Fermented foods", CRC Press, 2018.		
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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Programme	B.Tech.	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV43	DAIRY TECHNOLOGY	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- Describe the composition of milk, identify the approximate content of individual types present, and describe physicochemical characteristics of the main components.
- Integrate their knowledge of equipment"s used during the processing of milk and its products.
- Elucidate how dairy products (such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved.
- Use their acquaintance of the processing conditions of fat rich dairy products and industrial byproducts.
- Identify the packaging materials in dairy industries and to understand the health benefits of dairy products.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Acquire knowledge on milk and milk products processing.	K1
CO2: Apply the knowledge of equipments during the processing of milk and its products.	K3
CO3: Integrate the milk product processing methods and its importance in dairy industries.	K3
CO4: Infer knowledge of dairy products and industrial byproducts processing technique.	K3
CO5: Analyze packaging materials and its importance in dairy industries.	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** 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
CO 2	2			2	1				2		1				1
CO 3	2	3	2	3		2		1				2	1	2	3
CO 4	2	3	2	3		2		2				1	1	2	3
CO 5			2			1	2	1						2	3

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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 DAIRY TECHNOLOGY	Periods	9
Introduction and history of dairy development in India; Milk: Composition and nutritional value of milk, properties, microbiology of milk; Procurement of milk; National quality control laws.			
Unit - II	**PROCESSING OF MILK AND ITS PRODUCTS**	Periods	9
Quality assurance, milk storage and transportation; standardization; Common dairy operations: Heat treatment centrifugation, homogenization, pasteurization, Ultra-high temperature (UHT) process, concentration process, coolin and freezing, membrane processes, lactic fermentation, fouling and sanitization; Non-thermal processing technique such as pulsed light, cold plasma, high pressure processing, ultrasonic, UV pasteurization.			
Unit – III	**INDUSTRIAL PRODUCTION OF TRADITIONAL, FERMENTED AND FAT RICH DAIRY PRODUCTS**	Periods	9
Media composition, Manufacturing process, Equipment & Storage: Butter ghee, paneer; Fermented milk products: Processing of yoghurt, cheese. Manufacturing process of Ice cream and kulfi; Production of dried/ condensed milk products (Milk powder, condensed milk).			
Unit - IV	**MANUFACTURING PROCESS OF MILK BY-PRODUCTS & PROCESSING OF VEGAN MILK**	Periods	9
Manufacturing process of milk byproducts: Skim milk, casein, whey concentrate; Vegan milk: plant based milk such as soya milk, almond milk, oat milk; Production process of vegan milk.			
Unit – V	**PACKAGING OF DAIRY PRODUCTS AND HEALTH BENEFITS**	Periods	9
Packaging: Distribution systems, packaging materials and filling operations; Aseptic food processing and packaging; Modern packaging techniques; packaging forms; Disposal of waste package materials. Human health benefits from various dairy products.			
		Total Periods	**45**

Text Books

1.	Pieter Walstra, Jan T M Wouters, Tom J Geurts, "Dairy Science & Technology", Taylor & Francis group publication, Second edition, 2006.
2.	Murlidhar Meghwal, Megh R Goyal, Rupesh S Chavan, "Dairy Engineering, Advanced Technologies & their application", Apple Academic press Inc, 2017.

References

1.	P Walstra, T J Geurts, Noomen Jettima, M.A.J S Van Boekel, "Dairy Technology: Principles of milk properties & processes", Marcel Dekkar Inc.1999.
2.	Gerrit Smit, "Dairy Processing improving quality", Woodhead publishing limited & CRC press LLC, 2003.
3.	Rhea Fernades, "Microbiology handbook dairy products", Leatherhead Publication, 2009.
4.	Barry A Law & A Y Tamime, "Technology of Cheese Making", Second edition, Wiley Blackwell, 2010

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5.	Singh Shivashraya,"Dairy Products and Quality Assurance: Vol.2", New India Publishing Agency,2014.
E-Resources	
1.	https://nptel.ac.in/courses/126/105/126105013/
2.	https://www.studocu.com/row/document/university-of-eldoret/dairy-technology/introduction-to-dairy-technology/3858951
3.	https://www.entrepreneurindia.co/Document/Download/Processing%20of%20Milk%20and%20Milk%20Products-88350-.pdf

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Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	-		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTV44	**FOOD NUTRITION & HEALTH SCIENCES**	**3**	**0**	**0**	**3**	40	60	**100**

Course Objective

The student should be made to,

- 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: Understand the role of nutrients, their requirements and the effect of deficiency and excess	K3
	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 -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	3			1			1				2	2	2
CO 2	1	1	3						1				2	2	2
CO 3	1	2	3	1					1				3	2	1
CO 4	1	2	3	1		1			1			2	3	2	2
CO 5	1	2	3	1		1			1			2	3	2	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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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, The 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,4th 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,14th edition 2016.		
References			
1.	B Srilakshimi , "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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Programme	**B. Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**BIOTECHNOLOGY**			Semester				
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV45	**CONFECTIONERY PRODUCTS**	3	0	0	3	40	60	100

Course Objective	The student should be made to, • Familiarize with the different methods of baking bread and recent advances in baking industry. • Learn microbiological aspects of bakery products, sanitation and hygiene of baking industries.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: understand and optimize different food Ingredients in baking process.	K2
	CO2: understand the mechanism of equipment used in preparation baking & confectionery products.	K2
	CO3: examine the rheological properties and microbiological aspects of baking products	K3
	CO4: categorize different methods of preparation of baking products.	K4
	CO5: explain different types of confectionery products & its production	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	2	2	1		1	1		2				2	1	1	1
CO 2	2	2	3		1	1		3				2	1	1	1
CO 3	2	2	3		1	2		2				2	2	2	2
CO 4	2	2	3		2	2		1				2	1	1	1
CO 5	2	2	2		1	1		1				2	1	1	1

Pre-requisites	Nil

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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Unit – I	INTRODUCTION TO BAKING	Periods	9
Classification of bakery products. Bakery ingredients and their functions-Essential ingredients Flour yeast and sour dough, water, salt- Other ingredients Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants.			
Unit – II	**EQUIPMENTS**	Periods	9
Introduction to utensils and equipments used in bakery industry with their purpose. Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and laminating-Fermentation enclosures and brew equipment - Ovens and Slicers. Rheology of dough Farinograph, Amylograph, Alveograph and Extensiograph.			
Unit – III	**BREAD MAKING PROCESS**	Periods	9
The Chemistry of dough Development. Bread making methods- Straight dough/bulk fermentation Sponge and dough- Activated dough development- Chorley wood bread process- Dough retarding and freezing-emergency No time process. Advantages and disadvantages of various methods of bread-making. Characteristics of good bread Internal characters; external characters. Bread defects/faults and remedies. Spoilage of bread - Causes, detection and prevention.			
Unit – IV	**BAKERY PRODUCTS**	Periods	9
Production of cakes and cookies/ biscuits. Types of biscuit dough's –Developed dough, short dough's, semi-sweet, enzyme modified dough's and batters. Cake making Ingredients and their function Structure builders. Tenderizers, moisteners and flavor enhancers. Production process for Wafers- type of flour, raising agents and maturing. Other miscellaneous products - puff pastry, chemically leavened. Problems of baking.			
Unit – V	**CONFECTIONERY PRODUCTS**	Periods	9
Definition, importance of sugar confectionery. General technical aspects of industrial sugar confectionery manufacture - compositional effects. Manufacture methods of high boiled sweets - Ingredients -.prevention of recrystalization and stickiness Types of confectionery products-Caramel, Toffee and Fudge and other confections-- ingredients - Formulation - Processing method- Quality control- Aerated confectionery- Methods of aeration - Manufacturing process-Chemistry of Hydrocolloids, Hydrocolloid pre-treatment Processes - product quality parameters, faults and corrective measures. Spoilage of confectionery products. Optimization of ingredients for different types of bread, toffees and sugar boiled confectionary.			
		Total Periods	**45**

Text Books	
1.	Matz, Samuel A., —Bakery Technology and Engineering, 3rd Edition, Chapman & Hall, London, 1992.
2.	"Confectionery Products Handbook", NPCS Board, Asia Pacific Business Press Inc., 2013
3.	Edwards W.P. — Science of bakery products, RSC, UK, 2007
References	
1.	Cauvain, Stanley P, and Young, Linda S., "Technology of Bread Making", springer, 2007
2.	Suchart Chaven, "Food Safety Management: Chapter 11. Honey, Confectionery and Bakery Products", Elsevier Inc. Chapters, 2013.
E-Resources	
1.	http://ecoursesonline.iasri.res.in/course/index.php?categoryid=102
2.	https://uou.ac.in/sites/default/files/slm/HM-302.pdf
3.	http://www.eiilmuniversity.co.in/downloads/Bakery_%26_confectionery.pdf

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Programme	**B.Tech.**	Programme Code		**105**	Regulation		**2019**	
Department	**Biotechnology**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV46	**PRODUCT DEVELOPMENT AND TECHNOLOGY TRANSFER**	3	0	0	3	40	60	100

Course Objective	This deal with technology transfer covers the activities associated with Drug Product, Agriculture and bioproducts to completion of technology transfer from R&D to the first receiving site and technology transfer related to post-marketing changes in manufacturing places.	
Course Outcome	the end of the course, the student should be able	Knowledge Level
	CO1: To understand the new drug product development process	K2
	CO2: To understand the agriculture product development process	K2
	CO3: To analysis the agriculture product development process	K4
	CO4: To understand the necessary information to transfer technology from R&D to actual manufacturing by sorting out various information obtained during R&D	K5
	CO5: To elucidate necessary information to transfer technology of existing products between various manufacturing places	K6
e-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	3	3	1	3
CO 2	2	2	3	2		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2	2	2	2					2				3	1	2
CO 5	2	2	3	2		3		3	2		2		2	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

Content of the syllabus

Unit – I	**PHARMACEUTICAL PRODUCT DEVELOPMENT**	Periods	**9**

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Development and informational content for Investigational New Drugs Application (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA), Supplemental New Drug Application (SNDA), Scale Up Post Approval Changes (SUPAC) and Bulk active chemical Post approval changes (BACPAC), Post marketing surveillance, Product registration guidelines – CDSCO, USFDA			
Unit - II	**AGRICULTURE PRODUCT DEVELOPMENT**	Periods	9
Aqua culture - Biofertilizer and Vermitechnology- Organic Farming, Mushroom cultivation- Azolla & Spirullina 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	**TECHNOLOGY DEVELOPMENT AND TRANSFER**	Periods	9
Technology development and transfer: WHO guidelines for Technology Transfer(TT): Terminology, Technology transfer protocol, Quality risk management, Transfer from R & D to production (Process, packaging and cleaning), Granularity of TT Process (API, excipients, finished products, packaging materials) Documentation, Premises and equipments, qualification and validation, quality control, analytical method transfer			
Unit – V	**APPROVED REGULATORY BODIES AND AGENCIES**	Periods	9
Approved regulatory bodies and agencies, Commercialization - practical aspects and problems (case studies), TT agencies in India - APCTD, NRDC, TIFAC, BCIL, TBSE / SIDBI; TT related documentation - confidentiality agreement, licensing, MoUs, legal issues.			
		Total Periods	**45**

ferences

1.	Pharmaceutical product development. Vandana V. Patrevale. John I. Disouza. Maharukh T.Rustomji. CRC Press, Group of Taylor and Francis.
2.	The process of new drug discovery and development. I and II Edition (2006) by Charles G. Smith, James T and O. Donnell. CRC Press, Group of Taylor and Francis.
3.	N. Chandrasekhara Rao, Ram Kumar Mishra,"Organised Retailing andAgri-Business", Springer 2016

Resources

1.	ps://ispe.org/training/course/pharmaceutical-technology-transfers
2.	ps://archive.nptel.ac.in/courses/112/107/112107217/
3.	ps://nptel.ac.in/courses/129105007

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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTV47	**Chemistry of Natural product**	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- learn, classify and understand the chemistry and structural aspects of medicinal compounds from various natural sources
- understand the structural elucidation principles of compounds from natural sources and relate their therapeutic applications

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: classify extract, isolate and characterize the natural products by chemical tests	K1
	CO2: understand the classification, metabolic pathways, metabolites and their structural elucidation	K2
	CO3: Illustrate the therapeutic applications of various molecules from natural sources	K3
	CO4: infer about the various methods used for purification process.	K4
	CO5: Assess and validate the various types of traditional drugs	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**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	3	3	2	2		3		2	2	2	2	2
CO 2	3	2		2	2	3	3					2	2	2	2
CO 3	3	2	2	2		2				2			2	2	2
CO 4	3	2		2	3	2	2				2	2	2	2	2
CO 5	3	2	2	2	3	2	2		3			2	2	2	2

Pre-requisites	Nil

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	**STRUCTURAL BASIS OF NATURAL PRODUCTS**	Periods	9

Chemical and spectral approaches to simple molecules of natural origin. Identification of natural products by

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chromatographic and spectroscopic methods- application of IR, NMR and Mass spectroscopy in the structural elucidation of organic compounds- Concept of stereoisomerism taking examples of natural products Eg.citral, menthol, camphor, ephedrine, atropine etc.; standardization of traditional drug formulations- chromatographic study of some herbal constituents			
Unit – II	**GLYCOSIDES**	Periods	**9**
Classification, biosynthetic studies and basic metabolic pathways, introduction to biogenesis of secondary metabolites- chemistry-general methods of extraction-isolation-chemical test- isolation and structural elucidation of sennosides, cardenolides and bufadienolides, digoxin and digitoxin- introduction to scillaren A and ouabain.			
Unit – III	**ALKALOIDS**	Periods	**9**
Classification, biosynthetic studies and basic metabolic pathways- introduction to biogenesis of secondary metabolites- chemistry- general methods of extraction- isolation- chemical tests- isolation and structural elucidation of Pyridine alkaloids- Tropane alkaloids- Quinoline and Isoquinoline alkaloids- Phenanthrene alkaloids- Indole alkaloids- Imidazole alkaloids- Alkaloid amines- Glycoalkaloid- Xanthine alkaloid			
Unit – IV	**TERPENES AND FLAVONOIDS**	Periods	**9**
Classification, biosynthetic studies and basic metabolic pathways, introduction to biogenesis of secondary metabolites- chemistry-general methods of extraction-isolation-chemical test- isolation and structural elucidation of flavonoids, quercetin; Terpenes- special isoprene rule, mono, diterpenes, triterpenes and sesquitterpenes, and structural elucidation of citral, carvone, menthol and camphor; steroids- cholesterol, colour reactions, reaction of steroids, stigmasterol, p- Sitosterol, bile acids, ergosterol, diosgenin, solasodine, hecogenin.			
Unit – V	**STUDY OF TRADITIONAL DRUGS**	Periods	**9**
Classification of indigenous drugs traditional drugs, common vernacular names, botanical source, chemical constituents, uses and marketed formulations with ingredients like – Amla, Shatavari, Bhilwua, bael, bach, rasna, punarnava, gokhru, shankhapushpi, brahmi adusa, arjuna, lahsun, guggul, gymnema, neem, tulsi, Shilajit and Spirulina			
		Total Periods	**45**
Text Books			
1.	O.P. Agarwal, "Chemistry of Organic Natural Products: Volume I and II", Goel Publishing House, 1980.		
2.	Gurdeep R. Chatwal, "Organic Chemistry of Natural Products: volume I and II", edited by Arora M, Himalaya publishing house, 2014.		
3.	I.L. Finar, "Organic Chemistry: Stereochemistry and the Chemistry Natural Products", Volume II, V edition, 2002.		
References			
1.	James E Robbers, Varro E Tyler and Lynn R Brady, "Pharmacognosy", Wolters Kluwer India Pvt. Ltd., Ninth edition, 2011.		
2.	William C. Evans "Trease and Evans Pharmacognosy", Elsevier Health, UK, 16th edition, 2009.		
E-Resources			
1.	https://www.nature.com/articles/s41573-020-00114-z		
2.	https://link.springer.com/book/9783540406693		
3.	https://chem.libretexts.org/Bookshelves/Organic Chemistry/Basic Principles of Organic Chemistry(Roberts and Caserio)/30%3A Natural Products and Biosynthesis		

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY		Semester		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV48	FOOD MICROBIOLOGY	3	0	0	3	40	60	100

Course Objective

- The course aims to develop the knowledge of students in the basic area of Food Microbiology.
- This is necessary for effective understanding of food processing and technology.
- This course will enable the students to appreciate the role of microbes in food spoilage, preservation of foods and food borne infections.

Course Outcome

he end of the course, the student should be able to,	Knowledge Level
CO1: Understand and identify the various microbes associated with foods and food groups.	K1
CO2: Understand and identify the role of these microbes in food spoilage, food preservation.	K2
CO3: Understand the role of pathogens in food borne infections.	K3
CO4: Describe the methods for the control of microbes in food.	K4
CO5: Categorize the types of traditional microbial and rapid microbial load assessment methods.	K5

Pre-requisites -

CO/POMapping (3/2/1indicates strength of correlation)3-Strong,2–Medium,1-Weak

COs	Programme Outcomes(POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	2	3	2	2	3	1	2	3	3	3
CO2	3	2	3	1	3	2		3	1	3	2	2	2	2	2
CO3	2	3	3	2	3		3	2	2	1	3	2	3	3	3
CO4	3	3	3		3	3	2	1		2	3	3	2	3	3
CO5	2	2		2	3			2	3	3	3	3	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

Content of the syllabus

Unit –I	MICROBES IN FOOD FERMENTATIONS	Periods	9

Microbes of importance in food fermentations, – homo & hetero-fermentative bacteria, yeasts & fungi; biochemistry of fermentations – pathways involved, lactic acid bacteria fermentation and starter cultures, alcoholic fermentations -yeast fermentations - characteristics and strain selection, fungal fermentations. microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

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Unit - II	ROLE OF MICROBES IN SPOILAGE OF FOODS	Periods	9
Introduction to food microbiology, scope of food Microbiology-Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products.			
Unit –III	**MICROBIAL SPOILAGE AND FOOD BORNE DISEASES**	Periods	9
Microbial spoilage of different types of foods– fruits and vegetables, meat, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods; Food borne disease – types, symptoms, causes and control measure - Gastroenteritis, Listeriosis, Salmonellosis, Shigellosis, Vibriosis, Campylobacteriosis. Food toxins – Aflatoxin and Botulism.			
Unit –IV	**CONTROL OF MICROBES IN FOODS**	Periods	9
Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials; physical methods- low and high temperatures, drying, radiation and high pressure; tolerance of microbes to chemical and physical methods in various foods.			
Unit –V	**MICROBIAL LOAD ASSESSMENT**	Periods	9
Traditional method: Stand Plate Count, Most Probable Number, Direct microbial count, Dye reduction test indicator, swab/swab-rinse method, Membrane Filter. Rapid method: spiral platter, Direct epifluorescence Microscopy (DEFT), impedance, microcalorimetry, flow cytometry, Fluorescent antibody, RIA, ELISA.			
		Total Periods	**45**

Text Books	
1.	Charles W. Bamforth, David J. Cook. "Food, Fermentation, and Micro-organisms",2nd Edition, John Wiley & Sons Ltd. 2019
2.	Ramesh C. Ray, Montet Didier. "Microorganisms and Fermentation of Traditional Foods" CRC Press,2014.
3.	Vijaya Ramesh. " Food Microbiology". MJP Publishers, Chennai, 2007.
4.	Jay, J.M. "Modern Food Microbiology". 4th Edition. CBS Publishers, 2003.
References	
1.	Ray, Bibek and ArunBhunia. "Fundamental Food Microbiology" 4th Edition, CRC Press, 2008
2.	Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
3.	Doyle, Michael P. "Food Microbiology: Fundamentals and Frontiers". 2nd Edition, ASM Press, 2001.
4.	Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
E-Resources	
1.	https://onlinecourses.swayam2.ac.in/cec19_ag03/preview
2.	https://onlinecourses.swayam2.ac.in/cec22_ag01/preview
3.	https://archive.nptel.ac.in/courses/126/103/126103017/

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY		Semester		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV49	FOOD QUALITY,SAFETY STANDARDS AND CERTIFICATION	3	0	0	3	40	60	100

Course Objective

- To understand the rules and regulations given by different food authority around the world to maintain food quality and safety.
- To be aware of the Quality Assessment and certifications of food materials.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand about Food Quality and security	K1
CO2: Know about the food Safety required for Industry	K2
CO3: Awareness on regulatory and statutory bodies in India and the world	K3
CO4: Comprehend the quality assurance and delivery of safe to end users.	K4
CO5: Analyze and identify Rules, regulations and certifications related for processing foods	K5

Pre-requisites -

CO/POMapping
(3/2/1indicates strength of correlation)3-Strong,2–Medium,1-Weak

COs	Programme Outcomes(POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	2	3	2	2	3	1	2	3	3	3
CO2	3	2	3	1	3	2		3	1	3	2	2	3	2	2
CO3	2	3		2	3		3		2	1	3	2	3	2	3
CO4	3	3	3	1	3	2	2	1		2	2		2	2	1
CO5	1		2	2	3		2	2	3	2		2	1	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 FOOD QUALITY	Periods	9

Food Quality – its need and its role in Food Industry- Classification of Quality Attributes and their role in food Quality-Objectives, Importance and Functions of Quality Control-Methods of quality concepts of Dough Rheology

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- Quality Assessment of Food materials – Fruits and Vegetables - Cereals and legumes- dairy Products - Meat, Poultry, Egg and Processed food Products			
Unit - II	**FOOD SAFETY AND SECURITY**	Periods	**9**
Introduction to food safety and security: Hygienic design of food plants and equipment's, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials.			
Unit –III	**FOOD REGULATIONS**	Periods	**9**
Introduction to Food GMPs, cGMPs (US FDA & WHO), HVAC Systems, Food HVAC Rules and Design, Validation of HVAC Systems, HVAC Audit and Inspection, WIP, CIP, Sanitation and Hygiene Practices and In-Process, Good Laboratory Practices (GLP), Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO).			
Unit –IV	**FOOD QUALITY ASSURANCE**	Periods	**9**
Guidelines for Sample preparation, Instrument operation and Interpretation of results, laboratory demonstration and requirements, ISO requirement for food testing lab (ISO 17025), ISO 22000 – Importance and Implementation, Swab Analysis in-Process and Off – Line Process, FSSAI Regulations for food laboratory.			
Unit –V	**CODEX COMMISSION AND CERTIFICATIONS**	Periods	**9**
Codex Alimentarius Commission – Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc – BIS-AGMARK-HACCP-GHP- ISO- Halal certifications- Kosher certifications.			
		Total Periods	**45**
Text Books			
1.	Ronald F.Cichy and Jaemin cha "Food Safety and Quality Management, 2019		
2.	Mead, G. "Poultry Meat Processing and Quality", Woodhead Publishing, England, 2004.		
3.	Da –Wen Sun, "Thermal Food Processing: New Technologies and Quality Issues, 2nd Edition, CRC Press/Taylor & Francis, Boca Raton, Florida,USA, 2012.		
4.	Food Quality Assurance: Principles and Practices by Inteaz Alli,CRC publications, 2003		
References			
1.	The food safety information handbook by Cynthia A. Robert, 2009, ISBN: 978-1-949324-75-4, 2019		
2.	Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003		
E-Resources			
1.	Food quality and certification Prepared by Dr. Jessie Suneetha W Mrs. Syamala B College of Food Science and Technology, Pulivendula and Mrs. Preeti Sagar R College of Food Science and Technology, Bapatla		
2.	https://onlinecourses.swayam2.ac.in/cec20_ag06/preview		
3.	https://onlinecourses.nptel.ac.in/noc23_ge32/preview		

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Verticals -5
Industrial Biotechnology

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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester			

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV51	**FERMENTATION TECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The student should be made to, • Recognize the overall industrial fermentation process and the process flow sheet. • Gain the knowledge on fermentor design and the components involved in it. • 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 design of fermentor and its ancillary parts.	K2
	CO 3 : Extend their knowledge on sterilization process	K2
	CO 4 : Apply various unit operations involved in recovery and purification processes	K3
	CO 5: Apply and analyze their knowledge on 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	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	2	1		3	2			2		3	2	2
CO 2	2	2	3		3		2	3			3	1	2	2	2
CO 3	2	3	3		3		2	2			2		3	2	2
CO 4	2	2	3	2	2		2				2	1	2	2	2
CO 5	2	2	3	2	3		3	2			2	2	2	2	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
4. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION TO FERMENTATION TECHNOLOGY**	Periods	9
Substrates 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 & improvement of Strains.			
Unit – II	**DESIGN OF FERMENTOR**	Periods	9
Fermentor- Basic design - Body construction, components (agitator, baffles, probes, valves) and their uses, other fermentation vessel (air lift, packed column fermentor), Use of computer in fermentor			
Unit – III	**STERILIZATION PROCESSES & KINETICS**	Periods	9
Media sterilization and its types, Kinetics of media sterilization, Design of batch and continuous sterilization processes. Calculation of Del factor and holding time. 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 – 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
Fermented food products – Beer, Wine; Biopolymers, Microbial fungicides and Pesticides, Future of fermentation technology and its products.			
		Total Periods	**45**
Text Books			
1.	BryceC F A., and Mansi E L., "Fermentation microbiology & Biotechnology", 3rd Edition CRC Press, 2011.		
2.	Dubey R C, "A Textbook of Biotechnology" 5th revised Edition S. Chand Publishing. Ltd, 2014.		
ferences			
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", 2nd Edition, Panima Publishing, 2000.		
4.	Kumar H D, "A Textbook on Biotechnology" 2 nd Edition. Affiliated East West Press Pvt.Ltd, 1998.		
5.	Peter F. Stanbury., Allan Whitaker., Stephen J., "*Principles* of *Fermentation Technology" 2nd Edition reprint*. Elsevier · 2013.		
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	**2019**
Department	**BIOTECHNOLOGY**			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV52	**Analytical Techniques in Bioindustries**	3	0	0	3	40	60	100

Course Objective

The student should be made to,
- Learn different types of basic instruments.
- Emphasize the identification and quantitative analysis of biological substances.
- Understand the separation techniques.
- Study the principles of various instruments used in biotechnological industries.
- Interpret the use of different chromatographic techniques.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the basic techniques of different instruments used in biotechnology industries.	K2
	CO2: Comprehend the working principles of spectroscopy.	K2
	CO3: Infer the knowledge on microscopy and centrifugation.	K2
	CO4: Apply the principle of electrophoresis techniques to find the molecular weight of nucleic acids and proteins.	K3
	CO 5: Illustrate the separation process using different chromatography techniques.	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** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2					2		1	3		1	2	3	3	
CO 2	3	1	2		3										
CO 3	3	2	3	1						2		2	2	2	1
CO 4		2		3		2			2			2		3	2
CO 5	3	2		2						2			3	2	1

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	BASIC TECHNIQUES IN INDUSTRIES	Periods	9

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Measurement of pH: pH Indicators, pH meter- Design, construction and working principle, types of pH meter- manual and digital meter, types of probe/electrode (glass electrode, reference electrode), calibration using acid and base, titration of acids, turbidity meter, conductivity/ TDS meter, dissolved oxygen (DO) meter: construction and working principle, spectrofluorimetry-analysis of biological samples, redoximetric methods, amperometry, electrogravimetry.			
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	**MICROSCOPY AND CENTRIFUGATION**	Periods	**9**
Light microscope, Electron microscope: Transmission electron microscope, Scanning electron microscope, Fluorescent and confocal microscopy, Stereo zoom microscope. Centrifugation: Introduction, Basic Principle of Sedimentation, Types of centrifuge, bench top centrifuge, high speed refrigerated centrifuges, preparative and analytical ultracentrifuge: Density gradient Centrifugation, Differential Centrifugation, Molecular weight determination.			
Unit – IV	**ELECTROPHORESIS**	Periods	**9**
Theory and applications of electrophoresis; Agarose electrophoresis, polyacrylamide electrophoresis (PAGE), Sodium Dodecyl Sulfate (SDS) PAGE, 2D PAGE; Disc-gel and slab-gel electrophoresis; Gradient electrophoresis - Capillary electrophoresis; 2D Electrophoresis -Isoelectric focusing, pulse-field gel electrophoresis.			
Unit – V	**CHROMATOGRAPHIC TECHNIQUES**	Periods	**9**
Introduction to chromatography, Principles of chromatography, size exclusion, ion exchange and affinity chromatography. High performance liquid chromatography (HPLC), Gas liquid chromatography (GLC), Thin layer chromatography (TLC), Paper chromatography, GC-MS, LC-MS, Chromatofocussing.			
		Total Periods	**45**
Text Books			
1.	Friefelder. D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, W.H. Freemen and Company, San Francisco, 2nd edition, 1982.		
2.	Douglas A Skoog, Donald M West, F. James Holler, Stanley R Crouch, Fundamentals of analytical chemistry, Thomson, Brooks/cole,9th edition, 2014.		
References			
1.	Seidman and Moore, Basic laboratory methods for biotechnology, Longman, 2nd Edition, 2009.		
2.	Goutam Bhowmik, Analytical Techniques In Biotechnology, Tata McGraw Hill Education Private Limited, 2010.		
3.	Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill Education, 2005.		
4.	Instrumental methods of chemical analysis - B.K. Sharma, Goel publishing housing, Meerut, 24th 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/		

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	-

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV53	**PRINCIPLES OF BIOMEDICAL ENGINEERING**	3	0	0	3	40	60	100

Course Objective	The objective of this course is to aid each student in making progress in the application of engineering principles and methods to solve medical problems.	
Course Outcome	At the end of the course, the student should be able to,	KL
	CO1: Understand the basic concept of biomedical engineering principles and human anatomy system.	K2
	CO2: Explain the physiology of human organ system.	K1
	CO3: Describe the functioning of various measuring instruments, display devices and application on the biomedical devices.	K1
	CO4: Explain the fundamentals of biomedical signal and image processing.	K1
	CO 5: Illustrate the working principle of the various therapeutic biomedical equipment used in hospitals.	K4
Pre-requisites	Knowledge of basic biology, human anatomy and electronic devices & circuits will be essential	

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
CO 1	2												3	2	3
CO 2	3	3	3									3	2	3	2
CO 3	3	3	3		3							3	2	2	2
CO 4	3	3	1		3							3	2	3	3
CO 5	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

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Content of the syllabus			
Unit – I	**INTRODUCTION**	Periods	9
Introduction to biomedical engineering. Role and functions of human organ system: Structure and function of Cell & cellular components–Cardiovascular system – Lymphatic system - Respiratory system – Integumentary system – Endocrine system – Digestive system – Excretory system -Reproductive system – Skeletal system – Muscular system – Nervous system.			
Unit - II	**HUMAN PHYSIOLOGY**	Periods	9
Membrane Potential. Fluid and electrolytic balance. Immune response – models of immune response. Blood Pressure – Homeostasis –Cardiac output – Heart Sounds. Velocity of Conduction of Nerve Impulses – Nervous control of Heart. Major Muscles of Limbs and their actions. Physiological aspects of respiration. Movement of GI tract. Mechanism of Urine formation – Urine Reflex – Skin and Sweat Gland – Temperature regulation. Optics of Eye. Structure and functions Internal Ear.			
Unit – III	**BIOMEDICAL INSTRUMENTATION**	Periods	9
Medical instrumentation – Amplifiers - High input impedance, active filters, timers ADC and DAC circuits electrodes and transducers. Biomedical transducers & bioelectrodes; Analytical instruments; Biosensors; Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS).			
Unit – IV	**BIOMEDICAL SIGNAL AND IMAGE PROCESSING**	Periods	9
Fundamentals of digital signal and image processing. Medical imaging systems; X-ray system, C.T. Scan, Ultrasound (A, B and M scans). MRI and Positron Emission Tomography.			
Unit – V	**THERAPEUTIC EQUIPMENTS**	Periods	9
Principles of Therapeutic Instruments: Instruments for cardiology – Cardiac pacemakers, Cardiac defibrillators; Instruments for surgery – Surgical diathermy machine, Physiotherapy & electrotherapy equipment; Haemodialysis; Pulmonary & Radiotherapy instruments – Anaesthesia machine,Radiotherapy; Ventilators.			
		Total Periods	**45**

Text Books	
1.	Sundararajan Madihally,Principles of Biomedical Engineering, Second Edition.Artech House,2019.
References	
1.	Reddy D.C., Biomedical Signal Processing-Principles & Techniques. Tata McGraw Hill,2005.
2.	John G. Webster, Biomedical Instrumentation, Wiley Publications.2007.
3.	Chang Liu, „Foundations of MEMS", Pearson Education Inc., 2012.
4.	CL.Ghai – A textbook of Practical physiology – 5th Ed Jaypee Medical Publishers, 2003.
5.	Khandpur R.S Tata McGraw, Handbook of Biomedical Instrumentation. New Delhi,2004
E-Resources	
1.	https://ocw.mit.edu/courses/health-sciences-and-technology/hst-582j-biomedical-signal-and-image-processing-spring-2007/
2.	http://psnacet.edu.in/bme_dia.html
3.	https://www.drstore.in/by-specialty/physiotherapy/therapeutic-equipments.html

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Programme	B.Tech	Programme Code	105	Regulation	2019
Department	BIOTECHNOLOGY			Semester	

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV54	INSTRUMENTATION & PROCESS CONTROL	3	0	0	3	40	60	100

Course Objective	To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: To understand the importance of measurement in process industries.	K3
	CO2: To know of systems and their responses to different input methods.	K3
	CO3: To understand the principles of controllers and control elements for different applications & to development of block diagram.	K3
	CO4: To study transient response & stability of closed loop system.	K4
	CO5: Gain Knowledge of frequency response and stability analyses & exhibit familiarity with advance technique.	K5

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak

COs	Programme Outcomes (POs)												**CO/PSO Mapping** 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	2	2							1	2	3	2	2
CO 2	3	2	2	2		2				1			3	2	2
CO 3	2	3	2	3			1				1		3	2	2
CO 4	2	3	1	2	2	2			2				3	2	2
CO 5	2	1	2		2			2		2	1		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	**MEASUREMENTS & INSTRUMENTATION**	Periods	**9**
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases			
Unit – II	**OPEN LOOP SYSTEMS**	Periods	**9**
Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag			
Unit – III	**CLOSED LOOP SYSTEMS**	Periods	**9**
Closed loop control systems, Development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.			
Unit – IV	**FREQUENCY RESPONSE**	Periods	**9**
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C- C tuning rules			
Unit – V	**ADVANCED CONTROL SYSTEMS**	Periods	**9**
Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.			
		Total Periods	**45**
Text Books			
1.	Stephanopoulos, G., "Chemical Process Control ", Prentice Hall of India, 2013.		
2.	Coughnowr, D., "Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2018		
3	Seborg D.E., Edgar D.F., Mellichamp D.A. and Doyle III F.J., "Process Dynamics and Control", 3rd Edition, Prentice Hall of India, 2011		
References			
1.	Marlin, T. E., "Process Control ", 2nd Edn, McGraw Hill, New York, 2000		
2.	Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997.		
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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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.Tech**	Programme Code		**105**	Regulation		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV55	**PHARMACEUTICAL PACKAGING TECHNOLOGY**	3	0	0	3	40	60	100

Course Objective	The objective of the course is: • To provide knowledge on the importance of packaging technology. • To know the packaging requirements in pharmaceutical products. • To make the students design packaging material for different dosage forms	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Understand the categories of packaging materials in pharmaceutical industry.	K2
	CO2: Choose primary packaging materials for different pharmaceutical dosage forms.	K3
	CO3: Select packaging material for solid dosage form	K3
	CO4: Design packaging material for liquid formulation	K4
	CO5: Evaluate the regulations of the packaging materials.	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**	**PS O1**	**PS O 2**	**PSO 3**
CO 1	3	2	2	1	2	2						2	3	3	2
CO 2	3	2	2	2	2	2						1	3	2	2
CO 3	2	2	2	2	2	2						1	3	2	2
CO 4	3	3	3	2	2	2						1	3	2	2
CO 5	2	3	1	2	2	2						1	3	2	2

Pre-requisites	Biomaterials, Analytical Instrumentation, 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

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Unit – I	PHARMACEUTICAL PACKAGING	Periods	9
Introduction of packaging - classification of packaging - packaging essential requirements- functions of packaging - importance / significance of pharma packaging - main packaging materials - ideal package material properties.			
Unit – II	**PRIMARY PACKAGING MATERIAL**	Periods	9
Glass containers- introduction - selection of glass as packaging materials for the pharmaceutical products - properties of glass - production of glass - types of glass - test for glass containers- advantages and disadvantages of glass containers. Metal containers- aluminium - aluminium foil - collapsible tubes and stainless steel. Polymers -and plastics- introduction to plastics - raw materials of plastics - types of plastics - resin identification code - plastics and packaging and testing of plastic containers.			
Unit – III	**SOLID DOSAGE FORM PACKAGING**	Periods	9
Blister package- introduction to blister package - types of blisters - advantages and disadvantages of blister packaging - types of problems/ defects. Strip package- strip Packaging Process - packaging materials - child-resistant and multi-dose strip packaging.			
Unit – IV	**LIQUID FORMULATION AND STERILE PRODUCT PACKAGING**	Periods	9
Liquid Formulation - Factors influencing selection of liquid filling machinery - balanced and unbalanced constant level filling – volumetric – gravimetric - level sensing - time fill - peristaltic and overflow liquid filling machinery. Sterile product packaging- various types of containers used for sterile products like ampoules – vials - bottles for I.V. fluid			
Unit – V	**QUALITY CONTROL AND REGULATIONS OF PACKAGING MATERIALS**	Periods	9
Specifications–quality control tests–methods and evaluation of packaging of materials– stability of packaging materials–law and regulations governing packaging.			
		Total Periods	**45**

Text Books	
1.	D.A. Deak, E.R. Evans, I.H. Hall, "Pharmaceutical Packaging Technology", Taylor and Francis,2010.
2.	Edward J. Bauer, Pharmaceutical Packaging Handbook. CRC Press, 20019.
3.	S. Natarajan, M. Govindarajan, B. Kumar, "Fundamental of Packing Technology", PHI Learning Pvt ltd., New Delhi, 2009.
References	
1.	Anonymous,"Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials",2nd Edition, World Health Organization,2004.
2.	U.K. Jain, D.C. Goupale, S. Nayak, "Pharmaceutical Packaging Technology", 2nd ed., Pharma Med Press, Hyderabad, 2008.
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc23_ge32/
2.	https://www.slideshare.net/ERINDAVIS4/pharma-packaging-technology
3.	https://www.expresspharma.in/trends-in-pharma-packaging-plastindia-2023

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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		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV56	**Bioreactor for Recombinant product**	3	0	0	3	40	60	100

Course Objective

The student should be made to,

- Select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
- Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- identify problems and seek practical solutions for large scale implementation of Biotechnology.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Understand the concepts of bioreactor operation	K1
CO2: Discuss the scope of industrial biotechnology	K2
CO3: Learn the production of various commercial recombinant products	K3
CO4: infer about recombinant enzyme production	K4
CO5: Assess the various types of recombinant products and its process	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	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	2		3		2	2	2	2	2
CO 2	3	2	2	2	2	3	3					2	2	2	
CO 3	3	2	2	2		2				2			2		2
CO 4	3	2	2	2	3	2	2				2	2	2		2
CO 5	3	2	2	2	3	2	2		3			2	2	2	2

Pre-requisites	Nil

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	BASIC BIOREACTOR CONCEPTS	Periods	9

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation –

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Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors			
Unit – II	**BIOREACTOR OPERATION**	Periods	9
Common operations of bioreactor, Identification of common factors for smooth operation of bioreactors, Spectrum of basic bioreactor operations, Bioreactor operation for immobilized systems, plant and animal cell cultures			
Unit – III	**RECOMBINANT CELL CULTIVATION**	Periods	9
Different host vector system for recombinant cell cultivation strategies and advantages. *E.coli*, yeast *Pichia pastoris* / *Saccharomyces cereviseae*, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system			
Unit – IV	**RECOMBINANT ENZYMES**	Periods	9
Recombinant enzymes – introduction & current market status; List of enzymes from recombinant microorganisms; Production characteristic features of different host systems; Host systems for the production of recombinant enzymes – E. coli, Bacillus sp., Yeast, Plants and mammals.			
Unit – V	**RECOMBINANT PRODUCTS**	Periods	9
Whole cell immobilization and their industrial application. Production of penicillin, recombinant Insulin, amino acids-lysine and glutamic acid. recombinant antigens as vaccines.			
		Total Periods	**45**

Text Books	
1.	Shuler, M.L., Kargi F., "Bioprocess Engineering – Basic Concepts ", Prentice Hall, 2nd Edition, 2015
2.	Shanmugam.S, Sathishkumar.T and Shanmugaprakash M. (2012). Enzyme Technology, Second Edition, IK International Publishers, India
3.	Glick, B.R. and Pasternak J.J., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", 3rd Edition, ASM Press, 2003
References	
1.	Anton Moser, "Bioprocess Technology, Kinetics and Reactors", , Springer Verlag.
2.	Glick B.R. and Pasternak J.J., "Molecular Biotechnology", Third Edition, ASM Press, 2003.
E-Resources	
1.	https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Boundless)/07%3A_Microbial_Genetics/7.23%3A_Genetic_Engineering_Products/7.23C%3A__Biochemical_Products_of_Recombinant_DNA_Technology
2.	https://www.slideshare.net/pranithapr/recombinant-protein
3.	https://www.pharmatutor.org/articles/pharmaceutical-products-of-recombinant-dna-technology-an-overview

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Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**			
Department	**BIOTECHNOLOGY**			Semester				
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV57	**Stoichiometry and Chemical Process Calculations**	3	0	0	3	40	60	100

Course Objective	To introduce the basic calculation techniques, laws about the behaviour of gases, liquids and solids, for analysing and designing chemical processing equipment with the help of data sources containing relevant physical and chemical properties	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Known the fundamental of chemical process calculation in industries	K1
	CO2: Understand and apply composition of mixtures/solution and determine Pressure, volume and temperature of glass using equation of state	K2
	CO3: Gain Knowledge on Humidity and its types	K3
	CO4: Apply the law of conversion of mass for unit processes and evaluate yield, conversion, recycle ratio/purge/bypass of chemical reactors.	K4
	CO5: Develop the information of Energy balance with chemical reaction in process industry	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**	**PS O1**	**PS O 2**	**PSO 3**
CO 1	1	2	2	2			2	1				2	3	3	3
CO 2	2	3	2	2	2		2		1		1		3	3	3
CO 3	2	3	2	2			2	1		2			2	2	2
CO 4	2	2	2	2	1	2	2						2	2	2
CO 5	1	3		3			2		2	1		1	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

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Content of the syllabus			
Unit – I	**UNITS AND DIMENSIONS**	Periods	
Fundamental and derived units, conversion, conversions of equations, Dimensional and dimensionless constants, mass and volume relations, Stoichiometric and composition relations			
Unit – II	**IDEAL GASES AND VAPOUR PRESSURE**	Periods	
Ideal gas law, Dalton's Law, Amagat's Law and Average molecular weight of gaseous mixtures. Effect of temperature on vapour pressure, Vapour pressures of miscible and immiscible liquids and solutions, Raoult's Law and Henry's Law.			
Unit – III	**HUMIDITY AND SOLUBILITY**	Periods	
Partial saturation, Humidity- Absolute Humidity, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, and adiabatic saturation temperature			
Unit – IV	**MATERIAL BALANCE**	Periods	
General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction, crystallization. Combustion of coal, fuel gases and sulphur, Recycling operations, Bypassing streams, Excess reactant – Limiting reactant- Selectivity and Yield			
Unit – V	**ENERGY BALANCE**	Periods	
General steady state energy balance equation, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, theoretical flame temperature and adiabatic flame temperature.			
		Total Periods	

Text Books	
1.	Narayanan, K.V. and Lakshmi Kutty, B. "Stoichiometry and Process Calculations", 2nd Edition.,2017
2.	Bhatt, B.I. and Thakore, S.M., "Stoichiometry", 5th Edition, Tata McGraw Hill Education Pvt.,Ltd,.2011
3.	Gavhane, K. A. "Introduction to Process Calculations", Nirali Publication, 2016.
References	
1.	Venkataramani, V., Anantharaman, N. and Meera Sheriffa Begum K. M. "Process Calculations",2nd,ed.PHI Learning Pvt. Ltd., 2011
2.	Himmelblau, D. M. and Riggs, B.J. "Basic Principles and Calculations in Chemical Engineering", 8thEdition, Prentice Hall International series, 2012
E-Resources	
1.	https://nptel.ac.in/courses/113104010
2.	nptel.ac.in/courses/103/105/103105209
3.	nptel.ac.in/courses/103/103/103103165

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Programme	**B.Tech**	Programme Code		**105**	Regulation		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV58	**Bioprocess Technology**	3	0	0	3	40	60	100

Course Objective	The course aims to make the students • understand the fundamentals of fermentation ,bioprocess development and biological product recovery • acquire in depth knowledge on design and optimization ofbio process operations and equipment	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: understand the Fundamentals of Bioprocess in industries	K2
	CO2: Analyze various design criteria of different type of bioreactor	K3
	CO3: Interpret the kinetic parameters of growth of organism	K3
	CO4: Evaluate the cost benefit in product recovery	K4
	CO5: Develop process and product of industrial importance	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**	**PS O1**	**PS O 2**	**PSO 3**
CO 1	3	3	2	2	1	2					1	2	3	3	3
CO 2	3	3	2	2									2	1	2
CO 3	3	2	2	2	1								2	2	1
CO 4	3	2	2	2		1					2	2	3	3	2
CO 5	3	2	3	2	1						2	3	3	1	1

Pre-requisites	Microbiology, basic industrial biotechnology, fermentation technology

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	**Fundamentals of Bioprocess**	Periods	**9**
Concept of Fermentation and Bioprocess technology, The fundamental concept of Fermentation and bioprocess technology ,Types of bioprocesses ,Design and formulation of Media for industrial bioprocess Criteria for medium design, carbon/nitrogen sources, nutrients , Sterilization of media Unit			
Unit – II	**Bioreactors-design**	Periods	**9**
Types and operation, Bioreactors, bioreactor design, criteria, operation and types of bioreactors. Agitation and aeration in the bioreactor, impeller and sparger design. Concept of scale up, scale up challenges. Influence of various bioprocess parameters viz. pH, temperature, medium components on product synthesis Bioprocess monitoring and control, automated control vs manual control of bioprocesses			
Unit – III	**Fermentation mode and kinetic models**	Periods	**9**
Kinetic models - Unstructured, Compartment, Single cell, Molecular mechanistic models. Modes of operation - Batch operation, Continuous operation, Fed -batch culture, Oxygen transfer, Different types of bioreactors, Aeration and Agitation systems, Immobilized cells, Selection of the reactor,			
Unit – IV	**Downstream processing**	Periods	**9**
Definition, cost involved in downstream processing, Typical steps involved in Downstream processing, Criteria for downstream processing, Target application of product vs cost, separation of cells and broth, Typical unit operation for downstream processing filtration, centrifugation, chromatography, solvent extraction, HPLC. Methods for cell breakage for harvesting intercellular products.			
Unit – V	**Bioprocess based products and application**	Periods	**9**
Commercial production of various bioprocess based products (Bioethanol, butanol, citric acid, acetic acid) Antibiotics-penicillin, streptomycin, tetracycline. Single cell protein; amino acids: glutamic acid, lysine ,Types and nature of wastes generated from bioprocesses			
		Total Periods	**45**
Text Books			
1.	Stanbury PF, Whitaker A, Hall SJ., Principles of Fermentation Technology, 2nd Edition,Aditya Books (P) Ltd, 1997		
2.	Prave P, Faust U, Sittig W, Sukatsch DA., Fundamentals of Biotechnology, Panama Publishing Corporation, Bangalore, 2015		
3.	El-Mansi EMT, Bryce CFA, Demain AL, Allman AR., Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor and Francis Group, 2017.		
References			
1.	Glazer AN, Nikaldo H Microbial Biotechnology, W H Freeman and company Network,2005		
2.	Flickinger MC, Drew SW., Encyclopedia of Bioprocess Technology, John Wiley & Sons, 2012		
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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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.Tech**	Programme Code		**105**	Regulation		**2019**	
Department	**BIOTECHNOLOGY**				Semester			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTV59	**Metabolic Engineering**	3	0	0	3	40	60	100

Course Objective

The course aims to

- Provide a basic knowledge about strategic manipulation of metabolism
- Provide quantitative perspective of metabolic regulations and developing metabolic models
- Demonstrate metabolic network construction and reconstruction.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Apply knowledge of mathematics, science, and engineering	K3
CO2:Integrate modern biology with engineering principles	K3
CO3:Analyze flux to identify nodal control and Model enzyme kinetics and metabolic fluxes along with control	K4
CO4: Identify, formulate, and solve biochemical engineering problems	K4
CO5: Design metabolic models to represent metabolic networks in single cells and at the organ	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	1	1						1	3	3	2
CO 2	3	2	1	1	2	1						1	3	3	2
CO 3	3	2	1	1	3	1						1	3	2	2
CO 4	3	3	2	1	2	1						1	3	2	2
CO 5	3	2	2	1	2	1						1	3	3	2

Pre-requisites Cell and microbiology, Biochemical Thermodynamics, Bioprocess Principles

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	**Basics of metabolic engineering**	Periods	**9**
Cellular metabolism; order and molecularity of the reactions; concepts of chemical equilibrium; stoichiometry of cellular reactions; reaction rates, dynamic mass balances, yield coefficients and linear rate equations			
Unit – II	**Metabolic pathway analysis and regulation**	Periods	**9**
Metabolic pathways databases, Modelling and measurement of synthetic accessibility; Overview of enzyme activity and concentration; global control regulation; Limiting accumulation of end products, regulation of metabolic networks, Alteration of feedback regulation			
Unit – III	**Basics of metabolic flux analysis**	Periods	**9**
Concept of Nodal points, Linear and Branched pathways, Determined, over determined and undetermined systems; sensitivity analysis, OPT flux Software for MFA. Identification of independent pathways, Flux control coefficients; MCA analysis of metabolic networks			
Unit – IV	**Fundamentals of metabolic control analysis**	Periods	**9**
Direct flux determination, carbon metabolite balances, applications of metabolic flux analysis with respect to E.coli / yeast, Determination of flux control coefficients, concentration control coefficients, Randomized and targeted strain development strategies with specific examples/case studies, Recent developments in Metabolic design.			
Unit – V	**Metabolic control analysis and design**	Periods	**9**
Synthetic Biology, Design of genetic circuits, Amino acid production by glutamic acid bacteria, flux analysis of deletion mutants in C. glutamicum, producers and applications for secondary metabolites, Metabolic engineering application in Biopharmaceuticals, Bioremediation, Biofuels and Agriculture and food.			
		Total Periods	**45**
Text Books			
1.	George Stephanopoulos, Aristos A Aristidou, Jens Nielsen, Metabolic Engineering Principles and Methodologies. Academic Press Inc, 2015.		
2.	S. Sen, L. Datta and S. Mitra , Machine Learning and IoT: A Biological Perspective, CRC Press, Taylor and Francis Group, 2012.		
3.	Chapman & Hall. Arul Jayaraman, Juergen Hahn , Quantitative Biology: From Molecular to Cellular Systems, Academic press,2019.		
References			
1.	Michael E Wall ,Methods in Bioengineering: Systems Analysis of Biological Networks, Artech House Publishers,2013		
2.	Stanbury PF, Whitaker A, Hall SJ., Principles of Fermentation Technology, 2nd Edition, Aditya Books (P) Ltd, New Delhi, 1997.		
E-Resources			
1.	https://archive.nptel.ac.in/courses/102/105/102105086/		
2.	http://www.courses.sens.buffalo.edu/ce307/		
3.	https://www.studocu.com/en-gb/document/university-of-manchester/immunology		

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Open Elective – I

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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
U19BTOE1	**BIOLOGY FOR ENGINEERS**	3	0	0	3	40	60	100

Course Objective	At the end of the course, the students would have learnt about the basics of biology necessary for engineers.	
Course Outcome	Course Outcomes	Knowledge Level
	CO1: Explain the Morphology and chemical composition of the cell and function of each organelle present in the cell with the help of microscope.	K2
	CO2: Explain the process of human physiological system and its cell functioning.	K2
	CO3: Explain the importance of microbiology and immunological science to know the reactions of our body.	K2
	CO4: Discuss the biological science related to the different disciplinary areas.	K2
	CO 5: Explain the importance of genetics and how bioscience is related to other technical areas.	K2
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** 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			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

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	**CELL BIOLOGY**	Periods	**9**
Introduction to the cell biology – Cell size and shape - Chemical composition - Classification of cell and its properties; Cell membrane- Nucleus –Mitochondria- Endoplasmic Reticulum – Lysosome and Peroxisome; Microscopy and its types.			
Unit - II	**CELL PHYSIOLOGY**	Periods	**9**
Cell cycle; Cell signaling, Transport across cell membrane; Introduction to Human physiology – Circulatory system - Respiratory system - Excretory system – Nervous system.			
Unit – III	**IMMUNOLOGICAL SCIENCE**	Periods	**9**
Immune system and its types; Functional properties of antibodies; Helper T cells and T cell activation; Importance of Microbiology.			
Unit – IV	**IMPLEMENTATION OF BIOMATERIALS**	Periods	**9**
Types of biomaterials and applications, macromolecular machines, biological motor, Nano-biomolecules and its various types; Principles and Application of Biosensor; Basics of Biochips – Bio fertilizer– Bio fuel.			
Unit – V	**ADVANCES IN BIOLOGICAL SCIENCES**	Periods	**9**
Fundamentals of Bio mechanics - Neural Network; Introduction to stem cell & therapy and basic understanding on tissue engineering. - Introduction to Genetics; Genetic Engineering and its Application, Safety Hazardous Effect.			
		Total Periods	**45**
Text Books			
1.	Dr.Sohini Singh and Dr.Tanu Allen, "Biology for Engineers", Vayu Education of India, New Delhi, 2014.		
References			
1.	Arthur T. Johnson, "Biology for Engineers" CRC Press, 2011.		
E-Resources			
1.	www.bio12.com/ch3/RaycroftNotes.pdf		
2.	www.engineering.uiowa.edu/bme050/cvb-solids.pdf		
3.	www.biologyjunction.com/mendelian_genetics.html		

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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**
U19BTOE2	**BIOFUELS AND BIOENERGY**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective

The student will have an elaborate knowledge on,

- Environmental aspects of bioenergy.
- Bioenergy and biofuel technologies
- Biomass fuels production and treatment.
- Conversion of biomass for energy application.
- Economic aspect of bioenergy and biofuel.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the overview of bioenergy and sources of biomass.	K2
	CO2: Acquire knowledge about different sources of biofuels and its production	K3
	CO3: Identify the Sources and methods for ethanol production.	K3
	CO4: Evaluate the waste distribution and importance of converting into product	K5
	CO5: Awareness about estimation of economic aspect of bioenergy and biofuel.	K4

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

CO/PSO Mapping			
PSOs			
PSO1	**PSO 2**	**PSO 3**	
3	1	2	
3	3	3	
3	3	3	
3	2	2	
3	2	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	**INTRODUCTION TO BIOFUELS AND BIOENERGY**	Periods	**9**
Definition, Global Energy Outlook, Carbon cycle, Climate change, Sustainability, Biomass Feedstocks - foo and fiber production – meat and dairy production, Processes and Technologies, Environment and Ecology			
Unit - II	**CROP OILS, BIODIESEL, AND ALGAE FUELS**	Periods	**9**
Vegetable Oils - Production and Use of Vegetable Oils - Composition of Vegetable Oils - Use of Vegetabl Oil as Alternative Diesel Fuel - Use of Vegetable Oil in direct heating - Use of Vegetable Oil for Combine Heat and Power - Algae Oil Extraction - Microalgae and Growth - Algae Harvesting - Algae Oil Extractio methods - By-Product Utilization, Manufacture of Biodiesel - Historical Background of Biodiese Manufacture - Transesterification Process for Biodiesel Manufacture - Properties of Biodiesel			
Unit – III	**ETHANOL PRODUCTION**	Periods	**9**
Fuel Ethanol from Corn - Corn-to-Ethanol Process Technology - By-Products/Co-products of Corn Ethanol Ethanol as Oxygenated and Renewable Fuel - Ethanol Vehicles, Ethanol from Lignocellulose Lignocellulose and Its Utilization - Lignocellulose Conversion - Agricultural Lignocellulosic Feedstock Cellulosic Ethanol Technology - Energy Balance for Ethanol Production from Biomass			
Unit - IV	**CONVERSION OF WASTE TO BIOFUELS, BIOPRODUCTS, AND BIOENERGY**	Periods	**9**
Types of Waste and Their Distributions - Waste Preparation and Pretreatment for Conversion - Technologies for Conversion of Waste to Energy and Products - Future of the Waste Industry			
Unit – V	**ECONOMICS**	Periods	**9**
Factors Affecting Economics, Economic Analyses, Life-Cycle Costs, Present Worth and Levelized Costs, Externalities, Project Development, Cost (Value) of Energy for Different Sources			
		Total Periods	**45**
Text Books			
1.	Sunggyu Lee, Y.T. Shah, "Biofuels and Bioenergy Processes and Technologies", CRC Press Taylor & Francis Group, 2012		
2.	Vaughn, Nelson, Kenneth Starcher, "INTRODUCTION TO BIOENERGY", Garland Science., New York, 2002		
References			
1.	Anju Dahiya, "Bioenergy: Biomass to Biofuels and Waste to Energy", Elsevier Science, 2020		
2.	Yebo Li and Samir Kumar Khanal, "Bioenergy: Principles and Applications", Wiley-Blackwell, 2016		
3.	Judy D. Wall and Caroline S. Harwood, "Bioenergy", ASM press 2008		
4.	Ted Weyland, "Bioenergy: Sustainable Perspectives" Callisto, 2016		
5.	OzcanKonur, "Bioenergy and Biofuels", 2018		
E-Resources			
1.	https://www.etipbioenergy.eu/advanced-biofuels-overview		
2.	https://www.iea.org/fuels-and-technologies/bioenergy		
3.	https://www.renewableenergyworld.com/types-of-renewable-energy/tech/biofuels/		

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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**
U19BTOE3	**BIO-BUSINESS**	**3**	**0**	**0**	**3**	**40**	**60**	**100**

Course Objective	• To make the students to understand about 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
	CO2: Infer knowledge on various ventures for biobusiness	K2
	CO3: Implement the bioproduct production.	K3
	CO4: Organizing various supportive organisation for biobusiness.	K5
	CO5: Attributes of bioethical skills.	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** 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	3	3	1	3
CO 2	2	2	3	1		1	2	2	2		3	3	1	3	2
CO 3	2	3	2								2	3	3	2	2
CO 4	2		2	2					2				3	1	2
CO 5	2		3			3		3	2		2		2	3	3

Course Assessment Methods

Direct

4. Continuous Assessment Test I, II & III
5. Assignment & Quiz
6. End-Semester examinations

Indirect

1. Course - end survey

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

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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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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**VI**		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTOE4	**BASICS OF BIOINFORMATICS**	**3**	**0**	**0**	**3**	40	60	**100**

Course Objective	The student should be made to, • 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

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	2	1			3	3							3	2	3
CO 2	2	1			3	3							2	3	2
CO 3	2	1			2	3							2	3	3
CO 4	2	1			3	3							2	3	3
CO 5	2	1			3	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

Content of the syllabus

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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	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**VI**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BTOE5	**HUMAN HEALTH AND NUTRITIONAL DISORDERS**	3	0	0	3	40	60	100

Course Objective	1. Understand the role of nutrition in different stages of life cycle. 2. Gain experience in planning nutrition for different stages. 3. Analyze the role of various nutrients and vitamins important in maintaining health during pregnancy. 4. Evaluate the roles of nutrition and behavior during Adolescence. 5. 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
	CO 1: Understand the basics of nutrition, Nutritional assessment and RDA	K2
	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.	K2
	CO 5: Analyze the importance of nutrients and diet for maintaining healthy life	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					3						2	3	3	3
CO 2	2												3	2	2
CO 3	3		2			3				2			3	2	2
CO 4	2			1		3							3	3	2
CO 5	3									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

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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, 5th 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,14th Edition, 2014.
4.	Mahtab, S, Bamji, Kamala Krishnasamy, G.N.V. Brahmam, "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". 2nd Edition. Blackwell,2009.
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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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.Tech**	Programme Code	**105**	Regulation	**2019**		
Department	**BIOTECHNOLOGY**			Semester	**VI**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTOE6	**WASTE MANAGEMENT**	3	0	0	3	40	60	100

Course Objective	The student should be made • To learn the logistics of waste management • To understand the segregation of waste in the logistics of waste management • To study the handling of hotel, biomedical, hazardous, electronic, plastic, C & D waste • To acquire knowledge on recycling and reuse of waste	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the basic concepts of waste management	K2
	CO2: Know about domestic, municipal, market & hotel waste	K2
	CO3: Understand the procedure in handling and disposal of hazardous waste	K2
	CO4: Know the methods of handling and disposal of E-waste & plastics	K2
	CO5: Analyze different methods to recycle & reuse of waste materials	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** PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2		1							2		2	2		
CO 2	2		1								2		2		
CO 3	3		1							2		2	2		
CO 4	2		1										2		
CO 5	3		1							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

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Unit – I	INTRODUCTION TO WASTE MANAGEMENT	Periods	9
Introduction, Logistics, Human Components, Technological Components- Waste Handling Equipment and Technology, Social Aspects and Managerial Goals, Steps in a waste management logistics process			
Unit – II	**DISPOSAL OF MUNICIPAL AND MARKET WASTE, HOTEL WASTE**	Periods	9
Segregation of different types of municipal waste, methods of collection of those waste, transportation of the waste from the source site to the processing site and different treatment methods (Sanitary landfill methods) used to process the wastes			
Unit – III	**DISPOSAL OF BIOMEDICAL AND HAZARDOUS WASTE**	Periods	9
Segregation of different types of hospital and biomedical waste, steps involved in the collection of those waste, transportation of the waste from hospitals and clinics to the processing site and different treatment methods used to treat and process the wastes			
Unit – IV	**DISPOSAL OF ELECTRONIC, C & D AND PLASTIC**	Periods	9
Segregation of different types of E-waste and plastic waste based on type, collection procedure utilized in collecting these waste, transportation of the waste from dumped sites to the processing site and different treatment methods used to treat and process the wastes			
Unit – V	**RECYCLE AND REUSE OF WASTE**	Periods	9
Re-use, General Process of Recycling, Precautions for Recycling –Aluminium, Glass, Precautions while Recycling of Plastics, Precautions while Recycling paper Amplifying benefits from waste			
		Total Periods	**45**

Text Books	
1.	Wastes to Resource : Waste Management Handbook http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf
2.	Technical EIA guidance manual for common hazardous waste treatment, storage and disposal facilities http://environmentclearance.nic.in/writereaddata/Form1A/HomeLinks/TGM_%20Comman%20Municipal%20Sold%20Waste%20Management_160910_NK.pdf
References	
1.	Integrated solid waste management, George Tchobanoglous and Hillary theisen, Samuel Vigil, McGraw Hill
2.	Environmental Engineering Mackenzie L Davis, David A Cornwell
3.	Disposal and recovery of municipal solid waste, Michael E Henstock Butterworths, Ann Arbor Science
E-Resources	
1.	Using Waste Audits to Improve Recycling & Recovery Programs https://www.youtube.com/watch?v=DVbB7mVY42Y
2.	https://nptel.ac.in/courses/120/108/120108005/
3.	https://nptel.ac.in/courses/105/106/105106056/

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OPEN ELECTIVE – III

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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	**2019**		
Department	**BIOTECHNOLOGY**				Semester	-		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTOE7	**FOOD PROCESSING AND PRESERVATION TECHNOLOGY**	**3**	**0**	**0**	**3**	40	60	**100**
Course Objective	Upon completion of this course, the student will be able to: 1. Understand nutrition values in food and various food additives added to the foods 2. Discuss various processing and preservation techniques. 3. Identify various technologies in the processing of foods. 4. Identify various technologies in preservation of food. 5. Understand various packing techniques							
Course Outcome	At the end of the course, the student should be able to,					Knowledge Level		
	CO1: Understand the basics of food processing					K1		
	CO2: Explain why foods are needed to be processed					K2		
	CO3: understand how foods are processed at low and high temperature					K3		
	CO4: understand how foods are processed by non-thermal methods					K3		
	CO5: Explains how foods are packed					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**
CO1	2	2	1			3						2	3	3	3
CO2	2	2	2					3	2			2	3	2	2
CO3	3	2	3	2	3	3		3	2	2		2	3	2	2
CO0004	3	2	3	2	3	3		3	2	2		2	3	2	2
CO5	3	2	3	2	3		3	3	2	2		2	3	2	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	**Nutrition And Additives of Food**	Periods	**9**
Introduction to Food Chemistry, Constituents of food, energy value of foods and nutritional aspects of foodstuffs, Classification of additives; food colorants- natural and artificial, food flavors; enzymes as food processing aids			
Unit - II	**Methods of food processing**	Periods	**9**
Methods of processing cereals - wheat, rice, maize, pulses. Processing of fruits and vegetables - meat - fish - poultry - egg. Processing of oil seeds. processing of milk and milk products. Processing of condiments and spices - Beverages, tea, coffee and cocoa. HACCT.			
Unit – III	**Food preservation by Thermal methods**	Periods	**9**
freezing and refrigeration: Introduction to refrigeration - cool storage - freezing – definition - principle of freezing freezing curve -changes occurring during freezing - types of freezing - slow freezing, quick freezing. introduction to thawing, changes during thawing and its effect on food. Thermal Processing- Commercial heat preservation methods – Blanching, Sterilization, Pasteurization, Thermal destruction of microorganism,			
Unit - IV	**Food preservation by non-Thermal methods**	Periods	**9**
Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology			
Unit – V	**Food Packaging**	Periods	**9**
Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, costs of packaging and recycling of materials			
		Total Periods	**45**
Text Books			
1.	Potter NN (2013) Food science		
References			
1.	ManoranjanKalia (2014) Food Quality Management Second Edition, Aggrotech Publishing Academy, Udaipur.		
2.	Khetarpaul, Neelam. "Food Processing and Preservation." Daya Publications, 2005		
3.	GopalaRao, Chandra. "Essentials of Food Process Engineering". B.S. Publications, 2006		
4.	Singh, M.K. "Food Preservation" Discovery Publishing, 2007		
E-Resources			
1.	http://www.fao.org/wairdocs/x5434e/x5434e00.html		
2.	https://nptel.ac.in/courses/126105015/		
3.	https://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		**2019**
Department	**BIOTECHNOLOGY**					Semester		-
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
U19BTOE8	**FORENSIC TECHNOLOGY**	**3**	**0**	**0**	**3**	40	60	**100**
Course Objective	• To prepare students for entry-level positions in the fields of forensictechnology • 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,							KL
	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							K4
	CO4: Analyze the non-biological samples and characterize							K4
	CO5: Implement forensic examination in different levels and documentation							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	1		2	3	1	2			1	2			1	2	
CO 2	2	2	1	2	1				1		1		2		2
CO 3	2		1	2	1		1						3	2	1
CO 4	1	2	2	2	3		1							2	
CO 5	1			2	3	2		2	2	2	3		1		1

Course Assessment

MethodsDirect

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	**BASICS OF FORENSIC SCIENCE**	Periods	**9**

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History and Development; Crime Scene Management and Investigation- Collection, preservation, packing and forwarding of physical and trace evidence for analysis; Legal and Court procedure pertaining to Expert Testimony			
Unit – II	**FORENSIC TOOLS AND TECHNIQUES**	Periods	**9**
Need of 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 Instrumentation, Correlation of MS with molecular structure. Application of MS in Forensic Science.			
Unit – III	**ANALYSIS OF BIOLOGICAL SAMPLES**	Periods	**9**
Fresh Blood-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; 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;Examination and identification of deceased from skeletal remains.			
Unit – V	**FORENSIC EXAMINATION**	Periods	**9**
Preliminary examination of documents-Identification of handwriting, signatures and detection of forgeries; Reproduction of documents (photographic, mechanical) and their examination; Physical and chemical erasures, obliterations, additions, alterations, indentations, secret writings and charreddocuments; Inks, papers and their scientific examinations including instrumental analysis			
		Total Periods	**45**

Text Books	
1.	William G. Eckert, Introduction to Forensic Sciences, 2nd Ed. New York: CRC Press, 2000
2.	Suzanne Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques, Fifth Edition, CRC Press, 2019
References	
1.	V.V. Pillay, Textbook of Forensic Medicine and Toxicology,Paras Medical Publishers 18th Ed.2017
2.	Richard Saferstein, Criminalistics: An Introduction to Forensic Science, Global Edition, Pearson Publications, 2014
3.	B R Sharma, Forensic science in criminal investigation & trials, Universal Law Publishing, 6th Edition, 2020
4.	MaThew E. Johll , Investigating Chemistry: A Forensic Science Perspective, 2009
5.	B. D Alberts Bray, J. Lewis, K. Roberts and J.D. Watson. Molecular Biology of Cell, 4thed, New York: Garland Publishing, 2002
E-Resources	
1.	https://sites.google.com/site/introductiontoforensicscience/file-cabinet
2.	https://www.coursera.org/learn/forensic-science/home/welcome
3.	https://www.studocu.com/en-us/document/fairleigh-dickinson-university/forensic-science/forensic-science-lecture-notes-1-15/6529798

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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	**2019**	
Department	**BIOTECHNOLOGY**					Semester	-	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BTOE9	**BIODIVERSITY AND BIOPROSPECTING**	3	0	0	3	40	60	100

Course Objective	i) To recall the different types of biodiversity across the world. ii) To identify the importance of population growth in each taxon and its respective diversity. iii) To explain the basic concepts of Bioprospecting with respect to Biodiversity.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Identify the importance of the Global Biodiversity in current scenario.	K2
	CO2: Recognize the concepts of animal and plant taxonomy.	K2
	CO3: Understand the importance of the Population growth and effectof environment on the growth.	K3
	CO4: Known the concepts of microbial taxonomy and its classification.	K5
	CO5: Deduce elementary thoughts of Bioprospecting with respect to Biodiversity	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	2	2	1	2		1	2	3					2	3	2
CO 2	3				2	2		3		2			2	1	1
CO 3	3	3	2		3	2		3	1	2	1		3	3	3
CO 4	3	1	2		2	2		3			1		3	1	2
CO 5	2					3	2	1					2	2	1

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**

Biodiversity - Biodiversity as a natural resource - Types of Biodiversity - Vegetational Zones -Major Biodiversity areasof the world - Zones of Faunal distribution - Biodiversity Hot Spots

Unit - II	**ANIMAL TAXONOMY AND PLANT TAXONOMY**	Periods	**9**

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Introduction - Animal Taxonomy- Principles and rules of Taxonomy- Taxonomical hierarchy – Zoological nomenclature, ICZN regulations - Plant Taxonomy - Introduction to major plant groups and evolutionary relationships - Concept of species - History of plant taxonomy - Code of nomenclature - Systems of classification.			
Unit – III	**ECOLOGY**	Periods	**9**
Population growth: Growth types and growth models, exponential and logistic models, Effect of environment on population growth - diversity distribution, factors affecting diversity, impact of exotic species. Neo-Darwinism: spontaneous mutation controversy, effects of natural selection on populations, Levels of selection, groupselection controversy, selfish gene theory.			
Unit - IV	**MICROBIAL TAXONOMY AND DIVERSITY**	Periods	**9**
Microbial diversity: Outline classification of microorganisms. Fungi: Criteria for classification and identification - Types of vegetative forms, Types of spores, fruiting bodies and life cycles - Bacteria:Concept of species - Criteria for classification - Morphology in Actinomycetes, Cyanobacteria and Mycobacteria - Major classes of bacteria. Viruses: Outline classification.			
Unit – V	**BIOPROSPECTING**	Periods	**9**
Bioprospecting Act - Introduction - Phases of Bioprospecting - Exemption to Act - Fields of Bioprospecting. Bioprospecting - Definition- Introduction - Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources.			
		Total Periods	**45**
Text Books			
1.	V.N. Naik illustrated, reprint Tata McGraw-Hill Education., New Delhi 1984		
2.	Pandey Angiosperms: Taxonomy, Anatomy, Economic Botany & Embryology, Publisher: S Chand & Co Ltd., New Delhi		
References			
1.	Ashlock., Principles of Animal Taxonomy., New York: McGraw-Hill, ©1991.		
2.	M. Gadgil., A methodology manual for scientific inventorying, monitoring and conservation of Biodiversity., New York: McGraw-Hill, ©1991.		
3.	S Ram Reddy and MA Singara Charya -Microbial Diversity: Exploration and Bioprospecting.		
E-Resources			
1.	www.ncbi.nlm.nih.gov		
2.	https://nptel.ac.in/courses/102/104/102104082/		
3.	www.engineering.uiowa.edu/bme050/cvb-solids.pdf		

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OPEN ELECTIVES OFFERED BY OTHER DEPARTMENTS

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN

(AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

Department of Computer Science and Engineering

UG R2019

LIST OF OPEN ELECTIVE COURSE (OEC)

Course code	Course name	Category	L	T	P	C	CA	ESE	Total
U19CSOE1	Introduction to IoT	OEC	3	0	0	3	40	60	100
U19CSOE2	Ethical Hacking	OEC	3	0	0	3	40	60	100
U19CSOE3	Smart Sensor Technologies	OEC	3	0	0	3	40	60	100
U19CSOE4	Web Designing	OEC	3	0	0	3	40	60	100
U19CSOE5	Data Analytics	OEC	3	0	0	3	40	60	100
U19CSOE6	Enterprise Java	OEC	3	0	0	3	40	60	100
U19CSOE7	Open Source Software	OEC	3	0	0	3	40	60	100
U19CSOE8	Python Programming	OEC	3	0	0	3	40	60	100

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Department of Electrical and Electronic Engineering

UG R2019

LIST OF OPEN ELECTIVE COURSE (OEC)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EEOE1	Electron Devices	3	0	0	3	40	60	100
U19EEOE2	Electrical Safety	3	0	0	3	40	60	100
U19EEOE3	Energy Auditing	3	0	0	3	40	60	100
U19EEOE4	Energy Storage Technologies	3	0	0	3	40	60	100
U19EEOE5	Biomass Energy Systems	3	0	0	3	40	60	100
U19EEOE6	Energy Efficient Lighting System	3	0	0	3	40	60	100
U19EEOE7	Soft Computing techniques	3	0	0	3	40	60	100
U19EEOE8	Electrical Systems in industry	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	**2019**			
Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				Semester	**OPEN ELECTIVE**			
CURRICULUM									
LIST OF OPEN ELECTIVE									
Course Code	**Course Name**	**Category**	**Periods / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ESE**	**Total**
OPEN ELECTIVE-I									
U19ECOE1	Basics of Electronics In Automation Appliances	OE	3	0	0	3	40	60	100
U19ECOE2	Biomedical Instrumentation	OE	3	0	0	3	40	60	100
U19ECOE3	Automotive Electronics	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-II									
U19ECOE4	Satellite Communication	OE	3	0	0	3	40	60	100
U19ECOE5	VLSI Design and Its Applications	OE	3	0	0	3	40	60	100
U19ECOE6	Digital Image Processing	OE	3	0	0	3	40	60	100
OPEN ELECTIVE-III									
U19ECOE7	Basics of Communication Systems	OE	3	0	0	3	40	60	100
U19ECOE8	Wireless Sensor Networks	OE	3	0	0	3	40	60	100
U19ECOE9	PCB Design and Fabrication	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	**2019**		
Department	**INFORMATION TECHNOLOGY**			Semester	-		

CURRICULUM

(Applicable to the students admitted from the academic year 2019- 2020 onwards)

LIST OF OPEN ELECTIVES

Course Code	Course Name	Hours /Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19ITOE1	Mobile application development	3	0	0	3	40	60	100
U19ITOE2	Robotics	3	0	0	3	40	60	100
U19ITOE3	Basics of Cloud Computing	3	0	0	3	40	60	100
U19ITOE4	Introduction to Data Structures	3	0	0	3	40	60	100
U19ITOE5	Cyber Security	3	0	0	3	40	60	100
U19ITOE6	Information Technology Essentials	3	0	0	3	40	60	100
U19ITOE7	Business intelligence and its Applications	3	0	0	3	40	60	100
U19ITOE8	Internet of Things	3	0	0	3	40	60	100
U19ITOE9	Introduction to Java Programming	3	0	0	3	40	60	100
U19ITOE10	Introduction to R Programming	3	0	0	3	40	60	100
U19ITOE11	Ethical Hacking	3	0	0	3	40	60	100
U19ITOE12	Cyber Forensics	3	0	0	3	40	60	100
U19ITOE13	E Learning Techniques	3	0	0	3	40	60	100

Signature of BoS Chairman

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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	**106**	Regulation	**2019**
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	Total
U19BMOE1	Biotelemetry	OE	3	0	0	3	40	60	100
U19BMOE2	Virtual Instrumentation	OE	3	0	0	3	40	60	100
U19BMOE3	Hospital Waste Management	OE	3	0	0	3	40	60	100
U19BMOE4	Medical Robotics	OE	3	0	0	3	40	60	100
U19BMOE5	Healthcare Management Systems	OE	3	0	0	3	40	60	100
U19BMOE6	Biometric Systems and Their Applications	OE	3	0	0	3	40	60	100
U19BMOE7	Biomedical Instrumentation	OE	3	0	0	3	40	60	100
U19BMOE8	Medical Informatics	OE	3	0	0	3	40	60	100
U19BMOE9	ICU and Operation Theatre Equipments	OE	3	0	0	3	40	60	100
U19BMOE10	Telemedicine	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	**2019**
Department	**COMPUTER SCIENCE AND TECHNOLOGY**			Semester	-
CURRICULUM (Applicable to the students admitted from the academic year 2019- 2020 onwards)					

LIST OF OPEN ELECTIVES

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CTOE1	Fundamentals of Artificial Intelligence	3	0	0	3	40	60	100
U19CTOE2	Fundamentals of Information Security	3	0	0	3	40	60	100
U19CTOE3	Fundamentals of Data Science	3	0	0	3	40	60	100
U19CTOE4	Foundations of Machine Learning	3	0	0	3	40	60	100
U19CTOE5	Fundamental of Data Visualization	3	0	0	3	40	60	100
U19CTOE6	Computer Forensics	3	0	0	3	40	60	100

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rks
Total
100
100
100
100
100
100

MINOR DEGREE VERTICALS OFFERED BY OTHER DEPARTMENTS

Signature of BoS Chairman

VERTICAL II - CYBER SECURITY

$ common to CSE and IT

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E. / B.Tech.**	Programme Code	101	Regulation	**2019**
Department	**COMPUTER SCIENCE AND ENGINEERING**			Semester	-

CURRICULUM

(Applicable to the students admitted from the academic year 2021- 2022 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19CSV21	Information Security	PEC	3	0	0	3	40	60	100
U19CSV22	Cyber Security	PEC	3	0	0	3	40	60	100
U19CSV23	Cryptography and Network Security$	PEC	3	0	0	3	40	60	100
U19CSV24	Cyber Law and Ethical Hacking#	PEC	3	0	0	3	40	60	100
U19CSV25	Social Network Analysis#	PEC	3	0	0	3	40	60	100
U19CSV26	Semantic Web#	PEC	3	0	0	3	40	60	100
U19ITV23	Cyber Forensics #	PEC	3	0	0	3	40	60	100
U19CTV23	Biometrics Systems#	PEC	3	0	0	3	40	60	100

common to CSE,IT and CST

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VERTICAL IV - INTERNET OF THINGS & CLOUD COMPUTING

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E. / B.Tech.**	Programme Code	101	Regulation	**2019**
Department	**COMPUTER SCIENCE AND ENGINEERING**			Semester	-

CURRICULUM

(Applicable to the students admitted from the academic year 2021- 2022 onwards)

se Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19CSV41	Embedded Systems#	PEC	3	0	0	3	40	60	100
U19CSV42	Smart Sensor Technologies#	PEC	3	0	0	3	40	60	100
U19CSV43	Security in Computing#	PEC	3	0	0	3	40	60	100
U19CSV44	Industry 4.0	PEC	3	0	0	3	40	60	100
U19ITV41	Software Defined Networks$	PEC	3	0	0	3	40	60	100
U19ITV42	Information Storage and Management$	PEC	3	0	0	3	40	60	100
U19CTV41	Fundamentals of Virtualization#	PEC	3	0	0	3	40	60	100
U19CTV43	Big Data Toolsand Techniques#	PEC	3	0	0	3	40	60	100

# common to CSE,IT and CST
$ common to CSE and IT

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VERTICAL III - ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E. / B.Tech.**	Programme Code	101	Regulation	**2019**
Department	**COMPUTER SCIENCE AND ENGINEERING**			Semester	-

CURRICULUM

(Applicable to the students admitted from the academic year 2021- 2022 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19CSV31	Data Warehousing and Data Mining	PEC	3	0	0	3	40	60	100
U19CSV32	Data Science and Analytics	PEC	3	0	0	3	40	60	100
U19CSV33	Fundamentals of Deep Learning	PEC	3	0	0	3	40	60	100
U19CSV34	Advanced Database Systems[$]	PEC	3	0	0	3	40	60	100
U19CSV35	Soft Computing	PEC	3	0	0	3	40	60	100
U19CSV36	Knowledge Management[$]	PEC	3	0	0	3	40	60	100
U19ITV34	Business Intelligence and its Applications[$]	PEC	3	0	0	3	40	60	100
U19ITV35	Digital Image Processing[$]	PEC	3	0	0	3	40	60	100

$ common to CSE and IT

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Department of Electrical & Electronics Engineering

R 2019 - Vertical Courses

S.No	Instrumentation & Control
1	U19EEV31-Communication Engineering
2	U19EEV32-Computer Architecture
3	U19EEV33-Intelligence Techniques
4	U19EEV34-Bio Medical Instrumentation
5	U19EEV35-Robotics and Control
6	U19EEV36-Modern Control Theory
7	U19EEV37-PLC & SCADA
8	U19EEV38-Intellectual Property Rights

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VERTICAL VII - ELECTRONICS ENGINEERING AND ADMINISTRATION SYSTEM

	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
rogramme	**B.E.,**	Programme Code	103	Regulation	**2019**
Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**			Semester	-

CURRICULUM

(Applicable to the students admitted from the academic year 2021- 2022 onwards)

ourse Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19ECV71	Pattern Recognition	PEC	3	0	0	3	40	60	100
U19ECV72	Medical Electronics	PEC	3	0	0	3	40	60	100
U19ECV73	Remote Sensing	PEC	3	0	0	3	40	60	100
U19ECV74	Automotive Electronics	PEC	3	0	0	3	40	60	100
U19ECV75	Industry 4.0	PEC	3	0	0	3	40	60	100
U19ECV76	Digital Video Processing	PEC	3	0	0	3	40	60	100
U19ECV77	Principles of Public Administration	PEC	3	0	0	3	40	60	100
U19ECV78	Administrative Theories	PEC	3	0	0	3	40	60	100
U19ECV79	Indian Administrative System	PEC	3	0	0	3	40	60	100

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DEPARTMENT OF BIOMEDICAL ENGINEERING

VERTICALS – VI: 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	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	-

CURRICULUM
(Applicable to the students admitted from the academic year 2021- 2022 onwards)

Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMV61	Clinical Engineering	3	0	0	3	40	60	100
U19BMV62	Hospital Planning andManagement	3	0	0	3	40	60	100
U19BMV63	Medical WasteManagement	3	0	0	3	40	60	100
U19BMV64	Economics and Management forEngineers	3	0	0	3	40	60	100
U19BMV65	Bio Statistics	3	0	0	3	40	60	100
U19BMV66	Forensic Sciencein Healthcare	3	0	0	3	40	60	100
U19BMV67	AI and Its Medical Applications	3	0	0	3	40	60	100
U19BMV68	Medical Informatics	3	0	0	3	40	60	100

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DEPARTMENT OF COMPUTER SCIENCE AND TECHNOLOGY

MINOR DEGREE - ARTIFICIAL INTELLIGENCE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19CTV31	Pattern Recognition Techniques	PEC	3	0	0	3	40	60	100
U19CTV32	Deep Learning	PEC	3	0	0	3	40	60	100
U19CTV33	Business Intelligent and its Analytics	PEC	3	0	0	3	40	60	100
U19CTV34	Data Visualization	PEC	3	0	0	3	40	60	100
U19CTV35	Natural Language Processing	PEC	3	0	0	3	40	60	100
U19CTV36	Neuro Fuzzy and Genetic Programming	PEC	3	0	0	3	40	60	100
U19CTV37	Knowledge Based Decision Support System	PEC	3	0	0	3	40	60	100
U19CTV38	Data Science Techniques	PEC	3	0	0	3	40	60	100

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Engineering for Women,
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