KIT - Kalaignarkarunanidhi Institute of Technology

(An Autonomous Institution)

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NAAC with 'A' GRADE & NBA (BIOTECH, CSE, ECE, EEE & MECH)
An ISO 9001 : 2015 Certified Institution

Coimbatore - 641 402.

CURRICULUM & SYLLABUS - 2023

(For Students admitted from the Academic Year 2023-24 and onwards)

I to VI Semester

Bachelor of Technology in Biotechnology

Department of Biotechnology

Vision and Mission of the Department

Vision

+	To offer quality education and research in the field of Biotechnology and to foster technologically competent and socially responsible professionals.

Mission

+	To provide outcome based competent education in Biotechnology towards the career aspirations of students by advanced laboratories and value added programmes.
+	To collaborate with industries and premier institutions to make the students competitive and industry ready professionals.
+	To cultivate research outlook, entrepreneurial attributes, interpersonal skills, moral values and societal commitments among students.

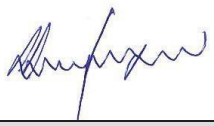
Program Educational Objectives (PEO's)

PEO 1	Graduates will be successful professionals in industry, skilled researchers, or globally competitive entrepreneurs.
PEO 2	Graduates will possess critical thinking skills to solve problems in Biotechnology and allied fields.
PEO 3	Graduates will demonstrate a lifelong commitment to learning in their professional careers.

Program Outcomes (PO's)

After the successful completion of the U.G. Program in Biotechnology, graduates will be able to:

PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design / Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.



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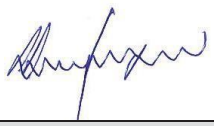
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Lifelong Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO's)	
After the successful completion of the U.G. Program in Biotechnology, graduates will be able to :	
PSO 1	Identify and solve emerging problems in Biotechnology and allied fields.
PSO 2	Support fundamental and translational research in applied and interdisciplinary Biotechnology.



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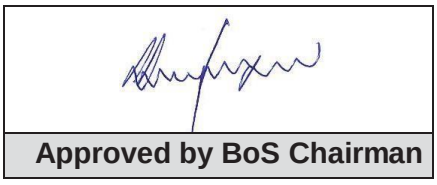
Curriculum

	Scheme of Instructions and Examinations (For Students admitted from the Academic Year 2023-24 and onwards)	

Semester - I										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
B23IPP101	Induction Program	**HS**	**-**	**-**	**-**	**-**	**0**	**-**	**-**	**-**
Theory / Theory with Practical										
B23MAT101	Matrices and Differential Calculus	**BS**	4	3	1	0	**4**	40	60	100
B23MET101	Engineering Graphics	**ES**	4	2	2	0	**4**	40	60	100
B23HST101	Heritage of Tamils	**HS**	1	1	0	0	**1**	40	60	100
B23ENI101	Professional Communication	**HS**	5	3	0	2	**4**	50	50	100
B23CHI101	Engineering Chemistry	**BS**	5	3	0	2	**4**	50	50	100
B23CSI102	Problem Solving and Python Programming	**ES**	5	3	0	2	**4**	50	50	100
Practical										
B23MEP101	Engineering Practices Laboratory	**ES**	4	0	0	4	**2**	60	40	100
Total credits to be earned							**23**			

Semester – II										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
Theory / Theory with Practical										
B23ENT201	Professional English	**HS**	2	2	0	0	**2**	40	60	100
B23MAT201	Integral Calculus and Complex Analysis	**BS**	4	3	1	0	**4**	40	60	100
B23HST201	Tamils and Technology	**HS**	1	1	0	0	**1**	40	60	100
B23BTT201	Biochemistry	**PC**	3	3	0	0	**3**	40	60	100
B23BTT202	Bioorganic Chemistry	**PC**	3	3	0	0	**3**	40	60	100
B23PHI101	Engineering Physics	**BS**	5	3	0	2	**4**	50	50	100
Practical										
B23BTP201	Biochemistry and Bioorganic Chemistry Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23CEP201	Soft Skills	**CEC**	2	2	0	0	**NC**	-	-	-
B23CEP202	Application Design and Development	**CEC**	1	1	0	0	**NC**	100	-	100
Total credits to be earned							**19**			



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Semester – III										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT304	Partial Differential Equations and Probability	**HS**	4	3	1	0	**4**	40	60	100
B23BTT301	Stoichiometry and Fluid Mechanics	**PC**	3	3	0	0	**3**	40	60	100
B23BTT302	Biochemical Thermodynamics	**PC**	3	3	0	0	**3**	40	60	100
B23BTT303	Bioprocess Principles	**PC**	3	3	0	0	**3**	40	60	100
B23BTT304	Cell Biology and Genetics	**PC**	3	3	0	0	**3**	40	60	100
B23BTI301	Microbiology	**PC**	5	3	0	2	**4**	50	50	100
Practical										
B23BTP301	Chemical Engineering Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23CEP301	Professional Certificate Course	**CEC**	2	0	0	2	**1**	100	-	100
Total credits to be earned							**23**			

In Plant Training – Minimum ONE WEEK has to be completed. Review will be conducted during the first week of 4th semester and included in 4th semester mark statement.

Semester IV										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT406	Biostatistics	**BS**	4	3	1	0	**4**	40	60	100
B23BTT401	Chemical Reaction Engineering	**PC**	4	3	1	0	**4**	40	60	100
B23BTT402	Enzymology and Enzyme Technology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT403	Molecular Biology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT404	Industrial Biotechnology	**PC**	3	3	0	0	**3**	40	60	100
B23BTI401	Analytical Methods in Biotechnology	**PC**	5	3	0	2	**4**	50	50	100
Practical										
B23BTP401	Cell and Molecular Biology Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23CEP402	In Plant Training	**CEC**	-	-	-	-	**NC**	-	-	-
B23MCP401	Professional Development Course	**MC**	0	0	0	2	**1***	100	-	100
Total credits to be earned							**23**			

Summer Internship – Duration 15 days (Review will be conducted in first week of Semester V and its credit will be included in Semester V).

***The Grades earned by the students will be recorded in the marksheet, however the same shall not be considered for the computation of CGPA

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Semester – V										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23BTT501	Mass Transfer Operations	**PC**	4	3	1	0	**4**	40	60	100
B23BTT502	IoT Applied Bioprocess Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTT503	Protein Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTT504	Genetic Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTExxx	Professional Elective I	**PE**	3	3	0	0	**3**	40	60	100
-	Open Elective I	**OE**	3	3	0	0	**3**	40	60	100
B23MCT50x	Mandatory Course I	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT505	Holistic insight into UN SDGs	**MC**	2	2	0	0	**NC**	100	-	100
Practical										
B23BTP501	Bioprocess Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23BTP502	Genetic Engineering Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23CEP501	Summer Internship	**CEC**	-	-	-	-	**1**	100	-	100
Total credits to be earned							**24**			

Semester – VI										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23BTT601	Immunology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT602	Nanobiotechnology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT603	Bioinformatics	**PC**	3	3	0	0	**3**	40	60	100
B23BTT604	Bioethics, Biosafety and IPR	**PC**	3	3	0	0	**3**	40	60	100
B23BTExxx	Professional Elective II	**PE**	3	3	0	0	**3**	40	60	100
-	Open Elective II	**OE**	3	3	0	0	**3**	40	60	100
B23MCT60x	Mandatory Course II	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT605	Cyber Safety Concepts	**MC**	2	2	0	0	**NC**	100	-	100
Practical										
B23BTP601	Immunology Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23BTP603	Innovative Design Practices	**PW**	4	0	0	4	**2**	40	60	100
Total credits to be earned							**22**			

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Semester – VII										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23BTT701	Downstream Processing	PC	3	3	0	0	3	40	60	100
B23BTT702	Biopharmaceutical Technology	PC	3	3	0	0	3	40	60	100
B23BTT703	Genomics and Proteomics	PC	3	3	0	0	3	40	60	100
B23MGT701	Total Quality Management	HS	3	3	0	0	3	40	60	100
B23BTExxx	Professional Elective III	PE	3	3	0	0	3	40	60	100
B23BTExxx	Professional Elective IV	PE	3	3	0	0	3	40	60	100
B23HST701	Universal Human Values	HS	2	2	0	0	2	40	60	100
Practical										
B23BTP701	Downstream Processing Laboratory	PC	4	0	0	4	2	60	40	100
B23BTP702	Project Work Phase I	PW	6	0	0	6	4	40	60	100
Total credits to be earned							26			

Semester – VIII										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23BTP801	Project Work Phase II	PW	16	0	0	16	8	40	60	100
Total credits to be earned							8			

HUMANITIES AND SOCIAL SCIENCES (HS)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23IPP101	Induction Program	HS	-	-	-	-	0	-	-	-
B23ENI101	Professional Communication	HS	5	3	0	2	4	50	50	100
B23HST101	Heritage of Tamils	HS	1	1	0	0	1	40	60	100
B23ENT201	Professional English	HS	2	2	0	0	2	40	60	100
B23HST201	Tamils and Technology	HS	1	1	0	0	1	40	60	100
B23MAT304	Partial Differential Equations and Probability	HS	4	3	1	0	4	40	60	100
B23MGT701	Total Quality Management	HS	3	3	0	0	3	40	60	100
B23HST701	Universal Human Values	HS	2	2	0	0	2	40	60	100

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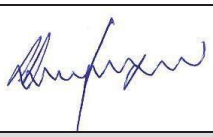
BASIC SCIENCES (BS)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
B23MAT101	Matrices and Differential Calculus	BS	4	3	1	0	4	40	60	100
B23CHI101	Engineering Chemistry	BS	5	3	0	2	4	50	50	100
B23MAT201	Integral Calculus and Complex Analysis	BS	4	3	1	0	4	40	60	100
B23PHI101	Engineering Physics	BS	5	3	0	2	4	50	50	100
B23MAT406	Biostatistics	BS	4	3	1	0	4	40	60	100

ENGINEERING SCIENCES (ES)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MET101	Engineering Graphics	ES	4	2	2	0	4	40	60	100
B23CSI102	Problem Solving and Python	ES	5	3	0	2	4	50	50	100
B23MEP101	Engineering Practices Laboratory	ES	4	0	0	4	2	60	40	100

PROFESSIONAL CORE (PC)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23BTT202	Bioorganic Chemistry	PC	3	3	0	0	3	40	60	100
B23BTT201	Biochemistry	PC	3	3	0	0	3	40	60	100
B23BTP201	Biochemistry and Bioorganic Chemistry Laboratory	PC	4	0	0	4	2	60	40	100
B23BTT301	Stoichiometry and Fluid Mechanics	PC	3	3	0	0	3	40	60	100
B23BTT302	Biochemical Thermodynamics	PC	3	3	0	0	3	40	60	100
B23BTT303	Bioprocess Principles	PC	3	2	1	0	3	40	60	100
B23BTT304	Cell Biology and Genetics	PC	3	3	0	0	3	40	60	100
B23BTI301	Microbiology	PC	5	3	0	2	4	50	50	100
B23BTP302	Chemical Engineering Laboratory	PC	4	0	0	4	2	60	40	100
B23BTT401	Chemical Reaction Engineering	PC	4	3	1	0	4	40	60	100
B23BTT402	Enzymology and Enzyme Technology	PC	3	3	0	0	3	40	60	100
B23BTT403	Molecular Biology	PC	3	3	0	0	3	40	60	100
B23BTT404	Industrial Biotechnology	PC	3	3	0	0	3	40	60	100



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B23BTI401	Analytical Methods in Biotechnology	**PC**	5	3	0	2	**4**	50	50	100
B23BTP401	Cell and Molecular Biology Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23BTT501	Mass Transfer Operations	**PC**	4	3	1	0	**4**	40	60	100
B23BTT502	IoT Applied Bioprocess Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTT503	Protein Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTT504	Genetic Engineering	**PC**	3	3	0	0	**3**	40	60	100
B23BTP501	Bioprocess Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23BTP502	Genetic Engineering Laboratory	**PC**	4	0	0	4	**2**	60	40	100
B23BTT601	Immunology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT602	Nanobiotechnology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT603	Bioinformatics	**PC**	3	3	0	0	**3**	40	60	100
B23BTT604	Bioethics, Biosafety and IPR	**PC**	3	3	0	0	**3**	40	60	100
B23BTP601	Immunology Laboratory	**PC**	2	0	0	2	**2**	60	40	100
B23BTT701	Downstream Processing	**PC**	3	3	0	0	**3**	40	60	100
B23BTT702	Biopharmaceutical Technology	**PC**	3	3	0	0	**3**	40	60	100
B23BTT703	Genomics and Proteomics	**PC**	3	3	0	0	**3**	40	60	100
B23BTP701	Downstream Processing Laboratory	**PC**	4	0	0	4	**2**	60	40	100

MANDATORY COURSE (MC)

Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
B23MCT501	Environmental Sustainability	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT502	Elements of Literature	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT503	Foundations of Yoga	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT504	Export Import Management	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT601	Education Psychology	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT602	Life Style Education	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT603	Startup and Venture Funding	**MC**	2	2	0	0	**NC**	100	-	100
B23MCT604	Indian Knowledge System	**MC**	2	2	0	0	**NC**	100	-	100

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Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI
Bioprocess and Biochemical Engineering	**Medical Biotechnology**	**Agro Biotechnology**	**Animal Biotechnology**	**Computational Biotechnology**	**Quality and Regulatory Affairs**
Bioprocess Control and Instrumentation	Cancer Biology	Plant Biotechnology	Fundamentals of Animal Biotechnology	Fundamentals of Algorithms for Bioinformatics	Clinical Trials and Health care policies in Biotechnology
Fermentation Technology	Biopharmaceuticals and Biosimilars	Therapeutic application of phytochemicals	Animal Health and Nutrition	Molecular Modeling	Biotechnological products and its validation
Food Biotechnology	Tissue Engineering	Biofertilizer production and Mushroom cultivation	Animal Physiology and Metabolism	Computer Aided Drug Design	Quality Assurance and Quality Controlling Biotechnology
Environmental Biotechnology	Molecular Therapeutics and Diagnostics	Biotechnological approach in crop improvement	Animal Cell Culture Technology	Metabolomics and Metabolic Engineering	Entrepreneurship and patent design
Bioenergy and Biofuels	Vaccine Technology	Plant tissue culture and transformation techniques	Advances in Animal Biotechnology	Data Mining and Machine Learning Techniques for Bioinformatics	Intellectual Property Rights in Biotechnology
Bioreactor Design and Scale up process	Biomedical Engineering	Advanced techniques in agro forestry	Biotechniques in Animal Breeding	Programming for Bioinformatics Applications	Biosafety and Hazard Management
Biosensors	Stem Cell Technology	Biomaterials	Modern Bioanalytical Techniques	Human Genetics	Biodiversity

PROFESSIONAL ELECTIVE (PE)											
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**			
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
VERTICAL I – BIOPROCESS AND BIOCHEMICAL ENGINEERING											
B23BTE901	Bioprocess Control and Instrumentation	**PE**	3	3	0	0	**3**	40	60	100
B23BTE902	Fermentation Technology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE903	Food Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE904	Environmental Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE905	Bioenergy and Biofuels	**PE**	3	3	0	0	**3**	40	60	100
B23BTE906	Bioreactor Design and Scale up process	**PE**	3	3	0	0	**3**	40	60	100
B23BTE907	Biosensors	**PE**	3	3	0	0	**3**	40	60	100

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VERTICAL II – MEDICAL BIOTECHNOLOGY										
B23BTE908	Cancer Biology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE909	Biopharmaceuticals and Biosimilars	**PE**	3	3	0	0	**3**	40	60	100
B23BTE910	Tissue Engineering	**PE**	3	3	0	0	**3**	40	60	100
B23BTE911	Molecular Therapeutics and Diagnostics	**PE**	3	3	0	0	**3**	40	60	100
B23BTE912	Vaccine Technology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE913	Biomedical Engineering	**PE**	3	3	0	0	**3**	40	60	100
B23BTE914	Stem Cell Technology	**PE**	3	3	0	0	**3**	40	60	100
VERTICAL III – AGRO BIOTECHNOLOGY										
B23BTE915	Plant Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE916	Therapeutic application of phytochemicals	**PE**	3	3	0	0	**3**	40	60	100
B23BTE917	Biofertilizer production and mushroom cultivation	**PE**	3	3	0	0	**3**	40	60	100
B23BTE918	Biotechnological approach in crop improvement	**PE**	3	3	0	0	**3**	40	60	100
B23BTE919	Plant tissue culture and transformation techniques	**PE**	3	3	0	0	**3**	40	60	100
B23BTE920	Advanced techniques in agro forestry	**PE**	3	3	0	0	**3**	40	60	100
B23BTE921	Biomaterials	**PE**	3	3	0	0	**3**	40	60	100
VERTICAL IV – ANIMAL BIOTECHNOLOGY										
B23BTE922	Fundamentals of Animal Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE923	Animal Health and Nutrition	**PE**	3	3	0	0	**3**	40	60	100
B23BTE924	Animal Physiology and Metabolism	**PE**	3	3	0	0	**3**	40	60	100
B23BTE925	Animal Cell Culture Technology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE926	Advances in Animal Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE927	Biotechniques in Animal Breeding	**PE**	3	3	0	0	**3**	40	60	100
B23BTE928	Modern Bioanalytical Techniques	**PE**	3	3	0	0	**3**	40	60	100
VERTICAL V – COMPUTATIONAL BIOTECHNOLOGY										
B23BTE929	Fundamentals of Algorithms for Bioinformatics	**PE**	3	3	0	0	**3**	40	60	100
B23BTE930	Molecular Modeling	**PE**	3	3	0	0	**3**	40	60	100
B23BTE931	Computer Aided Drug Design	**PE**	3	3	0	0	**3**	40	60	100
B23BTE932	Metabolomics and Metabolic Engineering	**PE**	3	3	0	0	**3**	40	60	100
B23BTE933	Data Mining and Machine Learning Techniques for Bioinformatics	**PE**	3	3	0	0	**3**	40	60	100
B23BTE934	Programming for Bioinformatics Applications	**PE**	3	3	0	0	**3**	40	60	100
B23BTE935	Human Genetics	**PE**	3	3	0	0	**3**	40	60	100

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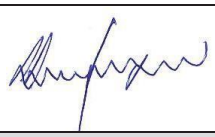
VERTICAL VI – QUALITY AND REGULATORY AFFAIRS										
B23BTE936	Clinical Trials and Health care policies in Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE937	Biotechnological products and its validation	**PE**	3	3	0	0	**3**	40	60	100
B23BTE938	Quality assurance and quality controlling Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE939	Entrepreneurship and patent design	**PE**	3	3	0	0	**3**	40	60	100
B23BTE940	Intellectual property rights in Biotechnology	**PE**	3	3	0	0	**3**	40	60	100
B23BTE941	Biosafety and Hazard Management	**PE**	3	3	0	0	**3**	40	60	100
B23BTE942	Biodiversity	**PE**	3	3	0	0	**3**	40	60	40

PROJECT WORK (PW)										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
B23BTP603	Innovative Design Practices	**PW**	4	0	0	4	**2**	40	60	100
B23BTP702	Project Work Phase I	**PW**	6	0	0	6	**4**	40	60	100
B23BTP801	Project Work Phase II	**PW**	16	0	0	16	**8**	40	60	100

CAREER ENHANCEMENT COURSE (CEC)										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
B23CEP201	Soft Skills	**CEC**	2	2	0	0	**1**	-	-	-
B23CEP301	Professional Certificate Course	**CEC**	2	0	0	2	**1**	100	-	100
B23CEP402	In Plant Training	**CEC**	-	-	-	-	**NC**	-	-	-
B23CEP501	Summer Internship	**CEC**	-	-	-	-	**1**	100	-	100

OPEN ELECTIVE COURSES-OFFERED BY DEPARTMENT OF BIOTECHNOLOGY										
Course Code	**Course Name**	**CT**	**Instructional Hours**					**Assessment**		
			CP	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**Total**
B23BTO501/ B23BTE917	Biofertilizer production and mushroom cultivation	**OE**	3	3	0	0	**3**	40	60	100
B23BTO601/ B23BTT603	Bioinformatics	**OE**	3	3	0	0	**3**	40	60	100



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SUMMARY										
S. No.	Subject Area	Credits As per Semester								Credit Points
		I	II	III	IV	V	VI	VII	VIII	
1	HS	5	3	4				5		**17**
2	BS	8	8		4					**20**
3	ES	10								**10**
4	PC		8	18	19	17	14	11		**87**
5	PE					3	3	6		**12**
6	OE					3	3			**6**
7	PW						2	4	8	**14**
8	CEC			1		1				**2**
9	MC (Non Credit)				✓	✓	✓			
	Total	**23**	**19**	**23**	**23**	**24**	**22**	**26**	**8**	**168**

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Semester - I

B.E. / B.Tech.	B23MAT101 - MATRICES AND DIFFERENTIAL CALCULUS (Common to all Branches)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To develop the use of matrices that is needed by engineers for practical applications.
2.	To understand the concept of functions of several variables.
3.	To recognize and classify ordinary differential equations.
4.	To apply the concept of ordinary differential equations in engineering disciplines.
5.	To learn the applications of Laplace transforms in engineering.

UNIT - I	MATRICES	12

Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley Hamilton theorem – Quadratic form: Nature, Reduction to canonical form by orthogonal transformation.

UNIT - II	FUNCTIONS OF SEVERAL VARIABLES	12

Partial differentiation –Total derivative – Jacobians – Taylor's series expansion for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT - III	ORDINARY DIFFERENTIAL EQUATIONS	12

Higher order linear ordinary differential equations with constant coefficients - Method of variation of parameters - Simultaneous differential equations.

UNIT - IV	APPLICATIONS OF ORDINARY DIFFERENTIAL EQUATIONS	12

Solution of specified differential equations connected with electric circuits - Law of Natural growth and decay - Simple harmonic motion (Differential equations and associated conditions need to be given)

UNIT - V	LAPLACE TRANSFORMS	12

Existence conditions - Properties (excluding proofs) - Transform of standard functions -Transforms of derivatives and integrals - Inverse Laplace transform - Applications to solution of linear second order ordinary differential equations with constant coefficients.

Total Instructional hours : 60

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Course Outcomes	
CO1	Make use of Eigen values and Eigen vectors to reduce the quadratic form into canonical form and to find the powers of a square matrix.
CO2	Identify the maxima and minima problems.
CO3	Solve differential equations which existing in different engineering disciplines.
CO4	Develop the applications of differential equations in various engineering field.
CO5	Apply Laplace transform and inverse transform to solve differential equations with constant coefficients.

Text Books	
1.	Grewal B.S.,"Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2015.
2.	Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media - An imprint of Lakshmi Publications Pvt., Ltd., New Delhi, 7th Edition, 2015.
3.	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2015.
4.	George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir, "Thomas' Calculus", Pearson, 14th Edition, 2018.

Reference Books	
1.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2019.
2.	Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
3.	Ramana B V., "Higher Engineering Mathematics", Tata Mc Graw Hill Publishing Company, New Delhi, 2017.
4.	Veerarajan T., "Engineering Mathematics for Semester I and II", Tata Mc Graw Hill Publishing Company, New Delhi, 2019.
5.	Gean Duffy., "Advanced Engineering Mathematics with MATLAB", A CRC Press Company, Boca Raton London, New York Washington, D.C, 2nd edition 2009. (Free e-book downloaded from www.EasyEngineering.net.pdf).

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B.E / B.Tech	B23MET101 – ENGINEERING GRAPHICS (COMMON TO ALL)	L	T	P	C
		2	2	0	4

Course Objectives	
1.	Understand the conventions and method of Engineering drawing.
2.	Construct and interpret the basic Engineering drawings.
3.	Improve their visualization skills so that they can apply these skills in new product development.
4.	Enhance their technical communication skill in the form of communicative drawings.
5.	Comprehend the theory of projection.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION)	2
Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.	

UNIT - I	PLANE CURVES AND FREE HANDSKETCHING	14
Basic Geometrical constructions, Curves used in Engineering practices-Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles – Representation of Three-Dimensional objects – Layout of views - Free hand sketching of multiple views from pictorial views of objects.		

UNIT - II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	14
Orthographic projection - principles - Principal planes - First angle projection - Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		

UNIT - III	PROJECTION OF SOLIDS	14
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.		

UNIT - IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	14
Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.		

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UNIT - V	ISOMETRIC AND PERSPECTIVE PROJECTIONS	14
Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-prisms, pyramids and cylinders by visual ray method.		

COMPUTER AIDED DRAFTING	3
Introduction to drafting packages and demonstration of their use Basic Geometrical constructions using AUTOCAD	
Total Instructional hours : 75	

Course Outcomes : Students will be able to	
CO1	Construct the basic engineering curves and freehand sketching of basic geometrical constructions and multiple views of objects.
CO2	Solve problems related to projections of points, straight lines and planes
CO3	Build the projection of simple solids.
CO4	Apply the knowledge acquired on practical applications of sectioning and development of solids.
CO5	Construct simple solids and its sections in isometric view and projections, and also to draw its perspective views.

Text Books	
1.	K.V.Natarajan, “A text book of Engineering Graphics”, 28th Edition, Dhana Lakshmi Publishers, Chennai, 2015.
2.	N.D. Bhatt and V.M. Panchal, “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2014.

Reference Books	
1.	K. Venugopal and V.Prabhu Raja, “Engineering Graphics”, New Age International Publishers, 2017.
2.	K.R.Gopalakrishna., “Engineering Drawing” (Vol. I & II combined) Subhas Publications, Bangalore, 2018.
3.	N.S Parthasarathy and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015.

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B.E. / B.Tech.	B23HST101 - தமிழர் மரபு	L	T	P	C
		1	0	0	1

அலகு - I	மொழி மற்றும் இலக்கியம்	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 - II	மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக்கலை	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 கோவில்களின் பங்கு.

அலகு - III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்	3

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

அலகு - IV	தமிழர்களின் திணைக் கோட்பாடுகள்	3

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

அலகு - V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டில் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப் படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

மொத்தம் - 15 காலங்கள்

BoS Chairman

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 வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroy of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

BoS Chairman

B.E / B.Tech	B23HST101 - HERITAGE OF TAMILS (COMMON TO ALL BRANCHES)	L	T	P	C
		1	0	0	1

UNIT - I	LANGUAGE AND LITERATURE	3

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

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

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

UNIT - IV	THINAI CONCEPT OF TAMILS	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	3

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

Total Instructional hours : 15

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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 வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroyb of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

BoS Chairman

B.E. / B.Tech. (Except CSBS)	B23ENI101 – PROFESSIONAL COMMUNICATION	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To enhance listening and reading ability of learners to comprehend various forms of speech or conversations.
2.	To develop learners' verbal ability through complex texts and speak effectively in real life and workplace context.
3.	To make use of grammatical knowledge to enhance fluency.
4.	To foster learners' ability to write convincing job applications and effective reports.
5.	To develop learners language proficiency through LSRW skills.

UNIT - I	9
Listening	Listening for general information - specific details - conversation - Audio / video (formal & informal); Telephone conversation
Speaking	Self-Introduction; Introducing a friend; - politeness strategies - making polite requests & polite offers
Reading	Introduction to technical texts, scientific texts
Writing	Extended definitions, Writing checklists, Recommendation
Language development	Gerunds, Infinitives
Vocabulary development	Technical vocabulary, abbreviations, British & American spelling

UNIT - II	9
Listening	Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities
Speaking	Narrating personal experiences / Talking about events and situations
Reading	Reading longer technical texts, Summarizing
Writing	Interpreting graphical representations, Writing dialogues about formal and informal contexts
Language development	Use of conjunctions and prepositions
Vocabulary development	Numerical adjectives, Transitional device

BoS Chairman

UNIT - III	9
Listening	Listen to a classroom lecture; listening to advertisements about products
Speaking	Picture description - describing locations in workplace, Presenting product, describing shape, size and weight - talking about quantities - talking about precautions, discussing advantages and disadvantages - making comparisons
Reading	Cause & effect texts, practice in speed reading
Writing	Process writing, Use of sequence words, Analytical and issue based essays
Language development	Subject verb agreement, Pronoun concord / pronoun antecedent
Vocabulary development	Sequence words, Misspelled words, Content v/s Function words

UNIT - IV	9
Listening	Listening to TED Talks, Educational videos and completing exercises based on them
Speaking	Short speech (Just A Minute) - Extempore and persuasive speech, discussing and making plans-talking about tasks-talking about progress
Reading	Reading for details in personal and professional emails
Writing	Drafting personal and professional emails, job application - cover letter, résumé preparation, Internship letter
Language development	Clauses, if conditionals
Vocabulary development	Finding suitable synonyms, Paraphrasing

UNIT - V	9
Listening	Listening to debates/ discussions and panel discussions, listening to interviews
Speaking	Making predictions - talking about a given topic, giving opinions & facts, describing a process, discussing safety issues (making recommendations)
Reading	Reading and understanding technical articles
Writing	Writing reports, Minutes of meeting, Writing feasibility, survey and industrial reports
Language development	Reported speech, Active and Passive voice, Impersonal passive, Idioms
Vocabulary development	Verbal analogies, Purpose statements
	Total Theory Instructional hours : 45 **Total Lab Instructional hours : 30**

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Course Outcomes : Students will be able to	
CO1	Develop listening skills to respond appropriately in general and academic purposes.
CO2	Develop strategies and skills to enhance their ability to read and comprehend.
CO3	Apply vocabulary skills to improve their language skills.
CO4	Build writing skills with specific reference to technical writing.
CO5	Demonstrate language proficiency through LSRW skills.

Text Books	
1.	Board of Editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad : 2016
2.	Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

Reference Books	
1.	Raman, Meenakshi and Sharma, Sangeetha “Technical Communication Principles and Practice” Oxford University Press: New Delhi, 2014.
2.	Kumar, Suresh. E. “Engineering English” Orient Blackswan: Hyderabad, 2015.
3.	Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4.	Davis, Jason and Rhonda LIss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
5.	Communicative English for Engineers and Professionals- Nitin Bhatnagar & Mamta Bhatnagar.
6.	Skills for Success. Listening and Speaking. Level 4- Margret Brooks.
7.	Grammar F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press : Oxford, 2011.

Exercises for Batch of 30 Students

1. Listening Comprehension
2. Self- introduction
3. Short presentation
4. Group Discussion

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B.E / B.Tech	B23CHI101 - ENGINEERING CHEMISTRY (COMMON TO ALL BRANCHES)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To make the students conversant with boiler feed water requirements, related problems, water treatment and inculcate practical skills in the water quality analysis.
2.	To make the students conversant with basics of polymer chemistry.
3.	To make the students conversant with basic of electrochemical reactions, corrosion and induce experimental skills in the electro-analytical techniques.
4.	To make the student acquire sound knowledge of energy devices.
5.	To develop an understanding of the basic concepts of nano materials.

UNIT - I	WATER TECHNOLOGY	17

Hardness of water : Types, expression of hardness and their units, hardness problems, boiler troubles - scale and sludge, caustic embrittlement, boiler corrosion, priming and foaming

Treatment of Boiler feed water : Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning)

External treatment : Ion exchange process, Zeolite process

Desalination of brackish water : Reverse osmosis - municipal water treatment, break point chlorination

Determination of alkalinity in water sample, Determination of total, temporary & permanent hardness of water by EDTA method. Estimation of iron content of the water sample using spectrophotometer.

UNIT - II	POLYMERS	9

Polymers : Definition, polymerization, types - addition and condensation polymerization, free radical mechanism - tacticity – biodegradable polymer (PHBV) and conducting polymer (poly-aniline)

Plastics : Classification, preparation, properties and uses of PVC, teflon, nylon-6, 6 and epoxy resin

Rubber : Vulcanization of rubber, synthetic rubbers -n-butyl rubber and SBR

Moulding : Ingredients - compression and Injection

BoS Chairman

UNIT - III	ELECTROCHEMISTRY AND CORROSION	16

Electrochemistry : Redox reaction, electrode potential - oxidation potential, reduction potential, Nernst equation (derivation) - measurement and applications - electrochemical series and its significance
Corrosion : causes - types-chemical and electrochemical corrosion (galvanic and differential aeration), corrosion control - electrochemical protection (sacrificial anodic method and impressed current cathodic method)
Estimation of iron content of the given solution using potentiometer, Conductometric titration of strong acid vs strong base, Estimation of copper in brass

UNIT - IV	ENERGY DEVICES	9

Batteries : Types of batteries – primary (alkaline battery) and secondary battery (lead acid battery, lithium-ion-battery), Fuel Cells (H2 - O2 fuel cell)
Super Capacitors : Principle, construction, working and applications
Photo voltaic cell : Solar cells - principle, construction, working and applications

UNIT - V	NANOCHEMISTRY	9

Basics : Distinction between molecules, nanoparticles and bulk materials- surface area to volume ratio
Synthesis : Top-down process (ball milling) - Bottom-up process (chemical vapour deposition and sol-gel method)
Properties of nano materials - Optical, electrical, thermal and mechanical
Applications of nano materials - Medicine, Industries, electronics and biomaterials

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Explain the characterization of water and quantitative analysis of alkalinity, hardness and Iron
CO2	Develop the basics of polymer chemistry.
CO3	Illustrate the principles of electrochemical reactions, corrosion and estimation of copper in alloy.
CO4	Apply the concepts of energy devices and its engineering applications.
CO5	Organize the basics of nano chemistry and its applications.

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Text Books	
1.	Dara, S S and Umare, S S, “A Textbook of Engineering Chemistry”, Chand S & Company Ltd., New Delhi, 2015.
2.	Jain, P C and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company Pvt. Ltd., New Delhi, 2015
3.	Vogel’s Textbook of Quantitative Chemical Analysis, 8th edition, 2014.

Reference Books	
1.	Friedrich Emich, “Engineering Chemistry”, Scientific International Pvt. Ltd., New Delhi, 2014.
2.	Prasanta Rath, “Engineering Chemistry”, Cengage Learning India Pvt. Ltd., Delhi, 2015.
3.	Shikha Agarwal, “Engineering Chemistry - Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.
4.	Charles P. Poole and Frank J. Owens, "Introduction to nanotechnology", John Wiley Sons, New Jersey, 2003.

Equipment Needed for 30 Students

1. Conductivity Meter - 10
2. Potentiometer - 10
3. Spectrophotometer - 02
4. Electronic Balance - 01

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B.E.	B23CSI102 - PROBLEM SOLVING AND PYTHON PROGRAMMING (COMMON TO AERO, AGRI, BT AND MECH)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To develop python programs with conditional statements and loops.
2.	To learn how to use strings, functions and pass arguments in Python.
3.	To use python data structures such as lists, tuples, and dictionaries.
4.	To use file concepts and to build a package using Python modules for reusability.
5.	To learn the fundamentals of data manipulations with Python.

UNIT - I	INTRODUCTION TO PYTHON PROGRAMMING	9

Introduction : Python basics and its scripting modes – Variables, Operators - Control Structures : if, if - else, nested if, if – elif ladder statements - Iterative statements : while, for, Nested loops, else in loops, break, continue and pass statements.

UNIT - II	STRINGS AND FUNCTIONS	9

Strings : Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions. Regular expression: Matching the patterns, Search and replace. Functions: Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments.

UNIT - III	COLLECTIONS	9

List : Create, Access, Slicing, Negative Indices, List Methods, and comprehensions, Tuples : Create, Indexing and Slicing, Operations on tuples. Dictionary: Create, add, and replace values, operations on dictionaries

UNIT - IV	SETS AND FILE HANDLING	9

Sets : Create and operations on set, Files : Manipulating files and directories, text files : reading / writing text and numbers from / to a file; creating and reading a formatted file (csv or tab separated)

UNIT - V	MODULES AND PACKAGES	9

Modules: Importing module, standard modules, executing modules. Packages: Importing Packages, simple programs using built-in functions of packages like pandas, jumpy, matplotlib

Total Instructional hours : 45

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List of Experiments		
Expt. No.		**Description of the Experiments**
1.	Programs Using Simple Statements	
	a.	Exchange the values of two variables,
	b.	Circulate the values of n variables,
	c.	Distance between two points.
2.	Programs Using Conditionals and Iterative Statements	
	a.	Number Series
	b.	Number Patterns
	c.	Pyramid Pattern
3.	Programs Using built-in and user defined Functions	
	a.	Factorial of a Number
	b.	Largest Number in a list
	c.	Area of Shape
4.	Programs using Strings	
	a.	Reversing a String
	b.	Checking Palindrome in a String
	c.	Counting Characters in a String
	d.	Replacing Characters in a String
5.	Operations of Lists	
	a.	Basic Operations (Insertion, Updating, deletion, accessing, List Comprehensions)
	b.	Implement linear search and binary search using list.
	c.	Matrix operations using Nested List.
	d.	Implement Merge, Bubble and Insertion sort
6.	Create a tuple and perform its operations for the following :	
	a.	Basic Operations (Insertion, Updating, deletion, accessing)
	b.	Items present in a library
	c.	Components of a car
	d.	Materials required for construction of a laboratory

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7.	Operations of Dictionaries	
	a.	Python program to create a dictionary with integer keys, and print the keys, values & key-value pairs
	b.	Python program to randomize (shuffle) values of dictionary
8.	Operations of Sets	
	a.	Basic operations of set (Membership, Operations and Modifications)
9.	Programs using File Handling	
	a.	Copy from one file to another.
	b.	Word count
	c.	Longest word
10.	Python programs using Time and Calendar related functions	
	a.	Print the current time using time module.
	b.	Display the calendar of given month of the year using calendar module.
11.	Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)	
Total Instructional hours: (45+15) = 60		

Course Outcomes : Students will be able to	
CO1	Outline the different problem-solving techniques.
CO2	Make use of various data types and control structures to solve a given problem.
CO3	Develop C programs with different types of arrays and string operations
CO4	Experiment with the usage of pointers and functions in C.
CO5	Build C Programs data using structures and unions

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of the Equipment	Quantity required (Nos.)
1.	HP Make, Core i5, 11th Generation, 16GB RAM PCs, Operating systems: Windows* 10 or later, macOS, and Linux. Python* version: 3.10.X	30

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Text Books	
1.	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Updated for Python 3, Shroff / O ‘Reilly Publishers, 2016
2.	Reema Thereja, “Python Programming using Problem Solving Approach”, 4th Impression, Oxford University Press, 2019.
3.	Python Course Data Analysis with Python by Bernd Klein, 2021.

Reference Books	
1.	John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and expanded Edition, MIT Press, 2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python : An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd, 2016.
3.	Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd, 2015.
4.	Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.

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B.E. / B.TECH	B23MEP101 – ENGINEERING PRACTICES LABORATORY (GROUP - A & B) (Common to all Branches)	L	T	P	C
		0	0	4	2

Course Objectives	
1.	Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work, sawing, planning, making joints in wood materials used in common household wood work.
2.	Welding various joints in steel plates using arc welding work; machining various simple processes like turning, drilling, tapping in parts; assembling simple mechanical assembly of common household equipments, making a tray out of metal sheet using sheet metal work.
3.	To provide exposure to the students with hands on experience on various basic Engineering practices in Electrical Engineering.
4.	To provide exposure to the students with hands on experience on various basic Engineering practices in Electronics Engineering.

GROUP – A (CIVIL & MECHANICAL)		
I	**Civil Engineering Practices**	**12**
	Plumbing Works Making basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings	
Carpentry Preparation of wooden joints by sawing, planning and cutting		
1.	Planning & Polishing operation	
2.	Half lap joint	
3.	Cross lap joint	
II	**Mechanical Engineering Practices**	**18**
	Welding Workshop Study of welding tools and equipment's - Study of various welding methods - Instruction of BI standards and reading of welding drawings.	

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Exercise in arc welding for making	
1.	Lap joint
2.	Butt joint
3.	Demonstration of gas welding and cutting.
Machine Shop	
1.	Drilling and Tapping
2.	Lathe Exercise – Facing operation
3.	Lathe Exercise – Straight turning and Chamfering
Sheet metal	
Making of small parts using sheet metal	
1.	Making of Square Tray

GROUP – B (ELECTRICAL & ELECTRONICS)	**30**
Expt. No.	**Description of the Experiments**
1.	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2.	Fluorescent lamp and Stair case wiring.
3.	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
4.	Measurement of energy using single phase energy meter.
5.	Measurement of resistance to earth of an electrical equipment.
6.	Study of Electronic components and equipment's – Resistor color coding
7.	Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
8.	Study of logic gates AND, OR, EX-OR and NOT.
9.	Soldering & desoldering practices.
10.	Study of Fan, Iron Box, Emergency Lamp, Telephone and FM Radio.
	Total Instructional Hours: 60

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Course Outcomes : Students will be able to	
CO1	Explain the pipe connections and identify the various components used in plumbing.
CO2	Develop simple wooden joints using wood working tools and simple components using lathe and drilling machine.
CO3	Construct simple lap, butt and tee joints using arc welding equipment and simple parts using sheet metal.
CO4	Construct Residential house wiring, Fluorescent lamp wiring and Stair case wiring.
CO5	Measure electrical quantities such as voltage, current, power & power factor in RLC Circuit, resistance to earth, AC signal parameter (peak-peak, RMS period, frequency) and ripple factor.
CO6	Examine logic gates (AND, OR, EOR and NOT), Electronic components and equipment's.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS			
GROUP – A (CIVIL & MECHANICAL)			
Sl. No.	**Description of Equipment**		**Quantity required**
1.	Assorted components for plumbing, Consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.		15
2.	Carpentry vice (fitted to work bench)		15
3.	Standard woodworking tools		15
4.	Models of industrial trusses, door joints, furniture joints		5
5.	Power Tools :		
	(a)	Rotary Hammer	2
	(b)	Demolition Hammer	2
	(c)	Circular Saw	2
	(d)	Planer	2
	(e)	Hand Drilling Machine	2
	(f)	Jigsaw	2
6.	Arc welding transformer with cables and holders		5
7.	Welding booth with exhaust facility		5

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8.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	
9.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2
10.	Centre lathe	2
11.	Hearth furnace, anvil and smithy tools	2
12.	Moulding table, foundry tools	2
13.	Power Tool: Angle Grinder	2
14.	Study-purpose items: Centrifugal pump, Airconditioner	1

GROUP – B (ELECTRICAL & ELECTRONICS)		
Sl. No.	**Description of Equipment**	**Quantity required**
1.	Assorted Electrical Components for House Wiring	15 sets
2.	Electrical Measuring Instruments	10 sets
3.	Iron Box	1
4.	Fan and Regulator	1
5.	Emergency Lamp	1
6.	Megger	1
7.	Digital Live Wire Detector	2
8.	Soldering Guns	10
9.	Assorted Electronic Components for Making Circuits	50
10.	Multipurpose PCBs	10
11.	Multi Meters	10
12.	Telephone	2
13.	FM radio	2
14.	Regulated Power Supply	2
15.	CRO (30MHz)	2
16.	Bread board	10
17.	Digital IC types (IC 7432, IC 7408, IC 7400, IC 7404, IC 7402, IC 7486)	Each 10

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Semester - II

B.E. / B.Tech. (Except CSBS)	B23ENT101 – PROFESSIONAL ENGLISH	L	T	P	C
		2	0	0	2

Course Objectives	
1.	To develop the listening and reading skills of first year engineering and technology students.
2.	To help learners' develop vocabulary through reading skills.
3.	To enhance learners' grammatical knowledge.
4.	To enhance the learners' ability of writing different complex texts.
5.	To develop the competency of learners through LSRW skills.

UNIT - I		6
Listening	Listening to voicemail & messages; Listening and contextualizing.	
Speaking	Replying to polite requests and offers, understanding basic instructions.	
Reading	Short comprehension passages, practice in skimming & scanning.	
Writing	Writing Instructions.	
Language development	Parts of Speech, Wh - Questions, yes or no questions, Question tags.	
Vocabulary development	Prefixes - suffixes.	

UNIT - II		6
Listening	Listening commentaries and announcements.	
Speaking	Role Play exercises based on workplace contexts.	
Reading	Comprehension questions including dialogues and conversations.	
Writing	Writing different types of Paragraph.	
Language development	Regular & Irregular Verbs, Tenses.	
Vocabulary development	Understanding contextual meaning, Synonyms.	

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UNIT - III	6
Listening	Listening to a product launch-sensitizing leaners to the nuances of persuasive communication.
Speaking	Debate - discussion on current issues.
Reading	Short texts and longer passages - note making.
Writing	Understanding text structure, use of reference words and discourse markers, jumbled sentences.
Language development	Idioms and Phrases, Degrees of comparison.
Vocabulary development	One word substitutes.

UNIT - IV	6
Listening	Listening to short academic videos.
Speaking	Making short presentation through short films.
Reading	Intensive and Extensive reading-reading different types of magazines.
Writing	Letter writing- formal and informal.
Language development	Direct / indirect questions.
Vocabulary development	Phrasal verbs

UNIT - V	6
Listening	Listening to talks/lectures by specialists on specific topics.
Speaking	Discussion on general and current topics.
Reading	Longer texts - cloze reading.
Writing	Writing short essays, developing outline, identifying main and subordinate ideas, Dialogue writing.
Language development	Spelling and Punctuations, Modal verbs.
Vocabulary development	Collocations
Total Instructional hours : 30	

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Course Outcomes : Students will be able to	
CO1	Develop listening and reading skills for effective communication
CO2	Develop vocabulary skills
CO3	Build grammatical understanding
CO4	Explain opinions efficiently in writing formal and informal contexts
CO5	Develop knowledge through LSRW skills.

Text Books	
1.	Board of Editors Using English, “A Course book for Undergraduate Engineers and Technologists”, Orient Black Swan Limited, Hyderabad : 2015.
2.	Richards, C. Jack,“ Interchange Students Book - 2”, New Delhi, CUP, 2015.

Reference Books	
1.	Bailey, Stephen, “A practical guide for students”, New York Rutledge, 2011.
2.	Raman, Meenakshi and Sharma, Sangeetha “Technical Communication Principles and Practice” Oxford University Press: New Delhi, 2014.
3.	Dutt P. Kiranmai and Rajeevan Geeta, “Basic Communication Skills”, Foundation Books, 2013.

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B.E. / B.TECH.	B23MAT201 - INTEGRAL CALCULUS AND COMPLEX ANALYSIS (Common to all Branches)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To recognize various techniques of integration.
2.	To apply integration techniques in evaluating area and volume of solids.
3.	To develop the use of Vector calculus in two and three dimensional spaces.
4.	To demonstrate understanding of the basic concepts of complex differentiation.
5.	To understand Cauchy theorem and Cauchy integral formulae and apply these to evaluate complex contour integrals.

UNIT - I	INTEGRAL CALCULUS	12

Riemann sum – Definite and Indefinite integrals - Substitution rule (Exponential, logarithmic, Trigonometric functions) – Integration by parts – Integration of Rational functions by Partial fraction.

UNIT - II	MULTIPLE INTEGRALS	12

Double integrals : Double integrals in Cartesian coordinates - Double integrals in Polar coordinates – Area enclosed by plane curves – Triple integrals: Evaluation of triple integrals - Volume as triple integral (Simple problems)

UNIT - III	VECTOR CALCULUS	12

Gradient and directional derivative - Divergence and curl - Solenoidal and Irrotational vector fields - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and applications (for cubes and rectangular parallellopipeds)

UNIT - IV	COMPLEX DIFFERENTIATION	12

Analytic functions - Cauchy - Riemann equations (excluding proof) – Properties of analytic function – Harmonic conjugate - Construction of analytic function by Milne Thomson method – Bilinear transformation.

UNIT - V	COMPLEX INTEGRATION	12

Cauchy's integral theorem – Cauchy's integral formula – residues - Cauchy's Residue theorem – Evaluation of real integrals – Stereographic projection – Use of circular contour and semicircular contour (excluding poles on real axis)

Total Instructional hours : 60

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Course Outcomes : Students will be able to	
CO1	Develop Fundamental Theorem of Calculus, techniques of Integration such as substitution, partial fractions and integration by parts.
CO2	Make use of integration to compute multiple integrals, area, volume, integrals in polar coordinates
CO3	Apply the line, surface and volume integrals for verification of Green's, Gauss and Stokes theorems.
CO4	Construct Analytic function and develop Conformal Mapping
CO5	Identify infinite series of a complex function within the contour and types of the singularities, finding of complex integrals

Text Books	
1.	Grewal B.S.,"Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3.	George B. Thomas , Joel Hass , Christopher Heil , Maurice D. Weir, "Thomas' Calculus", Pearson, 14th Edition, 2018.

Reference Books	
1.	Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media - An imprint of Lakshmi Publications Pvt., Ltd., New Delhi, 7th Edition, 2015.
2.	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition 2019.
3.	O'Neil, P.V.,"Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd, New Delhi, 7th Edition 2017.
4.	Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5.	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics", (Tata McGraw Hill Education Pvt. Ltd), 6th Edition, New Delhi, 2012.
6.	Gean Duffy., "Advanced Engineering Mathematics with MATLAB", A CRC Press Company, Boca Raton London, New York Washington, D.C, 2nd edition 2009. (Free e-book downloaded from www.EasyEngineering.net.pdf)

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B.E. / B.Tech.	B23HST201 - தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

அலகு – I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்	3

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு – II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோவில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோவில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக்கலை

அலகு – III	உற்பத்தித் தொழில் நுட்பம்	3

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருவாக்குதல், எ.ஃ.கு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு – IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	3

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன் வளம் - முத்து மற்றும் முத்துக் குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்

அலகு – V	அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	3

அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின் பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்

மொத்தம் – 15 காலங்கள்

BoS Chairman

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 வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroy of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

BoS Chairman

B.E. / B.Tech.	B23HST201 - TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT - I	WEAVING AND CERAMIC TECHNOLOGY	3

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

UNIT - II	DESIGN AND CONSTRUCTION TECHNOLOGY	3

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

UNIT - III	MANUFACTURING TECHNOLOGY	3

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

UNIT - IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3

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

UNIT - V	SCIENTIFIC TAMIL & TAMIL COMPUTING	3

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

Total Instructional hours : 15

BoS Chairman

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 வெளியீடு)
5.	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL - (in print)
6.	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by : International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by : International Institute of Tamil Studies).
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10.	Studies in the Histroyb of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by : The Author)
11.	Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12.	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by : RMRL) - Reference Book.

BoS Chairman

B. TECH.	B23BTT201 – BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the biomolecules.
2.	To understand the fundamentals of biomolecules.
3.	To understand the structure and regulations of biomolecules.
4.	To understand the metabolism of biomolecules. .
5.	To understand the metabolism and regulation of hormones.

UNIT - I	INTRODUCTION TO BIOCHEMISTRY	9

Foundations of Biochemistry - Cellular, Physical and Chemical.

Water : chemical nature, ionization, Hydrogen bonding and hydrophobic interactions, Water as a reactant.

Buffers : pH, pKa, Henderson and Hasselbalch equation and biological buffers.

UNIT - II	CARBOHYDRATES AND THEIR METABOLISM	9

Carbohydrates : Monosaccharides, disaccharides, polysaccharides – Starch, glycogen, cellulose, chitin, proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulphate.

Carbohydrate metabolism : Glycolysis, TCA cycle, oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Photosynthesis, metabolism of carbohydrates in anaerobic conditions.

UNIT - III	LIPIDS AND THEIR METABOLISM	9

Lipids : Types; fatty acids, triacyl glycerides, phospholipids, sphingolipids, glycolipids, sterols, biological membranes.

Fatty acid metabolism : Fatty acid synthesis, elongation, unsaturation. Beta oxidation, ketone bodies; lipid biosynthesis - TAG synthesis and cholesterol biosynthesis - Regulation.

UNIT - IV	AMINO ACIDS AND THEIR METABOLISM	9

Amino acids - classification- structure - properties - chemical reactions. Peptide bond.

Proteins – primary, secondary, tertiary and quaternary structures, structural and functional proteins. Introduction to enzymes.

Amino acid metabolism : Amino acid oxidation, urea cycle, amino acid biosynthesis (Glutamate, Serine).

BoS Chairman

UNIT - V	NUCLEIC ACIDS AND THEIR METABOLISM	9
Nucleic acids : Chemical composition of nucleic acids- bases, nucleosides, nucleotides, nucleic acid polymers, structure, functions of nucleic acids. Watson and Crick model of DNA. **Nucleotide metabolism :** Salvage and de nova synthesis, degradation – Regulation.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the basic structure of life and the physiochemical properties of water.
CO2	Explain the structure and metabolism of carbohydrates
CO3	Illustrate the various structures of lipids and their metabolic pathway.
CO4	Identify the organization of proteins and their metabolism
CO5	Make use of the chemistry and metabolism of nucleic acids.

Text Books	
1.	Lehninger, “Principles of Biochemistry” 8th Ed DL Nelson, MM. Cox (Eds.) 2013.
2.	Satyanarayana, U and Chakerapani U, “Biochemistry” 6th Ed, Books & Allied (P) Ltd, 2021.

Reference Books	
1.	Voet D and Voet JG, “Biochemistry”, 4th Ed. John Wiley & Sons Inc. 2010.
2.	Rastogi, SC. “Biochemistry” 3rd Ed. Tata McGraw-Hill, 2010.

BoS Chairman

B. TECH.	B23BTT202 – BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To explain the fundamental concepts pertaining to atoms and bonding.
2.	To understand stereochemical aspects of atoms and molecules.
3.	To understand substitution and addition reactions along with their applications in biological world.
4.	To understand kinetics and catalysis in organic chemical reactions.
5.	To understand the structure and properties of phytochemicals.

UNIT - I	ATOMS AND BONDING	9

Overview of bioorganic chemistry – atoms, electrons and orbitals - covalent Bonds - Octet rule - Polar covalent Bonds – Electronegativity - Electrophiles and Nucleophiles – Concept of Resonance - Inductive and mesomeric effects - formal charge - Resonance Acids and Bases - Acid Base equilibria - SP^3 hybridization.

UNIT - II	STEREOCHEMISTRY	9

Special properties of carbon as the centre of organic world - Fisher projections and absolute configurations - Stereochemical activity around the tetrahedral carbon - Cis- trans isomerism, Conformation analysis of ethane, butane and cyclohexane - optical activity and chiral centres - Optical activity of glucose.

UNIT - III	MECHANISM OF SUBSTITUTION AND ADDITION REACTION	11

S_N1 and S_N2 reaction on tetrahedral carbon - Nucleophilic addition of aldehydes and ketones: Hydration, acetal formation, acetal protection – Reactions of carbonyl group with amines – esterification and ester hydrolysis – saponification of an ester – hydrolysis of amides - Ester enolates – Claisen condensation – Michael condensation – Substitution and addition reactions in the biological world, examples.

UNIT - IV	KINETICS AND CATALYSIS	8

Reaction kinetics– Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Reactivity –Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis.

BoS Chairman

UNIT - V	CHEMISTRY OF PHYTOCHEMICALS	8
Sources, general structure, functions, examples and uses of flavonoids, flavones, anthocyanins, tannins, alkaloids, isoprenes, glycosides and volatile oils.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the basic concepts of organic chemistry related to atoms and bonding.
CO2	Explain the three-dimensional alignment of atoms in space.
CO3	Compare the different types of Chemical reactions involved in biomolecules
CO4	Illustrate the concepts of kinetics and catalysis in organic chemistry.
CO5	Identify the structure and functions of various phytochemicals.

Text Books	
1.	Carey Francis A, “Organic Chemistry”, 8th Ed. Tata McGraw Hill, 2009.
2.	Kalsi PS and Jagtap S, “Pharmaceutical, Medicinal and Natural Product Chemistry”, Narosa Publishing House, New Delhi, 2013.

Reference Books	
1.	Page MI and Williams A, “Organic and Bioorganic Mechanisms”, Pearson, 2010.
2.	Penney C and Dugas H, “Bioorganic Chemistry: A Chemical Approach to Enzyme Action” 3rd Ed. Springer, 2003.
3.	Chatwal GR, “Organic Chemistry of Natural products” Vol. I & II, Himalaya Publishing House, New Delhi, 2011.

BoS Chairman

B.E. / B.Tech.	B23PHI101 - ENGINEERING PHYSICS (Common to all Branches)	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To gain knowledge on the basics of properties of matter, its applications and inculcate practical skills in the determination of elastic property of the materials.
2.	To acquire knowledge & experimental skills on the concepts of Photonics and their applications in fiber optics.
3.	To have adequate knowledge on the concepts of electrical, magnetic properties of materials and enhance the practical skills in determination of electrical properties of the materials.
4.	To get knowledge on advanced physics concepts of quantum theory and its applications in SEM, TEM and induce practical skills in microscope.
5.	To enhance the fundamental knowledge of students in Crystal Physics and its Applications relevant to various streams of Engineering and Technology.

UNIT - I	PROPERTIES OF MATTER	14

Elasticity - Modulus, types of modulii of elasticity, Stress - strain diagram and its uses - factors affecting elastic modulus and Twisting couple, torsion pendulum; theory and experiment

Bending of beams - Bending moment - uniform and non- uniform bending; theory and experiment - I - shaped girders and its applications

Determination of rigidity modulus - Torsion pendulum - Determination of Young's modulus by non-uniform bending method - Determination of Young's modulus by uniform bending method

UNIT - II	PHOTONICS AND FIBER OPTICS	12

Lasers ; properties of laser-spontaneous and stimulated emission-amplification of light by population inversion - Einstein's A and B coefficients - derivation – Types of laser; Nd. - YAG Laser, Semiconductor lasers; homojunction and heterojunction, Industrial and Medical Applications

Fiber Optics ; Principle, Numerical Aperture and Acceptance Angle - Types of optical fibres - Fiber optic communication System - Block diagram - Medical Applications - Endoscopy

Determination of wavelength of the Laser using grating- Determination of particle size using Laser - Determination of Numerical aperture and acceptance angle of an optical fiber

BoS Chairman

UNIT - III	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	12

Classical free electron theory – Relaxation time and collision time - Expression for electrical conductivity – Thermal conductivity – Wiedemann - Franz law – Lorentz number - Drawbacks of classical theory - Quantum theory - Fermi - Dirac statistics – variation of Fermi level with temperature

Introduction to magnetic materials – Comparision of Dia, Para and Ferro magnetic materials – Domain theory of ferromagnetism - Hysteresis - Soft and Hard magnetic materials - Ferrites and its applications.

Determination of specific resistance of the wire using Carey Foster's Bridge

UNIT - IV	QUANTUM PHYSICS	12

Black body radiation; Planck's theory (derivation) - wave particle duality- debroglie's wavelength - concept of wave function and its physical significance

Wave equation ; Schroedinger's time independent and time dependent equations, particle in a one-dimensional rigid box. Applications; Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM)

Determination of thickness of a thin wire by using travelling microscope

UNIT - V	CRYSTAL PHYSICS	10

Crystal Structures; Single crystalline, polycrystalline and amorphous materials - unit cell - space lattice - crystal systems - Bravais lattices - Miller indices- inter - planar distances – coordination number and packing factor for SC, BCC, FCC and HCP structures

Crystal imperfections; Point and Line defects - Burger vector

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Categorize the basics of properties of matter and its applications, classify the elastic properties of materials by using uniform, non-uniform bending method and torsional pendulum apparatus
CO2	Explain the basics of Laser, Fiber Optics and their applications, determination of Particle size, Wavelength of laser and acceptance angle, numerical aperture of optical fiber.
CO3	Justify the concepts of electrical, magnetic properties of materials, determination of Specific resistance of the material
CO4	Determine the thickness of thin sheet using travelling microscope and explain the basics of quantum theory
CO5	Classify and compare the different types of Crystals, their structures and its defects

BoS Chairman

Text Books	
1.	Bhattacharya, D.K. & Poonam, T, “Engineering Physics”, Oxford University Press, 2015.
2.	Gaur, R.K. & Gupta, S.L. “Engineering Physics”, Dhanpat Rai Publishers, 2012.
3.	Pandey, B.K. & Chaturvedi, S. “Engineering Physics”, Cengage Learning India, 2012.
4.	Rajendran V, “Engineering Physics”, Tata McGraw Hill, Publishing Company, New Delhi, 2011.
5.	Wahab, M.A. - Solid State Physics: Structure and Properties of Materials, Narosa Publishing House, 2009.

Reference Books	
1.	Halliday, D., Resnick, R. & Walker, J. “Principles of Physics””, Wiley, 2015.
2.	Serway, R.A. & Jewett, J.W. “Physics for Scientists and Engineers”, Cengage Learning, 2010.
3.	Tipler, P.A. & Mosca, G. “Physics for Scientists and Engineers with Modern Physics”, W.H. Freeman, 2007.
4.	Avadhanulu M.N, “Engineering Physics - Volume 1”, S.Chand & Company Ltd., New Delhi, 2010.
5.	Garcia, N. & Damask, A. - Physics for Computer Science Students. Springer - Verlag, 2012.
6.	Senthil Kumar, G. Physics Laboratory I & II, VRB publishers Pvt. Ltd., Chennai (2016).

Equipment Needed for 30 Students

1. Diode Laser (2 mS power) , He – Ne Laser source (2mW), Optical Fibre Kit - 06
2. Travelling Microscope ,Knife edge, Slotted weights - 19
3. Carey Foster Bridge - 06
4. Air Wedge Apparatus with Travelling Microscope - 06
5. Torsional Pendulum - 06

BoS Chairman

B. TECH.	B23BTP201 – BIOCHEMISTRY AND BIOORGANIC CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To have hands on experience in the preparation of various solutions and buffers
2.	To build the basic knowledge on the qualitative and quantitative study of biomolecules

Expt. No.	List of Experiments
1.	Basic laboratory calculations and standardization of solutions.
2.	Preparation of buffers.
3.	Determination of pKa by titration method.
4.	Qualitative analysis of sugars.
5.	Qualitative analysis of amino acids.
6.	Estimation of glucose by DNS method.
7.	Estimation of Protein by Lowry/Bradford method.
8.	Determination of acid value and iodine number of oil.
9.	Synthesis of aspirin.
10.	Extraction and estimation of lycopene from tomato.
11.	Extraction of caffeine from various coffee powder samples.
12.	Saponification reactions of vegetable oils.
13.	Extraction of oil from seed (Soxhlet apparatus).
	Total Instructional hours : 30

BoS Chairman

Course Outcomes : Students will be able to	
CO1	Develop reagents and buffers for analytical purpose.
CO2	Dissect the biomolecules qualitatively
CO3	Examine the biomolecules quantitatively
CO4	Construct organic compounds at laboratory level
CO5	Test for the extraction of bioactive molecules from natural sources.

References	
1.	Sadasivam S and Manickam A, “Biochemical Methods”, 3rd Ed. New Age International (P) Limited, New Delhi, 2005.
2.	Plummer DT, “An Introduction to Practical Biochemistry”, 3rd Ed. London; New York : McGraw-Hill.
3.	Siegel IH, “Biochemical Calculations”, 2nd Ed. John Wiley & Sons, London, 2014
4.	Vogel AI and Tatchell AR, “Vogel’s Text book of Practical Organic Chemistry”, 5th Ed. Longman Scientific and Technical & John Wiley & Sons, 2004
5.	Shanmugam S, Sathishkumar T and Paneerselvam K, “Laboratory Handbook on Biochemistry”, Prentice - Hall, India Pvt. Ltd., 2010

BoS Chairman

B.E. / B.Tech.	B23CEP201 – SOFT SKILLS (Common to all Branches)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To identify personality using evaluation method.
2.	To encourage creative thinking by practice.
3.	To enrich interpersonal skills through integrated activities.
4.	To develop social and professional etiquette.
5.	To identify and apply employability skills for professional success.

UNIT - I	SELF EVALUATION	6
Introduction to soft skills, Familiarize oneself, Self-understanding, SWOT analysis, Goal Setting.		

UNIT - II	INNOVATIVE THINKING	6
Divergent thinking, Encourage curiosity, Writing a story, Poster making.		

UNIT - III	INTERPERSONAL SKILLS	6
Interpersonal skills - Need & Components – Understanding Intercultural Competence - Team Work-Problem Solving Skills - Conflict Management & Resolutions in Workplace, Leadership skills, Managerial skills.		

UNIT - IV	BUSINESS ETIQUETTE	6
Define Etiquette -Types and Importance of Workplace Etiquette - Basic Corporate Etiquette - Telephone Etiquette - Meeting & E-mail Etiquette - Customer Service Etiquette.		

UNIT - V	CORPORATE SKILLS	6
Work Ethics - Adaptability - Analytical Reasoning - Lateral Thinking - Stress & Time Management.		
Total Instructional hours : 30		

BoS Chairman

Course Outcomes : Students will be able to	
CO1	Develop the Interpersonal Skills.
CO2	Show the creative skill in different aspects.
CO3	Explain their ideas through conversations.
CO4	Develop adequate Soft Skills required for the workplace.
CO5	Develop leadership qualities.

References	
1.	Butterfield, Jeff “Soft Skills for Everyone” Cengage Learning, New Delhi, 2015.
2.	S.Hariharanetal ”Soft Skills” MJP Publishers : Chennai, 2010.
3.	Peter, Francis “Soft Skills and Professional Communication” New Delhi : Tata McGraw Hill, 2012. Print.
4.	Meenakshi Raman, Shalini Upadhyay, ’Soft Skills’, Cengage Learning India Pvt. Ltd, Delhi, 2018.
5.	M.S. Rao, ‘Soft Skills Enhancing Employability’, I. K. International Publishing House Pvt. Ltd, New Delhi, 2010
6.	Sabina Pillai, Agna Fernandez, ‘Soft Skills and Employability Skills’, Cambridge University Press, 2018.
7.	John Peter.A, ‘Self – Development and Professional Excellence’, Cengage Learning India Pvt. Ltd, Delhi, 2019.

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B.E./ B.Tech	B23CEP202 - APPLICATION DESIGN AND DEVELOPMENT (Common to All UG Branches)	L	T	P	C
		2	0	0	NC

Course Objectives	
1.	To understand the basics concepts of SDLC and web development basics.
2.	To introduce the concepts of styling with CSS
3.	To understand the fundaments concepts of JavaScript
4.	To acquire the skills to manipulate the Document Object Model (DOM)
5.	To introduce version control concepts using Git and GitHub.

UNIT - I	SDLC and Web Development Basics	3

Introduction to Software Development Lifecycle (SDLC): Waterfall Model – Phases, Methods - Best Practices.

HTML Fundamentals: Introduction – Versions - HTML5 Standards - Tags - Semantic Elements – Forms - Media(Images, Audio, Video) – Tables - Lists

UNIT - II	Styling with CSS & Frameworks	3

CSS : Introduction – Selectors - Box Model (Margins, Padding, Borders) – Colors - Backgrounds – Frameworks: Introduction to Bootstrap - Tailwind CSS

UNIT - III	JavaScript Programming Essentials	3

JavaScript Basics - Variables - Data Types - Operators - Conditional Statements – Loops - Functions and events - Function Declarations - Event Handling.

UNIT - IV	DOM, Form Handling & Error Management	3

Document Object Model (DOM) Manipulation - Form Handling - Validation - Page Redirection - Error Handling – Exception handling in JavaScript.

UNIT - V	Version Control & Shell Scripting	3

Git & GitHub - Repositories - Branching – Merging – Remote Repositories - Advanced Git actions – Advanced Git Actions: Pull Requests- Issues - Contribution to Open Source

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- Developer Communities: Google Developer – Group - Stack Overflow - Kaggle - Shell Scripting: Process Management - File Handling - User & Group Management.
Total Instructional hours: 15

Course Outcomes: Students will be able to	
CO1	Understand the phases and best practices of the Software Development Life Cycle (SDLC), and apply HTML5 features to structure web page
CO2	Construct visually appealing web pages by applying CSS styling techniques
CO3	Apply the use of JavaScript programming constructs
CO4	Build a JavaScript application by make use of client-side form validation, manage redirection, and handle exceptions and manipulate DOM.
CO5	Utilize version control systems like Git and GitHub for collaborative development.
Text Books	
1.	Jon Duckett, "HTML and CSS: Design and Build Websites", John Wiley & Sons, Inc, 2011.
2.	Marijn, Haverbeke, "Eloquent JavaScript: A Modern Introduction to Programming", 3rd Edition, William Pollock Publisher, 2019.
3.	Scott Chacon and Ben Straub, "Pro Git", 2 nd Edition, APress Publication, 2024

Reference Books	
1.	Jennifer Robbins, "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", O'Reilly Media, Inc., 2012.
2.	Douglas Crockford, "JavaScript: The Good Parts", O'Reilly Publications, 2008
3.	Cameron Newham, "Learning the Bash Shell", 3rd Edition, O'Reilly Media, Inc,
4	https://www.freecodecamp.org/
5	https://developer.mozilla.org/en-US/docs/Web/JavaScript
6	https://www.codecademy.com/catalog/subject/web-development

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Semester - III

B.TECH	B23MAT304 – PARTIAL DIFFERENTIAL EQUATIONS AND PROBABILITY (BIOTECH)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To introduce the basic concepts of PDE for solving standard partial differential equations.
2.	To understand Fourier series analysis in representation of Periodic signals.
3.	To develop Fourier series techniques in solving wave and heat flow problems.
4.	To introduce the basic concepts of probability and random variables
5.	To introduce the basic concepts of two dimensional random variables

UNIT – I PARTIAL DIFFERENTIAL EQUATIONS	12
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of first order partial differential equations of the forms $f(p,q) = 0$, $z = px + qy + f(p,q)$ - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.	

UNIT – II FOURIER SERIES	12
Dirichlet's conditions - General Fourier series -Odd and even functions - Half range sine series - Half range cosine series - Complex form of Fourier series - Parseval's identity - Harmonic analysis.	

UNIT – III BOUNDARY VALUE PROBLEMS	12
Classification of second order linear PDE - Method of separation of variables - Solutions of one dimensional wave equation - One dimensional equation of heat conduction - Steady state solution of two dimensional equation of heat conduction - Fourier series solutions in Cartesian coordinates.	

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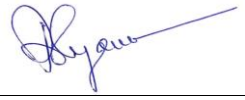
UNIT – IV PROBABILITY AND RANDOM VARIABLES	12
Probability - Conditional probability - Baye's theorem - Discrete and continuous random variables - Moments - Moment generating functions - Binomial, Poisson and Normal distributions.	

UNIT – V TWO - DIMENSIONAL RANDOM VARIABLES	12
Joint distributions - Marginal and conditional distributions - Covariance - Correlation and linear regression -Transformation of random variables.	
	Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Solve the partial differential equations with constant coefficients.
CO2	Solve differential equations using Fourier series analysis.
CO3	Apply Fourier series to solve boundary value problems.
CO4	Develop the concepts of probability and standard distributions.
CO5	Apply the basic concepts of two dimensional random variables.

Text Books	
1.	Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2020.
2.	Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics" Volume III, S. Chand & Company Ltd., 2016.
3.	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

Reference Books	
1.	RamanaB.V.., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
3.	Wylie C. Ray and Barrett Louis C.,"Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
4.	Devore. J.L., "Probability and Statistics for Engineering and the Sciences",Cengage Learning, New Delhi, 8th Edition, 2014.



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B.TECH.	B23BTT301 – STOICHIOMETRY AND FLUID MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of unit conversion, the use of ideal gas and real gas law in composition calculation.
2.	To develop the material balance for different unit operations and unit processes.
3.	To develop the energy balance equation for various chemical processes and to apply this in phase change operations.
4.	To understand the properties of fluids and to develop the Bernoulli's equation using the principle of continuity equation.
5.	To study the principle and operation of fluid flow measuring device and various types of pumps.

UNIT - I	BASIC CHEMICAL CALCULATIONS	9

Dimension, systems of units – basic and derived units, conversion, composition of mixture and solutions, calculations of pressure, volume and temperature using ideal gas law, use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT - II	MATERIAL BALANCE	9

Concept of material balance, overall and component balance, Applications of material balance to unit operations – evaporator, distillation (Binary system), liquid-liquid extraction, solid-liquid extraction, drying, absorption, crystallization and mixing/blending, recycle and bypass illustration, Material balance with chemical reaction – limiting and excess reactants, combustion reaction.

UNIT - III	ENERGY BALANCE	9

General energy balance equation for open systems and closed system, heat capacity, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, standard heat of reaction, formation, combustion, solution and mixing, phase change operations, calculation of standard heat of reaction from heat of formation and combustion, effect of temperature on heat of reaction.

UNIT - IV	FLUID PROPERTIES AND DYNAMICS	9

Physical and rheological properties of fluids, types of flow, pressure measuring device – manometer, continuity equation and energy equation, Bernoulli’s equation, Dimensional analysis.

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UNIT - V	TRANSPORTATION AND METERING OF FLUIDS	9
Measurement of fluid flow – Orifice meter, Venturimeter, Rotameter and Pitot tube, Transportation of fluid – Positive displacement pumps, Rotary and Reciprocating pumps, Centrifugal pumps, Loss due to friction in pipes and fittings.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Solve problems in pure components and mixtures using system of units and ideal gas law.
CO2	Apply the concepts of material balance in various unit operations and unit processes.
CO3	Utilize the basics of energy balance in various chemical processes.
CO4	Make use of the basic fluid properties and continuity equation in a fluid system.
CO5	Identify the performance of various flow meters and pumps using the fluid flow properties.

Text Books	
1.	Bhatt B I and Thakore S B “Stoichiometry”, 5th Ed. Tata McGraw Hill, 2012.
2.	Gavhane K A, “Introduction to Process calculations (Stoichiometry)”, Nirali Publication, 2016.

Reference Books	
1.	Sikdar D C. “Chemical Process Calculations”, PHI learning Private Ltd, 2013.
2.	Rajput R K, “Fluid Mechanics & Hydraulic Machines”, S. Chand Limited, 2008.
3.	Himmelblau D M “Basic Principles & Calculations in Chemical Engineering” 6th Ed., PHI, 2006.
4.	Mc Cabe W L, Sonith J C and Harriot P “Unit Operations of Chemical Engineering” 6th Ed., McGraw Hill, 2001.
5.	Bansal R K, “A Textbook of Fluid Mechanics”, Laxmi Publications, 2008.

BoS Chairman

B. TECH.	B23BTT302 – BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To estimate properties of fluids using thermodynamic laws.
2.	To acquire knowledge on partial molar properties in solutions.
3.	To calculate extent of phase change at equilibrium.
4.	To analyse chemical reactions at equilibrium conditions.
5.	To apply thermodynamic principles to describe microbial growth and product formation.

UNIT - I	FUNDAMENTALS OF THERMODYNAMICS	9

Fundamentals and basic concepts, first law of thermodynamics – Flow and non-flow processes, PVT- behaviour for pure fluids, estimation of thermodynamic properties using equations of state; Second Law of thermodynamics; calculations involving actual property exchanges; Maxwell's relations and applications.

UNIT - II	SOLUTION THERMODYNAMICS	9

Partial molar properties; concepts of chemical potential and fugacity; composition models for ideal and non-ideal solutions; activity and activity coefficient; Gibbs Duhem equation, Property changes of mixing.

UNIT - III	PHASE EQUILIBRIA	9

Criteria for phase equilibria, Phase equilibria in single and multicomponent systems, Duhem's Theorem, Vapour- Liquid Equilibria (VLE), Phase diagrams for binary solution, VLE calculations- binary systems and multi component systems, Phase equilibrium in ideal solution, Azeotropes, Vapour- Liquid Equilibrium at low and high pressures, liquid-liquid equilibrium, Ternary equilibrium diagrams.

UNIT - IV	CHEMICAL REACTION EQUILIBRIA	9

Criteria for chemical reaction equilibrium, Equilibrium criteria for homogeneous chemical reactions, evaluation of equilibrium constant, effect of temperature and pressure on equilibrium constant, Giauque functions, calculation of equilibrium conversion and yields for single and multiple reactions.

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UNIT - V	BIOTHERMODYNAMICS	9
Stoichiometry of autotrophic and heterotrophic microbial growth; thermodynamics of maintenance; Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert – Pirt Relation for Electron Donor; thermodynamics and stoichiometry of product formation.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Identify the properties of fluids using the laws of thermodynamics.
CO2	Make use of the concepts of partial molar properties in solution thermodynamics.
CO3	Utilize phase equilibrium concepts in ideal and non-ideal solutions.
CO4	Test for chemical reactions at equilibrium conditions.
CO5	Examine the microbial growth and product formation using thermodynamic principles.

Text Books	
1.	Narayanan K V, “A Text Book of Chemical Engineering Thermodynamics”, 2nd Ed., PHI, 2013.
2.	Smolke C D, “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010.

Reference Books	
1.	Smith J M, Van Ness H C and Abbot M M, “Introduction to Chemical Engineering Thermodynamics”, 8th Ed., Tata McGraw-Hill, 2019.
2.	Sandler SI, “Chemical, Biochemical and Engineering Thermodynamics”, Wiley, 1989.

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B. TECH.	B23BTT303 – BIOPROCESS PRINCIPLES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To impart knowledge on microbial fermentation processes with all its prerequisites.
2.	To endow the students with the basics of microbial isolation, preservation and strain improvement
3.	To enhance the skills of students to develop media for the fermentation process
4.	To provide insights on sterilization methods and kinetics.
5.	To implement stoichiometric and energetics to estimate microbial growth and product formation.

UNIT - I	OVERVIEW OF FERMENTATION PROCESSES	9

Overview of fermentation industry; Range of fermentation; general requirements of fermentation processes; Types of fermenters; basic configuration of batch fermentor and ancillaries; Parameters to be monitored and controlled.

UNIT - II	ISOLATION, PRESERVATION AND STRAIN IMPROVEMENT	9

Isolation, screening, and maintenance of microbes for industrial processes. Strain selection and improvement methods. Inocula development for Industrial fermentations.

UNIT - III	MEDIA DESIGN FOR FERMENTATION PROCESS	9

Media formulation - medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements; examples of simple and complex media; design of media for industrial fermentations; Medium optimization.

UNIT - IV	STERILIZATION KINETICS	9

Sterilization types; Thermal death kinetics; Design of Batch and continuous sterilization; Sterilization of the fermenter, feeds and liquid wastes, Filter sterilization- fermentation media and air; Sterilization of fermenter exhaust air.

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UNIT - V	METABOLIC STOICHIOMETRY AND ENERGETICS	9
Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Construct the general requirements of fermentation processes.
CO2	Identify the techniques of isolation, preservation, and strain improvement of industrially relevant microbes.
CO3	Develop the strategies to formulate media for growth and product formation.
CO4	Compare the different sterilization techniques involved in various bioprocess operations.
CO5	Examine the metabolic stoichiometry and energetics in microbial processes.

Text Books	
1.	Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, 3rd Ed., Elsevier Science, 2016.
2.	Doran, Pauline M. “Bioprocess Engineering Principles”, Elsevier, 2nd Ed., 2012.

Reference Books	
1.	Shuler M L and Kargi F, “ Bioprocess Engineering”, Pearson Education India; 2nd Ed., 2015.
2.	Lydersen B K. “Bioprocess Engineering Systems, Equipment and Facilities” JohnWiley, 1994.
3.	Bailey J E and Ollis D F, “Biochemical Engineering Fundamentals”, 2nd Ed., McGraw Hill, 1986.

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B. TECH.	B23BTT304 – CELL BIOLOGY AND GENETICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basic structure and functions of cell and its organelles.
2.	To provide insights about intercellular interactions.
3.	To understand the specific aspects of the cell cycle and explore different implications of cell cycle regulation.
4.	To know the fundamentals of genetics and sex determination.
5.	To understand the facts of evolutionary genetics.

UNIT - I	CELL STRUCTURE AND FUNCTIONS OF THE ORGANELLES	9

Introduction to cell biology; Comparison of eukaryotic and prokaryotic cells; cellular organelles – structure and functions - disorders related to organelles; biological membrane organization - fluid mosaic model - membrane proteins – functions of membrane proteins; cytoskeletal proteins.

UNIT - II	CELL TRANSPORT AND SIGNAL TRANSDUCTION	9

Cell Transport : Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na^+, K^+, Ca^{2+} pumps, Cotransport: uniport, symport antiporter system. Ligand gated, voltage gated channels, Agonists and Antagonists.

Signal Transduction : Receptors – extracellular signalling, Cell surface and cytosolic receptors with examples; autocrine, paracrine, endocrine models; Secondary messengers – cAMP, cGMP, DAG and IP3; Growth hormones.

UNIT - III	CELL CYCLE AND REGULATION	9

Cell cycle; cell division – types: mitosis and meiosis; cell cycle regulation – cyclins and CDKs – checkpoints – CDK inhibitors; cancer - oncogenes and tumour suppressor genes; apoptosis – MAPK and AKT pathways; Introduction to stem cells.

Cell cycle analysis - Flow cytometry and Microscopic techniques.

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UNIT - IV	MENDELIAN GENETICS AND SEX DETERMINATION	9

Mendel's experiment and principle of segregation, monohybrid crosses dominance and recessiveness; Principle of independent assortment - dihybrid crosses; multiple alleles - ABO blood type, Rh factor alleles, Mendelian problems. Non- Mendelian ratios – Interaction of genes – codominance – incomplete dominance - linkage and crossing over.

Mechanism of sex determination, sex differentiation, sex linked inheritance. – pedigree analysis.

UNIT - V	MUTATION AND EVOLUTIONARY GENETICS	9

Mutations - spontaneous, physical and induced; applications of mutation; organization of DNA in mitochondria and plastids; cytoplasmic male sterility in plants; Genetic variation; random mating and Hardy – Weinberg method; inbreeding, outbreeding and assortative mating; genetic equilibrium, evolutionary genetics.

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the different types of cells and the structure and function of intracellular organelles
CO2	Demonstrate the concept of cellular transport and signal transduction to unlock revolutionary advancements in healthcare and biotechnology
CO3	Explain the different channels and signaling pathways involved in cell cycle for unveiling different therapeutic strategies
CO4	Utilize the laws of Mendelian genetics in predicting hereditary disorders.
CO5	Select from the various breeding techniques to improve agricultural practices.

Text Books	
1.	Simmons M J and Snustad DP, "Principles of Genetics", John Wiley, 2012.
2.	Lodish H, Berk A, Zipurursky S L, Matsudaria P, Baltimore D and Darnell J, "Molecular Cell Biology", WH Free Man and Company, 2000.

Reference Books	
1.	Gardner E J and Simmons M J and Snustad D P, "Principles of Genetics", John Wiley, 2006.
2.	Rastogi S C, "Cell Biology, India": New Age International Pub. Ltd., 2001.
3.	Robert H T, Principles of Genetics, Tata McGraw Hill, 2002.
4.	Hardin J, and Bertoni G, "Becker's World of the Cell", 9th Ed. Pearson Education, 2018.

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B. TECH.	B23BTI301 – MICROBIOLOGY	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To perform different bacterial staining techniques
2.	To classify microbes based on their structure, function and biochemical profile.
3.	To calculate microbial growth and growth requirements
4.	To outline the control measures of microorganisms
5.	To prepare microbial metabolites with industrial applications

UNIT - I	INTRODUCTION TO MICROBIOLOGY	9 + 6

History : History and discoveries, classification, and nomenclature of microorganisms.

Microscopy : Light, fluorescent, dark field, phase contrast and electron microscopy; Microscopic examination of microorganisms morphology and fine structure of bacteria.

Staining : Principles of stains and different staining techniques: Simple, Gram's, Acid fast, negative, capsular, endospore and flagellar staining.

Isolation of microorganisms; Staining of microorganisms : Simple, Gram's, Endospore, Capsule staining, Staining of fungi.

UNIT - II	MICROBIAL DIVERSITY	9 + 3

Taxonomy and classification system – structure and functions of cellular components of bacteria, fungi, algae and viruses

Identification of microbes – morphological and biochemical analysis

Culture methods: Broth, slant, agar deep, pour plate, spread plate and streak plate. Preservation of microorganisms: glycerol stock, lyophilisation and cryopreservation.

UNIT - III	GROWTH AND REPRODUCTION OF MICROORGANISMS	9 + 3

Growth : Factors affecting growth; types of culture media; nutritional types, growth curve - methods of enumeration of microorganisms, preservation techniques.

Reproduction : Reproduction in Bacteria, virus, fungus, actinomycetes and molds. Replication of viruses: Lytic and Lysogenic life cycle –importance of bacteriophages.

Quantification of microbes: Enumeration of total heterotrophic bacteria in soil Microbial growth curve : Bacteria and Yeast

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UNIT - IV	CONTROL OF MICROORGANISMS	9 + 3
Physical and chemical control of microorganisms; principles of sterilization; heat sterilization (moist heat and dry heat), radiation and filtration; disinfection: phenol, alcohol and detergents; chemotherapy and antibiotics, mode of action and resistance to antibiotics. **Effect of disinfectants - Phenol coefficient test; Antibiotic sensitivity assay; Membrane filtration technique.**		

UNIT - V	APPLIED MICROBIOLOGY	9
Bacterial metabolism – Aerobic and anaerobic respiration; fermentation; role of microorganisms in nitrogen, phosphorus and sulfur cycle. Industrial use of microorganisms: pharmaceutical industries (production of penicillin, vitamin B-12); food industries (dairy and brewery), agriculture - biofertilizers, biopesticides; bioremediation, bioleaching.		
Total Theory Instructional hours : 45		
Total Lab Instructional hours : 15		

Course Outcomes : Students will be able to	
CO1	Demonstrate different microbial staining techniques used for visualisation under microscope.
CO2	Identify bacteria based on morphological and biochemical tests.
CO3	Test for the microbial growth and their mode of reproduction and its dependency on nutritional requirements.
CO4	Examine the efficiency of different sterilization methods
CO5	Explain the significance of industrially relevant microbial metabolites.

Text Books	
1.	Willey J M, Sandman K M and Wood D H, Prescott's Microbiology, 12th Ed., Mc Graw Hill Pvt. Ltd., 2022.
2.	Pelczar M J, Chan E C S and Krein N R, Microbiology, 5th Ed., Affiliated East West Press Private Limited New Delhi, 2023.

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Reference Books	
1.	Ray B and Bhuniya A, “Fundamental Food Microbiology”, 5th Ed. CRC Press, USA, 2013.
2.	Lim D, “Microbiology”, 2nd Ed. WCB - McGraw Hill, 2001.
3.	Talaron K, Talaron A, Casita, Pelczar and Reid, “Foundations in Microbiology”, W.C. Brown Publishers, 2005.

BoS Chairman

B. TECH.	B23BTP301 – CHEMICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To understand the principle and calibrate the types of flow meters.
2.	To develop a sound knowledge on different types of pumps.
3.	To understand the working principles of various heat transfer equipment.
4.	To understand the basic principle of distillation equipment.
5.	To study the filtration characteristics of plate and frame filter press and leaf filter.

List of Experiments	
Expt. No.	**Description of the Experiments**
1.	Measuring the fluid flow through a pipe using constant area flow meter – Venturimeter.
2.	Measuring the fluid flow through a pipe using constant area flow meter – Orificemeter.
3.	Measuring the fluid flow through a pipe using variable area flow meter – Rotameter.
4.	Determination of velocity and friction factor in flow through straight pipe.
5.	Characteristic curves of centrifugal pump.
6.	Characteristic curves of reciprocating pump.
7.	Determination of heat transfer coefficient in a parallel flow double pipe heat exchanger.
8.	Determination of heat transfer coefficient in a counter flow double pipe heat exchanger.
9.	Determination of heat transfer coefficient in a shell and tube heat exchanger.
10.	Verification of Rayleigh's equation by simple distillation.
11.	Batch filtration studies using a Leaf filter.
12.	Batch filtration studies using a Plate and Frame Filter press.
	Total Instructional hours : 30

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Course Outcomes : Students will be able	
CO1	Estimate the coefficient of discharge in flow meters and energy losses in straight pipe.
CO2	Test for the efficiency of various pumps.
CO3	Examine the heat transfer co-efficient in heat exchangers.
CO4	Determine the composition of binary mixture using simple distillation.
CO5	Classify the filtration characteristic in various filtration equipment.

Reference Books	
1.	McCabe W L, Smith J C and Harriott P. "Unit Operations in Chemical Engineering", 7th Ed., McGraw Hill, 2014.
2.	Bird R B, Stewart W E and Lightfoot E N, "Transport Phenomena", 2nd Ed., Wiley, 2006
3.	Coulson J M , Richardson J F, and Sinnott R K "Chemical engineering design", 6th Ed., Elsevier, 2019.
4.	Green D and Perry R, "Perry's Chemical Engineers' Handbook", 8th Ed., 2007.

Semester - IV

B.TECH	B23MAT406 – BIOSTATISTICS (BIOTECH)	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To understand the concepts of Statistics.
2.	To introduce the testing of hypothesis for small and large samples.
3.	To provide the basic concepts for classifications of design of experiments.
4.	To apply the knowledge of Time series analysis.
5.	To learn the statistical quality control which plays major role in agriculture and bioscience field.

UNIT – I INTRODUCTION TO STATISTICS	12
Statistics - Definition, Types. Types of variables - Organizing data - Measures of central tendency - Mean, Median, Mode, Geometric mean and Harmonic mean. Measures of dispersion - Range, Quartile deviation, Mean deviation, Standard deviation and Lorenz Curve – Coefficient of variation – Coefficient of Dispersion.	

UNIT – II TESTING OF HYPOTHESIS	12
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance - Contingency table (test for independent) - Goodness of fit.	

UNIT – III DESIGN OF EXPERIMENTS	12
One way and two - way classifications - Completely randomized design - Randomized block design - Latin square design - 2^2 factorial design.	

UNIT – IV TIME SERIES ANALYSIS	12
Meaning of Time series analysis - Components of Time series - Variations in time series - Trend analysis - Measurement of Cyclical variations - Measurement of Seasonal variations and Irregular variations - Forecasting errors.	

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UNIT – V STATISTICAL QUALITY CONTROL	12
Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts) - Tolerance limits - Acceptance sampling.	
	Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Interpret the statistical data using for measures of central tendency and dispersion.
CO2	Identify Large and small samples for testing of hypothesis.
CO3	Construct the ANOVA tables for CRD, RBD and LSD.
CO4	Make use of critical understanding of the main concepts of time series analysis.
CO5	Develop the sampling distributions and statistical quality control techniques used in engineering and management problems.

Text Books	
1.	Kapoor, VK. and Gupta, SC., “Fundamentals of Mathematical Statistics ", Sultan Chand & sons, 12th Edition, 2020.
2.	Kandasamy P., Thilagavathy K., and Gunavathy K., "Statistics and Numerical Methods" S. Chand & Company Ltd., 2018.
3.	Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2020.

Reference Books	
1.	Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 9th Edition, 2020.
2.	Abhaya Indrayan and Rajeev Kumar Malhotra, “Medical Biostatistics”, Chapman & Hall, New Delhi, 4th Edition, 2017.
3.	P. K. Mohanty and S. K. Patel, "Basic Statistics”, Scientific Publishers, India, 2nd Edition 2019.
4.	G. Shankar Rao, "Probability and Statistics for Science and Engineering", Kindle Edition, Universities Press India, 2020.
5.	Chap T. Le, Lynn E. Eberly, “Introductory Biostatistics” Wiley Publication, 2nd Edition, 2016.

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B. TECH.	B23BTT401 – CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives : The aim of this course is to	
1.	To utilize the concepts of reaction kinetics in chemical reactions.
2.	To construct the performance equation for ideal reactors.
3.	To demonstrate the flow behaviour and conversion of non-ideal reactors.
4.	To examine the reaction mechanism and kinetics of heterogeneous reactions.
5.	To analyse the various industrial reactors for gas-liquid reactions.

UNIT - I	REACTION KINETICS	9 + 3

Classifications of chemical reactions, Factors affecting rate of reactions. Order and molecularity, Rate equation, Effect of concentration and temperature on rate constant, theories of reaction rate - Arrhenius theory and Collision theory.

UNIT - II	IDEAL REACTORS	9 + 3

Classification of reactors, Performance equations: batch, plug flow and mixed flow reactors; Space time and Space velocity; Size comparison of single reactors, Multiple reactor systems- Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, Recycle reactor.

UNIT - III	NON- IDEAL REACTORS	9 + 3

Non-ideality in reactors, reasons for non-ideal flow, RTD: RTD function and measurement, RTD in plug flow and mixed flow reactor, Conversion in non-ideal flow, relation among E,F and C curve, non ideal flow models: tank-in-series and dispersion models.

UNIT - IV	HETEROGENEOUS REACTING SYSTEM	9 + 3

Rate equation for heterogeneous reactions, Ideal contacting patterns, Solid catalysed reactions-mechanism. Catalyst deactivation-types and mechanism, surface kinetics and pore resistance.

UNIT - V	INDUSTRIAL REACTORS FOR G/L REACTIONS	9 + 3

Reactors to carry out G/L reactions on solid catalysts-slurry, trickle bed, fluidized bed, contacting patterns in the fixed bed and fluidized bed catalytic reactors.

Total Instructional hours : 60

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Course Outcomes : Students will be able to	
CO1	Summarize the concepts of reaction mechanism and kinetics in chemical reactions
CO2	Interpret the performance equations to predict the conversion in ideal reactors.
CO3	Utilize the residence time distribution studies to study the non-ideal reactors.
CO4	Develop the kinetics of heterogeneous reacting system involving solid catalyst.
CO5	Select the industrial reactors to carry out gas-liquid reaction on solid catalyst.

Text Books	
1.	Levenspiel O, “Chemical Reaction Engineering”, 3rd Ed., Wiley, 2006.
2.	Fogler H S, “Elements of Chemical Reaction Engineering”, 5th Ed., Pearson, 2016.

Reference Books	
1.	Nauman E B, “Chemical Reactor Design, Optimization, and Scaleup”, 2nd Ed., John Wiley & Sons, 2008.
2.	Missen R W, Mims C A and Saville B A, “Introduction to Chemical Reaction Engineering and Kinetics”, John Wiley 1999.
3.	Dawande S D, “Principles of Reaction Engineering”, 1st Ed., Central Techno Publications, 2001.
4.	Smith J M, “Chemical Engineering Kinetics”, 3rd Ed., McGraw Hill, 1981.

BoS Chairman

B. TECH.	B23BTT402 – ENZYMOLOGY AND ENZYME TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To develop an understanding of the nature and mechanism of enzymes
2.	To investigate the kinetics of enzyme catalyzed reactions
3.	Make students to know extraction and purification of enzymes
4.	Give some examples of applications of enzymes in a range of fields.

UNIT - I	PRINCIPLES OF ENZYMOLOGY	9

Chemistry of enzymes, Classification of enzymes, Monomeric and Oligomeric enzymes, Mechanisms of enzyme action, Concept of active site, Energetics of enzyme substrate complex formation, specificity of enzyme action, principles of catalysis – collision theory, transition state theory, role of entropy in catalysis.

UNIT - II	BIOTRANSFORMATION APPLICATIONS OF ENZYMES	9

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

UNIT - III	KINETICS OF ENZYME ACTION	9

Kinetics of single substrate reactions - estimation of Michaelis – Menten parameters, turnover number; kinetics of multi substrate enzyme catalysed reactions; Investigation of the kinetics of enzyme catalysed reactions, Cooperativity; Koshland, Némethy, Filmer and Monod Changeux Wyman models, Allosteric regulation of enzymes.

UNIT - IV	ENZYME INHIBITION AND IMMOBILIZATION	9

Types of inhibitions and models- competitive, non-competitive, uncompetitive, mixed, partial, substrate; pH and temperature effect on enzymes; Immobilization- types, merits and demerits, applications; enzyme reactors.

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UNIT - V	ENZYME EXTRACTION, PURIFICATION AND APPLICATIONS	9
Identification, extraction and purification of enzymes from plant, animal and microbial sources; applications of enzymes in industrial, healthcare and environmental sectors.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the basic chemistry of enzymes and the various theories pertaining to catalysis.
CO2	Demonstrate the role of enzymes in biological reactions.
CO3	Develop kinetic models to determine the rate equations for different enzymes.
CO4	Identify the type of enzyme inhibition.
CO5	Select suitable enzyme purification methods for various sources.

Text Books	
1.	Palmer T, “Enzymes: Biochemistry, Biotechnology and Clinical Chemistry”, Affiliated East-West Press Pvt. Ltd, New Delhi, 2008.
2.	Dugas, Hermann “Bioorganic Chemistry: A Chemical Approach to Enzyme Action”, 3rd Ed., Springer, 2003.

References Books	
1.	Faber K., “Biotransformations in Organic Chemistry”, 4th Ed., Springer, 2000.
2.	Lee J M, “Biochemical Engineering”, PHI, USA, 1992.
3.	Bailey J E and Ollis D F, “Biochemical Engineering Fundamentals”, McGraw Hill, 1986.
4.	Blanch H W and Clark S D, “Biochemical Engineering”, Marcel Dekker Inc., 1997.

BoS Chairman

B. TECH.	B23BTT403 – MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide comprehensive background of salient features of nucleic acids and DNA models.
2.	To impart detailed understanding of key events of DNA replication and repair.
3.	To provide adequate knowledge about Transcription process in prokaryotes and eukaryotes and post transcriptional modifications.
4.	To develop comprehensive understanding regarding the genetic codes and translational process in prokaryotes and eukaryotes and post translational modifications.
5.	To give detailed explanation of transcriptional regulation in prokaryotic as well as eukaryotic organisms.

UNIT - I	NUCLEIC ACIDS AND THEIR ORGANIZATION	9

Historical developments of molecular biology; Evidence of nucleic acids as genetic material – Griffith, Hershey and Chase, Avery McLeod & McCarty experiments; Chemistry and Nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, Forms of DNA: A, B, Z and their function; Genome organization in prokaryotes and eukaryotes; Structure and Types of RNA.

UNIT - II	DNA REPLICATION AND REPAIR	9

Central dogma of Molecular Biology; DNA replication- Models of DNA replication; Prokaryotic and Eukaryotic DNA replication- Origin and steps - initiation, elongation and termination; Enzymes, accessory proteins and their mechanisms; DNA replication errors and their repair.

UNIT - III	TRASCRIPTION	9

Structure of mRNA, promoter, RNA polymerases, transcription factors and terminators; Process of transcription in prokaryotes and eukaryotes: Initiation, Elongation & Termination of transcription (Rho dependent and independent); Post transcriptional processing of RNA- capping, splicing, polyadenylation and RNA editing; mRNA stability; Inhibitors of transcription.

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UNIT - IV	TRANSLATION	9
Components of translational machinery in prokaryotes and eukaryotes: structure and function of ORF, tRNA, rRNA, aminoacyl synthetases, Ribosomes, Ribosome binding sites; Process of Translation in prokaryote and eukaryote: Initiation, Elongation & Termination. Concept of genetic code and Wobble hypothesis. Post translational modifications of protein, Protein folding, Protein targeting and degradation; Inhibitors of translation.		

UNIT - V	REGULATION OF GENE EXPRESSION	9
Principle of gene regulation: negative and positive regulation; inducer, repressor, co- repressor, activators, co-activators, silencers, insulators, enhancers; Gene regulation in prokaryote: concept of operon model, (lac, trp and ara operon); Regulation of gene expression with reference to lambda phage life cycle; Gene regulation in eukaryotes: DNA looping model, hormonal control of gene expression (steroid and non-steroid), regulations at level of translation.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain the physical and chemical nature of DNA and RNA.
CO2	Summarize DNA replication in prokaryotes and eukaryotes.
CO3	Demonstrate the transcription mechanism.
CO4	Identify the genetic codes and utilize the translation machinery.
CO5	Classify regulation of gene expression with suitable examples.

Text Books	
1.	Friefelder D, “Molecular Biology”, 2nd Ed., Narosa Publishing House, New Delhi, 2009.
2.	Watson J, Baker T, Bell S, Gann A, Levine M and Losick R, “Molecular Biology of the Gene”, Pearson Education, Inc., 2008.

Reference Books	
1.	Friefelder D and Malacinski M G. “Essentials of Molecular Biology” 2nd Ed., Panima Publishing, 1993.
2.	Tropp B E, “Molecular Biology: Genes to Proteins”. 3rd Ed., Jones and Bartlett, 2008.

BoS Chairman

B. TECH.	B19BTT404 – INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the basics and fundamentals of Industrial bioprocess.
2.	To acquire knowledge on various bioproducts produced by the microorganisms.
3.	To know different microbial fermented foods.
4.	To know the importance of rDNA technology through fermentation.
5.	To formulate the bulk production of agriculture based bioproducts.

UNIT - I	BASICS OF INDUSTRIAL BIOTECHNOLOGY	9

Introduction – Scope and importance of Industrial Biotechnology; Basics of upstream and downstream processing in bioprocess; Strategies of industrial fermentation technology; Industrial media and nutrition. Process flow sheeting – block diagrams, pictorial representation.

UNIT - II	MICROBIAL METABOLITES	9

Microbial metabolites: Introduction, types: Primary and Secondary metabolites; Major products of industrial Biotechnology: Organic acids (citric acid, acetic acid), Amino acids (glutamic acid, lysine), Alcohol (ethanol, acetone), Antibiotics (penicillin, streptomycin), Vitamins (Vitamin B2).

UNIT - III	INDUSTRIAL BIOPRODUCTS	9

Production of industrial enzymes (amylases, proteases and lipases); Biopreservatives (bacteriocins, Nisin); Fermented Foods- classic (wine, bread, vinegar), new fermented food (non-dairy yogurt, fermented vegetables); Production of dairy products: (yogurt, kumis and cheese); Technique of mass culture of algae (SCP); Bioplastics- bio-PET.

UNIT - IV	RECOMBINANT PRODUCTS	9

Recombinant products using microbial, animal and plant cell culture platforms - Production of recombinant proteins (insulin, human growth hormone), Vaccines and recombinant vaccines, Monoclonal antibodies-production and advantages, transgenic animals, plant molecular farming.

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UNIT - V	AGRO-INDUSTRIAL BIOTECHNOLOGY	9
Biofertilizers in agro ecosystem; Biopesticides – advantages and its applications. Composting – Vermicomposting and its methods; Bioremediation and bioleaching - introduction, scope and applications.		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the scope of Biotechnology and tell the basics of Industrial bioprocess and to develop a bio product with flowsheet.
CO2	Explain about the steps and operation involved in various metabolites production.
CO3	Outline the industrially important microbial strains for the production of biopolymers, enzymes and food products.
CO4	Make use of rDNA technology in the production of recombinant bioproducts.
CO5	Develop biotechnology techniques for the production of ecofriendly agricultural bioproducts.

Text Books	
1.	Lee S Y, Nielsen J. and Stephanopoulos G., “Industrial Biotechnology: Products and Processes”, John Wiley & Sons, 2016.
2.	Waites M J., Morgan N L., Rockey J S, Higton G, “Industrial Microbiology: An Introduction” Blackwell, 2001.
3.	Cruger W, Cruger A, “A Textbook of Industrial Microbiology”, Panima Publishing Corporation, 2nd Edition, 2005.
4.	Okafor N, “Modern Industrial Microbiology and Biotechnology”, CRC Press, 2007.

Reference Books	
1.	Casida L E. “Industrial Microbiology”, New Age International Pvt. Ltd, 1968.
2.	Pandey A, Negi S, Soccol C R, “Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products”, Elsevier, 2016.
3.	Presscott and Dunn’s, “Industrial Microbiology”, CBS Publisher, 1987.
4.	Saikai R, “Microbial Biotechnology”, New India Publishing, 2008.
5.	Frazier W C, Westhoff D C and Vanitha N M, “Food Microbiology”, 5th Ed, McGraw Hill, 2017.

BoS Chairman

B.TECH.	B23BTI401 – ANALYTICAL METHODS IN BIOTECHNOLOGY	L	T	P	C
		3	0	2	4

Course Objectives	
1.	To familiarize with the concepts of measurement, precision and errors.
2.	To impart understanding of various spectroscopy techniques in sample analysis.
3.	To understand and characterize biological samples at atomic, molecular and structural levels.
4.	To provide an insight about separation of biomolecules based on its physical and chemical characteristics.
5.	To understand and apply thermal and electro-analytical techniques for sample characterization.

UNIT - I	PRINCIPLES OF ANALYTICAL METHOD VALIDATION	9 + 3

Concepts of precision, accuracy, reproducibility, Repeatability, specificity, detection limit, quantitation limit and linearity range; method development, positive and negative controls; noise – sources, signal to noise ratio, improving signal to noise ratio; measurement errors – types; methods of quantification; instrument sensitivity; calibration approaches.

Estimate precision and validity in an experiment; Estimate limits of detection using aluminium alizarin complex.

UNIT - II	MOLECULAR SPECTROSCOPY	9 + 9

Measurement of transmittance and absorbance; Beer-Lambert's law – derivation and deviations from the law; spectroscopy - spectrophotometers – qualitative and quantitative absorption measurements – types of spectrophotometers – UV-visible, IR, FTIR, Raman spectroscopy – principle, instrumentation and applications.

Validation of Beer-Lambert's law; Estimation of nucleic acids and proteins; Chemical actinometry using potassium ferrioxalate; Finding the molar absorptivity and stoichiometry of the Fe^{3+}-1,10 phenanthroline using absorption spectrometry; Finding the pKa of 4-nitrophenol using absorption spectroscopy.

UNIT - III	STRUCTURAL ELUCIDATION AND RADIOISOTOPE METHODS	9

Mass spectrometry: MALDI-TOF– principle and instrumentation; Electron spray ionization [ESI] and chemical ionization [CI] – principle, instrumentation and applications; X-ray diffraction and nuclear magnetic resonance (NMR): principle, instrumentation and applications.

Radioactivity – principles, radioactive isotopes and labelling, types of radioactive decay; scintillation counters – principle, instrumentation and applications.

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UNIT - IV	CHROMATOGRAPHY AND ELECTROPHORESIS	9 + 3
Chromatography - principles, van Deemter equation, elution methods; column chromatography - Gel filtration, Ion exchange and affinity chromatography; HPLC, GC. Electrophoresis – principles, agarose gel, 2D-gel electrophoresis, Native/SDS-PAGE; enzyme zymography; capillary electrophoresis; isoelectric focusing; isotachophoresis. **Chromatography analysis using TLC; Chromatography analysis using column chromatography.**		

UNIT - V	THERMAL METHODS AND ELECTRO-ANALYTICAL TECHNIQUES	9
Thermal methods - principle, instrumentation and applications - thermo-gravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Electroanalytical methods - electrochemical cells - electrodes, reference electrodes, ion selective electrodes and pH meter; potentiometry; voltammetry; colorimetry and amperometry – theory, instrumentation and applications; sensors- oxygen sensors, glucose sensors.		
		Total Theory Instructional hours : 45
		Total Lab Instructional hours : 15

Course Outcomes : Students will be able to	
CO1	Summarize the concepts of accuracy and reproducibility while measuring various parameters
CO2	Extend the spectroscopy techniques in estimating, processing, visualizing and interpreting different samples
CO3	Identify the analyte structure using spectrometry techniques and radioisotope methods.
CO4	Utilize chromatography and electrophoresis for separation process.
CO5	Make use of thermal and electro-analytical methods for predicting the characteristics of an analyte

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Text Books	
1.	Skoog D A, Holler F J and Crouch S R, “Instrumental Methods of Analysis”, 6th Ed., Cengage Learning, 2016.
2.	Wilson K and Walker J, “Principle and Techniques of Practical Biochemistry", 5th Ed., Cambridge University Press, Oxford, 2002.
3.	Chatwal G R and Anand S K, “Instrumental Methods of Chemical Analysis”, 5th Ed., Himalaya Publishing House, India, 2012.

Reference Books	
1.	Sharma B K, “Instrumental Methods of Chemical Analysis”, 24th Ed., Goel Publishing House, India, 2014.
2.	Heftman E. “Chromatography”, 6th Ed., Elsevier, Netherlands, 2004.

BoS Chairman

B. TECH.	B23BTP401 – CELL AND MOLECULAR BIOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To demonstrate various techniques to learn the morphology and identification of cells.
2.	To provide hands-on experience in performing basic molecular biology techniques.
3.	To understand phenotypic characterization of cells.
4.	To demonstrate protein and nucleic acid separation using electrophoresis.
5.	To analyze DNA from various samples.

Expt. No.	List of Experiments
1.	Introduction to microscopes – principle and working of different microscopes
2.	Identification of given plant, animal and bacterial cells & their components by microscopy
3.	Staining for different stages of mitosis in Allium cepa (Onion)
4.	Enumeration of microbes from soil/water
5.	Biochemical characterization of bacteria
6.	Cell viability assay – Trypan blue
7.	Electrophoresis - Agarose and Polyacrylamide Gel
8.	Extraction of genomic DNA from microbial source (bacteria)
9.	Extraction of genomic DNA from plant source
10.	Extraction of genomic DNA from animal sample
11.	Qualitative and quantitative analysis of DNA using UV-spectrophotometer
12.	Extraction of plasmid DNA
13.	Amplification and sequencing of DNA
	Total Instructional hours : 30

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Course Outcomes : Students will be able to	
CO1	Illustrate the cells and their components using microscope.
CO2	Interpret the total microbial count in the given sample.
CO3	Classify bacterial strains based on phenotypic characteristics.
CO4	Evaluate nucleic acids and proteins using molecular biology techniques.
CO5	Identify the genotypic characteristics of organisms using extracted DNA.

Reference Books	
1.	Rickwood D and Harris J R, “Cell Biology: Essential Techniques”, John Wiley, 1996.
2.	Cappuccino J G and Sherman N, “Microbiology: A Laboratory Manual”, 4th Ed., Addison- Wesley, 1999.
3.	Sambrook J and Russell D W, “The Condensed Protocols: From Molecular Cloning : A Laboratory Manual”, Cold Spring Harbor, 2006.

BoS Chairman

Semester - V

B.TECH.	B23BTT501-MASS TRANSFER OPERATIONS	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To understand the basic mechanisms of diffusion and interphase mass transfer.
2.	To apply the material balance concept in stage calculation for absorber.
3.	To understand the principle and stage calculation of batch and continuous distillation.
4.	To learn the stage calculation and operation of extraction equipments.
5.	To know the principle and stage calculation of leaching and drying.

Pre-requisite (if any)

Stoichiometry and Fluid Mechanics, Biochemical thermodynamics

UNIT 1	DIFFUSION AND INTERPHASE MASS TRANSFER	9 + 3

Introduction to mass transfer operations, Molecular diffusion in gases and liquids, Concept of mass transfer coefficients, Theories of mass transfer – Film theory, penetration theory and surface renewal theory, Inter phase mass transfer, Individual and overall mass transfer coefficients.

UNIT 2	ABSORPTION	9 + 3

Gas absorption and stripping – Equilibrium, Material balance – Selection of solvents for absorption –Tray tower absorber – design of absorber – Calculation of number of theoretical stages – Tray efficiency, Packed tower absorber – Tower packing and characteristics – Determination of height of packing using HTU and NTU calculations.

UNIT 3	DISTILLATION	9 + 3

Vapour-Liquid equilibria – Raoult's law, Vapor–Liquid equilibrium diagrams for ideal and non-ideal systems – Principle of distillation – Flash distillation, differential distillation, steam distillation, Multistage continuous rectification – Number of ideal stages by McCabe – Thiele method. – Total reflux, minimum reflux ratio, optimum reflux ratio.

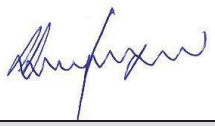
UNIT 4	LIQUID-LIQUID EXTRACTION	9 + 3

Liquid–Liquid extraction – Solvent characteristics – Equilibrium stage wise contact calculations for batch and continuous extractors – differential contact equipment – spray, packed, mechanically agitated contactors, pulsed extractors, centrifugal extractors and supercritical extraction.

UNIT 5	LEACHING AND DRYING	9 + 3

Solid–Liquid equilibria – Equipment for leaching operations – calculation of number of stages – Single stage and multi stage continuous cross current and counter current. Drying – Principle and classification of dryer – Types of moisture content, humidity – Estimation of drying rates, drying curve – Calculation of drying time under constant drying conditions – Different types of dryers.

Total Instructional Hours : 60



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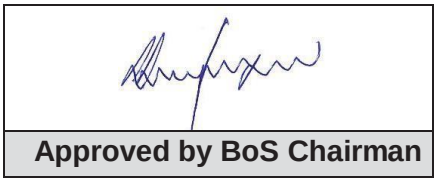
Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the mechanism of diffusion and interphase mass transfer.	K2
CO2	Apply the concept of material balance to determine the stage calculation in gas absorption process.	K3
CO3	Make use of phase equilibrium concept and perform stage calculation graphically for batch and continuous distillation.	K3
CO4	Utilize the ternary equilibrium concepts to determine the number of stages for liquid- liquid extraction process.	K3
CO5	Identify the number of stages in leaching operation and estimation of drying time for dryer.	K3

Textbooks	
1.	Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw – Hill Book Co., 2017.
2.	Mc Cabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2017.
3.	Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2015.

Reference Books	
1.	Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 6th Edition, Asian Books Pvt. Ltd., India, 2006.
2.	Binay K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd Edition, PHI Learning Ltd, 2013.
3.	J.D. Seader and E.J. Henley, "Separation Process Principles", 2nd Edition, John Wiley, 2006.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	2	2	1	-	2	-	2	3	3
CO2	3	3	3	3	-	2	2	1	-	2	-	2	3	3
CO3	3	3	3	3	-	2	2	1	-	2	-	2	3	3
CO4	3	3	3	3	-	2	2	1	-	2	-	2	3	3
CO5	3	3	3	3	-	2	2	1	-	2	-	2	3	3
Wt. Avg	**3**	**3**	**3**	**3**	**-**	**2**	**2**	**1**	**-**	**2**	**-**	**2**	**3**	**3**



Approved by BoS Chairman

B.TECH.	B23BTT502-IoT APPLIED BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To establish foundational knowledge of bioreactor principles and configurations.
2.	To develop bioengineering skills for the production of biochemical products using integrated biochemical processes
3.	To device ecofriendly bioprocessing technologies.

Pre-requisite (if any)
Mass Transfer Operations, Enzymology and Enzyme Technology, Bioprocess Principles.

UNIT 1	CONFIGURATION OF BIOREACTORS	9

Ideal reactors and their characteristics: CSTR, PFR, Fed-batch cultivation, Cell recycle cultivation, Cell recycle cultivation in wastewater treatment; Advanced Reactor Designs: two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed and bubble column reactor. Introduction to smart bioreactors with IoT-based sensors and actuators; real-time monitoring of temperature, pH, DO, and agitation through connected devices.

UNIT 2	BIOREACTOR SCALE – UP	9

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

UNIT 3	BIOREACTOR CONSIDERATIONS IN ENZYME SYSTEMS	9

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors — packed bed, fluidized bed and membrane reactors. Monitoring enzyme activity and efficiency using biosensors and IoT networks.

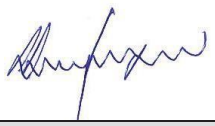
UNIT 4	MODELLING AND SIMULATION OF BIOPROCESSES	9

Study of unstructured models for analysis of various bioprocess — compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism, kinetics of growth and product formation model – Monod model and Luedeking–Piret equation. Real-time simulation and optimization using IoT-enabled data.

UNIT 5	RECOMBINANT CELL CULTIVATION	9

Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris/ Saccharomyces cereviseae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system. Smart bioreactor platforms for high-throughput recombinant cultivation.

Total Instructional Hours: 45



Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Choose reactors with various configurations for specific processes.	K2
CO2	Develop scale up strategies for bioreactors based on mass transfer and impeller properties.	K3
CO3	Construct immobilized enzyme reactors.	K3
CO4	Analyze bioprocessing using modes and dynamic simulations.	K4
CO5	Apply bioreactor considerations for the development of recombinant products.	K3

Reference Books	
1.	Sarfaraz K. Niazi, Justin L. Brown, "Fundamentals of Modern Bioprocessing", Taylor & Francis, 2017.
2.	James Edvin Bailey, David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill, 2017.
3.	James M. Lee, Biochemical Engineering, PHI Learning Ltd, USA.1992.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	-	3	3	-	-	-	-	3	3	3
Wt. Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Approved by BoS Chairman

B.TECH	B23BTT503-PROTEIN EGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To identify the different interactions involved in protein building
2.	To study about the different protein structures and their functional relationship
3.	To know about the protein sequence analysis and their comparison using latest tools

Pre-requisite (if any)
Biochemistry, Molecular Biology

UNIT 1	BONDS & BUILDING BLOCKS OF PROTEINS	9

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

UNIT 2	PROTEIN ARCHITECTURE	9

Primary structure: peptide mapping, peptide sequencing - automated Edman method, Secondary structure: Prediction of structures and Super-secondary structures: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures.

UNIT 3	TERTIARY STRUCTURE	9

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes.

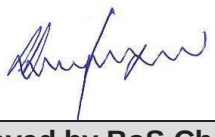
UNIT 4	STRUCTURE-FUNCTION RELATIONSHIP	9

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

UNIT 5	PROTEOMICS	9

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

Total Instructional Hours: 45



Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline the organization of protein structure through the various interactions in protein.	K2
CO2	Interpret the different levels of protein structure.	K2
CO3	Identify the major factors for protein folding.	K3
CO4	Dissect the role of functional proteins in various field of study and their latest application in their research.	K4
CO5	Analyze and compare protein sequence data.	K4

Textbooks	
1.	Branden C. and Tooze J., "Introduction to Protein Structure", 2nd Edition, Garland Pub., NY, 1999.
2.	Voet D. and Voet G., "Biochemistry", 5th Edition, John Wiley and Sons, 2018.

Reference Books	
1.	Moody P.C.E.and Wilkinson A.J., "Protein Engineering", IRL Press, Oxford, UK, 1990.
2.	Creighton T.E., "Proteins", Freeman W H, 2nd Edition, 1993.
3.	Mallorie N. Sheehan., "Protein Engineering – Design, Selection and Applications", Nova Science Publishers, UK 2013.
4.	Kurra Venkata Gopaiah., " Protein Engineering", Random Publications, 1st Edition, 2017.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	3	2	2	2	2	2	3	3
CO2	3	3	3	3	3	2	2	3	-	-	2	3	2	3
CO3	2	2	3	2	3	2	3	2	2	1	2	3	2	3
CO4	3	2	2	2	3	3	2	2	-	2	1	1	2	2
CO5	2	3	3	2	2	3	2	3	2	1	3	2	3	3
Wt. Avg.	**2.6**	**2.6**	**2.6**	**2.2**	**2.6**	**2.4**	**2.4**	**2.4**	**1.2**	**1.2**	**2**	**2.2**	**2.4**	**2.8**

Approved by BoS Chairman

B.TECH.	B23BTT504-GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the strategies of Transformation and selection of recombinants.
2.	To deliver fundamental facts of transgenic technology.
3.	To understand about application of DNA manipulation techniques in Biotechnology.

Pre-requisite (if any)
Molecular Biology

UNIT 1	MOLECULAR TOOLS IN GENETIC ENGINEERING	9
DNA Exonucleases and Endonucleases- Restriction Enzymes – types, nomenclature, recognition sequence, cleavage pattern, restriction digestion and its analysis, Ligase, Polymerases, DNA Modifying enzymes. Linkers, adaptors and homopolymer tailing.		
UNIT 2	**CLONING VECTORS AND LIBRARY CONSTRUCTION**	**9**
E. coli vectors – construction and features of plasmids, Expression vectors, bacteriophage vectors – Lambda phage & M- 13 phage vectors, cosmids, phasmids, shuttle vectors, yeast vectors - 2µm plasmid, yeast episomal plasmid and YACs, transfer and cloning of recombinant vectors, construction of genomic DNA libraries, cDNA libraries and their applications.		
UNIT 3	**PCR, BLOTTING AND FINGER PRINTING TECHNIQUES**	**9**
Preparation of labeled probes and primers, PCR and its applications, southern blotting, northern blotting, DNA sequencing methods – Maxam & Gilbert method, Sangers and Automated sequencing method, DNA finger printing technique- RFLP and RAPD and its applications.		
UNIT 4	**GENE TRANSFER METHODS AND MUTAGENESIS**	**9**
Gene transfer techniques – transformation, transfection, electroporation, lipofection and gene gun methods, site specific mutagenesis, transposon mutagenesis, gene knockout technologies.		
UNIT 5	**APPLICATIONS OF TRANSGENICS AND ETHICS**	**9**
Application of genetic engineering in agriculture, animal husbandry, medicine, environmental management and industries, limitations and Ethical considerations in genetic engineering.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain basic principles of rDNA technology.	K2
CO2	Outline various vectors for cloning and expression of the transgene.	K2
CO3	Apply the various molecular techniques for DNA analysis.	K3
CO4	Demonstrate the various gene transfer techniques.	K3
CO5	Make use of genetic engineering for the production of transgenic.	K3

Approved by BoS Chairman

Textbooks	
1.	Brown TA, "Gene Cloning and DNA Analysis: An Introduction" 6th Edition, Wiley-Blackwell, 2010.
2.	Glick B, and Pasternak JJ, "Molecular Biotechnology Principles and Applications of Recombinant DNA", 5th Edition, Wiley, 2017.

Reference Books	
1.	Primrose SB and RM Twyman, "Principles of Gene Manipulation and Genomics", 6th Edition John Wiley & Sons, New York, 2006.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	3	3	2	2	1	-	-	2	2	-	-	2	3	3
CO4	3	3	-	-	-	-	-	2	2	-	-	2	3	3
CO5	3	3	1	1	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**

Approved by BoS Chairman

B.E / B.Tech	B23MCT505- Holistic Insight into UN SDGs (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand the origin, purpose, and significance of the UN Sustainable Development Goals (SDGs).
2.	To explore the 17 SDGs, their interconnections, and challenges in achieving them.
3.	To analyze global and local case studies of SDG implementation.
4.	To evaluate the role of governments, businesses, and individuals in sustainable development.
5.	To develop practical solutions and action plans for achieving SDGs at community and policy levels

SYLLABUS:

UNIT - I	INTRODUCTION TO SUSTAINABLE DEVELOPMENT & SDGS	6

Concept of **sustainability** and its evolution.

UN Millennium Development Goals (MDGs) vs. Sustainable Development Goals (SDGs).

Overview of the **17 SDGs**, their targets, and indicators.

Importance of **global collaboration** for sustainable development.

UNIT - II	PEOPLE-CENTERED SDGS (SDG 1–6)	6

SDG 1: No Poverty – Causes, measures & policies.

SDG 2: Zero Hunger – Food security & sustainable agriculture.

SDG 3: Good Health & Well-being – Universal healthcare & disease prevention.

SDG 4: Quality Education – Inclusive and equitable education.

SDG 5: Gender Equality – Women's empowerment & equal opportunities.

SDG 6: Clean Water & Sanitation – Water conservation & access to sanitation.

Approved by BoS Chairman

UNIT - III	ECONOMIC & INFRASTRUCTURE SDGS (SDG 7–12)	6

SDG 7: Affordable & Clean Energy – Renewable energy solutions.

SDG 8: Decent Work & Economic Growth – Inclusive economic policies.

SDG 9: Industry, Innovation & Infrastructure – Sustainable development & digital transformation.

SDG 10: Reduced Inequalities – Social inclusion & global justice.

SDG 11: Sustainable Cities & Communities – Smart urban planning & resilience.

SDG 12: Responsible Consumption & Production – Circular economy & waste management.

UNIT - IV	ENVIRONMENTAL SDGS (SDG 13–15)	6

SDG 13: Climate Action – Climate change impacts & mitigation strategies.

SDG 14: Life Below Water – Ocean conservation & marine biodiversity.

SDG 15: Life on Land – Forest preservation & biodiversity protection.

UNIT - V	Governance & Global Partnerships (SDG 16–17)	6

SDG 16: Peace, Justice & Strong Institutions – Human rights & good governance.

SDG 17: Partnerships for the Goals – Role of international cooperation, businesses & individuals.

Course Outcomes: Students will be able to	
CO1	Explain the origin, purpose, and significance of the UN Sustainable Development Goals.
CO2	Summarize the 17 SDGs, their interconnections, and challenges in achieving them.
CO3	Interpret global and local case studies of SDG implementation.
CO4	Describe the roles of governments, businesses, and individuals in sustainable development.
CO5	Illustrate practical solutions and action plans for achieving SDGs at community and policy levels.

Approved by BoS Chairman

Text Books	
1.	Sachs, J. D. (2015). The Age of Sustainable Development. Columbia University Press.
2.	United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development.
3.	Griggs, D., Stafford-Smith, M., Gaffney, O., & Rockström, J. (2017). Sustainable Development Goals: Harnessing Business to Achieve the SDGs Through Finance, Technology and Innovation. Routledge.
4.	Mebratu, D., & Swilling, M**. (2019).** Transformational Infrastructure for Development of a Wellbeing Economy. Springer.

Reference Books	
1.	Leal Filho, W. (Ed.). (2020). Encyclopedia of the UN Sustainable Development Goals. Springer.
2.	Sachs, J. D. (2021). The Decade of Action: Mobilizing the World to Achieve the SDGs. Columbia University Press.

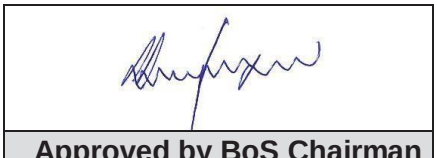
Approved by BoS Chairman

B. TECH.	B23BTP501–BIOPROCESS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To expose the students with insights into enzyme characterization and immobilization techniques.
2.	To acquire knowledge on the methods to explore microbial growth in various systems under diverse environmental conditions.
3.	To understand the operations of bioreactor and to apply the knowledge of mass transfer in bioprocess.

Expt. No.	List of Experiments
1.	Microbial Growth kinetics in Batch culture
2.	Deactivation kinetics of microbial growth
3.	Batch Sterilization kinetics
4.	Residence time distribution studies in batch and Packed bed reactor
5.	Estimation of K_La by Dynamic gassing out method.
6.	Estimation of K_La by Sulphite oxidation method.
7.	Medium optimization using Plackett Burman design
8.	Medium optimization using Response Surface Methodology
9.	Enzyme kinetics – Determination of Michaelis Menten parameters
10.	Enzyme activity – Effect of pH
11.	Enzyme activity – Effect of temperature and Deactivation kinetics
12.	Enzyme inhibition kinetics
13.	Enzyme immobilization – Gel entrapment
14.	Comparative studies on kinetics of free and immobilized enzymes
	Total Instructional hours: 30

Course Outcomes: Students will be able to	
CO1	Analyze the growth and death kinetics of microorganisms.
CO2	Investigate the influence of diverse factors on enzyme kinetics and activity
CO3	Evaluate the performance of various bioreactors.
CO4	Analyze and calculate the oxygen mass transfer coefficient in bioreactors.
CO5	Design optimal media composition and process parameters for enhanced biomass/product yield



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LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
Sl. No.	**Description of the Equipment**	**Quantity required (Nos.)**
1.	Autoclave	1
2.	Hot Air Oven	1
3	Incubator	1
4.	Light Microscope	4
5.	Incubator Orbital Shaker	1
6.	Laminar Air Flow Chamber	1
7.	UV-Vis Spectrophotometer	1
8.	Bio-reactor	1
9.	Centrifuge	1
10.	Weigh balance	1
11.	Water bath	1

Reference Books	
1.	Anton Moser, “Bioprocess Technology, Kinetics and Reactors”, Springer Verlag. 2011.
2.	James EB and DF Ollis, “Biochemical Engineering Fundamentals”, McGraw Hill, 2nd Ed. 1986.
3.	Michael L. Shuler, Fikret Kargi, Matthew De Lisa, Bioprocess Engineering, Prentice Hall, 3rd Edition, 2017

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	2	2	2	2	2	2	3	3	3
CO2	3	3	3	3	-	2	2	2	2	2	2	3	3	3
CO3	3	3	3	3	1	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	-	2	2	2	2	2	2	3	3	3
CO5	3	3	3	3	5	3	3	1	2	2	2	3	3	3
Wt. Avg.	**3**	**3**	**3**	**3**	**1**	**2.2**	**2.2**	**1.8**	**2**	**2**	**2**	**3**	**3**	**3**

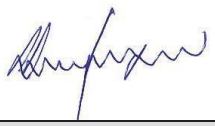
Approved by BoS Chairman

B. TECH.	B23BTP502-GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To deliver hands on experience in performing basic recombinant DNA techniques.
2.	To describe the common applications of Genetic Engineering in research.

Expt. No.	List of Experiments
1.	Preparation of Plasmid DNA
2.	Elution and Purification of DNA from agarose gels
3.	Restriction enzyme digestion
4.	Ligation
5.	Transformation & Selection of recombinants – Blue white screening assay
6.	Southern blotting
7.	Western Blotting
8.	PCR amplification of genes
9.	Colony lysate PCR
10.	DNA Sequencing and Analysis
	Total Instructional hours : 30

Course Outcomes : Students will be able to	
CO1	Develop recombinants using DNA modifying enzymes.
CO2	Analyze the expression of transgenes in the host cell.
CO3	Analyze the nucleic acid and protein samples using blotting techniques.
CO4	Utilize thermal cycler for gene amplification.
CO5	Experiment with DNA Sequencing and Analysis.



Approved by BoS Chairman

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
Sl. No.	**Description of the Equipment**	**Quantity required (Nos.)**
1.	pH meter	1
2.	Horizontal Gel Electrophoresis	2
3	Vertical Gel Electrophoresis	1
4.	UV-Vis Spectrophotometer	1
5.	Blotting Apparatus	1
6.	Autoclave	1
7.	Hot Air Oven	1
8	Weigh balance	1
9	Water bath	1

References	
1.	Old RW and SB Primrose, “Principles of Gene Manipulation : An Introduction to Genetic Engineering”, Blackwell Science, 2001.
2.	Ausubel FM, R Brent, RE Kingston and DD Moore, “Current Protocols in Molecular Biology”, Greene Publishing Associates, NY, 2010,
3.	Berger Sl and Kimmer AR, “Methods in Enzymology”, Vol. 152, Academic Press, 1987.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	1	1	2	2	2	1	2	3	3
CO2	3	3	3	3	2	1	1	2	2	2	1	2	3	3
CO3	3	3	3	3	3	2	1	2	2	2	1	2	3	3
CO4	3	3	3	3	3	2	1	2	2	2	1	2	3	3
CO5	3	3	3	3	3	3	1	2	2	2	1	2	3	3
Wt. Avg.	**3**	**3**	**3**	**3**	**2.6**	**1.8**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**

Approved by BoS Chairman

Semester - VI

B.TECH.	B23BTT601– IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the general concepts of immune system, immune organs and cells.
2.	To know about antigens and antibodies.
3.	To get familiarize with the mechanisms related to cell and antibody mediated immunity
4.	To know about the types of hypersensitivity reaction and also immune response to different infectious agents.
5.	To understand autoimmunity, immunology behind graft acceptance and rejection and immunodeficiency disease/disorders.

Pre-requisite (if any)
Cell Biology, Biochemistry

UNIT 1	INTRODUCTION TO IMMUNE SYSTEM	9
Historical perspective, Innate and adaptive immunity, Cells of the immune system – Haematopoiesis, Organs of the immune system.		
UNIT 2	**ANTIGENS AND ANTIBODIES**	**9**
Immunogenicity vs Antigenicity, Factor that influence immunogenicity, Epitopes, Haptens, Pattern-recognition receptors, Basic structure of antibodies, Immunoglobulin fine structure, Antibody mediated effector functions, Antibody classes, Antigenic determinants, B-cell receptor, Immunoglobulin super family, Monoclonal antibodies, Antigen-Antibody interactions: Cross-reactivity, precipitation and agglutination, immunological assays.		
UNIT 3	**HUMORAL AND CELLULAR IMMUNITY**	**9**
Major histocompatibility complex – antigen processing and presentation, Cell mediated immunity: T- Cell receptor, T- cell maturation, activation and differentiation. Humoral immune response: B-cell generation, activation, differentiation and regulation of B-cell development, Cytokines, The complement system.		
UNIT 4	**HYPERSENSITIVE REACTIONS AND IMMUNE RESPONSE TO INFECTIOUS DISEASES**	**9**
Gell and Coombs classification of hypersensitivity. Protective immune response to viral infections, bacterial infections, fungal infections, protozoan diseases, diseases caused by parasitic worms (Helminths) and emerging infectious disease. Cancer and the immune system.		
UNIT 5	**AUTOIMMUNITY, TRANSPLANTION IMMUNOLOGY AND IMMUNODEFICIENCY**	**9**
Organ-specific and systemic autoimmune diseases. Immunologic basis of graft rejection, clinical manifestation of graft rejection, general and specific immunosuppressive therapy, immune tolerance to allografts and clinical transplantation. Primary immunodeficiency, AIDS and other secondary immunodeficiencies.		
Total Instructional Hours: 45		

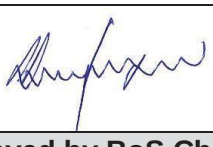
Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Outline the general concepts of immune system and describe the cells and organs of the immune system	K2
CO2	Illustrate the properties of antigens and antibodies; and demonstrate various antigen-antibody interactions	K2
CO3	Explain the concept of cell and antibody mediated immunity and outline the mechanism of complement system	K2
CO4	Illustrate the mechanism behind hypersensitivity and molecular mechanisms involved in pathogenesis of diseases caused by various pathogenic organisms.	K2
CO5	Outline the mechanism behind transplantation immunology, concept of autoimmunity and immunodeficiency.	K2

Textbooks	
1.	Owen JA, Punt J and Stranford SA, “Kuby Immunology”, Macmillan International, 8th Edition, 2019.
2.	Delves PJ, Martin SJ, Burtn DR and Roitt IM, “Roitt’s Essential Immunology”, 13th Edition, Wiley – Blackwell, 2016.

Reference Books	
1.	Richard C, “Immunology: A Short Course” 8th Edition, John Wiley, 2021.
2.	Khan FH, “Elements of Immunology” Pearson Education, 2009.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	2	2	2	2	2	2	2	1	2	2
CO2	1	2	1	1	2	2	3	1	1	2	1	1	2	2
CO3	2	2	2	2	2	3	3	2	3	2	2	2	2	2
CO4	2	1	3	2	3	1	2	3	2	1	3	3	3	1
CO5	3	2	3	2	3	2	3	2	3	1	2	2	2	3
Wt. Avg	**2**	**1.6**	**2.2**	**1.8**	**2.4**	**2**	**2.6**	**2**	**2.2**	**1.6**	**2**	**1.8**	**2.2**	**2**



Approved by BoS Chairman

B.TECH.	B23BTT602 – NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the nanoscale processes and nanomaterials
2.	To interpret the different synthesis methods and various characterization techniques
3.	To construct the protein-based nanomaterials based on structural and functional principles
4.	To develop the DNA based nanomaterials
5.	To apply the theoretical knowledge for the development of nanomedicine and nanosensors

Pre-requisite (if any)
Engineering Physics or Material science for Biotechnologists, Biochemistry

UNIT 1	NANOSCALE PROCESSES AND NANOMATERIALS	9

Overview of nanoscale processes and characterization of nanomaterials – Physicochemical properties of nanomaterials – Concepts in nanotechnology – Natural nanomaterials –Types of Nanomaterials: Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Polymeric nanoparticles, Buckyballs, Nanotubes – Synthesis and assembly of nanoparticles and nanostructures using bio-derived templates

UNIT 2	SYNTHESIS AND CHARACTERIZATION	9

Physical, Chemical and Biological means of Synthesis – Biomimetics approaches - Characterization of nanomaterials: Spectroscopy like UV, FTIR - Electron Microscopy – TEM, SEM - X-ray Diffractometry and Atomic Force Microscopy

UNIT 3	PROTEIN-BASED NANOTECHNOLOGY	9

Overview of protein nanotechnology – Nanotechnology with S-Layer protein – Engineered nanopores – Bacteriorhodopsin and its potential – Protein assisted synthesis of metal nanoparticles – Synthesis of protein-based nanoparticles – Protein nanopaticle-hybrids – Covalent and non-covalent protein nanoparticle conjugates – Protein- carbon nanotube conjugates. Protein folding – Self-assembly – Self-organization – Information-Driven nanoassembly – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self-replication.

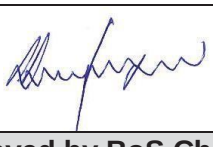
UNIT 4	DNA-BASED NANOTECHNOLOGY	9

DNA-based nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – Self assembling DNA structures – DNA-nanoparticle conjugates – DNA-carbon nanotube conjugates – DNA templated electronics – DNA nanostructures for mechanics and computing – DNA nanomachine.

UNIT 5	NANOBIOTECHNOLOGICAL APPLICATIONS	9

Promising nanobiotechnologies for applications in medicine –Liposomes in nanomedicine – Therapeutic applications of nanomedicine – Nano-Sized carriers for drug delivery and drug carrier systems – Protein and peptide nanoparticles, DNA based nanoparticles, Lipid matrix nanoparticles for drug delivery – Nanobiosensors for imaging and diagnosis. Applications in Tissue Engineering and regenerative medicine.

Total Instructional Hours: 45



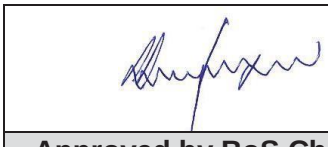
Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Summarize the nanoscale processes and nanomaterials	K2
CO2	Relate the different synthesis methods and various characterization techniques	K2
CO3	Develop protein-based nanomaterials based on structural and functional principles	K3
CO4	Construct the DNA based nanomaterials	K3
CO5	Make use of the theoretical knowledge for the development of nanomedicine and nanosensors	K3

Textbooks	
1.	Niemeyer, C.M. and Mirkin, C.A., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley-VCH, 2006.
2.	Goodsell, D.S., "Bionanotechnology – Lessons from Nature", John Wiley and Sons, 2015.

Reference Books	
1.	Shoseyov, O. and Levy I., "Nanobiotechnology: Bioinspired Devices and Materials of the Future", Humana Press, 2008.
2.	Gazit, E., and Mitraki, A., "Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology", Imperial College Press, 2013.
3.	Jesus M. de la Fuente and Grazu, V., "Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles" Elsevier, 2012

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	1	1	2	2	1	2	2	2	2	1
CO2	2	-	1	2	-	-	1	1	2	1	-	-	2	-
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO4	2	2	3	2	2	1	2	2	2	2	2	2	2	2
CO5	3	1	2	1	2	2	2	2	2	3	1	2	3	2
Wt. Avg	**2.4**	**1.75**	**2.2**	**1.8**	**2**	**1.75**	**2**	**2**	**2**	**2.2**	**1.75**	**2.25**	**2.4**	**2**



Approved by BoS Chairman

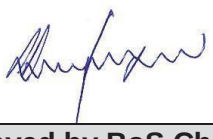
B. Tech.	B23BTT603 – BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the knowledge of databases and its maintenance.
2.	To provide the basic concept of various algorithms
3.	To deliver the knowledge on protein designing and its interactions.

Pre-requisite (if any)
Biochemistry, Molecular Biology, Protein Engineering

UNIT 1	INTRODUCTION TO BIOINFORMATICS	9
Scope of Bioinformatics, Databases- DBMS, Biological databases-classification-importance, Sequence Databases- GenBank, NCBI, DDBJ, EMBL, UniProt, SWISS-PROT, PIR, TrEMBL, Structural Databases-PDB, SCOP, CATH, pfam.		
UNIT 2	**SEQUENCE ANALYSIS**	**9**
Sequence Alignment- Sequence Homology Vs Sequence Identity Vs Sequence Similarity, Types of Sequence alignment methods- PSA, MSA, Scoring Function and Substitution Matrices-PAM & BLOSUM, Algorithms-Needleman-Wunch & Smith-Watermann, BLAST and its types, FASTA.		
UNIT 3	**PHYLOGENETIC RELATIONSHIPS**	**9**
Introduction to Phylogenetics-Parts of Phylogenetic Tree-Types of trees, Molecular Clock Theory, Distance Based Method- UPGMA, NJ, Character Based Method- Maximum Parsimony Method, Maximum Likelihood Method, Method of evaluating phylogenetic tree- Bootstrapping, Jackknife resampling, Data perturbation.		
UNIT 4	**STRUCTURAL ANALYSIS**	**9**
Protein Structure Visualization, Structural Prediction- Primary structure & Secondary Structure, tertiary Structure-Homology Modelling, Hidden Markov Model, Threading, Ab-initio method, Validation by Ramachandran plot.		
UNIT 5	**APPLICATIONS**	**9**
System Biology-Introduction and its importance, Microarray Data analysis, Approaches to drug designing and discovery.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Examine various biological databases.	K4
CO2	Compare genomic and proteomic sequences using various bioinformatics tools.	K5
CO3	Measure the evolutionary relationship using phylogenetic methods	K5
CO4	Compare vast genomic and proteomic dataset.	K5
CO5	Develop basic bioinformatics scripts with Perl programming.	K6

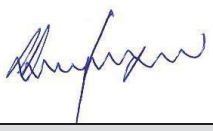


Approved by BoS Chairman

Text Books	
1.	Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press. ,4th edition 2014
2.	Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press. 1999
3.	Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison, Cambridge University Press. 2013
4.	Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press. 2nd edition, 2004.

Reference Books	
1.	Next Generation Sequencing Data Analysis, by Xinkun Wang CRC Press 2016

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	3	3	3	2	3	3	2	3
CO2	3	2	3	3	2	2	2	3	1	3	3	3	3	2
CO3	3	3	2	2	3	3	2	2	2	3	2	2	3	3
CO4	2	3	2	3	3	3	3	3	2	2	2	3	2	3
CO5	3	3	3	2	2	3	2	3	3	3	3	3	2	2
Wt. Avg.	**2.8**	**2.6**	**2.6**	**2.4**	**2.6**	**2.6**	**2.4**	**2.8**	**2.2**	**2.6**	**2.6**	**2.8**	**2.4**	**2.6**



Approved by BoS Chairman

B. Tech.	B23BTT604- BIOETHICS, BIOSAFETY AND IPR	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide fundamental knowledge of research ethics in clinical trials and their control guidelines.
2.	To provide the basic concept of biosafety and its related quality checks and safety audits
3.	To deliver the knowledge on IPR and its protecting organizations

Pre-requisite (if any)
Animal biotechnology, Biopharmaceutical biotechnology

UNIT 1	INTRODUCTION TO ETHICS OF CLINICAL TRIALS	9

Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Ethical committee system including ahistorical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research, Handling of genetically modified organism.

UNIT 2	QUALITY CONTROL AND GUIDELINES	9

Quality assurance and governance - quality control in clinical trials; Monitoring and audit; Inspections; Pharmacovigilance; Research governance; Trial closure and pitfalls-trial closure; Reporting and legal requirements; Common pitfalls in clinical trial management.

UNIT 3	INTRODUCTION TO BIOSAFETY AND QUALITY CHECKS	9

Need for safety in pharma and biotech industries; Safety Programs – components and realization; Potential hazards – extreme operating conditions, toxic chemicals and biowastes; safe handling. Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

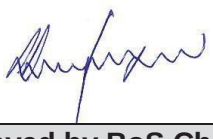
UNIT 4	RISK ANALYSIS AND SAFETY AUDITS	9

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. Hazard identification safety audits, checklist, what if analysis,
vulnerability models - event tree analysis, fault tree analysis, Hazan past accident analysis.

UNIT 5	INTRODUCTION TO IPR AND ITS INTERNATIONAL BACKGROUND	9

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets. International Background of Intellectual Property-Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

Total Instructional Hours: 45



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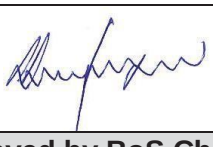
Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline all aspect of clinical trials and the ethical standards required to conduct clinical trials.	K2
CO2	Infer the quality standards and control parameters in clinical trials.	K2
CO3	Make use of the various biosafety requirements and quality checks needed in pharma industries	K3
CO4	Organize the different risk analysis and audit process for biosafety	K3
CO5	Classify the different categories of IPR and demonstrate the role of different organizations and their responsibilities in the protection of IPR at the international level.	K2

Textbooks	
1.	Lee, Chi-Jen; etal., “Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor & Francis,2011.
2.	Fawatt, H.H. and Wood, W.S., “Safety and Accident Prevention in Chemical Operation“, Wiley Interscience, 1965.
3.	Skeleton, B., Process Safety Analysis: An introduction, Institution of chemical Engineers, U.K., 1997.
4.	B.S. Rao, P.V. Appaji, “Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice”, 2015.

Reference Books	
1.	Matoren, Gary M. “The Clinical Research Process in the Pharmaceutical Industry.” Marcel Dekker,1984.
2.	Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ, 1990
3.	Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	2	2	1	3	3	3	3	3	3
CO3	3	3	3	1	1	3	2	2	3	3	1	3	3	3
CO4	3	2	3	2	2	3	2	2	3	2	2	3	3	3
CO5	3	3	-	2	-	-	3	-	2	2	-	1	2	2
Wt. Avg.	**3**	**2.8**	**2.4**	**2.2**	**1.8**	**1.8**	**2**	**1.6**	**2.8**	**2.6**	**1.8**	**2.6**	**2.8**	**2.8**



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B.Tech CSBS	B23MCT605 CYBER SAFETY CONCEPTS	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand various types of cyber-attacks and cyber-crimes
2.	To learn threats and risks within context of the cyber security
3.	To have an overview of the cyber laws & concepts of cyber forensics
4.	To study the defensive techniques against these attacks
5.	To understand various cyber security privacy issues

UNIT- I	Introduction to Cyber Security	9

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT- II	Cyberspace and the Law & Cyber Forensics	9

Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics

UNIT- III	Cybercrime: Mobile and Wireless Devices	9

Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops.

UNIT- IV	Cyber Security	9

Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations

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UNIT- V	Privacy Issues	9
Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains medical, financial, etc.		
		Total Instructional hours: 45

Course Outcomes : Students will be able to	
CO1	Analyze and evaluate the cyber security needs of an organization.
CO2	Understand Cyber Security Regulations and Roles of International Law.
CO3	Design and develop a security architecture for an organization.
CO4	Understand fundamental concepts of data privacy attacks.
CO5	Explain fundamental concepts of data privacy and analyze the role of privacy policies and privacy-preserving techniques.

Text Books	
1.	Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2.	B.B. Gupta, D.P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.
Reference Books	
1.	Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2.	Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

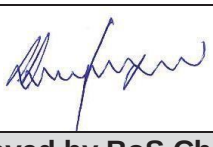
Approved by BoS Chairman

B. TECH.	B23BTP601–IMMUNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To develop skills of students in immunological techniques by performing simple experiments in the laboratory.
2.	To perform techniques like blood grouping, ELISA and identification of T-cells.

Expt. No.	List of Experiments
Hematology and Immune cells	
1.	Blood smear preparation and identification of leucocyte by Giemsa stain
2.	Serum separation and storage
3.	Separation of Mononuclear cells by Ficoll-hypaque
4.	Separation of leucocytes by dextran methods
Immunology – Agglutination	
5.	Identification of ABO blood group with Rh-factor
6.	Haemagglutination and Latex agglutination test
7.	Widal and VDRL test
8.	Complement fixation
Immunology – Precipitation	
9.	Ouchterlony double immunodiffusion
10.	Immunoelectrophoresis
11.	Single radial immunodiffusion
12.	Rocket Immunoelectrophoresis
13.	Enzyme Linked Immuno Sorbent Assay (ELISA)
Total Instructional hours: 30	

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Dissect the morphology of blood cells using Giemsa stain.	K4
CO2	Examine immune cells using haematology technique	K4
CO3	Inspect the antigen-antibody reactions by agglutination techniques	K4
CO4	Test for the antigen-antibody reactions by Precipitation techniques	K4
CO5	Analyze the sample using ELISA	K4



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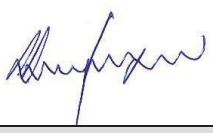
LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
Sl. No.	**Description of the Equipment**	**Quantity required (Nos.)**
1.	Microwave Oven	1
2.	Light Microscope	8
3	ELISA Reader	1
4.	Hot Plate	4
5.	Vortex mixer	4
6.	Table top refrigerated centrifuge	1
7.	Fluorescent Microscope	1
8	Weighing balance	1
9	Water bath	1

Reference Books	
1.	Hudson L. and Hay HC, “Practical Immunology” Blackwell Scientific Publications, 2008.
2.	Hay FC, Westwood OMR, Nelson PN and Hudson L, Practical Immunology, Wiley-Blackwell Publications, 2006.
3.	Rollins DM, Temenak JJ, Shields P and Joseph SW, “Microbial Pathogenesis Laboratory Manual” 2nd Edition, Published and Available Online, 2003.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	-	-	3	-	-	3	1	1
CO2	3	3	2	1	-	1	-	-	3	-	-	3	1	1
CO3	3	3	2	1	-	1	-	-	3	-	-	3	1	1
CO4	3	3	2	1	-	1	-	-	3	-	-	3	1	1
CO5	3	3	2	1	-	1	-	-	3	-	-	3	1	1
Wt. Avg.	**3**	**3**	**2**	**1.2**	**-**	**1**	**-**	**-**	**3**	**-**	**-**	**3**	**1**	**1**



Approved by BoS Chairman

PROFESSIONAL ELECTIVE

VERTICAL – I: BIOPROCESS AND BIOCHEMICAL ENGINEERING

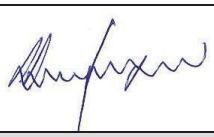
B.Tech.	B23BTE901 – BIOPROCESS CONTROL AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce students with the various types of instrumentation used in bioprocessing and the techniques for precise measurement.
2.	To Enhance knowledge of control strategies and their practical applications to improve bioprocess efficiency.
3.	To develop skills in modeling and simulating bioprocess systems to enhance control and support informed decision-making.

Pre-requisite (if any)
Bioprocess Principles, Analytical Methods in Biotechnology

UNIT 1	INTRODUCTION TO BIOPROCESS CONTROL	9
Overview of bioprocess control systems, types of control systems, basic control loop elements (sensors, controllers, actuators), control strategies (open-loop vs. closed-loop), and importance of control in bioprocessing.		
UNIT 2	**INSTRUMENTATION IN BIOPROCESSING**	**9**
Types of instruments used in bioprocessing, measurement techniques (pH, temperature, pressure, flow), data acquisition systems, and signal processing. Calibration and validation of instruments.		
UNIT 3	**CONTROL SYSTEMS IN BIOPROCESSES**	**9**
Control of fermentation processes, feedback control, feedforward control, PID control strategies, and their applications in batch and continuous bioprocesses.		
UNIT 4	**MODELING AND SIMULATION OF BIOPROCESS SYSTEMS**	**9**
Mathematical modeling of bioprocesses, dynamic modeling, use of simulation software for process design, and optimization of bioprocess control systems.		
UNIT 5	**APPLICATIONS OF CONTROL SYSTEMS IN BIOPROCESSING**	**9**
Case studies of bioprocess control, implementation of control strategies in industrial bioprocesses, and advancements in bioprocess instrumentation and control technologies.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the types and importance of control systems in bioreactor control	K2
CO2	Identify diverse instrumentation techniques to ensure precise measurement and effective monitoring of critical parameters in bioprocessing.	K3
CO3	Develop control strategies for fermentation processes, with a focus on feedback and feedforward control mechanisms.	K3
CO4	Utilize software tools to model and simulate bioprocess systems, aiming to optimize performance and enhance process outcomes.	K3
CO5	Examine the practical use of control systems and instrumentation in industrial bioprocessing, highlighting their influence on efficiency and product quality.	K4



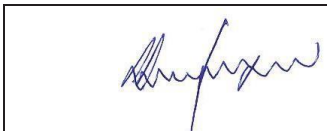
Approved by BoS Chairman

Textbooks	
1.	McCarty, P. L. & Siegrist, R. L. (2003). Biological Wastewater Treatment, 2nd ed. CRC Press.
2.	Stephanopoulos, G., “Chemical Process Control”, Prentice Hall of India, 2003.
3.	Shankar, R. & Raghunathan, S. (2010). Bioprocess Control: Modeling and Control of Bioprocesses, Springer.

Reference Books	
1.	Process Control Instrumentation Technology (8th Edition) by Curtis Johnson ,2008.
2.	B. K. Bandyopadhyay, & S. Ghosh. (2008). Instrumentation and Control in Chemical Engineering, PHI Learning Pvt. Ltd.
3.	Lee, J. M. (1996). Biochemical Engineering, Prentice Hall.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	1	1	1
CO3	2	2	2	-	-	-	-	-	-	-	-	1	1	1
CO4	3	3	2	2	3	-	-	-	-	-	-	2	1	1
CO5	3	3	3	2	3	1	-	-	-	-	-	2	1	1
Wt. Avg	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**



Approved by BoS Chairman

B.Tech.	B23BTE902- FERMENTATION TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Recognize the overall industrial fermentation process and the process flow sheet.
2.	Understand the knowledge on algal biotechnology.
3.	Interpret the knowledge on production of commercially important primary metabolites & secondary metabolites.
4.	Understand the biological effluent treatment process.
5.	Apply the knowledge for the production of modern biological products.

Pre-requisite (if any)

Biochemistry, Microbiology, Bioprocess Engineering.

UNIT 1	INTRODUCTION TO FERMENTATION	9

History and development of fermentation industry; General requirements of fermentation processes; types of fermentation — homo fermentation, hetero fermentation - solid state and submerged fermentation, category of fermentation based on end product formed — lactic acid fermentation, alcohol fermentation, acetic acid fermentation, butyric acid fermentation.

UNIT 2	MICROBIAL BIOTECHNOLOGY	9

Primary and secondary screening of algae for oil production, Essential characters of raw materials for biofuel production, Current technologies of biofuel production, Cyanobacterial and algal fuels, Fine chemicals and nutraceuticals from algae, UV absorbing pigments from macroalgae, seaweed biotechnology.

UNIT 3	FUTURE ASPECTS OF FERMENTATION TECHNOLOGY	9

Fermented agricultural products - Microbial fungicides, Pesticides, organic chemicals and Pharmaceuticals, Fermented food products — Beer, Wine, Genetically Modified Organisms, Biopolymers. Microbial leaching, Effluent treatment using microbes, Future of fermentation technology and its products.

UNIT 4	BIOLOGICAL EFFLUENT TREATMENT	9

Microbes involved in aerobic and anaerobic processes in nature; Water treatment- BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal; secondary treatments; use of membrane bioreactor; aquaculture effluent treatment; Aerobic sludge and land fill leachate process; aerobic digestion.

UNIT 5	FERMENTATION PROCESS ECONOMICS	9

Process economics: General fermentation process economics; materials usage and cost; capital investment estimate; production cost estimate. Case studies –Traditional product and recombinant product; Bioprocess validation: Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP and CIP.

Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Summarize the basics of industrial fermentation and other processes	K2
CO2	Extend their knowledge on algal Biotechnology.	K2
CO3	Outline the commercial production of primary and secondary metabolites.	K2
CO4	Infer on the biological effluent treatment process.	K2
CO5	Explain their knowledge on the importance of fermentation process economics.	K2

Textbooks	
1.	Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology.(2016) Butterworth-Heinemann Press. UK.
2.	H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology.(2014). Academic Press.

Reference Books	
1.	T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. (2006). CRC Press, USA.
2.	Pandey A, Lasroche C, Soccol C. R and Dussop C. G. Advances in Fermentation technology (2008).Asiatech publishers Inc.
3.	Peter,Max S. and Timmerhaus, Klaus D,Plant Design and Economics for Chemical Engineers,McGraw Hill.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO2	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO3	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO4	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO5	2	1	-	-	-	-	-	-	-	-	-	3	3	3
Wt. Avg.	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Approved by BoS Chairman

B. TECH.	B23BTE903 – FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of the principles and practices of food processing and preservation.
2.	To equip students with the knowledge of unit operations involved in food processing.
3.	To explore the applications of Biotechnology in enhancing food quality, safety, and nutritional value.
4.	To familiarize students with food safety regulations and quality control measures.
5.	To introduce students to emerging technologies and innovations in food processing.

UNIT 1	FUNDAMENTALS OF FOOD PROCESSING AND PRESERVATION	9
Introduction to food processing: Significance, scope, and history. Food composition and properties: Water activity, pH, texture, rheology, and thermal properties. Principles of food preservation: Thermal processing (Pasteurization, sterilization, canning, UHT), Low-temperature preservation (Refrigeration, freezing, cryopreservation), Dehydration and concentration (Drying, evaporation, membrane concentration), Irradiation, Chemical preservation (Acids, salts, preservatives, antioxidants). Food packaging: Materials, methods, and shelf-life considerations; Food spoilage: biochemical and microbial spoilage.		
UNIT 2	**UNIT OPERATIONS IN FOOD PROCESSING**	**9**
Size reduction and separation : Grinding, milling, sieving, filtration, centrifugation, extraction. Mixing and blending : Types of mixers and their applications. Heat transfer in food processing: Conduction, convection, radiation, heat exchangers. Evaporation and distillation: Principles and equipment, mass transfer. Membrane separation: Ultrafiltration, reverse osmosis, nanofiltration, membrane fouling. Extrusion cooking: Principles and applications. Mass and Energy balances in food processing.		
UNIT 3	**FOOD MICROBIOLOGY AND FERMENTATION TECHNOLOGY**	**9**
Microorganisms in food: Bacteria, yeasts, molds, and viruses; growth kinetics. Food spoilage microorganisms and their control. Foodborne illnesses and their prevention: Pathogens and toxins. Principles of food fermentation: Biochemical pathways, kinetics. Fermented food products: Curd, yoghurt, Wine, beer, Pickles. Probiotics and prebiotics: Applications and benefits. Food microbiology analytical techniques.		
UNIT 4	**FOOD QUALITY AND SAFETY**	**9**
Food quality parameters: Sensory, nutritional, chemical, and microbiological analysis. Food safety and hygiene: Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP). Hazard Analysis and Critical Control Points (HACCP): Principles and implementation. Food regulations and standards: FSSAI, Codex Alimentarius, ISO 22000. Food adulteration and detection: Methods and techniques. Food labelling and traceability: Requirements and importance.		
UNIT 5	**BIOTECHNOLOGY AND NOVEL TECHNOLOGIES IN FOOD PROCESSING**	**9**
Enzyme technology in food processing: Applications and examples, enzyme kinetics. Genetic modification of food crops and animals: Benefits, concerns, and regulations. Applications of biotechnology in improving food quality and safety. Novel food processing technologies : High-pressure processing (HPP); Pulsed electric field (PEF) processing; Ultrasonic processing; 3D food printing and Cold plasma processing. Nanotechnology in food: Applications and safety considerations. Sustainable		

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food processing: Waste management, resource efficiency.
Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		**Knowledge Level**
CO1	Apply the principles of food preservation and processing to various food products.	K3
CO2	Experiment with different unit operations and their impact on food quality.	K3
CO3	Identify the role of microorganisms in food spoilage, fermentation, and food safety.	K3
CO4	Develop food quality and safety parameters using relevant analytical techniques.	K3
CO5	Compare the applications of biotechnology and novel technologies in food processing.	K4

Text Books	
1.	Desrosier N.W., Desrosier J.N., "The Technology of Food Preservation", CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2018.
2.	Potter N.N., Hotchkiss J.H., "Food Science", Springer Science & Business Media, New York, 1995.
3.	Fellows P.J., "Food Processing Technology: Principles and Practice", Woodhead Publishing, Cambridge, 2017.
4.	Jay J.M., Loessner M.J., Golden D.A., "Modern Food Microbiology", Springer Science & Business Media, New Delhi, 2005.
5.	Singh R.P., Heldman D.R., "Introduction to Food Engineering", Academic Press, San Diego, 2014.

References Books	
1.	Rao D.G., "Fundamentals of Food Engineering", PHI Learning Pvt. Ltd., New Delhi, 2010.
2.	Barbosa-Cánovas G.V., Ibarz A., "Unit Operations in Food Engineering", CRC Press, Boca Raton, 2003.
3.	Rahman M.S. (Ed.), "Handbook of Food Preservation", CRC Press, Boca Raton, 2007.
4.	Food Safety and Standards Authority of India (FSSAI), "Regulations and Guidelines", FSSAI, New Delhi.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO2	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO3	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO4	2	1	-	-	-	-	-	-	-	-	-	3	3	3
CO5	2	1	-	-	-	-	-	-	-	-	-	3	3	3
Wt. Avg.	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

Approved by BoS Chairman

B.Tech.	B23BTE904 - ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To establish a foundational knowledge of ecosystem principles and the range of environmental issues
2.	To plan biotechnological solutions to environmental pollution
3.	To learn the treatment and disposal of biomedical wastes.

Pre-requisite (if any)
Genetic Engineering

UNIT 1	ECOSYSTEM PRINCIPLES AND GLOBAL ENVIRONMENTAL ISSUES	9

Environmental Biotechnology: Definition, Concept and Scope. Biogeochemical cycling in the ecosystem (Water, Carbon, Phosphorus, Nitrogen and Sulfur). Microbial ecology, Response of microbes, plants and animals to environmental stresses. Global environmental issues: ozone layer depletion, greenhouse effect and water scarcity.

UNIT 2	ENVIRONMENTAL POLLUTION AND BIOTECHNOLOGICAL SOLUTIONS	9

Water, air and soil pollution; BOD, COD; Introduction to Wastewater Treatment: Primary, Secondary and tertiary treatment methods, Sewage-sludge disposal and utilization; Solid-waste management (4R principle), Microbial system for heavy metal accumulation, Biosorption, Biotransformation, Bioleaching, In-situ and Ex-situ bioremediation.

UNIT 3	BIODEGRADATION OF INDUSTRIAL POLLUTANTS	9

Xenobiotic compounds - recalcitrant, hazardous wastes, and genetic engineering approach for biodegradation; Biodegradation of wastes from pesticide: textile, tannery, paper, food, pharmaceutical and distillery industries.

UNIT 4	WASTE TO WEALTH	9

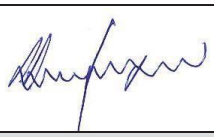
Biomass from wastes: Sources and applications; Ethanol from lignocellulosic waste. Biofuels (biohydrogen, biodiesel, bio methanol, biobutanol and bioethanol): Sources, production and applications; Biogas: Chemistry and production techniques.

UNIT 5	MANAGEMENT OF BIOMEDICAL WASTES	9

Biomedical waste: Definition, Regulations and guidelines, Sources, Categories of biomedical waste, Segregation, collection and disposal of biomedical wastes, Biomedical waste treatment facilities: incinerator, autoclave and microwave systems, Form I, II and III.

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Relate global environmental issues with the biogeochemical cycling of elements.	K2
CO2	Plan suitable biotechnological solutions to environmental pollution.	K3
CO3	Construct suitable procedures for the bioremediation of industrial wastes.	K3
CO4	Make use of waste materials to be converted into valuable products.	K3
CO5	Apply the management strategies to evaluate the impact of biomedical waste on environmental deterioration.	K3



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Textbooks	
1.	Vallero DA, "Environmental Biotechnology - A Biosystems Approach", 2nd Ed., Academic Press, 2015.
2.	Agarwal SK., "Environmental Biotechnology", APH Publishing Corporation, New Delhi, 2002.

Reference Books	
1.	Evans GM and JC Furlong, "Environmental Biotechnology: Theory and application", 2nd Ed., JohnWiley & Sons, 2011.
2.	Dubey, R.C., "A textbook of Biotechnology", S. Chand and Company Ltd, New Delhi, 2010.
3.	Pradipta Kumar Mohapatra, "Textbook of Environmental Biotechnology", I. K International, 2006
4.	Cheremisinaff, NP, "A textbook for waste and wastewater treatment", Prentice Hall, New Delhi, 2003.
5.	Cruger, W and A Cruger, "A Textbook of Industrial Microbiology", Panima Publishing Corporation,New Delhi, 2003.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	1	-	-	1	3	1	-	-	-	2	2	2
CO2	3	3	3	2	-	2	3	2	-	-	-	2	3	3
CO3	3	2	2	-	2	2	3	2	-	-	-	2	3	3
CO4	3	3	2	-	-	2	3	1	-	-	-	2	3	3
CO5	3	3	2	1	-	3	3	3	-	2	2	2	3	2
Wt. Avg.	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**2**	**2**	**2**	**3**	**3**

Approved by BoS Chairman

B.Tech.	B23BTE905-BIOENERGY AND BIOFUELS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the composition and pretreatment methods of biomass.
2.	To understand the production of ethanol and its applications.
3.	To study the biodiesel production process and its impact on environment.
4.	To learn the production of various biofuels and its processing technology.
5.	To understand the applications and environmental impact of biofuels and its byproducts

Pre-requisite (if any)
Biochemistry, Basic Industrial Biotechnology

UNIT 1	INTRODUCTION	9
Classification of Biofuels. Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.		
UNIT 2	**ETHANOL**	**9**
Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.		
UNIT 3	**BIODIESEL**	**9**
Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions Expanding biodiesel production.		
UNIT 4	**OTHER BIOFUELS**	**9**
Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts- Biobutanol, Biopropanol, bioglycerol–Principles, materials and feedstocks-Process technologies and techniques-Advantages and Limitations.		
UNIT 5	**APPLICATIONS OF BIOFUELS**	**9**
Life cycle environmental impacts of biofuels and co products – Environmental sustainability of biofuels – Energy security and supply, Economic sustainability of biofuels.		
		Total Instructional Hours : 45

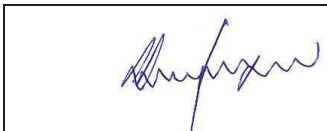
Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the properties and pretreatment methods of biomass.	K2
CO2	Demonstrate the production of ethanol and bioethanol.	K2
CO3	Understand the production of biodiesel, environmental impact and its economics.	K2
CO4	Use the biomass as inexpensive feedstock for sustainable and renewable energy.	K3
CO5	Analyze bioenergy systems and their potential in future energy supply.	K4

Approved by BoS Chairman

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

Reference Books	
1.	Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.
2.	Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016.
3.	Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, InTech, 2011.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	1	2	1	-	1	-	-	2	3
CO2	2	1	2	-	-	2	3	1	-	1	-	-	2	3
CO3	2	1	2	-	-	2	3	1	-	1	-	-	2	3
CO4	2	1	2	-		2	3	1	-	1	-	-	2	3
CO5	2	1	2	-	-	2	3	1	-	1	-	-	2	3
Wt. Avg	**2**	**1**	**2**	**-**	**-**	**2**	**3**	**1**	**-**	**1**	**-**	**-**	**2**	**3**



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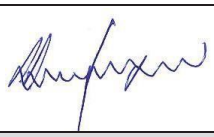
B.Tech.	B23BTE906 - BIOREACTOR DESIGN AND SCALE UP PROCESS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the basics of bioreactor design
2.	To understand the concepts of scale-up and scale down
3.	To know the requirements for design and operation of microbial, plant and animal cell bioreactors

Pre-requisite (if any)
Bioprocess principles

UNIT 1	BASIC BIOEACTOR CONCEPTS	9
Bioreactor Operation – Batch operation, sem-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.		
UNIT 2	**AERATION AND AGITATION IN BIOPROCESS SYSTEM**	**9**
Mass transfer in agitated tanks; Power requirement for mixing; Agitation rate studies – Mixing time and residence time distribution; Bioreactor Geometry – Reactor, impeller, sparger and baffle design; shear damage, bubble damage, methods of minimizing cell damage. Case Studies for Aeration and Agitation.		
UNIT 3	**SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT**	**9**
Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries		
UNIT 4	**BIOREACTOR SCALE UP AND SCALE DOWN**	**9**
Scale-up Techniques: – Scale up by geometric similitude. constant power consumption per volume, constant mixing time, constant impeller tip speed, constant volumetric mass transfer co-efficient; Scale–down Related Aspects; Case Studies in Bioreactor Scaleup and Scale-down Aspects.		
UNIT 5	**CASE STUDIES**	**9**
Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Classify the different types of reactors involved in bioprocess.	K2
CO2	Explain about various aeration and agitation methods used in bioprocess system.	K2
CO3	Identify the materials and design considerations of bioprocess equipment.	K3
CO4	Make use of the scale-up and scale-down concepts in bioreactor design.	K3
CO5	Apply these in bioreactor design for microbial, plant and animal cell cultures.	K3



Approved by BoS Chairman

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

Reference Books	
1.	S.Liu, Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design, Elsevier, 2016
2.	Octave Levenspiel, Chemical Reaction Engineering, Wiley 2016.
3.	James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill 1986

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	1	3	1	-	-	-	2	2	2
CO2	3	3	3	2	-	2	3	2	-	-	-	2	3	3
CO3	3	2	2	-	2	2	3	2	-	-	-	2	3	3
CO4	3	3	2	-	-	2	3	1	-	-	-	2	3	3
CO5	3	3	2	1	-	3	3	3	-	2	2	2	3	2
Wt. Avg.	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**-**	**2**	**2**	**2**	**3**	**3**

Approved by BoS Chairman

B.Tech.	B23BTE907 – BIOSENSORS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the principle, operations and classification of biosensors
2.	To introduce transducers and physiological property measurement using biosensor
3.	To expose the structural aspects for the design of biosensors for various applications
4.	To acquire knowledge in biomembranes and their fabrications
5.	To analyze the role of biosensors in varied applications of life science

UNIT - I	ELECTROCHEMISTRY, CLASSIFICATION AND OPERATION	9

Electrochemistry single electrode potential- Nernst equation Tafel plot Electrical components DC and AC Circuits Operational amplifiers and functions desired characteristics of biosensors: reliability, simplicity, cost, and related parameters. Classification and components of Biosensor Advantages and limitations, biocatalysis based biosensors, Types of enzyme electrodes.

UNIT - II	TRANSDUCERS IN BIOSENSORS	9

Types of transducers, principles and applications Calorimetric, acoustic, optical (absorption, fluorescence, bio/chemiluminescence, surface Plasmon resonance (SPR)), potentiometric / amperometric, conductrometric / resistor metric, piezoelectric, semiconductor (ion sensitive field effect transistor (ISFET), enzyme field effect transistor (ENFET), impedimetric, mechanical and molecular electronics based transducers. Chemiluminiscence based biosensors.

UNIT - III	BIOSELECTIVE LAYERS	9

Bioselective layers: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Microbial metabolism; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Methods for application of bio selective layers in desired patterns- pin-based spotting; Metabolic sensors – glucose; phenols and amines; inhibitors.

UNIT – IV	BIO MEMBRANES: MASS TRANSPORT AND FABRICATION	9

Mass transport: Mass transport effect of analytes to the surface of the biosensor transducer on the detected signal
and associated kinetics. micro fluid flow system based biosensor design. Different assay types (Displacement, competitive, sandwich, and direct). Biosensor fabrication methods: Electrospinning, self-assembled monolayers, Screen printing, photolithography, micro contact printing, micro-electromechanical system (MEMS).

UNIT – V	BIOSENSOR ENGINEERING AND APPLICATIONS	9

Applications- Case studies: Glucose, urea and cholesterol biosensors; Biosensors in cancer and HIV early diagnosis; Artificial neural networking and use in prediction of bioprocess and control; Implantable sensors for long-term monitoring; Drug development and detection; Industrial on-line monitoring, Environmental monitoring; Technological process control; veterinary, agriculture, Food quality control.

Total Instructional Hours: 45

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Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain the concepts of electrochemistry.	K2
CO2	Summarize the transducers and their types in biosensors.	K2
CO3	Demonstrate different bio-selective layers.	K3
CO4	Identify the mass transport effect in bio membranes.	K3
CO5	Select the role of biosensors in various fields and their potential uses.	K3

Text Books	
1.	Ursula SK, “Chemical Sensors and Biosensors for Medical and Biological Applications”, Wiley- VCH, 1998.
2.	Skoog DA, Holler FJ and Timorthy AN, “Principles of Instrumental Analysis”, 6th Ed. 2006.
3.	Buerk DG, “Biosensors: Theory and Applications”, Technomic, Lancaster, 1993.
4.	Cooper J and Cass T, “Biosensors”, Oxford University Press, 2004.
5.	Sensors in Bioprocess Control (Biotechnology and Bioprocessing Series) by John Twork, 2020.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	-	3	2	2	2	-	2	1	-	-	1	2	-	3
CO2	3	3	3	2	3	1	2	1	-	-	1	-	2	3
CO3	2	1	3	2	3	2	2	1	-	-	1	-	2	2
CO4	2	2	3	3	3	-	3	2	-	-	1	2	3	2
CO5	3	3	2	3	2	-	3	1	-	-	1	1	3	2
Wt. Avg.	**2**	**2.4**	**2.6**	**2.4**	**2.6**	**0.6**	**2.4**	**1.2**	**0**	**0**	**1**	**1**	**2**	**2.4**

Approved by BoS Chairman

VERTICAL – II: MEDICAL BIOTECHNOLOGY

B.Tech.	B23BTE908 – CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Understand the basics of cancer and cancerous cells.
2.	Discuss the significance of carconogeneis in the development of cancer
3.	Interpret the role of oncogenes and their growth factors.
4.	Make understanding on process of cancer metastasis and their dysregulation factors.
5.	Gain knowledge on the advancement in cancer treatment
6.	Design the novel drugs to treat cancer or to reduce the effect of carcinogenesis.

Pre-requisite (if any)

Cell biology and Molecular biology

UNIT 1	FUNDAMENTALS OF CANCER BIOLOGY	7

Definition and description of Cancer, Cell division, mutations – cancer, Cancer development – stages of tumor development, Hallmarks of malignant diseases, Classification human cancers, Macroscopic and microscopic features of neoplasms, Grade and stage of neoplasms.

UNIT 2	CAUSES OF CANCER	11

Carcinogen, Chemical carcinogenesis – Historical perspectives, Metabolic activation of chemical carcinogens, DNA adduct formation, interaction with oncogenes and tumor suppressor genes, epigenetic changes induced by carcinogens, Mechanism of tumor initiation, Promotion, and Progression, Irradiation carcinogenesis, Oxygen, free radicals, aging and cancer, Genetic susceptibility, Multiple mutations in cancer, DNA repair mechanisms, Viral carcinogenesis.

UNIT 3	MOLECULAR BIOLOGY OF CANCER	9

DNA repair defects and genomic instability in cancer cells. Signal targets and cancer, activation of kinases; Oncogenes, identification & retroviruses. Detection of oncogenes & proto-oncogene activity. Growth factors related to transformation. Telomerase.

UNIT 4	CANCER METASTASIS	9

Clinical significances of invasion, Molecular genetic of metastasis development, stromal microenvironment and carcinogenesis, dysregulation of cancer, associated genes Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT 5	ADVANCES IN CANCER THERAPY	9

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy. Recent technology to detect cancer diseases and advanced technology to cure cancer diseases. Targeted drug delivery methods to cure cancer.

Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain the development and proliferation of cancer with specific causes.	K2
CO2	Outline the influence of carcinogenesis in the cancer development.	K2
CO3	Identify the pathways and therapeutic target of cancer.	K3
CO4	Outline the steps involves in metastasis and tumor cell invasion	K2
CO5	Develop novel drugs and technologies for the treatment of cancer	K3

Textbooks	
1.	Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
2.	McDonald, F et al., " Molecular Biology of Cancer" 2nd Edition. Taylor & Francis, 2004.
3.	Pezzella, F., Tavassoli, M., & Kerr, D. J. (Eds.). (2019). Oxford textbook of cancer biology. Oxford University Press.
4.	Pelengaris, S., & Khan, M. (Eds.). (2013). The molecular biology of cancer: A bridge from bench to bedside.
5.	Hejmadi, M. (2014). Introduction to cancer biology. Bookboon

Reference Books	
1.	King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996.
2.	Ruddon, Raymond W. " Cancer Biology" IIIrd Edition . Oxford University Press, 1995
3.	Margaret A. Knowles, Peter J Selby, An Introduction to Cellular and Molecular Biology of Cancer, 4th Edition, Oxford Medical Publication, 1991.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	3	-	3	-	1	-	2	-	2	1	-	1
CO2	3	1	2	1	3	-	1	-	3	-	2	2	2	2
CO3	2	2	2	-	2	1	2	-	2	-	1	2	2	2
CO4	2	2	2	-	2	-	2	-	-	-	1	2	2	2
CO5	3	3	3	3	3	2	1	2	3	-	3	3	2	2
Wt. Avg	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**-**	**2**	**2**	**2**	**2**

Approved by BoS Chairman

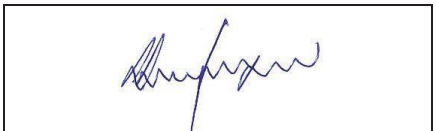
B.Tech.	B23BTE909 – BIOPHARMACEUTICALS AND BIOSIMILARS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.
2.	To impart the knowledge of the various dosage forms and its implications in pharmaceutical technology.

Pre-requisite (if any)
Bioorganic Chemistry

UNIT 1	INTRODUCTION	9
Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.		
UNIT 2	**DOSAGE FORMS**	**9**
Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenterals – Pressurized dosage forms – Packaging techniques.		
UNIT 3	**ADVANCED DRUG DELIVERY SYSTEMS**	**9**
Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release.		
UNIT 4	**BIOSIMILARS**	**9**
Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.		
UNIT 5	**CASE STUDIES ON BIOPHARMACEUTICALS**	**9**
Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain the current regulatory aspects of pharmaceutical industries and interpret the pharmacodynamics and pharmacokinetics of drugs.	K2
CO2	Identify the formulation concepts and evaluate different dosage forms to meet out the compendial requirements.	K3
CO3	Outline novel drug delivery systems and their applications in therapeutic fields.	K2
CO4	Explain the design and analysis of biosimilar drugs.	K2
CO5	Demonstrate knowledge and understanding of current topical and newly emerging aspects of biopharmaceuticals.	K2



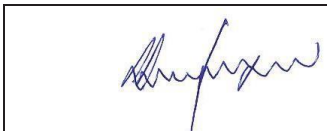
Approved by BoS Chairman

Textbooks	
1.	Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm, “Pharmaceutical Biotechnology: Fundamentals and application”, Springer, 4th Edition, 2013.
2.	Gary Walsh, “Pharmaceutical Biotechnology-Concepts and Application”, John Wiley and Sons Publishers, 1st Edition, 2007.
3.	Shein-Chung Chow, “Biosimilars: Design and Analysis of Follow-on Biologics”, CRC Press, 3rd Edition, 2013.

Reference Books	
1.	James Swarbrick, “Encyclopedia of Pharmaceutical Technology”, CRC Press, 4th Edition, 2013.
2.	Shayne Cox Gad, “Pharmaceutical Manufacturing Handbook: Production and Processes”, Wiley, 2nd Edition, 2011.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	2	2	2	3	1	2	3	-	2	2	-	-
CO2	1	3	1	2	-	-	-	-	2	-	2	2	2	2
CO3	2	1	3	1	2	-	2	-	2	-	2	3	2	2
CO4	1	2	1	2	2	1	-	-	3	-	3	3	3	2
CO5	3	-	2	2	3	2	2	1	3	-	3	3	3	2
Wt. Avg	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**-**	**3**	**3**	**3**	**2**



Approved by BoS Chairman

B.Tech.	B23BTE910 – TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

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

Pre-requisite (if any)
Biomaterials

UNIT 1	INTRODUCTION	9

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

UNIT 2	TISSUE ARCHITECTURE	9

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

UNIT 3	BIOMATERIALS	9

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

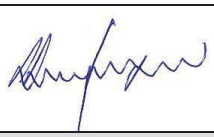
UNIT 4	BASIC BIOLOGY OF STEM CELLS	9

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

UNIT 5	CLINICAL APPLICATIONS	9

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

Total Instructional Hours: 45



Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline the basics of tissue engineering.	K2
CO2	Explain the components of tissue architecture.	K2
CO3	Summarize the stem cell characteristics and their relevance in medicine, awareness about the properties and broad applications of biomaterials.	K2
CO4	Explain the biology of stem cells and its therapeutic applications.	K3
CO5	Identify the scope of tissue engineering in various filed.	K3

Textbooks	
1.	Bernhard O.Palsson, Sangeeta N.Bhatia, ”Tissue Engineering” Pearson Publishers 2009.
2.	Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

Reference Books	
1.	Bernard N. Kennedy (editor). Stem cell transplantation, Tissue engineering, and cancer applications, Nova Science Publishers, 2008.
2.	Raphael Gorodetsky, Richard Schäfer.Stem cell-based tissue repair. RSC Publishing, 2011.
3.	R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004
4.	R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E. .I Thomas, J. Thomson, I. W.Gearhart, Essential of Stem Cell Biology, Elsevier Academic Press, 2nd Edition , 2009.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	1	1	1	1	-	-	-	1	3	2
CO2	3	-	-	1	1	1	1	1	-	-	-	2	3	2
CO3	3	2	1	1	1	1	2	2	-	-	-	2	3	3
CO4	3	2	1	1	1	1	2	2	-	-	-	2	3	2
CO5	3	2	1	2	1	1	2	2	-	-	-	2	3	2
Wt. Avg	3	2	1	1	1	1	1.6	1.6	-	-	-	1.8	3	2.2

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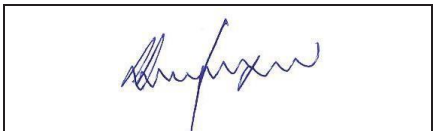

Approved by BoS Chairman

B.Tech.	B23BTE911 – MOLECULAR DIAGNOSTICS AND THERAPEUTICS	L	T	P	C
		3	0	0	3

Course Objectives

1.	To study the basics of molecular diagnositcs
2.	To learn the traditional disease diagnosis methods and tools for common infections and diseases
3.	To know about the various targeted therapy used in cancer treatment
4.	To apply various molecular techniques in clinical diagnostics

Pre-requisite (if any)

Microbiology, Genetic Engineering

UNIT 1	INTRODUCTION TO MOLECULAR DIAGNOSTICS	9

History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites; general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples.

UNIT 2	TRADITIONAL DISEASE DIAGNOSIS METHODS AND TOOLS	9

Diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium., Diagnosis of major fungal infections: Dermetophytoses, Candidiosis and Aspergillosis. · Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and · Retroviruses. · Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypanosomiasis, Leishmaniasis.

UNIT 3	DIAGNOSIS AND TREATMENT OF COMMON DISEASES	9

Atherosclerosis, ischemic heart disease and cerebrovascular disease; coagulation system and hypertension; metabolic syndrome and diabetes mellitus; asthma, allergy and inflammatory diseases of the lung; gastrointestinal system, including inflammatory bowel diseases.

UNIT 4	TARGETED THERAPY	9

Objective and types of targeted therapy, working mode of targeted therapy against cancer – by immunotherapy, by cell signaling interruption, by angiogenesis inhibitors, monoclonal antibody therapy, by apoptosis, hormone therapy for prostate cancer and hormone therapy for breast cancer; side effects of cancer treatment and drawbacks of targeted therapy. Targeted drug delivery – active and passive targeting, drug delivery vehicles

UNIT 5	TECHNIQUES IN MOLECULAR AND CLINICAL DIAGNOSTICS	9

PCR-based methods for mutation detection, alternative methods for mutation detection and DNA sequencing for disease association, microarray approaches for gene expression analysis, methods for analysis of DNA methylation; clinical diagnostic technologies: flow cytometry, medical cytogenetics, fluorescence *in situ* hybridization, immunohistochemistry and laser capture microdissection (FFPE).

Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline the basic of Molecular diagnosis	K2
CO2	Summarize the traditional diagnosis methods and tools for common infections	K2
CO3	Relate the common disease diagnosis and their treatment methods	K2
CO4	Identify targeted therapy for different cancer and targeted drug delivery	K3
CO5	Apply advanced molecular tools on clinical diagnosis	K3

Textbooks	
1.	Molecular Diagnostics by Harald Seitz Sarah Schumacher, Springer 2013 Ed.
2.	Fundamentals of Molecular Diagnostics by David E. Bruns, Edward.R, Ashwood, Carl A. Burtis, Elsevier Health Sciences 2007

Reference Books	
1.	Molecular Diagnostics: Fundamentals, Methods and Clinical Applications by Lela Buckingham, F. A. Davis Company 2019
2.	Molecular Cancer Therapeutics: Strategies for Drug Discovery and Development, by George C. Prendergast, Wiley & Sons, Inc. 2004.
3.	Molecular and Cellular Therapeutics by David Whitehouse, Ralph Rapley, Wiley & Sons, Ltd. 2012.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	2	2	1	1	1	2	2	3	2
CO2	3	2	2	1	-	2	2	1	1	1	2	2	3	2
CO3	3	2	2	1	1	2	2	1	1	1	2	2	3	2
CO4	3	2	2	1	1	2	2	1	1	1	2	2	3	2
CO5	3	2	2	1	3	2	2	1	1	1	2	2	3	2
Wt. Avg	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**

Approved by BoS Chairman

B.Tech.	B23BTE912–VACCINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the need for vaccine and how it imparts immunity.
2.	To learn the different methods of vaccine preparation.
3.	To understand the mode of vaccine development
4.	To discover various vaccine delivery methods.
5.	The regulatory and safety measures associated with vaccine development.

Pre-requisite (if any)

Immunology

UNIT 1	INTRODUCTION	9

Vaccines - definition, History of vaccine development, vaccine preventable infectious diseases, bacterial and viral vaccines and their importance to public health. Principles of vaccination. Basics of immunization; Immunization programs and role of WHO in immunization programs.

UNIT 2	TYPES OF VACCINES AND BIOLOGICALS	9

Vaccinology: Active and passive immunization; Live attenuated, killed, toxoid vaccines, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, immuno modulators, recombinant DNA and protein based vaccines, plant-based vaccines, edible vaccines, reverse vaccinology, combination vaccines, retro vaccinology, therapeutic vaccines; Peptide vaccines, conjugate vaccines; Cell based vaccines. Uses of nanoparticles in vaccine application.

UNIT 3	GENERAL REQUIREMENTS AND TECHNIQUES IN VACCINE PRODUCTION	9

Importance of cGMP in vaccine production. General manufacturing requirements: control of source materials, single harvest, purity and inactivation, control of vaccine in final bulk and final lot. Purification, preservation and formulation techniques. Commercial production of DPT, TT, polio, rabies and hepatitis vaccines. Commercial production of malarial vaccine.

UNIT 4	DELIVERY METHODS	9

Needle free vaccine delivery, ISCOMS, adjuvant delivery systems, intranasal and inhaled vaccine delivery, liquid jet and solid dose injectors, development of gene-based vectors. Delivery of immunogens through microspheres.

UNIT 5	REGULATORY AND BIOSAFETY MEASURES	9

Quality assurance in vaccine production. Regulatory issues – environmental concerns with the use of recombinant vaccines. Disease security and biosecurity principles and OIE guidelines – Biosafety aspects of vaccine production.

Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain the importance of vaccine and empower the public to understand the crucial role of vaccines in safeguarding health and building herd immunity	K2
CO2	Summarize different types of vaccines and its formulation	K2
CO3	Illustrate different production methodology to design a vaccine formulation	K2
CO4	Outline the suitable mode of administration for any vaccine formulation	K2
CO5	Explain the quality and regulatory measures in vaccine production	K2

Textbooks	
1.	Plotkin S, Orenstein W, Offit P, and Edwards K M, "Plotkin's vaccines", 7th Edition, Elsevier, 2017.
2.	Fox C V., "Vaccine Adjuvants: Methods and Protocols", Humana Press, 2017.

Reference Books	
1.	Ramadass P, "Animal Biotechnology - Recent Concepts and Developments", MJP Publications, 2008.
2.	Kindt T J, Goldsby RA, Osborne BA and Kuby J, "Kuby Immunology", W.H. Freeman & Company, 2007.
3.	Barton C, "Advances in Vaccine Technology and Delivery", Espicom Business Intelligence, 2009.
4.	Ellis RW, "New Vaccine Technologies", Landes Bioscience, 2001.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	-	-	-	-	-	1	1	1
CO2	2	1	-	-	-	1	-	-	-	-	-	1	1	1
CO3	2	1	1	-	-	1	-	-	-	-	-	1	2	2
CO4	2	1	1	-	-	1	-	1	-	-	-	1	1	2
CO5	2	1	1	-	-	1	-	1	-	-	-	1	1	1
Wt. Avg	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**1**	**2**

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Approved by BoS Chairman

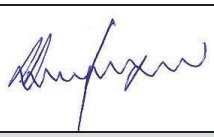
B.Tech.	B23BTE913 – BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the basics of human body and its physiological systems
2.	To study about the various analytical instruments for electrical and non-electrical parameters of human body
3.	To understand the principles of imaging devices and life assisting devices

Pre-requisite (if any)
Physics, Biochemistry

UNIT 1	HUMAN BODY SUBSYSTEM AND TRANSDUCERS	9
Brief description of muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities. Principles and classification of transducers for Bio-medical applications. Electrode theory, different types of electrodes; Selection criteria for transducers and electrodes.		
UNIT 2	**NON-ELECTRICAL PARAMETERS MEASUREMENT**	**9**
Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Blood Gas analysers, pH of blood – Measurement of blood pCO_2, pO_2.		
UNIT 3	**ELECTRICAL PARAMETERS MEASUREMENT AND ELECTRICAL SAFETY**	**9**
ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current - Instruments for checking safety parameters of biomedical equipments.		
UNIT 4	**IMAGING MODALITIES AND BIO-TELEMETRY**	**9**
Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.		
UNIT 5	**LIFE ASSISTING AND THERAPEUTIC DEVICES**	**9**
Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators - Heart Lung machine – Dialysers - Diathermy – Lithotripsy		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Demonstrate various applications of engineering and physiological subsystems in designing and developing human body systems.	K2
CO2	Classify the various types of analytical equipments for non-electrical parameters	K2
CO3	Illustrate the various types of analytical equipments for electrical parameters	K2
CO4	Explain the various types of imaging modalities and bio-telemetry	K2
CO5	Identify and solve the real-life problems by applying principles of biomedical engineering	K3



Approved by BoS Chairman

Reference Books	
1.	Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011.
2.	Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.
3.	M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	2	2	1	1	1	2	2	3	2
CO2	3	2	2	1	-	2	2	1	1	1	2	2	3	2
CO3	3	2	2	1	1	2	2	1	1	1	2	2	3	2
CO4	3	2	2	1	1	2	2	1	1	1	2	2	3	2
CO5	3	2	2	1	3	2	2	1	1	1	2	2	3	2
Wt. Avg	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**

Approved by BoS Chairman

B.Tech.	B23BTE914 – STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1.	To gain knowledge on animal and plant stem cells and the factors affecting stem cell differentiation
2.	To differentiate different types of stem cells and to characterize them
3.	To develop techniques to program stem cells into specific cell types
4.	To understand the role of stem cells in tissue engineering and regenerative medicine
5.	To become familiarized with stem cell technology and its applications for the betterment of society

UNIT 1	INTRODUCTION TO STEM CELLS	9

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

UNIT 2	HUMAN EMBRYONIC AND ADULT STEM CELL	9

Stem cells and their developmental potential. In vitro fertilization-culturing of embryos - blastocyst-inner cell mass-isolation and growing embryonic stem cells in lab; Identification and characterization of human embryonic stem cells. Somatic stem cells-test for identification of adult stem cells- adult stem cell differentiation-trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells

UNIT 3	DIFFERENTIATION OF STEM CELLS INTO CELL TYPES	9

Factors influencing cell specialization – internal factors – asymmetric segregation, cell signaling mechanisms – diffusion, direct contact and gap junctions; environmental factors – temperature, drugs and injuries; mechanism of stem cell differentiation – errors in cell differentiation – anaplasia, dysplasia and metaplasia

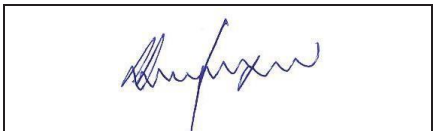
UNIT 4	STEM CELLS IN TISSUE ENGINEERING	9

Haematopoietic Stem Cells-Growth factors and the regulation of haematopoietic stem cells, clinical applications of haematopoietic stem cells; HLA matching, patient selection, peripheral blood and bone marrow transplantation; Mesenchymal stem cells and their role in bone tissue engineering-bone repair; Stem cell based gene therapy and benefits to human. Techniques in stem cell technology - fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging.

UNIT 5	APPLICATION AND ETHICAL ISSUES	9

Therapeutic applications-Parkinsons disease, Cancer stem cell – Neural stem cell for central nervous system repair – Spinal cord injury – use of ESC to treat heart disease – Burns and skin ulcers – Orthopaedic applications of stem cell - Insulin-producing Cells Derived from Stem cells: A Potential Treatment for Diabetes; Stem cell policy and ethics, stem cell research: Hype, hope and controversy.

Total Instructional Hours : 45



Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Infer knowledge on animal and plant stem cells and the factors affecting stem cell differentiation	K2
CO2	Identify different types of stem cells and to characterize them	K3
CO3	Develop techniques to program stem cells into specific cell types	K3
CO4	Build stem cells for its applications in tissue engineering and regenerative medicine	K3
CO5	Utilize stem cell technology and its applications for the betterment of society	K3

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

Reference Books	
1.	Peter Quesenberry., Stem cell biology and Gene Therapy, First Edition, Wiley-Liss, 1998.
2.	Kursad Turksen., Embryonic Stem cells – Protocols, Second Edition Humana Press, 2002
3.	AriffBongso, Eng Hin Lee., Stem Cells: From Bench to Bedside, World Scientific Publishing Co., 2005.
4.	Ali Gholamrezanezhad., Stem cells in clinic and Research, Intech, 2013

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	2	2	1	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Wt. Avg	**3**	**3**	**3**	**3**	**3**	**2.4**	**2.2**	**2.6**	**3**	**3**	**3**	**3**	**3**	**3**

Approved by BoS Chairman

VERTICAL – III: AGRO BIOTECHNOLOGY

B. TECH.	B23BTE915 – PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of the principles and applications of plant biotechnology.
2.	To equip students with knowledge of plant tissue culture, genetic engineering, and molecular breeding techniques.
3.	To explore the applications of plant biotechnology in crop improvement, stress tolerance, and secondary metabolite production.
4.	To familiarize students with the ethical and regulatory aspects of plant biotechnology.
5.	To provide a comprehensive understanding of the principles and applications of plant Biotechnology.

UNIT 1	PLANT TISSUE CULTURE AND MICROPROPAGATION	9
Introduction to plant tissue culture: Principles and techniques. Media preparation and sterilization. Micropropagation: Stages and applications. Callus culture and organogenesis. Somatic embryogenesis and synthetic seed production. Anther and pollen culture. Germplasm conservation and cryopreservation. Plant tissue culture based industrial applications.		
UNIT 2	**PLANT GENETIC ENGINEERING AND TRANSFORMATION**	**9**
Vectors for plant transformation: *Agrobacterium*-mediated transformation, direct gene transfer methods (particle bombardment, electroporation). Reporter genes and selectable markers. Gene silencing and RNA interference (RNAi). Genome editing technologies (CRISPR-Cas9). Transgenic plants for crop improvement: Herbicide resistance, insect resistance, disease resistance. Molecular farming and production of recombinant proteins in plants..		
UNIT 3	**MOLECULAR MARKERS AND PLANT BREEDING**	**9**
Principles and applications of molecular markers (RFLP, RAPD, AFLP, SSR, SNP). Marker-assisted selection (MAS). Genomic selection. Quantitative trait loci (QTL) mapping. Molecular breeding for crop improvement. Development of molecular maps. Application of bioinformatics in plant breeding		
UNIT 4	**PLANT STRESS BIOTECHNOLOGY AND SECONDARY METABOLITE PRODUCTION**	**9**
Mechanisms of plant stress tolerance (abiotic and biotic). Genetic engineering for stress tolerance. Metabolic engineering for enhanced secondary metabolite production. Plant cell cultures for secondary metabolite production. Hairy root cultures. Bioreactor design for plant cell cultures. Phytoremediation		
UNIT 5	**PLANT GENOMICS, PROTEOMICS, AND REGULATORY ASPECTS**	**9**
Plant genomics: Genome sequencing and analysis. Plant proteomics: Protein profiling and functional analysis. Plant metabolomics. Bioinformatics tools for plant Biotechnology. Ethical and regulatory aspects of plant Biotechnology. Biosafety and risk assessment of transgenic plants. Intellectual property rights (IPR) and patenting in plant Biotechnology.		
		Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Apply plant tissue culture techniques for plant propagation and genetic transformation.	K3
CO2	Utilize molecular markers and genetic engineering tools for crop improvement.	K3
CO3	Illustrate the mechanisms of plant stress tolerance and apply biotechnological approaches for enhancing stress resistance.	K2
CO4	Examine the biosynthetic pathways of secondary metabolites and develop strategies for their enhanced production.	K4
CO5	Make use of the ethical and regulatory considerations related to plant Biotechnology.	K3

Text Books	
1.	Bhojwani S.S., Razdan M.K., "Plant Tissue Culture: Theory and Practice", Elsevier, Amsterdam, 1996.
2.	Glick B.R., Patten C.L., Glick B.R., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, Washington D.C., 2010.
3.	Chawla H.S., "Introduction to Plant Biotechnology", Oxford & IBH Publishing Company, New Delhi, 2009.
4.	Slater A., Scott N.W., Fowler M.R., "Plant Biotechnology, The Genetic Manipulation of Plants", Oxford University Press, Oxford, (Year of publication, if available).

References Books	
1.	Stewart C.N. Jr., "Plant Biotechnology and Genetics: Principles, Techniques, and Applications", John Wiley & Sons, Hoboken, 2008.
2.	Chrispeels M.J., Sadava D.E., "Plants, Genes, and Crop Biotechnology", Jones & Bartlett Publishers, Sudbury, 2003.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE916- THERAPEUTIC APPLICATIONS OF PHYTOCHEMICALS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of the diverse classes of phytochemicals and their therapeutic applications in major diseases.
2.	To analyze the methods used for the extraction, isolation, and characterization of phytochemicals.
3.	To evaluate the applications of phytochemicals in drug discovery and development.

Pre-requisite (if any)
Bioorganic chemistry, Immunology

UNIT 1	INTRODUCTION TO PHYTOCHEMICALS AND THEIR CLASSIFICATION	9
Definition and scope of phytochemicals, Classification of phytochemicals based on chemical structure (e.g., alkaloids, flavonoids, terpenoids, polyphenols), Sources of phytochemicals (plants, marine organisms, microorganisms), Basic principles of plant secondary metabolism.		
UNIT 2	**EXTRACTION, ISOLATION, AND CHARACTERIZATION OF PHYTOCHEMICALS**	**9**
Methods of extraction (solvent extraction, supercritical fluid extraction, microwave-assisted extraction), Techniques for isolation and purification (chromatography, electrophoresis), Spectroscopic methods for characterization (UV-Vis, IR, NMR, Mass spectrometry), Quality control of Phytochemical extracts.		
UNIT 3	**PHYTOCHEMICALS AND THEIR THERAPEUTIC APPLICATIONS IN MAJOR DISEASES**	**9**
Role of Phytochemicals in cancer therapy (e.g., curcumin, resveratrol, paclitaxel), cardiovascular diseases (e.g., flavonoids, polyphenols), neurodegenerative diseases (e.g., Ginkgo biloba extracts, catechins), Anti-microbial applications, Phytochemicals in Diabetes treatment.		
UNIT 4	**MECHANISMS OF ACTION OF PHYTOCHEMICALS**	**9**
Antioxidant and free radical scavenging activities, Anti-inflammatory and immunomodulatory effects, Enzyme inhibition and modulation, Gene expression regulation, Signal transduction pathways.		
UNIT 5	**PHYTOCHEMICALS IN DRUG DISCOVERY AND DEVELOPMENT**	**9**
Phytochemicals as lead compounds for drug development, Pharmacokinetics and pharmacodynamics of phytochemicals, Clinical trials and safety evaluation, Nanotechnology-based delivery of phytochemicals, Future perspectives and challenges in phytochemical therapeutics.		
Total Instructional Hours: 45		

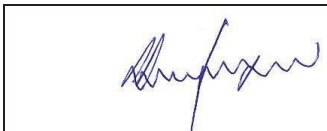
Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Classify and identify key phytochemicals and their sources.	K2
CO2	Apply methods for extracting, isolating, and characterizing phytochemicals.	K2
CO3	Understand the therapeutic potential of phytochemicals in major disease categories.	K2
CO4	Explain the mechanisms of action by which phytochemicals exert their therapeutic effects.	K2
CO5	Apply the role of phytochemicals in drug discovery and development.	K3

Approved by BoS Chairman

Textbooks	
1.	Pharmacognosy and Pharmacobiotechnology" by James E. Robbers, Varro E. Tyler, and Kurt Hostettmann. 1st Edition, 1996.
2.	"Natural Products: A biosynthetic approach" by Paul M. Dewick. 2nd Edition, 1997.
3.	"Chemistry of Natural Products" by Sujata V. Bhat, B.A. Nagasampagi, and M. Sivakumar, 2005.

Reference Books	
1.	"Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition." by Iris F. F. Benzie and Sissi Wachtel-Galor, 2011.
2.	"Plant Biochemistry" by Hans-Walter Heldt and Fiona Heldt, 4th Edition, 2010.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	-	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**



Approved by BoS Chairman

B. TECH.	B23BTE917 – BIOFERTILIZER PRODUCTION AND MUSHROOM CULTIVATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of the principles and practices of biofertilizer production and mushroom cultivation.
2.	To equip students with knowledge of microbial inoculants and their applications in sustainable agriculture.
3.	To explore the cultivation techniques and nutritional aspects of various edible mushrooms.
4.	To enable students to understand industrial mushroom processing, value addition, and quality control, including nutraceuticals and waste management.
5.	To familiarize students with the quality control and commercial aspects of biofertilizers and mushroom production.

UNIT - I	INTRODUCTION TO BIOFERTILIZERS AND MICROBIAL INOCULANTS	9

Introduction to biofertilizers: Significance and scope. Types of biofertilizers: Nitrogen-fixing, phosphate-solubilizing, potassium-mobilizing, and mycorrhizal biofertilizers. Microbial inoculants: *Rhizobium, Azotobacter, Azospirillum, Pseudomonas, Bacillus, Trichoderma*, and mycorrhizal fungi. Mechanisms of action of biofertilizers: Nitrogen fixation, phosphate solubilization, plant growth promotion. Carrier materials and their properties. Quality control of biofertilizers: Viability, purity, and efficacy testing.

UNIT - II	PRODUCTION TECHNOLOGY OF BIOFERTILIZERS	9

Isolation and characterization of effective microbial strains. Fermentation technology for biofertilizer production: Batch, fed-batch, and continuous fermentation. Scale-up and optimization of biofertilizer production. Formulation and packaging of biofertilizers. Storage and shelf-life of biofertilizers. Quality standards and FCO.

UNIT - III	MUSHROOM CULTIVATION: PRINCIPLES AND PRACTICES	9

Introduction to edible mushrooms: Nutritional and medicinal value. Cultivation techniques for various mushrooms: Oyster, button, shiitake, and milky mushrooms. Substrate preparation and sterilization. Spawn production and inoculation. Environmental control in mushroom cultivation: Temperature, humidity, and ventilation. Pest and disease management in mushroom cultivation.

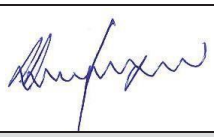
UNIT - IV	MUSHROOM PROCESSING AND VALUE ADDITION	9

Post-harvest handling and preservation of mushrooms. Processing of mushrooms: Drying, canning, and pickling. Value-added products from mushrooms: Mushroom powder, extracts, and nutraceuticals. Mushroom waste utilization. Quality assessment of mushrooms: Sensory, chemical, and microbiological analysis.

UNIT - V	COMMERCIAL ASPECTS AND ENTREPRENEURSHIP	9

Market potential and demand for biofertilizers and mushrooms. Economic analysis of biofertilizer and mushroom production. Entrepreneurial opportunities in biofertilizer and mushroom industries. Marketing and distribution strategies. Intellectual property rights (IPR) and patenting. Government schemes and subsidies.

Total Instructional hours : 45



Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Illustrate the principles of microbial inoculant production and application.	K2
CO2	Classify the different types of biofertilizers and their impact on soil fertility.	K2
CO3	Explain the cultivation techniques and nutritional value of various edible mushrooms.	K2
CO4	Demonstrate the quality and safety parameters of biofertilizers and mushroom products.	K2
CO5	Identify the commercial aspects and entrepreneurial opportunities in biofertilizer and mushroom industries.	K3

Text Books	
1.	Subba Rao N.S., "Soil Microbiology", Oxford & IBH Publishing Company, New Delhi, 2002.
2.	Himadri Panda H., "Manufacture of Biofertilizer and Organic Farming", Asia Pacific Business Press Inc., 2024.
3.	Tewari R.P., "Mushrooms: Cultivation, Marketing and Consumption", Daya Publishing House, Delhi, 2005.
4.	Chang S.T., Miles P.G., "Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact", CRC Press, Boca Raton, 2004.

References Books	
1.	Alexander M., "Introduction to Soil Microbiology", John Wiley & Sons, New York, 1977.
2.	Stamets P., "Mycelium Running: How Mushrooms Can Help Save the World", Ten Speed Press, Berkeley, 2005.

CO-PO-PSO Mapping

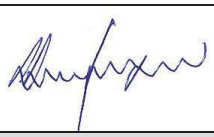
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	-	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	2	2	-	-	-	-	-	2	2	-	-	2	3	3

Approved by BoS Chairman

B. TECH.	B23BTE918 – BIOTECHNOLOGICAL APPROACHES IN CROP IMPROVEMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of biotechnological tools and their applications in crop improvement.
2.	To equip students with knowledge of molecular markers, genetic engineering, and genome editing techniques for crop enhancement.
3.	To explore the use of biotechnology in developing crops with improved yield, nutritional quality, and stress tolerance.
4.	To show students how to apply biotechnology tools to create crops that are both stress-resistant and nutritionally enhanced.
5.	To familiarize students with the regulatory and ethical considerations related to genetically modified crops.

UNIT - I	MOLECULAR MARKERS AND GENETIC MAPPING	9
Introduction to molecular markers: RFLP, RAPD, AFLP, SSR, SNP. Principles of genetic mapping: Linkage analysis, QTL mapping, association mapping. Marker-assisted selection (MAS): Principles and applications. Genomic selection: Principles and applications. Applications of bioinformatics in molecular marker analysis and genetic mapping.		
UNIT - II	**GENETIC ENGINEERING FOR CROP IMPROVEMENT**	**9**
Vectors for plant transformation: *Agrobacterium*-mediated transformation, direct gene transfer methods. Gene constructs and expression systems. Transgenic crops for improved yield, nutritional quality, and stress tolerance. Gene silencing and RNA interference (RNAi). Molecular farming: Production of recombinant proteins in plants.		
UNIT - III	**GENOME EDITING TECHNOLOGIES**	**9**
Principles and applications of genome editing technologies: CRISPR-Cas9, TALENs, ZFNs. Targeted gene modification and gene replacement. Genome editing for crop improvement: Enhanced disease resistance, herbicide tolerance, and nutritional enhancement. Off-target effects and their mitigation. Applications of genome editing in functional genomics.		
UNIT - IV	**BIOTECHNOLOGICAL APPROACHES FOR STRESS TOLERANCE AND NUTRITIONAL ENHANCEMENT**	**9**
Mechanisms of plant stress tolerance: Abiotic and biotic stresses. Genetic engineering for enhanced stress tolerance. Metabolic engineering for improved nutritional quality: Enhanced vitamin content, amino acid composition, and oil quality. Biofortification strategies for micronutrient enrichment. Application of Omics technology for stress and nutritional improvement.		
UNIT - V	**REGULATORY AND ETHICAL ASPECTS OF GENETICALLY MODIFIED CROPS**	**9**
Biosafety and risk assessment of genetically modified crops. Regulatory frameworks for GM crops: National and international regulations. Intellectual property rights (IPR) and patenting in plant biotechnology. Ethical considerations related to GM crops: Public perception and acceptance. Sustainable agriculture and the role of biotechnology. Case studies of successful biotechnology crop improvements – Golden rice, RNAi potatoes, drought tolerant maize.		
Total Instructional hours : 45		



Approved by BoS Chairman

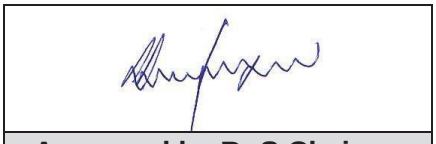
Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Summarize molecular marker techniques for genetic mapping and marker-assisted selection.	K2
CO2	Interpret genetic engineering tools for developing transgenic crops with desired traits.	K2
CO3	Extend genome editing technologies for precise modification of plant genomes.	K2
CO4	Explain the impact of biotechnological interventions on crop improvement and sustainable agriculture.	K2
CO5	Make use of the ethical and regulatory aspects of genetically modified crops.	K3

Text Books	
1.	Chawla H.S., "Introduction to Plant Biotechnology", Oxford & IBH Publishing Company, New Delhi, 2009.
2.	Glick B.R., Patten C.L., Glick B.R., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, Washington D.C., 2010.
3.	Slater A., Scott N.W., Fowler M.R., "Plant Biotechnology, The Genetic Manipulation of Plants", Oxford University Press, Oxford, 2008.
4.	Umesha S., "Plant Biotechnology", CRC Press, 2019.
5.	Nitish Kumar., "Biotechnology and Crop Improvement : Tissue Culture and Transgenic Approaches" Routledge, Tayler & Francis Group, UK.

References Books	
1.	Stewart C.N. Jr., "Plant Biotechnology and Genetics: Principles, Techniques, and Applications", John Wiley & Sons, Hoboken, 2008.
2.	Chrispeels M.J., Sadava D.E., "Plants, Genes, and Crop Biotechnology", Jones & Bartlett Publishers, Sudbury, 2003.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**



Approved by BoS Chairman

B.Tech.	B23BTE919- PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the principles, practices and application of the plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants.
2. To understand the importance of plant Genetic Engineering with its applicative value in pharmaceutical and food industry, agriculture and ecology.

Pre-requisite (if any)

UNIT 1	PLANT TISSUE CULTURE: AN OVERVIEW	9

Historical perspective; Totipotency; Organogenesis; Somatic embryogenesis; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

UNIT 2	PLANT GENOMICS	9

Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes using: transformation, mutant populations, knock out systems; Heterologous expression systems; Protein analysis.

UNIT 3	THE GENE TRANSFER TECHNIQUES FOR PRODUCTION OF TRANSGENIC PLANTS	9

Indirect Gene transfer Methods: structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in Agrobacterium mediated gene transfer. Direct gene transfer methods: Particle bombardment mediated transformation, Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Applications and limitations of Agrobacterium gene transfer. Plastid engineering: Introduction, importance, scope and technique

UNIT 4	APPLICATION OF PLANT TRANSFORMATION	9

Genetic Engineering for Herbicide resistance, Biotic and Abiotic Stress Resistance/Tolerance, Vitamins and other value addition compounds, Production of pharmaceutically important compounds, Bioenergy generation, Terminator technology.

UNIT 5	MOLECULAR MAPPING & MARKER ASSISTED SELECTION (MAS)	9

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning;

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Understand the use of different plant tissue culture (PTC) techniques for PTC Industries as well as research.	K2
CO2	Understand the structure and organization of genes & complexity of plant genome and able to identify the tools for gene identification and its functional analysis.	K2
CO3	Identify the different modern tools & techniques of Plant Genetic Engineering for crop improvement and sustainable agriculture.	K2
CO4	Analyse the impact of Plant Genetic Engineering in pharmaceutical and food industry, agriculture and ecology.	K2
CO5	Understand the Molecular Mapping & Marker Assisted Selection techniques.	K2

Approved by BoS Chairman

Textbooks	
1.	Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology of plants. Chichester, West Sussex: John Wiley & Sons.
2.	Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: An Introduction to Genetic Engineering. Oxford: Oxford University Press.

Reference Books	
1.	Primrose, S. B., & Twyman, R. M. (2006). Principles of gene manipulation and genomics. Malden, MA: Blackwell Pub.
2.	Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	-	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**

Approved by BoS Chairman

B.Tech.	B23BTE920 – ADVANCED TECHNIQUES IN AGRO FORESTRY	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the essential basics of phytogeography and forestry of India

Pre-requisite (if any)

Genetic Engineering, Plant tissue culture

UNIT 1	SILVICULTURE	9

General silvicultural principles; ecological and physiological factors influencing vegetation; natural and artificial regeneration of forests; nursery techniques; seed technology collection, storage, pre-treatment and germination; establishment and tendings. Silvicultural systems-clear felling, uniform, shafter-wood, selection, coppice and conversion systems. Social forestry-objectives, scope, necessity; agro-forestry; extension forestry: recreation forestry; people's participation.

UNIT 2	FOREST MENSURATION, MANAGEMENT AND UTILIZATION	9

Methods of measuring-diameter, girth, height and volume of trees; form factor; volume estimation of stand: sampling methods; yield calculation; current annual increment; mean annual increment; sample plots; yield and stand tables; scope and objectives of forest inventory; aerial survey and remote-sensing techniques. Forest management-objectives and principles; techniques; sustained yield relation; normal forest; growing stock; regulation of yield-methods of application; working plans-preparation and control. Forest utilisation: Logging and extraction techniques and principles; transport, storage and sale. Minor and major forest product : definition and scope. Collection, processing and disposal of minor and major forest products.

UNIT 3	ADVANCES IN TREE IMPROVEMENT	9

Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees. Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees. Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programs.

UNIT 4	ADVACNES IN WOOD AND NON-WOOD FOREST PRODUCTS	9

Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing. Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT 5	CLIMATE CHANGE AND FORESTRY	9

Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India.

Total Instructional Hours: 45

Approved by BoS Chairman

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Illustrate the various silviculture techniques.	K2
CO2	Explain about various measurement techniques of forest, its management and utilization.	K2
CO3	Identify the different tree improvement techniques.	K3
CO4	Make use of the different wood and non-wood forest products.	K3
CO5	Apply sustainable forest management for tackling climate changes.	K3

Textbooks	
1.	MacDonald. “Biogeography: Introduction to Space, Time and Life”, John Wiley & Sons, Inc., 2003.
2.	Sagreiya, K.P., “Forests and Forestry”, National Book Trust, India, 1967.

Reference Books	
1.	Dwivedi, A.P.,1993.A Text Book of Silviculture.International Book Distributors, Dehra Dun.
2.	Lal, J.B., 2003. TropicalSilviculture: NewImperatives: NewSystems, International Book Distributors, Dehra Dun.
3.	Shanmughavel, P., 2003: Techniques in Forestry, Pointer, Jaipur.
4.	Tiwari, K.M. and Singh, R.V., 1984. Social Forestry Plantations. Oxford & IBH Publishing Co., New Delhi

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	2	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**

Approved by BoS Chairman

B.Tech.	B23BTE921-BIOMATERIALS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Understand common use of biomaterials and its chemical structure, properties, and morphology.
2.	Understand the interaction between biomaterial and tissue for short term and long term implantations.
3.	Explain the types of material used to replace different organs & tissues of human body.

Pre-requisite (if any)
Biochemistry

UNIT 1	INTRODUCTION TO BIOMATERIALS	9

Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Pyrogenicity, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples.

UNIT 2	MATERIALS USED IN MEDICINE	9

Fabrics; Biologically Functional Materials; Ceramics; Natural materials; Composites, thin films, grafts and coatings; Pyrolytic Carbon for long-term medical Implants; Porous materials; Nano biomaterials.

UNIT 3	POLYMERIC & COMPOSITE BIOMATERIALS	9

Polymeric Biomaterials: Introduction, Basic structures of Polymers, Polymerization and its Types, Polyethylene, Polypropylene, Polyamides, Polyacrylates, Hydrogel, Bone cement, Fluorocarbon polymers, Silicon Rubber, Bioactive Polymers, Biodegradable Polymers, Applications. **Composite Biomaterials:** Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites.

UNIT 4	BIOCOMPATIBILITY TESTING & HOST REACTIONS TO BIOMATERIALS	9

Biocompatibility Testing: Introduction, In-Vitro Testing, In-Vivo Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. **Host Reactions to Biomaterials:** Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials.

UNIT 5	APPLICATION OF BIOMATERIALS	9

Cardiovascular Applications; Dental implants; Adhesives and Sealants; Ophthalmologic Applications; Orthopedic Applications; Drug Delivery System; Sutures; Bioelectrodes; Biomedical Sensors and Biosensors.

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Classify biomaterials and explain their properties, including biocompatibility and biodegradation.	K2
CO2	Explain about various materials used in medicine, including polymers, ceramics, composites, and nanomaterials.	K2
CO3	Identify the structure, synthesis, and applications of polymeric and composite biomaterials.	K3
CO4	Make use of the biocompatibility testing methods to analyse the host reactions to the implanted biomaterials.	K3
CO5	Apply biomaterials knowledge to various biomedical applications.	K3

Approved by BoS Chairman

Textbooks	
1.	Biomaterials, By Sujata V. Bhatt, Narosa Publishing House, New Delhi, India.
2.	Biomaterials: An introduction, By Joon B. Park, Roderic S. Lakes, Springer.

Reference Books	
1.	Biomaterials Science: An introduction to materials in medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Elsevier.
2.	Biomaterials: Principles and Applications, Edited by Joon B. Park, Joseph D. Bronzino, CRC Press.
3.	Biomaterials Medial Devices and Tissue Engineering by Fredrick H. Silver Chapman and Hall.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	2	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**

Approved by BoS Chairman

VERTICAL IV - ANIMAL BIOTECHNOLOGY

B.Tech.	B23BTE922 - FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1.	To understand the theories of origin and evolution of life.
2.	To develop knowledge on classification and natural selection of animal diversity.
3.	To learn about the animal cell culture techniques and its scale up.
4.	To know the micromanipulation of embryos, IVF and its equipment.
5.	To understand the concepts of transgenic animals and related ethical issues.

Pre-requisite (if any)

UNIT 1	**ORIGIN AND EVOLUTION OF LIFE**	**9**
Theories of the origin of life, early earth, modern self-assembly theories, Oparin and Haldane theory of chemical evolution, The Miller Urey experiment, Organic evolution, Development of evolution theory, Darwin's theory, Origin and evolution of human being.		
UNIT 2	**ANIMAL DIVERSITY**	**9**
Basis of classification, levels of organization (Symmetry, diploblastic and triploblastic organization), Coelom, segmentation, Notochord. The nature of natural selection, Examples of natural selection, levels of selection, selection of organisms and groups, species selection.		
UNIT 3	**STRUCTURAL ORGANIZATION AND CELL CULTURE TECHNIQUES**	**9**
Animals Tissues - Epithelial Tissue, connective Tissue, Muscle Tissue, Neural Tissue. Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture- monolayer culture, suspension culture.		
UNIT 4	**MICROMANIPULATION OF EMBRYOS**	**9**
What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.		
UNIT 5	**TRANSGENIC ANIMALS**	**9**
Introduction of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; Ethical issues on transgenic animals – Sheep, Goat, Cow, Pig		
Total Instructional Hours : 45		

Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Define the various theories of origin and evolution of life	K1
CO2	Understand the various level of organization and selection of organisms and groups	K2
CO3	Learn the organization of structure of animal tissues and know basics of animal cell culture technology	K2
CO4	Apply the concepts of micromanipulation technology & IVF	K3
CO5	Develop the production of transgenic animals and its ethical issues	K3

Textbooks	
1	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997

Reference Books	
1	Sue Dallas, Emily Jewell. Animal Biology and Care Wiley-Blackwell; 3rd edition
2	Franklin Shull A, George R. Larue, Alexander G. Ruthven. Principles of animal biology. Mc GrawHill agricultural and biological publications.
3	Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE923 - ANIMAL HEALTH AND NUTRITION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide the basic nutritional requirements for laboratory animals
2.	To gain knowledge about the animal health management and its behavior
3.	To understand the animal diseases diagnostics.
4.	To learn the techniques of animal therapeutic vaccines
5.	To know about the animal behavior through experimental studies.

Pre-requisite (if any)

UNIT 1	BASIC NUTRITIONAL REQUIREMENTS AND FEEDING	9
Nutritional requirements for rat, Mice, guinea pigs, rabbit. Types of diets: Natural, semi synthetic and synthetic. Feeding of water, nutrition to kids, young adults, mature adults. Significance of carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins.		
UNIT 2	**ANIMAL HEALTH AND DISEASE MANAGEMENT**	**9**
Bacterial and viral diseases in animals like rat, Mice, guinea pigs, rabbit, monkeys and horse- Type of diseases, Symptoms, causative agent, colonization and disease transmission. Control of parasites. Role of animal health committee in conducting experiments		
UNIT 3	**ANIMAL DISEASE DIAGNOSIS**	**9**
Monoclonal antibodies and their use in diagnosis; Antigen-antibody based diagnostic assays including radioimmunoassay and enzyme immunoassays; Immunoblotting; Nucleic acid based diagnostic methods including nucleic acid probe hybridization; Restriction endonuclease analysis; PCR, Real time PCR; Nucleic acid sequencing; Probiotics.		
UNIT 4	**ANIMAL VACCINES AND THERAPEUTICS**	**9**
Types of behavior, Behavioral observation of Mice, guinea pigs, rabbit. neuroscience research, chicken welfare, Spatial behavior, rat social behavior, zebrafish studies. Live stock and wild life summary data sheet.		
UNIT 5	**ANIMAL BEHAVIOR IN EXPERIMENTAL RESEARCH**	**9**
Types of behavior, Behavioral observation of Mice, guinea pigs, rabbit. neuroscience research, chicken welfare, Spatial behavior, rat social behavior, zebrafish studies. Live stock and wild life summary data sheet.		
Total Instructional Hours : 45		

Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the basic nutritional requirements	K2
CO2	Understand the animal disease management	K2
CO3	Learn the various diseases and its diagnostic methods.	K2
CO4	Apply the concepts of therapeutic methods	K3
CO5	Understand the behavior of animal on experiments	K2

Textbooks	
1.	Maynard LA, Loosli JK, Hintz HF and Warner RG. 1987. Animal Nutrition. Tata McGraw- Hill.
2.	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997
3.	Boix, J.; von Hieber, D.; Connor, B. (2018). Gait Analysis for Early Detection of Motor Symptoms in the 6-OHDA Rat Model of Parkinson's Disease. Frontiers in Behavioral Neuroscience, 12, 39.

Reference Books	
1.	NRC. 1994. Nutrient Requirements of Poultry, 9th Rev. ed. National Research Council. National Academy Press.
2.	NRC. 2012. Nutrient Requirements of Swine, 11th Rev. ed. National Research Council. National Academy Press.
3.	Zipser, B.; Schleking, A.; Kaiser, S.; Sachser, N. (2014). Effects of domestication of biobehavioural profiles: a comparison of domestic guinea pigs and wild cavies from early to late adolescence. Frontiers in Zoology, 11, 30.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE924 - ANIMAL PHYSIOLOGY AND METABOLISM	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To gain knowledge about the animal physiology
2.	To understand the concept of blood and circulatory system
3.	To understand the concept of digestive and respiratory system
4.	To know the nutrient transport and metabolism
5.	To learn the techniques of micromanipulation of embryos

Pre-requisite (if any)

UNIT 1	INTRODUCTION TO ANIMAL PHYSIOLOGY	9

The various physiological organ---systems and their importance to the integrative functionsof the animal body. The concept of homeostasis, including set point, negative and positivefeedback loops, and compensatory responses. Body fluid and its dynamics. Transport ofthrough biological membranes.

UNIT 2	BLOOD AND CIRCULATORY SYSTEM	9

Composition of blood, structure & functioning of its constitutes. Blood coagulation and anti-coagulants. Hemoglobin and its polymorphism. Anaemias. Sreticule---endothelial System. Body defense mechanism and immunogenesis. Structure and functions of the cardiovascular system, including the mechanical and electrical properties of cardiac muscle function. Excitation-contraction coupling in cardiac muscle. Reflex regulation of blood pressure.

UNIT 3	RESPIRATORY SYSTEM AND DIGESTIVE SYSTEM	9

Respiration: Structure and functions of the respiratory system, Structure and functions of smooth muscle, including excitation---contraction coupling in smooth muscle. Digestion: Structure, function and physiology of digestive system. Control of motility and secretion of alimentary canal and reflexes in the control of digestive functions. Control of rumen motility. Digestion in ruminant and monogastric animals.

UNIT 4	NUTRIENT TRANSPORT AND ENERGY METABOLISM	9

Food, energy, ATP, carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins, metabolic disorders, comparative nutrition, nutrigenomics, endocrinology, ruminology.

UNIT 5	MICROMANIPULATION OF EMBRYOS AND REPRODUCTION	9

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

Total Instructional Hours : 45

Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the basics of animal physiology	K2
CO2	Know the concepts of blood and circulatory systems	K2
CO3	Understand the concepts of respiratory and digestive system	K2
CO4	Understand the nutrient transport and metabolism	K2
CO5	Learn the micromanipulation technique	K2

Textbooks	
1.	Schmidt---Nielsen, Animal Physiology, Cambridge University Press.
2.	Christopher D. Moyes and Patricia M. Schulte, Principles of Animal Physiology, Pearson Press.
3.	William S. Hoar, General and Comparative Animal Physiology, Prentice Hall, India

Reference Books	
1.	Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.
2.	Arthur C. Guyton and John E. Hall, Textbook of Medical Physiology, W.B. Saunders Company.
3.	Animal Physiology, Richard W, Gordon A and Margaret A. Sinauer Associates, USA

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE925 - ANIMAL CELL CULTURE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1	To know the basic requirements of animal cell culture laboratory
2	To understand the cell culture media, types and reactors
3	To learn the techniques of cell culture and its scale up.
4	To gain the concepts of stem cells, methodology of production of transgenic animals and its applications.
5	To learn the various products from animal cell

Pre-requisite (if any)

UNIT 1	ANIMAL CELL LAB REQUIREMENTS	9

Safety - biosafety levels, SDS, safety equipments, personal protective equipments, safe laboratory practices; Basic cell culture equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory - Aseptic work area, Cell culture hood, Incubator, cryostorage, cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination.

UNIT 2	MEDIUM PREPARATION AND TYPES	9

Media components - Serum, tissue extracts, growth factors, hormones, carrier proteins, lipids, vitamins, additive, detergents; Types - natural media, synthetic media, chemically defined and serum free media – advantages, disadvantages, BSS, CMRL, Eagle's, RPMI, animal cell cultures, their maintenance and preservation; Sterilization of animal culture media, Characteristics of cells in culture – Contact inhibition, anchorage dependence, cell to cell communication, cell senescence.

UNIT 3	TECHNIQUES OF CELL CULTURE	9

History of cell culture development; Different tissue culture techniques including primary and secondary culture – Behavior of cells, Properties, Utility; Suspension culture, Organ culture, Explant culture; Established cell line cultures - Definition of cell lines, maintenance and characterization of cell lines; Measurement of viability and cytotoxicity - Cell cloning, cell synchronization and cell manipulation; Large-scale culture of cell lines- monolayer, suspension, and immobilized cultures. Organ and histotypic culture: Technique, advantages, limitations, applications.

UNIT 4	STEM CELLS AND TRANSGENIC ANIMALS	9

Stem cells - types (embryonic, adult, induced pluripotent), isolation, identification, expansion, differentiation and applications in modern clinical sciences, ethical issues. Transgenic animals – Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for human genetic disorder.

UNIT 5	PRODUCTS FROM ANIMAL CELL	9

Enzymes – asparaginase, collagenase, urokinase, pepsin, hyaluronidase; Hormones- leutinizing hormones, FSH; Vaccines - FMD, measles and mumps, rubella, rabies monoclonal antibodies, interferons, plasminogen activator.

Total Instructional Hours : 45

Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the basic requirements of animal cell culture lab facility	K2
CO2	Know the various types of animal cell culture media	K2
CO3	Make use of cell culture and scale up techniques to produce the animal products	K3
CO4	Apply the concept of stem cells and transgenic animals in the field of clinical research	K3
CO5	Develop the high valuable products from animal cell	K3

Textbooks	
1	Freshney R.I. Animal Cell Culture- a practical approach, 6th ed., 2010
2	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
3	Animal cell Biotechnology, R.E. Spier and J.B Griffiths. Academic Press. (1998).

Reference Books	
1	Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002
2	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997
3	Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE926 - ADVANCES IN ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn about the scope and importance of animal biotechnology and animal media preparation
2.	To prepare the animal cell culture techniques and bioreactors of animal cell culture.
3.	To learn about the micromanipulation of embryos and embryo transfer.
4.	To understand the concepts of gene transfer and types of gene therapy.
5.	To provide knowledge on stem cells and production of transgenic animals.

Pre-requisite (if any)

UNIT 1	BASICS OF ANIMAL BIOTECHNOLOGY	9

Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins. Introduction to basic tissue culture techniques - Types: natural media, synthetic media, chemically defined and serum free media – advantages, disadvantages, BSS, CMRL, Eagle's, RPMI, animal cell cultures, their maintenance and preservation.

UNIT 2	CELL CULTURE TECHNOLOGY	9

Culturing of cells, primary and secondary cell lines, Various types of cultures- suspension cultures, continuous flow cultures, immobilized cultures, organ cultures; somatic cell fusion; cell cultures as a source of valuable products; Various bio-reactors used for animal cell culture-Roller bottle culture; Sterilization of Cell culture media. Bioreactor process control, stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat; High technology vaccines: Hybridoma technology; Cell lines and their applications.

UNIT 3	MICROMANIPULATION AND ITS APPLICATION	9

What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.

UNIT 4	GENE TRANSFER AND GENE THERAPY	9

Gene constructs promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase. Different method of gene transfer and their limitations, Gene therapy-prospects and problems, Recent advancements in Gene therapy; Gene Knock out technology; Ethical aspects of gene therapy.

UNIT 5	STEM CELLS AND TRANSGENIC ANIMALS	9

Stem cells – sources, types, uses, ES cells, pluripotent stem cells, adult stem cell, epithelial stem cell, bone marrow and hematopoietic, neural stem cell, transgenic techniques, Stem cell mediated transgenic animals. Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; Biopharming –Transgenic animal production – Dolly (transgenic sheep), Transgenic mice, goat, rabbit, pig, fish, cow - case studies and application in expression of therapeutic proteins.

Total Instructional Hours : 45

Approved by BoS Chairman

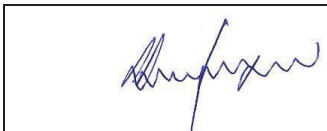
Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the scope and importance of animal biotechnology and animal media preparation.	K2
CO2	Learn the animal cell culture techniques and role of bioreactors used in animal cell culture.	K2
CO3	Make use of the micromanipulation of embryos and embryo transfer.	K3
CO4	Develop the gene transfer methods and gene therapies involved in animal production.	K3
CO5	Examine the sources and types of stem cells, production of various transgenic animals and its ethical aspects of animal biotechnology.	K4

Textbooks	
1.	Jan Freshney. R .Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.)Wiley & Sons. 2010.
2.	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997
3.	Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000

Reference Books	
1.	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2.	Gene therapy – From Laboratory to the Clinic,Hui, K.M. World Scientific PublishingCo. Pvt. Ltd. Singapore, 1994.
3.	Handbook of Stem Cells Volume 1 and 2 Eds Robert Lanza and others Elsevier Academic Press.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**



Approved by BoS Chairman

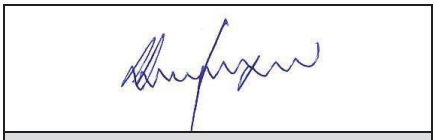
B.Tech.	B23BTE927 – BIOTECHNIQUES IN ANIMAL BREEDING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To educate the students about the basic requirements for cell culture and micromanipulation
2.	To provide depth knowledge about micromanipulation and application.
3.	To teach the importance of stem cell mediated production and guidelines

Pre-requisite (if any)
Cell Biology, Microbiology, Genetic Engineering

UNIT 1	BASIC REQUIREMENT FOR CELL CULTURE AND MICROMANIPULATION	9
Biosafety levels, safety equipments, personal protective equipments, safe laboratory practices. cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage, cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination. Micromanipulation tools: micromanipulator, pipette puller, pipette grinder, holding pipette.		
UNIT 2	**MICROMANIPULATION AND ITS APPLICATIONS**	**9**
Enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.		
UNIT 3	**STEM CELLS AND TRANSGENIC ANIMALS**	**9**
Stem cells – sources, types, uses, ES cells, pluripotent stem cells, adult stem cell, epithelial stem cell, bone marrow and hematopoietic, neural stem cell, transgenic techniques, Stem cell mediated transgenic animals.		
UNIT 4	**TRANSGENIC ANIMALS IN RESEARCH**	**9**
Ethics of transgenic technology, Dolly (transgenic sheep), Transgenic mice, rat, sheep, goat, rabbit, pig, fish, cow- case studies.		
UNIT 5	**ETHICAL GUIDELINES IN ANIMAL RESEARCH**	**9**
Justification on research, care and housing of laboratory animals, acquisition of laboratory animals, experimental procedure, CPCSEA guidelines. Animal integrity and ethical limits to breeding. Animal welfare issues. Record Maintenance as per guidelines.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain concept of basic tools requirement for cell culture and micromanipulation.	K2
CO2	Outline the process of micromanipulation and its applications.	K2
CO3	Illustrate the concept of stem cell and ES Cell of transgenic animals	K2
CO4	Make use of the research importance in transgenic animals.	K3
CO5	Apply CPCSEA ethical guidelines.	K3



Approved by BoS Chairman

Textbooks	
1.	Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

Reference Books	
1.	Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007
2.	Lewin, B. Genes VIII , Pearson Prentice Hall, 2004

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	2	-	3	-	2	1	1	2	3	2
CO2	3	3	2	3	1	-	1	-	2	2	2	2	3	3
CO3	3	3	3	2	2	1	-	2	1	2	1	1	3	3
CO4	3	3	3	3	2	3	3	-	2	1	3	2	3	3
CO5	3	3	3	2	2	1	3	3	3	1	2	3	3	3
Wt. Avg.	**2.8**	**2.8**	**2.8**	**2.6**	**1.8**	**1**	**2**	**1**	**2**	**1.4**	**1.8**	**2**	**3**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE928 – MODERN BIOANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Familiarize with the working principles, tools and techniques of analytical methods.
2.	Understand the strengths, limitations and creative use of bio analytical techniques for problem solving.
3.	Design experiment and understand instrumentation for analyzing biomolecules.

Pre-requisite (if any)
Analytical Methods in Biotechnology, Microbiology

UNIT 1	SPECTROSCOPY STUDY OF CHEMICAL COMPOUNDS AND BIO-MOLECULES	9

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

UNIT 2	DIFFRACTION TECHNIQUE	9

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

UNIT 3	CHROMATOGRAPHY	9

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

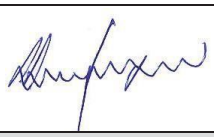
UNIT 4	MICROSCOPY	9

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

UNIT 5	ELECTROPHORETIC TECHNIQUES	9

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

Total Instructional Hours : 45



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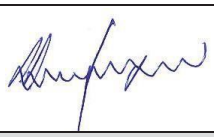
Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Apply spectroscopic technique to investigate biomolecules and monitor biochemical reactions.	K3
CO2	Utilize the fundamentals of lattice systems, X-ray diffraction techniques, and their applications in analysing crystallinity and macromolecular structures.	K3
CO3	Analyze the precise chromatographic/hybrid methods for purification and analysis of Biomolecules.	K3
CO4	Make use of the various microscopic techniques to visualize the structure of biomolecules.	K3
CO5	Identify the macromolecules using electrophoresis techniques.	K3

Textbooks	
1.	D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series. 2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009)
2.	Skoog, D.A., Crouch, S.R., and Holler, F.J. Principles of Instrumental Analysis, 6th edition, Brooks/Cole, USA, 2017.
3.	Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.

Reference Books	
1.	R. F. Boyer, Modern experimental biochemistry (Benjamin Cummings, San Francisco, 3rd ed., 2000).
2.	B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin; New York, 2nd ed., 2002).
3.	Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., "Introduction to Spectroscopy", 4th Edition, Brooks/Cole Cengage Learning, 2008.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
CO1	3	2	2	1	1	-	-	-	-	-	-	2	2	3
CO2	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO3	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO4	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO5	3	2	2	2	2	-	-	-	-	-	-	2	2	3
Wt. Avg	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**



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VERTICAL V - COMPUTATIONAL BIOTECHNOLOGY

B.Tech.	B23BTE929 - FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives

1.	To study various Algorithm design techniques and applying it in bioinformatics.
2.	To understand the algorithms such as Dynamic programming, HMM and ANN in Biological applications

Pre-requisite (if any)

Python programming

UNIT 1	INTRODUCTION TO ALGORITHMS	9

Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling sales man problem, sorting.

UNIT 2	DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS	9

Dynamic programming Principles and its uses. Local and Global alignment principles, Finding longest common subsequences, Heuristics second generation alignment tools for database searching : (Blast, FASTA, Clustal W), Statistical and Similarity based methods for gene prediction, Models of evolution.

UNIT 3	EXACT MATCH AND HIDDEN MARKOV MODELS	9

Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm, Hidden Markov Model: Forward and Backward Algorithms, Most probablestate path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

UNIT 4	ARTIFICIAL NEURAL NETWORKS	9

Introduction to Artificial Neural Networks (ANN): A Simple Neuron, Firing rule, Network layers, Architectures of Artificial Neural Network: Feed-Forward networks, Feed-Back networks, Perceptrons, Pattern recognition problems, Back Propagation Algorithm, Applications of Neural Networks.

UNIT 5	DNA AND RNA RELATED ALGORITHMS	9

Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, Finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold.

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline the basics of algorithms used in Bioinformatics.	K2
CO2	Apply the dynamic programming in sequence analysis.	K3
CO3	Analyze the macromolecules using HMM, ANN and other related algorithms.	K4
CO4	Examine the algorithms used in the study of DNA RNA interaction.	K4
CO5	Inference about the application of various algorithms in the field of	K4

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	biotechnology.	

Textbooks	
1.	Dan Gusfield- Algorthims on Strings, Trees and Sequences: Computer Science and Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198.
2.	Horowitz, S. Sahini, and Rajasekharan : Fundamentals of Computer Algorithms , Galgotia Publications.

Reference Books	
1.	Neil C.Jonesand Pavel .A Pevzner An introduction to Bioinformatics Algorthims.(computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068.
2.	R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic models of Proteins and Nucleic acids (2005) Cambridge University Press 0521540798.
3.	Michael.S.Waterman Introduction to Computational Biology : Maps, Sequences and Genomes . Waterman. Edition 2 (2012) Chapman and Hall/ CRC Press ISBN:1439861315.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**

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B.Tech.	B23BTE930- MOLECULAR MODELLING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To have a knowledge on recent advances and the limitations of the molecular modelling methods
2.	To know the introduction of molecular modeling to the students

Pre-requisite (if any)
Bioinformatics

UNIT 1	INTRODUCTION	9

Introduction to drug designing, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development. Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation.

UNIT 2	QUANTUM MECHANICS AND MOLECULAR MECHANICS	9

Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

UNIT 3	MOLECULAR DYNAMICS	9

Molecular Dynamics simulation methods – Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

UNIT 4	MOLECULAR DOCKING AND LEAD OPTIMIZATION	9

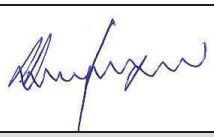
Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation- computer based tools for drug design.

UNIT 5	PHARMACOPHORE AND QSAR	9

Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Use of Genetic Algorithms.

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Outline the concepts of bioinformatics to be implemented in drug design and development.	K2
CO2	Interpret the idea of receptor and receptor-ligand complex, inhibition and inactivation of enzyme, receptor theories.	K2
CO3	Infer about the simple models for conformational changes using molecular dynamics simulations.	K2
CO4	Identify the concept of molecular modelling, mechanics and interactions for drug design.	K3
CO5	Make use of the pharmacophore 3D and various QSAR methodologies using genetic algorithms for protein design.	K3



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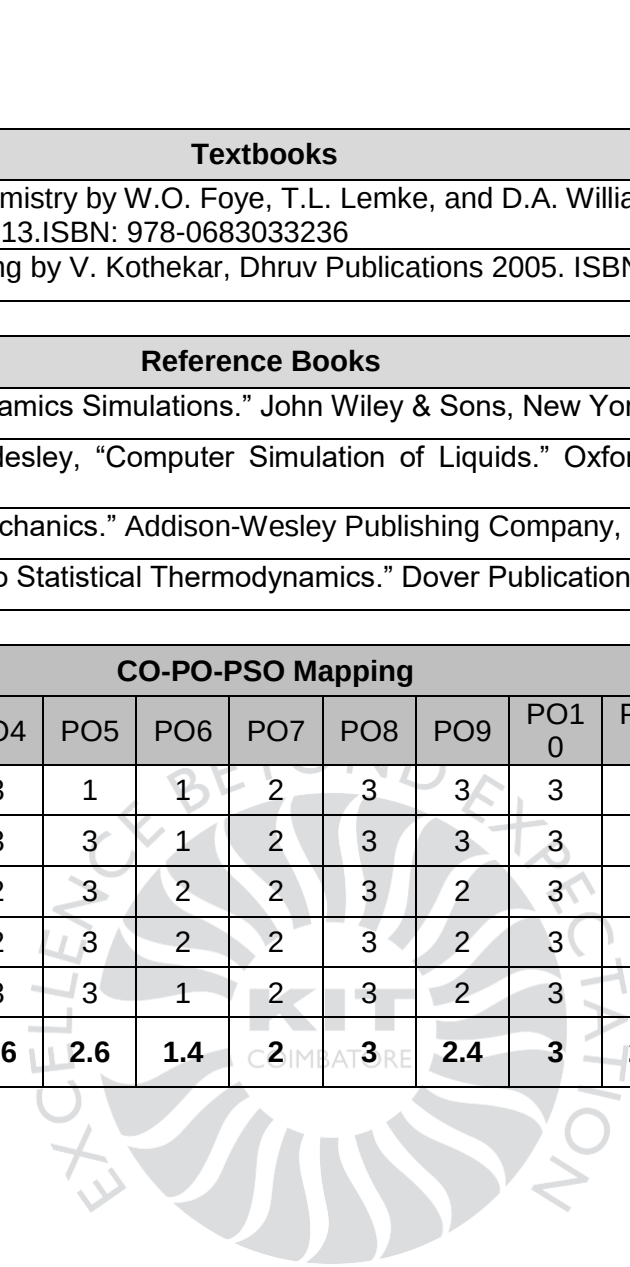
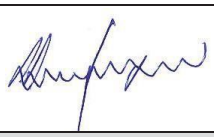
Textbooks	
1.	Principles of Medicinal Chemistry by W.O. Foye, T.L. Lemke, and D.A. Williams. Williams and Wilkins, Seventh Edition 2013.ISBN: 978-0683033236
2.	Essentials of Drug Designing by V. Kothekar, Dhruv Publications 2005. ISBN: 9788182400078.

Reference Books	
1.	J. M. Haile, “Molecular Dynamics Simulations.” John Wiley & Sons, New York, 1992.
2.	M. P. Allen and D. J. Tildesley, “Computer Simulation of Liquids.” Oxford Science Publications, Oxford, 1987.
3.	H. Goldstein, “Classical Mechanics.” Addison-Wesley Publishing Company, 1922.
4.	T. L. Hill, “An Introduction to Statistical Thermodynamics.” Dover Publications, New York, 1986.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**





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B.Tech.	B23BTE931 - COMPUTER AIDED DRUG DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the informatics approaches to the prediction of chemical properties of new drugs.
2.	To understand the appropriate tools for such a modelling, ranging from electronic Structure

Pre-requisite (if any)

UNIT 1	ELECTRONIC STRUCTURE METHODS	9
Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.		
UNIT 2	**MOLECULAR MODELING**	**9**
Bioactive vs. global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modeling including artificial intelligence methods.		
UNIT 3	**STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN**	**9**
Qualitative versus quantitative approaches advantages and disadvantages. Random screening, Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand based drug design.		
UNIT 4	**QSAR: ELECTRONIC EFFECTS**	**9**
Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter interdependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.		
UNIT 5	**MOLECULAR DOCKING**	**9**
Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, FlexS,Autodock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Infer about the fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.	K2
CO2	Interpret and practice the fundamental concepts of Molecular Modelling and Computer aided Drug Design.	K3
CO3	Identify the chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.	K3
CO4	Develop practical skills in computational approaches to analyse, predict, and engineer biomolecules and bimolecular systems.	K3
CO5	Apply the fundamental tools in techniques like docking, modelling, electronic structure methods which lead to new drug target design.	K3

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Textbooks	
1.	Andrew R. Leach, Molecular Modelling Principle and Application, 2nd Edition, Prentice Hall, England,2001.
2.	Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug
3.	Action, 3rd Edition, Academic Press, USA, 2014.
4.	Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, Marcel Dekker, New York, 1997.
5.	J. M. Goodman, Chemical Applications of Molecular Modelling, The Royal Society of Chemistry, Cambridge, 1998.

Reference Books	
1.	Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc., 2003.
2.	John B. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science, 2006.
3.	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.
4.	David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.
5.	Alan Hinchliffe, Molecular Modelling for Beginners, 2nd Edition, Wiley, United University of California, 2008.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**

Approved by BoS Chairman

B. Tech.	B23BTE932 - METABOLOMICS AND METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the production of bioproducts commercially.
2.	To Know the importance of therapeutically important metabolites.
3.	To understand about the bio products like enzymes, recombinant proteins.

Pre-requisite (if any)

UNIT 1	INTRODUCTION	9
Introduction to metabolism, metabolic pathways, metabolite, metabolomics; Methods/ approaches employed to study metabolism; Inter-relationship between genome, transcriptome, proteome and metabolome; Methods for measurement of metabolites level/concentration.		
UNIT 2	**REGULATORY PATHYWAYS**	**9**
Metabolic regulation and control, Homeostasis and metabolic control, metabolic flux, metabolic control Analysis, Demand Supply Analysis, mechanisms of flux control, Regulation of glycolysis in muscle as an example of metabolic regulation.		
UNIT 3	**METABOLIC PROCESSES**	**9**
Identification of metabolic regulation is a key point in metabolic engineering. Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by is enzymes, Feedback regulation.		
UNIT 4	**BIOCONVERSIONS & REGULATION OF ENZYME PRODUCTION**	**9**
Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co-metabolism, Product inhibition, mixed or sequential bioconversions, metabolic pathway manipulations to improve fermentation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing or the introduction of entirely new - metabolic pathways. Case Studies		
UNIT 5	**METABOLIC ENGINEERING WITH BIOINFORMATICS**	**9**
Metabolic pathway modelling, Analysis of metabolic control and the structure metabolic networks, Metabolomics, metabolomics measurements using NMR, Spectrophotometry, LCMS, and metabolic product in fermentation.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Infer the basic concepts of metabolic Engineering in Cellular organisms.	K2
CO2	Summarize about the primary and secondary metabolic pathways	K2
CO3	Explain the commercial production of Enzymes and Recombinant Proteins.	K2
CO4	Apply the concepts of metabolic pathway manipulations to improve fermentation products.	K3
CO5	Develop the strategies for metabolic engineering using computational biology.	K3

Approved by BoS Chairman

Textbooks	
1.	Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey, “Fermentation and Enzyme Technology”, A.E. Lilly M.D., John Wiley and sons, 1980
2.	Stanbury P.F.and Whitaker A., “Principles of Fermentation Technology”, Pergamon Press, 1984
3.	Zubay G., “Biochemistry, Macmillan Publishers”, 1989.

Reference Books	
1.	Gregory N.Stephanopoulos, “Metabolic Engineering Principles and Methodologies” Aristos et al-Elsevier.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**

Approved by BoS Chairman

B.Tech.	B23BTE933 - DATA MINING AND MACHINE LEARNING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the techniques used to analyses huge biological data to find the hidden patterns.
2.	To enable the students with a new rapidly evolving filed of machine learning and mining

Pre-requisite (if any)

UNIT 1	OVERVIEW OF MACHINE LEARNING TECHNIQUES	9

Supervised and unsupervised techniques. Empirical Risk Minimization, Structural Risk Minimization; Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.

UNIT 2	MACHINE LEARNING TECHNIQUES	9

Classification: Decision tree, Bayesian, Rule based classification, ANN, SVM, HMM; Case based reasoning and Applications in Bioinformatics. Clustering: Partition Methods, Hierarchical methods, Density based methods, Grid based clustering, Model based clustering, clustering of high dimensional data, constraints based clustering, Analysis of MD trajectories, Protein Array data Analysis.

UNIT 3	INTRODUCTION TO DATA MINING	9

Introduction to Data mining, Data mining Functionalities, Classification of Data mining Systems, Data Mining Task Primitives, Integration of Data mining systems, Major issues of Data mining.

UNIT 4	DATA PREPROCSSING AND VISUALIZATION	9

Overview of data preprocessing, Data cleaning, Data integration, Data reduction, Data transformation and discretization, Visualization- Visualizing a single attributes, Visualizing pair of attributes, Visualizing several attributes, Visualizing results of machine learning.

UNIT 5	APPLICATIONS OF DATA MINING	9

DNA/protein sequence Analysis, Genome analysis, Protein Structure Analysis, Pathway analysis, microarray data analysis, annotation, gene ontology, gene mapping. Biological data mining tools: Entrez, Blast, sequence retrieval system (SRS).

Total Instructional Hours: 45

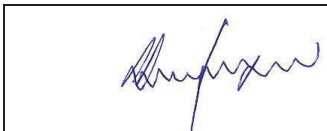
Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Infer the basic notions and terminology used in Machine learning and Data mining.	K2
CO2	Interpret the basic fundamental principles of modern data analysis.	K2
CO3	Outline the applications of Machine learning and Data mining in biological data.	K2
CO4	Develop the methods used for the data visualization and pre-processing of data.	K3
CO5	Make use of the applications of data mining in analysis of biological data.	K3

Approved by BoS Chairman

Textbooks	
1.	Witten, H. I., Frank, E. and Hall, M. A. 2011. Data Mining: Practical Machine Learning Tools and Techniques.
2.	Hastie, T., Tibshirani, R., Friedman, J. H. 2009. The Elements of Statistical Learning: Data Mining Interface and Prediction.
3.	Clarke, S. B., Fokoue, E. and Zhang, H. H. 2009 Principles and Theory for Data Mining and Machine Learning.

Reference Books	
1.	Data Mining: Concepts and Techniques by Jiawei Han and Micheline Kamber, 2000.
2.	Data Mining Techniques, A. K. Pujari, University Press, Hyderabad, 2006.
3.	Data mining in bioinformatics by Wang et al, Springer-Verlag, 2005.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**



Approved by BoS Chairman

B.Tech.	B23BTE934 – PROGRAMMING FOR BIOINFORMATICS APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To improve the programming skills and database development of the student.
2.	To introduce the fundamentals of Perl programming language to the student.
3.	To familiarize with Perl modules and to write scripts for manipulating/processing genomic and proteomic data

Pre-requisite (if any)
Biochemistry

UNIT 1	INTRODUCTION	9
Introduction to Operating systems, Linux commands, File transfer protocols FTP and telnet, Data life cycle, Database management system models. Structured Query Language (SQL) - Data Definition Language (DDL), Data Manipulation Language (DML) and Query by example.PL/SQL - Stored procedure, Database triggers; Relational Data Base Management system.		
UNIT 2	**PERL PROGRAMMING**	**9**
Perl overview, variables and data types, control Structure, loops- while loop, for loop, until loop, File handles - opening and closing files, reading and writing file handles, Library Functions: String specific functions, User defined functions.		
UNIT 3	**OPERATORS**	**9**
Arithmetic Operators, Assignment Operators, Logical operators, Equality Operators, Increment and Decrement Operators, String Concatenation and Repetition, Operators precedence and Associativity, Conditional Operators, Logical Operators, Operators for manipulating arrays, Operators for Manipulating hashes.		
UNIT 4	**REGULAR EXPRESSIONS**	**9**
Simple characters, * special character, . character, | character, Grouping with ()s, anchor characters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl.		
UNIT 5	**APPLICATIONS OF PERL IN BIOINFORMATICS**	**9**
Concatenating DNA Fragments, Transcription: DNA to RNA, Reading Protein Files, Finding Motifs, Simulating DNA, Generating Random DNA, Analysing DNA, Translating DNA to Proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation, Parsing Annotation, Parsing PDB files, Parsing BLAST output, Bio-perl.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Explain the basics of Linux operating system and the SQL for database creation and management	K2
CO2	Make use of the Perl data types to construct programs in Perl.	K3
CO3	Classify the various operators used in Perl programs.	K2
CO4	Identify the regular expressions, conditional statements and loops in Perl programs	K3
CO5	Apply Perl programming in handling genomics and proteomics data.	K3

Approved by BoS Chairman

Textbooks	
1.	James Tisdall, “Beginning Perl for Bioinformatics”, O’Reilly & Associates, 2001
2.	James Tisdall, “Mastering Perl for Bioinformatics”, O’Reilly, 2003.

Reference Books	
1.	Cynthia Gibas& Per Jambeck, “Developing Bioinformatics Computer Skills”, O’Reilly & Associates, 2000.
2.	Rex A. Dawyer, “Genomic Perl”, Cambridge University Press
3.	Elmasri and Navathe, “Fundamentals of Database Systems”, Addison Wesley. 2006

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	1	1	2	3	3	3	2	3	2	2
CO2	3	2	3	3	3	1	2	3	3	3	2	3	3	3
CO3	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO4	3	3	2	2	3	2	2	3	2	3	3	2	2	3
CO5	3	2	3	3	3	1	2	3	2	3	3	2	2	3
Wt. Avg.	**3**	**2.6**	**2.4**	**2.6**	**2.6**	**1.4**	**2**	**3**	**2.4**	**3**	**2.6**	**2.4**	**2.2**	**2.8**

Approved by BoS Chairman

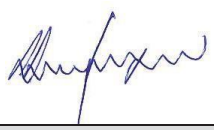
B.Tech.	B23BTE935 - HUMAN GENETICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamental principles of heredity and their application to human genetics.
2.	To gain a more comprehensive understanding of the complexities of inheritance and the various factors that contribute to genetic variation.
3.	To understand the genetic makeup of populations and how it changes over time.
4.	To explore the complexities of gene regulation and chromosome dynamics
5.	To gain in-depth knowledge of the genetic basis of specific human diseases.

Pre-requisite (if any)

UNIT 1	MENDEALIAN GENETICS AND BASICS OF HUMAN GENETICS	9
Mendel's study of heredity – Monohybrid crosses and Dihybrid crosses; The Punnett square methods; The Chi-square test; Mendelian segregation in human families; Allelic variation and Gene function; Law of segregation Law of independent assortment; History of Human Genetics; Pedigrees- gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits - Autosomal inheritance-dominant and recessive.		
UNIT 2	**CHROMOSOMAL BASIS OF INHERITANCE**	**9**
Sex Chromosomes and determination in Drosophila and human, X linked genes, Pedigree analysis; linkage and crossing over; Cytogenetics – Techniques, polyploidy and aneuploidy. Non-Mendelian inheritance; Genetic and Physical mapping; heredity and environment (twin studies).		
UNIT 3	**POPULATION GENETICS AND HUMAN GENETICS**	**9**
Derivation of Hardy and Weinberg's equilibrium, Factors affecting the equilibrium, Role of Euphenics, Eugenics and euthenics, Human Pedigree - Autosomal and Allosomal; Genetic counselling and Prenatal diagnosis, Epigenetics and Genomic imprinting, Role of genes in cancer.		
UNIT 4	**MOLECULAR GENETICS**	**9**
Human gene therapy; DNA fingerprints in forensic applications; Human genome project; Reverse Genetics: Antisense RNA; Transposable elements in humans; RNA interference; Activation and inactivation of whole chromosomes. Genetic basis of male and female infertility.		
UNIT 5	**CLINICAL GENETICS**	**9**
Muscle genetic disorders, mitochondrial syndromes, Genetic disorders of eye, neurogenetic disorders.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Relate the principles of Mendel's experiment, pattern of segregation of genes and its characters.	K2
CO2	Explain the mechanism of sex determination, linkages and crossing over.	K2
CO3	Apply genetic knowledge to real-world scenarios concerning human health and diseases.	K3
CO4	Make use of the variation in chromosomal patterns occurring at evolution and speciation.	K3



Approved by BoS Chairman

CO5	Utilize the genetic basis of normal and abnormal functioning of human body.	K3

Textbooks	
1.	Gardner, M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2015.
2.	E.J. Gardner, M.J. Simmons and. D.P. Snustad, Principles of Genetics, John Wiley, 2006

Reference Books	
1.	Robert HT, Principles of Genetics, Tata McGraw Hill, 2002
2.	Genetics: A Conceptual Approach, by Benjamin A. Pierce, 7th Edition 2020. W H Freeman & Co. New York, USA.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO2	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO3	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO4	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO5	3	3	-	-	-	-	-	-	-	-	-	3	1	1
Wt. Avg	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**

Approved by BoS Chairman

VERTICAL VI - QUALITY AND REGULATORY AFFAIRS

B.Tech.	B23BTE936 - CLINICAL TRIALS AND HEALTHCARE POLICIES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the various requirements for clinical research.
2.	To know about the different types and designs in clinical research
3.	To understand the concept of different forms for clinical studies and the regulations .
4.	To identify and learn the process and skills of different components and its element s in health care. creation and management of entrepreneurial venture
5.	To gain knowledge on patent filing and design different healthcare policies.

Pre-requisite (if any)

UNIT 1	REQUIREMENTS IN CLINICAL RESEARCH	9
Good clinical practice (ICH GCP E6), Clinical trial materials - Documentation, Investigational drugs, logistical materials. Ethics in Clinical trials – Regulations governing clinical trials		
UNIT 2	**TYPES AND DESIGNS IN CLINICAL RESEARCH AND SAFETY MONITORING IN CLINICAL TRIALS**	**9**
Types of research designs based on Controlling Method (Experimental, Quasi experimental, and Observational methods) Randomization techniques (Simple randomization, restricted randomization, blocking method and stratification),Time Sequences (Prospective and Retrospective), Sampling methods (Cohort study, case Control study and cross sectional study), Health outcome measures (Clinical & Physiological, Humanistic and economic)		
UNIT 3	**CLINICAL TRIAL STUDY AND GOVERNING REGULATIONS**	**9**
Roles and responsibilities of: Investigator, Study Coordinator, Sponsor, Monitor, Contract Research Organization, Site management Organizations Guidelines to the preparation of following documents: Protocols, Investigator's Brochure, Informed Consent Form, Case report forms, Contracts and agreements, Trial Master File preparation and maintenance, Investigator Site File, Pharmacy File, Dairy Cards		
UNIT 4	**OVERVIEW TO UNDERSTANDING THE HEALTHCARE SYSTEM**	**9**
Health care system components, Elements of a Health Care System, The Role and Financing Methods of Third-Party Payers, The Production of Medical Services, An Overview of the U.S. Health Care System, Production of Health Services and Provider Choice in the United States.		
UNIT 5	**HEALTH CARE POLICIES**	**9**
Health care policy- overview- Private health care sectors, Health policy and planning		
Total Instructional Hours : 45		

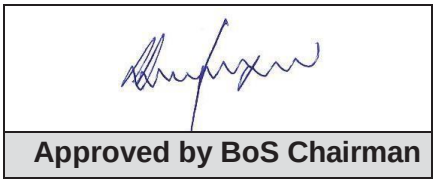
Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Explain the key requirements in Clinical research	K2
CO2	Demonstrate the types and designs in clinical research	K2
CO3	Develop different forms for clinical trial study and its regulations	K3
CO4	Summarize different components and elements of healthcare system	K2
CO5	Illustrate the different healthcare policies	K2

Textbooks	
1.	Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
2.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013 Guidance for Industry on Submission of Clinical Trial Application for Evaluating Safety and Efficacy by CDSCO (Central Drug Standard Control Organisation).

Reference Books	
1.	Santerre, Rexford E. Health economics. 2009.
2.	Bhat, R. (1993). The private/public mix in health care in India. *Health Policy and Planning*, *8*(1), 43–56.
3.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013. Guidance for Industry on Submission of Clinical Trial Application for Evaluating Safety and Efficacy by CDSCO (Central Drug Standard Control Organisation)

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	2	2	1	1	2	1
CO2	2	3	3	3	-	2	2	2	3	2	2	2	2	2
CO3	2	2	3	3	-	2	2	2	3	2	2	2	2	1
CO4	2	2	2	1	-	2	2	1	3	2	2	2	2	1
CO5	2	-	-	-	-	2	2	3	2	1	-	1	1	1
Wt. Avg	**2**	**2**	**2.67**	**2.33**	**-**	**2**	**2**	**1.8**	**2.6**	**1.8**	**1.75**	**1.6**	**1.8**	**1.2**



Approved by BoS Chairman

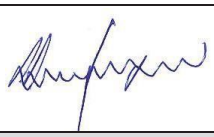
B.Tech.	B23BTE937 - BIOTECHNOLOGICAL PRODUCTS AND IVALIDATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the process of validation and quality assurance
2.	To describe the process of validation of pharmaceutical production
3.	To know the microbial quality control process for nutraceuticals
4.	To demonstrate the validation process for medical devices
5.	To analyze the validation of biotechnological process and equipments

Pre-requisite (if any)

UNIT 1	INTRODUCTION	9
Process validation and quality assurance: a) Installation Qualification (IQ), Operational Qualification (OQ) and Performance Qualification (PQ) for laboratory instruments. b) Methods of validation and calibration of equipments c) Documentation: importance and significance d) Current Good Manufacturing Practices (cGMP) and Current Good Laboratory Practices (cGLP).		
UNIT 2	**VALIDATION OF PHARMACEUTICAL PRODUCTION**	**9**
Introduction to Pharmaceutical Validation, Scope & merits of Validation, Validation and calibration of Master plan, ICH & WHO guidelines for calibration and validation of equipments, Validation of specific dosage form, Types of validation. Government regulation, Manufacturing Process Model, URS, DQ, IQ, OQ & P.Q. of facilities, Analytical method validation		
UNIT 3	**VALIDATION OF FOOD NEUTRACEUTICALS AND COSMETICS**	**9**
Microbiological quality control for Nutraceuticals		
UNIT 4	**VALIDATION OF MEDICAL DEVICES**	**9**
Validation and Verification of Medical device Physical and Mechanical Testing of medical device, Chemical Testing of Medical Device materials, Biological Testing of Medical Devices.		
UNIT 5	**BIOTECHNOLOGY PROCESS AND EQUIPMENT VALIDATION**	**9**
Process validation, General considerations for process equipments, Regulatory requirements for process validation, Documentation, Analytical methods		
Total Instructional Hours : 45		

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Outline the process of validation and quality assurance	K2
CO2	Interpret the validation of pharmaceutical production	K2
CO3	Illustrate the microbiological quality control of nutraceuticals	K2
CO4	Summarize the validation process of medical devices	K2
CO5	Make use of the Biotechnology process and equipment validation	K3

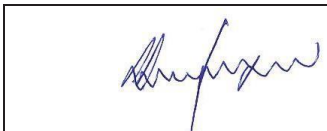


Approved by BoS Chairman

Textbooks	
1.	Pharmaceutical Process Validation; By Fra. R. Berry and Robert A. Nash
2.	Analytical Method validation and Instrument Performance Verification by Churg Chan, Heiman Lam, Y.C. Lee, Yue. Zhang, Wiley Inter Science.

Reference Books	
1.	Book: Leachables and Extractables Handbook: Safety Evaluation, Qualification, and Best Practices Applied to Inhalation Drug Products, Douglas J. Ball, Daniel L. Norwood, Cheryl L. M. Stults and Lee M. Nagao.
2.	Book: Medical Device 1st edition, Seeram Ramakrishna Lingling Tian Charlene Wang Susan Liao Wee Eong Teo, Woodhead Publishing, Hardcover ISBN: 9780081002896.
3.	Book: Biomaterials, Medical Devices and Combination Products: Biocompatibility Testing and Safety Assessment, Shayne Cox Gad, Samanta Gad-McDonald, CRC Press
4.	Process Validation: General Principles and Practices-FDA Guidelines

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	-	2	1	2	1	2	1	1	2	2
CO2	2	3	3	3	2	3	1	3	2	2	3	2	2	2
CO3	2	3	3	3	2	3	1	3	2	2	3	2	2	2
CO4	2	3	2	1	2	3	1	3	2	2	3	2	2	2
CO5	2	2	3	2	2	3	1	3	2	2	3	2	2	2
Wt. Avg	**2**	**2.4**	**2.6**	**2.2**	**2**	**2.8**	**1**	**2.8**	**1.8**	**2**	**2.6**	**1.8**	**2**	**2**



Approved by BoS Chairman

B. Tech.	B23BTE938 - QUALITY ASSURANCE AND QUALITY CONTROL IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the scope of quality certifications
2.	To understand the responsibilities of QA & QC departments in Clinical trials
3.	To understand the responsibilities of QA & QC departments in pharmaceutical industries
4.	To demonstrate the role of quality assurance and control in biomedical instrumentation industries
5.	To know the responsibilities of QA & QC departments in nutraceutical and cosmetic industries

Pre-requisite (if any)

UNIT 1	INTRODUCTION	9

Quality Assurance, Role of Quality Assurance**,** QA testing, Quality Control, Role of Quality Control, Test for quality control, Practice of cGMP- Overview of ICH Guidelines - QSEM, with special emphasis on Q-series guidelines. Good Laboratory Practices: Scope of GLP, Definitions, Quality assurance unit, protocol for conduct of non clinical testing, control on animal house, , scope of quality certifications, Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC)

UNIT 2	QUALITY ASSURANCE AND QUALITY CONTROL IN CLINICAL TRIALS	9

Clinical Trial Data Management- Standard Operating Procedures, Data management plan, CRF & Data base design considerations, Study set-up, Data entry, CRF tracking and corrections, Central lab, IVRS, source data. Data cleaning, managing laboratory and ADR data, Data transfer and database lock, Quality Control and Quality Assurance in CDM, Data mining and warehousing

UNIT 3	QUALITY ASSURANCE AND QUALITY CONTROL IN PHARMACEUTICAL INDUSTRIES	9

Schedule M – USFDA- Quality audit and self inspections SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

UNIT 4	QUALITY SYSTEM REGULATIONS AND QUALITY CONTROL OF MEDICAL DEVICES	9

Quality System Requirements 21 CFR Part 820, Labeling requirements 21 CFR Part 801, Post marketing surveillance of MD and Unique Device Identification (UDI), Quality System requirements and clinical evaluation and investigation. IMDRF study groups and guidance documents, ISO 13485, Quality Risk Management of Medical Devices: ISO 1497.

UNIT 5	QUALITY IN FOOD, NUTRACEUTICALS, BIOLOGICAL AND COSMETIC PRODUCTS	9

WHO guidelines on nutrition. NSF International: Its Role in the Dietary Supplements and Nutraceuticals Industries, NSF Certification, NSF Standards for Food And Dietary Supplements. Good Manufacturing Practices for Nutraceuticals, Quality, safety and legislation for herbal products in India, USA and European Union, Analysis of Cosmetics, Toxicity screening and test methods: Quality control and toxicity studies as per Drug and Cosmetics Act, Analysis of Food additives- milk constituents and milk products- Pesticide analysis

Total Instructional Hours : 45

Approved by BoS Chairman

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Summarize the scope of quality certifications	K2
CO2	Demonstrate the responsibilities of QA & QC departments in Clinical trials	K2
CO3	Explain the responsibilities of QA & QC departments in pharmaceutical industries	K2
CO4	Illustrate the role of quality assurance and control in biomedical instrumentation industries	K2
CO5	Compare the responsibilities of QA & QC departments in nutraceutical and cosmetic industries	K2

Textbooks	
1.	Willig, H., Tuckeman, M.M. and Hitchings, W.S., "Good Manufacturing Practices for Pharmaceuticals", 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000.
2.	Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J. Tobin and Gary Walsh.

Reference Books	
1.	P.P.Sharma. Cosmetics - Formulation, Manufacturing & Quality Control, Vandana Publications, New Delhi.

CO-PO-PSO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO1	2	1	1	-	-	2	2	2	2	2	1	1	2	1
CO2	2	3	1	2	-	2	2	2	2	2	3	2	2	2
CO3	2	2	1	2	-	2	2	2	2	2	3	2	2	2
CO4	2	2	1	2	-	2	2	2	2	2	3	2	2	2
CO5	2	2	1	2	-	2	2	2	2	2	2	2	2	1
Wt. Avg	**2**	**2**	**1**	**2**	**-**	**2**	**2**	**2**	**2**	**2**	**2.4**	**1.8**	**2**	**1.6**

Approved by BoS Chairman

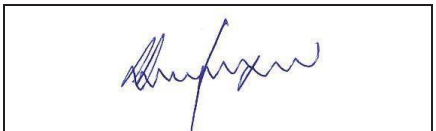
B.Tech.	B23BTE939 - ENTREPRENEURSHIP AND PATENT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

1.	To develop entrepreneurial skills and to acquire entrepreneurial quality, competency, and motivation
2.	To prepare business plan and to get familiarize with the various plans based on it
3.	To understand the concept and process of a Marketing plan, its contribution, and role in the growth and development of entrepreneurship.
4.	To learn the process and skills of creation and management of entrepreneurial venture
5.	To gain knowledge on patent filing and design

Pre-requisite (if any)

UNIT 1	**ENTREPRENEUR**	**9**
Entrepreneurial motivation – dynamics of motivation. Entrepreneurial competency – Concepts. Developing Entrepreneurial competencies - requirements and understanding the process of entrepreneurship development, self-awareness, interpersonal skills, creativity, assertiveness, achievement, factors affecting entrepreneur role		
UNIT 2	**BUSINESS IDEAS TO BUSINESS PLAN**	**9**
Discovering ideas and visualizing the business, Activity map, Business Plan - Developing a Business Plan – A Case Study		
UNIT 3	**MARKETING PLAN**	**9**
Market Analysis – Identifying the target market, Competition evaluation and Strategy Development, Choose Your Location and Set Up for Business, Marketing Your Business, Risk analysis		
UNIT 4	**OPERATIONS MANAGEMENT**	**9**
Company's Organization Structure, Recruitment and management of talent. Financial Organization, Financing methods available for entrepreneurs in India, Protect and Insure Your Business, Record Keeping and Accounting, Financial Management.		
UNIT 5	**PATENTS**	**9**
Patents – objectives and benefits of patent, Trademarks, copyright, Geographic indicators, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents. Commercialization of patents		
Total Instructional Hours : 45		



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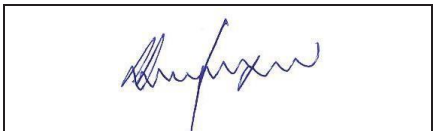
Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Understand the dynamic role of entrepreneurship and small businesses	K2
CO2	Construct a Business Plan	K3
CO3	Develop strategic Marketing plans	K3
CO4	Organize and Manage a Small Business along with its Financial Planning and Control	K3
CO5	Take Part in patent filing	K4

Textbooks	
1.	Hisrich, R.D. and Peters, M.P. (1995): Entrepreneurship – Starting, Developing and Managing a New Enterprise, Richard D., Inwin, INC, USA.
2.	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.

Reference Books	
1.	Entrepreneurship Ideas in Action—South-Western, 2000.
2.	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
3.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	-	-	2	2	1	-	-	1
CO2	2	3	3	3	2	1	-	2	3	3	3	2	2	2
CO3	2	2	3	3	2	1	-	2	3	3	3	2	-	1
CO4	2	2	2	1	2	1	-	1	3	3	3	2	-	-
CO5	2	-	-	-	2	-	-	3	2	3	-	-	3	1
Wt. Avg	**2**	**1.6**	**1.6**	**1.4**	**1.8**	**1**	**-**	**1.6**	**2.6**	**2.8**	**2**	**1.2**	**1**	**1**



Approved by BoS Chairman

B.Tech.	B23BTE940 - INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To make students aware about the Basic Concepts of IP in India & Abroad
2.	To disseminate the practical knowledge on the registration process for different IPRs
3.	To classify the different agreements and treaties related to IP laws.
4.	To make students aware about the cyber law and digital content protection.
5.	To understand and analyze the emerging issues and its preventive measures based on IP laws

Pre-requisite (if any)

UNIT 1	INTRODUCTION	9
Introduction to IPRs, Basic concepts and need for Intellectual Property - IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.		
UNIT 2	**REGISTRATION OF IPRs**	**9**
Meaning and practical aspects of registration of CopyRights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad		
UNIT 3	**AGREEMENTS AND LEGISLATIONS**	**9**
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.		
UNIT 4	**DIGITAL PRODUCTS AND LAW**	**9**
Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.		
UNIT 5	**ENFORCEMENT OF IPRs**	**9**
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.		
Total Instructional Hours : 45		

Course Outcomes After the successful completion of course, the students will be able to:		Knowledge Level
CO1	Relate the Basic Concepts of IP in India & Abroad	K2
CO2	Compare the registration process for different IPRs	K3
CO3	Identify the role of different agreements and treaties related to IP laws.	K3
CO4	Analyze the information on ethical issues linked to Digital innovations and Cyber law.	K4
CO5	Assess the emerging issues and its preventive measures based on IP laws	K5

Approved by BoS Chairman

Textbooks	
1.	Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited
2.	Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited

Reference Books	
1.	Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Edition, 2012.
2.	S. V. Satakar, “Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
3.	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
4	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012

CO-PO-PSO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	-	-	-	-	2	-	2	-	-	-	-	-	-
CO2	2	-	-	-	2	2	-	2	-	2	2	-	2	2
CO3	2	-	-	-	-	2	-	2	-	2	-	-	-	-
CO4	2	2	-	-	3	2	-	2	-	2	-	-	-	2
CO5	2	3	-	-	-	2	-	2	-	2	3	-	3	2
Wt. Avg	**2**	**1**	**-**	**-**	**1**	**2**	**-**	**2**	**-**	**1.6**	**1**	**-**	**1**	**1.2**

Approved by BoS Chairman

B.Tech.	B23BTE941 – BIOSAFETY AND HAZARD MANAGEMENT	L	T	P	C
		3	0	0	3

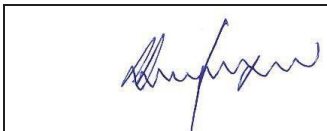
Course Objectives	
1.	To learn about implementation of safety procedures, risk analysis and assessment, hazard identification
2.	To analyze the risk associated with and assess it
3.	To identify and manage the Biohazards.

Pre-requisite (if any)
Bioethics

UNIT 1	INTRODUCTION	9
Need for safety in industries; Safety Programs – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling.		
UNIT 2	**QUALITY CHECKS**	**9**
Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety.		
UNIT 3	**RISK ANALYSIS**	**9**
Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.		
UNIT 4	**SAFETY AUDITS**	**9**
Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras- Vizag Bopal analysis.		
UNIT 5	**HAZARDOUS OPERATIONS**	**9**
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Classify potential hazards and explain the need for safety in industries.	K2
CO2	Apply different quality check and implement safety procedures	K3
CO3	Identify the different risk analysis and their assessment for prevention of hazardous events.	K3
CO4	Make use of the different safety audits and analysis of past accidents	K3
CO5	Explain about various hazardous operations and its impact.	K2

Textbooks	
1.	Skeleton, B., Process Safety Analysis: An introduction, Institution of chemical Engineers, U.K., 1997.
2.	Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis, Dyadem Press, 2004



Approved by BoS Chairman

Reference Books	
1.	Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prentice Hall, NJ, 1990.
2.	Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	-	-	2	2	1	-	-	1
CO2	2	3	3	3	2	1	-	2	3	3	3	2	2	2
CO3	2	2	3	3	2	1	-	2	3	3	3	2	-	1
CO4	2	2	2	1	2	1	-	1	3	3	3	2	-	-
CO5	2	-	-	-	2	-	-	3	2	3	-	-	3	1
Wt. Avg.	**2**	**1.6**	**1.6**	**1.4**	**1.8**	**1**	**-**	**1.6**	**2.6**	**2.8**	**2**	**1.2**	**1**	**1**

Approved by BoS Chairman

B.Tech.	B23BTE942 - BIODIVERSITY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn about different ecosystem and biodiversity in those ecosystem
2.	To understand the threats to biodiversity and to prevent such threats
3.	To study about different conservation approached for biodiversity preservation

Pre-requisite (if any)

Environmental Science and Engineering

UNIT 1	INTRODUCTION TO BIODIVERSITY	9

What is biodiversity, Scientific nomenclature and classification of biodiversity, Conservation and preservation of ecology, Measurement of species diversity, Ecosystem and community diversity, Distribution of biomes and global climate.

UNIT 2	ECOSYSTEM AND DIVERSITY	9

Energy, nutrient cycling and ecosystem services, Natural and sexual selection, Genetic diversity, genetics, and conservation genetics. Global patterns of biodiversity and Desert biogeography.

UNIT 3	THREATS TO BIODIVERSITY	9

Overview of threats to biodiversity, Overexploitation of natural resources, Global climate change, Ecological impacts of climate change, Invasive species, Habitat destruction and fragmentation, cumulative impacts of human population growth.

UNIT 4	BIODIVERSITY CONSERVATION	9

Approaches to the conservation of biodiversity and historical perspectives, Legal protection at the species level: The Endangered Species Act, Applied population ecology: monitoring populations and assessing extinction risk, management and establishment of populations.

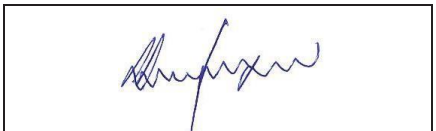
UNIT 5	PROTECTION OF ECOSYSTEM	9

Ex-situ conservation, Protecting and managing ecosystems, Restoring ecosystems, Conservation insights from paleoecology and historical ecology.

Total Instructional Hours: 45

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Classify biodiversity and explain their specification.	K2
CO2	Explain about various nutrient cycles and global patterns of biodiversity.	K2
CO3	Identify the different threats of biodiversity.	K3
CO4	Make use of the different approached for biodiversity conservation.	K3
CO5	Apply different conservation techniques for protection of ecosystem.	K3

Textbooks	
1.	Jadhav, H., & Bhosale, V.M. (1995). Environmental Protection and Laws, Himalaya Pub. House, Delhi
2.	Heywood, V.H., & Waston, R.T. (1995). Global Biodiversity Assessment, Cambridge Univ. Press.



Approved by BoS Chairman

Reference Books	
1.	Cunningham, W.P., Cooper, T.H., Gorhani, E., & Hepworth, M.T. (2001). Environmental Encyclopedia, Jaico Publ. House, Mumbai.
2.	Gleick, H.P. (1993). Water in Crisis, Pacific Institute for Studies in Dev., Environment & Security, Stockholm Env. Institute Oxford Univ. Press.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	2	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	2	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**2**	**3**	**3**

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OPEN ELECTIVE

Open Elective - I

B.E.	B23AEO501- PRINCIPLES OF FLIGHT (Common to all Except AERO)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the different component systems and functions.
2.	To understand the basic properties and principles behind the flight.
3.	To study the basic concepts of Aerodynamics.
4.	To study the different structures & construction.
5.	To study the various types of power plants used in aircrafts.

UNIT - I	AIRCRAFT CONFIGURATIONS	9

Brief History-Components of an airplane and their functions. Different types of flight vehicles, classifications. Basic instruments for flying.

UNIT - II	INTRODUCTION TO PRINCIPLES OF FLIGHT	9

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment. Different types of drag.

UNIT - III	INTRODUCTION TO AERODYNAMICS	9

Aerodynamic forces on aircraft – classification of NACA aerofoils, aspect ratio, wing loading, Mach number, centre of pressure and aerodynamic centre-aerofoil characteristics lift, drag curves.

UNIT - IV	INTRODUCTION TO AIRPLANE STRUCTURES AND MATERIALS	9

General types of construction, Monocoque, semi-monocoque. Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials.

Programme Coordinator

BoS Chairman

UNIT - V	POWER PLANTS USED IN AIRPLANES	9
Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production., Principles of operation of rocket, types of rockets		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Identify the types and classification of components and control system.
CO2	Identify the properties and principles to analyze lift, drag (including types), moment, and their variation with altitude.
CO3	Identify the aerodynamics forces and NACA Airfoils.
CO4	Identify different type of fuselage and constructions.
CO5	Categorize the different types of engines and principles of rocket.

Text Books	
1.	Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2.	E Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021

Reference Books	
1.	Kermode, A.C., “Flight without Formulae”, McGraw-Hill, 1997.
2.	Sadhu Singh, “Internal Combustion Engines and Gas Turbine”, SS Kataraia & Sons, 2015.
3.	Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

Programme Coordinator

BoS Chairman

B.Tech.	B23AGO501 - Farm Automation	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamentals and scope of farm automation systems.
2.	To study various types of sensors and their role in smart farming.
3.	To analyze the working of automation systems in field operations.
4.	To explore greenhouse automation and resource management.
5.	To examine the role of advanced technologies like AI, drones, and robotics in agriculture.

UNIT I	INTRODUCTION TO FARM AUTOMATION	9
Definition and scope – Historical development – Classification of automation systems: manual, semi-automated and fully automated – Benefits of automation – Limitations and challenges – Status of automation in Indian agriculture – Automation in small and large farms – Farm automation value chain – Socio-economic implications.		

UNIT II	SENSORS AND SMART FARMING COMPONENTS	9
Types of sensors: soil moisture, pH, temperature, humidity, light, nutrient sensors – Actuators – Microcontrollers and microprocessors (Arduino, Raspberry Pi) – IoT architecture for agriculture – Wireless sensor networks – Communication protocols – Data acquisition and cloud connectivity – Mobile apps and remote monitoring systems.		

UNIT III	AUTOMATION IN FIELD OPERATIONS	9
Automatic steering and GPS-guided tractors – Variable Rate Technology (VRT) – Autonomous planters and seeders – Spraying automation – Robotic weeders – Harvesting automation – Drones for crop health monitoring – Field mapping – Automation kits – Safety aspects in field automation.		

UNIT IV	GREENHOUSE AND RESOURCE MANAGEMENT AUTOMATION	9
Greenhouse control systems: Temperature, humidity, light, CO_2 , irrigation and nutrient management – Automation of fertigation and irrigation (drip, sprinkler) – Scheduling using weather data – Software tools and apps for DSS – Renewable energy-based automation – Case studies of protected cultivation systems.		

UNIT V	ADVANCED TECHNOLOGIES IN AUTOMATION	9
Artificial Intelligence (AI) and Machine Learning (ML) in farming decisions – Robotics in seeding, pruning, sorting and packaging – Machine vision systems – Drones and UAVs in agriculture – Automation for post-harvest management – Success stories from India and abroad – Future prospects and trends.		
		Total Instructional Hours: 45

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COURSE OUTCOMES: Students will be able to	
CO1	Explain the concept and scope of farm automation.
CO2	Identify and interpret various sensors and smart devices in agriculture.
CO3	Apply automation techniques in field operations.
CO4	Demonstrate the application of automation in greenhouse and resource management.
CO5	Evaluate advanced automation technologies and their integration into smart farming systems.

Text Books	
1.	Nageshwar Rao, *Precision Farming and Agricultural Automation*, Kalyani Publishers, 2020.
2.	Manjunatha K.S., *Farm Machinery and Automation*, Jain Brothers, New Delhi, 2018.
3.	Rajvir Yadav, *Agricultural Automation*, Biotech Books, New Delhi, 2021.

References	
1.	CIGR Handbook of Agricultural Engineering Volume VI – Information Technology, ASABE, USA.
2.	Mehta M.L., Verma S.R., and Sharma V.K., *Farm Machinery and Power Engineering*, Jain Brothers.
3.	Internet of Things: https://nptel.ac.in/courses/106105166
4.	Articles and Case Studies from ICAR, IARI, and SmartFarm India

Approved by BoS Chairman

B.E/ B.TECH	B23ADO501– GEN AI WITH OPEN SOURCE FRAMEWORK	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To Understand the Core Concepts of Artificial Intelligence
2.	To explain the Fundamentals of Generative AI and Its Architectures
3.	To Outline Open-Source GenAI Tools and Frameworks
4.	To identify the Prompt Engineering Techniques and Build Chatbots
5.	To study the Real-World Applications of Generative AI in Open-Source Domains

UNIT-I	BASICS OF AI	9

Introduction to AI - Future of AI – Applications of AI – History of AI- Types of AI- Intelligent Agent: Types of Agents- Characteristics of Intelligent Agents - Structure of Agents – Agents and Environments- Examples of AI.

UNIT-II	GEN AI MODELS	9

Introduction of Gen Ai- Sub Sets of Gen Ai- Model Creation - Types of Generative Ai transformer Based Architecture -LLM- GAN architecture - Training GANs and challenges) - Variants of GANs- VAE : Encoder, Decoder, and Latent space- Applications of VAEs

UNIT-III	OPEN SOURCE GEN AI	9

Gen AI in open source - Benefits of Open source AI -Open source tools for generative AI - Deep learning frameworks for generative AI- Advantages and Disadvantages of these frameworks

UNIT-IV	PROMPT ENGINEERING & CHATBOT DEVELOPMENT	9

Basics of Prompt Engineering- Few-shot - Zero-shot prompting - Prompt tuning vs Fine-tuning - Building a chatbot using: Lang Chain -RAG (Retrieval-Augmented Generation)

UNIT-V	USE CASES OF GEN AI IN OPEN SOURCE	9

Open-Source Generative AI Models-generative ai use cases in open source- visual content- audio generation- Text generation- Manufacturing- Supply chain and logistics- Retail & e-commerce- Automotive.

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	Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Explain Intelligent agents, and their interaction with environments.
CO2	Identify the structure and working principles of various Generative AI models
CO3	Apply open-source tools, frameworks, and platforms
CO4	Discover prompt engineering techniques
CO5	Examine use cases of Generative AI across various domains
TextBooks	
1.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 2021.
2.	Goodfellow I, Bengio Y and Courville, "A Deep Learning", MIT Press. Foster, D, 2022
Reference Books	
1.	Chollet, F. "Deep Learning with Python", Manning Publications, 2018
2.	Martin Musiol, "Generative Ai: Navigating the Course to the Artificial General Intelligence Future", John Wiley Sons, 2024

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B.E / B.Tech	B23AMO501 – PRINCIPLES OF MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of Machine Learning.
2.	To study the Supervised Learning with Classifications.
3.	To analyse Random Forest methods and Backpropagation.
4.	To identify the Clustering Techniques for Data Analysis.
5.	To infer the applications of Machine Learning and Dimensionality Analysis.

UNIT - I	INTRODUCTION	9

Introduction to Machine Learning – Need of Machine Learning – Machine Learning Applications – Types of Machine Learning Systems – Challenges – Machine Learning Process – Data Collection – Exploration – Preparation – Training – Optimization – Performance Measures.

UNIT - II	SUPERVISED LEARNING	9

Classification and Regression Technique – Linear Regression – Polynomial Regression – Logistic Regression – Generalization – Overfitting – Underfitting – Support Vector Machine – Kernels – KNN – Naïve Bayes Classifiers – Decision Tree.

UNIT - III	ENSEMBLE LEARNING TECHNIQUES	9

Random Forest – Ensemble Learning – Bagging – Boosting – Ada Boost – Gradient Boosting – Neural Networks – ANN Perceptron – MLP's and Backpropagation – Hyperparameter Optimization – Dimensionality Reduction.

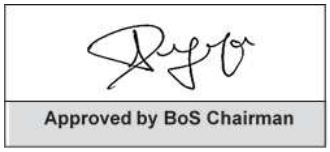
UNIT - IV	UNSUPERVISED LEARNING	9

Clustering – Techniques – K-Means Clustering – AGNES – DIANA – Density Based Clustering (DBSCAN) – Grid Based Clustering – Gaussian Mixtures – Clustering High Dimensionality Data – Outlier Analysis.

UNIT - V	APPLICATIONS OF ENSEMBLE LEARNING	9

Dimensionality Reduction Applications – Factor Analysis – Model Selection & Evaluation – Visualization of Results – Applications of ML : Medical Science, Fraud Detection, Traffic Prediction, Personal Assist, Stock Prediction.

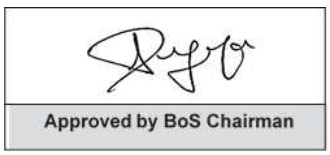
Total Instructional hours: 45



Text Books	
1.	Muller, Andreas C., and Sarah Guido. "Introduction to Machine Learning with Python : A Guide for Data Scientists." 3rd Edition, "O'Reilly Media, Inc.", 2016.
2.	Geron, Aurelien. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow : Concepts, Tools, and Techniques to build intelligent systems. 1st Edition, "O'Reilly Media, Inc.",

Reference Books	
1.	Himanshu Singh, Yunis Ahmed Lone, Deep Neuro-Fuzzy Systems with Python : With Case Studies and Applications from the Industry, 3rd Edition, 2019.
2	Leonardo De Marchi, Hands-On Neural Networks : Learn how to Build and Train Your First Neural Network Model using Python Book, 1st Edition, 2019.
3	James Loy, Neural Network Projects with Python : The Ultimate Guide to using Python to explore the true power of neural networks through six projects. 1st Edition, Kindle Edition,

Course Outcomes : Students will be able to	
CO1	Recall the basics of Machine Learning
CO2	Illustrate the Classification and Regressions
CO3	Identify the Concepts of Neural Networks and Ensemble Learning
CO4	Analyze the features of unsupervised Learning
CO5	Explain the applications of Machine Learning



B.E / B.Tech	BM23BMO501- PRINCIPLES OF BIOSENSORS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study the basic structural ,functional elements, the gaseous exchange and fluid maintenance of the human body.
2.	To learn the organs and structures involved in system formation and functions.
3.	To understand the functions of physiological system
4.	To Know the activity of sensory and motor nerves
5.	To analyse Different Physiological Conditions in the Human Body.

UNIT - I	INTRODUCTION TO BIOSENSOR	9
Biosensors- Advantages and limitations, various components of biosensors, Classification of Biosensors Based on Type of Transduction - Electrochemical, Optical, Acoustic, Calorimetric. Classification of Biosensors Based on Biological Element - Enzyme Sensor, Immunosensors, Cell-based Sensors		

UNIT - II	DESIGN OF BIOSENSOR	9
Introduction, Assay format, Immobilisation-Ligand Activity, Regeneration, Analysis of regeneration data, Signal correction, Buffer scouting, Extracting kinetic affinity constant, Extracting kinetic rate constant, Sensor Surfaces and Receptor Depth, Molecular Interaction.		

UNIT - III	OPTICAL AND BIOCHEMICAL BIOSENSORS	9
Principles of Optical biosensing, Immobilization of bio-recognition elements, Types of optical biosensor: Fiber optic, planar waveguide, Evanescent, Interferometric, and Surface plasmon resonance-biosensor-Applications. Chemical and other sensors - Biocatalysis based biosensors, Bio affinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used		

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in biosensor constructions.

UNIT - IV	IMMUNOSENSOR	9
introduction to Immuno biosensor- Enzyme Biosensor, Bio Affinity Biosensor, Labelled Immuno sensors, Non-Labelled Immuno sensors. Transducer Aspects of Immuno sensor Optical Immunosensor, Piezoelectric Crystal Immunosensors, Electrochemical Immunosensors. Biological Aspects of biosensor- Antibody Development, Immunosensor based Assay Development.		
UNIT - V	**DIAGNOSTIC APPLICATION OF BIOSENSOR**	**9**
Preparation of Doped Sol-Gel Glasses, Application of Sol-Gel Glasses in Biosensors- Glucose Biosensor, Urea Biosensor, Cholesterol Biosensor, Lactate Biosensor. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in healthcare.		
Total Instructional hours : 45		

Course Outcomes: Students will be able to	
CO1	Apply principles and concepts of biology and engineering to design biosensors.
CO2	Apply principles and concepts of electronics and electrochemistry to design electrochemical biosensors.
CO3	Recognize different types of transducers, and their application in biosensor design.
CO4	Apply principles and concepts of sensing and engineering to design biosensors for detection of markers in biofluids.
CO5	Apply engineering tools to evaluate parameters needed for point-of-care devices.

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Text book	
1.	Bansi D Malhotra, Anthony, Advances in Biosensors, Volume 5, 2003, Elsevier, Oxford.
2.	Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996
3.	Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
4.	Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

Reference Books	
1.	Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes, 1990.
2.	Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc. 1998.
3.	Tran Minh Canh - Sensor Physics & Technology – Biosensors, First Edition, Champan & Hall, 1993.
4.	Mathew A.Cooper, Label free Biosensors Techniques and Applications, Cambridge, 2009.

Program Coordinator

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B. TECH.	B23BTO501 – BIOFERTILIZER PRODUCTION AND MUSHROOM CULTIVATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide a comprehensive understanding of the principles and practices of biofertilizer production and mushroom cultivation.
2.	To equip students with knowledge of microbial inoculants and their applications in sustainable agriculture.
3.	To explore the cultivation techniques and nutritional aspects of various edible mushrooms.
4.	To enable students to understand industrial mushroom processing, value addition, and quality control, including nutraceuticals and waste management.
5.	To familiarize students with the quality control and commercial aspects of biofertilizers and mushroom production.

UNIT - I	INTRODUCTION TO BIOFERTILIZERS AND MICROBIAL INOCULANTS	9

Introduction to biofertilizers: Significance and scope. Types of biofertilizers: Nitrogen-fixing, phosphate-solubilizing, potassium-mobilizing, and mycorrhizal biofertilizers. Microbial inoculants: *Rhizobium, Azotobacter, Azospirillum, Pseudomonas, Bacillus, Trichoderma*, and mycorrhizal fungi. Mechanisms of action of biofertilizers: Nitrogen fixation, phosphate solubilization, plant growth promotion. Carrier materials and their properties. Quality control of biofertilizers: Viability, purity, and efficacy testing.

UNIT - II	PRODUCTION TECHNOLOGY OF BIOFERTILIZERS	9

Isolation and characterization of effective microbial strains. Fermentation technology for biofertilizer production: Batch, fed-batch, and continuous fermentation. Scale-up and optimization of biofertilizer production. Formulation and packaging of biofertilizers. Storage and shelf-life of biofertilizers. Quality standards and FCO.

UNIT - III	MUSHROOM CULTIVATION: PRINCIPLES AND PRACTICES	9

Introduction to edible mushrooms: Nutritional and medicinal value. Cultivation techniques for various mushrooms: Oyster, button, shiitake, and milky mushrooms. Substrate preparation and sterilization. Spawn production and inoculation. Environmental control in mushroom cultivation: Temperature, humidity, and ventilation. Pest and disease management in mushroom cultivation.

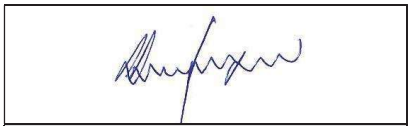
UNIT - IV	MUSHROOM PROCESSING AND VALUE ADDITION	9

Post-harvest handling and preservation of mushrooms. Processing of mushrooms: Drying, canning, and pickling. Value-added products from mushrooms: Mushroom powder, extracts, and nutraceuticals. Mushroom waste utilization. Quality assessment of mushrooms: Sensory, chemical, and microbiological analysis.

UNIT - V	COMMERCIAL ASPECTS AND ENTREPRENEURSHIP	9

Market potential and demand for biofertilizers and mushrooms. Economic analysis of biofertilizer and mushroom production. Entrepreneurial opportunities in biofertilizer and mushroom industries. Marketing and distribution strategies. Intellectual property rights (IPR) and patenting. Government schemes and subsidies.

Total Instructional hours : 45



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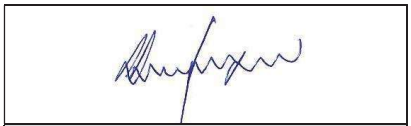
Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Illustrate the principles of microbial inoculant production and application.	K2
CO2	Classify the different types of biofertilizers and their impact on soil fertility.	K2
CO3	Explain the cultivation techniques and nutritional value of various edible mushrooms.	K2
CO4	Demonstrate the quality and safety parameters of biofertilizers and mushroom products.	K2
CO5	Identify the commercial aspects and entrepreneurial opportunities in biofertilizer and mushroom industries.	K3

Text Books	
1.	Subba Rao N.S., "Soil Microbiology", Oxford & IBH Publishing Company, New Delhi, 2002.
2.	Himadri Panda H., "Manufacture of Biofertilizer and Organic Farming", Asia Pacific Business Press Inc., 2024.
3.	Tewari R.P., "Mushrooms: Cultivation, Marketing and Consumption", Daya Publishing House, Delhi, 2005.
4.	Chang S.T., Miles P.G., "Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact", CRC Press, Boca Raton, 2004.

References Books	
1.	Alexander M., "Introduction to Soil Microbiology", John Wiley & Sons, New York, 1977.
2.	Stamets P., "Mycelium Running: How Mushrooms Can Help Save the World", Ten Speed Press, Berkeley, 2005.

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO2	2	1	-	-	-	-	-	2	2	-	-	2	3	3
CO3	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO4	2	2	-	-	-	-	-	2	2	-	-	2	3	3
CO5	2	2	-	-	-	-	-	2	2	-	-	2	3	3
Wt. Avg.	2	2	-	-	-	-	-	2	2	-	-	2	3	3



Approved by BoS Chairman

B.E.	B23CSO501- FOUNDATIONS OF DBMS (Except CSE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the fundamentals of data models, relational algebra and SQL.
2.	To represent a database system using ER diagrams and to learn normalization techniques.
3.	To understand the concepts of transaction, concurrency and recovery processing.
4.	To understand the internal storage structures using different file and indexing techniques
5.	To have basic knowledge about the Distributed databases, NOSQL and DB security

UNIT - I	RELATIONAL DATABASES	9

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL

UNIT - II	DATABASE DESIGN	9

Entity-Relationship model – ER Diagrams – Enhanced-ER Model – ER to Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form

UNIT - III	TRANSACTIONS	9

Transaction Concepts – ACID Properties – Schedules – Serializability – Transaction support in SQL – Need for Concurrency – Concurrency control –Two Phase Locking- Timestamp – Multiversion – Validation and Snapshot isolation– Multiple Granularity locking – Deadlock Handling – Recovery Concepts – Recovery based on deferred and immediate update – Shadow paging – ARIES Algorithm.

UNIT - IV	IMPLEMENTATION TECHNIQUES	9

RAID – File Organization – Organization of Records in Files – Data dictionary Storage – Column Oriented Storage– Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for Selection, Sorting and join operations – Query optimization using Heuristics - Cost Estimation.

Approved by BoS Chairman

UNIT - V	ADVANCED TOPICS	9
Distributed Databases: Architecture, Data Storage, Transaction Processing, Query processing and optimization – NOSQL Databases: Introduction – CAP Theorem – Document Based systems – Key value Stores – Column Based Systems – Graph Databases. Database Security: Security issues – Access control based on privileges – Role Based access control – SQL Injection – Statistical Database security – Flow control – Encryption and Public Key infrastructures – Challenges.		
Total Instructional hours: 45		

Course Outcomes: Students will be able to	
CO1	Construct basic SQL Queries using relational algebra
CO2	Build database using ER model and normalize the database
CO3	Organize transaction-related queries while ensuring consistency and concurrency control
CO4	Evaluate various indexing and file organization strategies to optimize query performance
CO5	Analyze relational DB and NoSQL DB

Text Books	
1.	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020.
2.	Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2017.

Reference Books	
1.	C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.

Approved by BoS Chairman

CO Mapping with PO & PSO

CO/PO & PSO		PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K3														
CO2	K3														
CO3	K3														
CO4	K5														
CO5	K4														
Weighted Average															

3 – Substantial **2- Moderate** **1- Low** **'-' – No Correlation**

Approved by BoS Chairman

B.E / B. TECH	B23ECO501 COMMUNICATION ENGINEERING (Common to All Except ECE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of modulation techniques in generation of amplitude modulation and angle modulation.
2.	To impart knowledge in random process
3.	To familiarize students' optimum receivers for binary digital modulation schemes
4.	To examine digital modulation formats and their power spectral
5.	To understand the properties of spread spectrum techniques to design robust and efficient communication systems

UNIT – I FUNDAMENTALS OF ANALOG COMMUNICATION	9
Basics of communication systems; Fundamentals of Principles of amplitude modulation; AM envelope; frequency spectrum and bandwidth; modulation index and percent modulation; AM Voltage distribution; AM power distribution; Angle modulation; FM and PM waveforms; phase deviation and modulation index; frequency deviation and percent modulation; Frequency analysis of angle modulated waves; Bandwidth requirements for Angle modulated wave.	

UNIT–II RANDOM PROCESS AND SAMPLING	9
Review of probability and random process; Gaussian and white noise characteristics; Noise in amplitude modulation systems; Noise in Frequency modulation systems; Pre-emphasis and Deemphasis; Threshold effect in angle modulation; Low pass sampling; Aliasing; Signal Reconstruction; Quantization; Uniform & non-uniform quantization; quantization noise; Nyquist criterion; Logarithmic Companding; PAM; PPM; PWM; PCM; TDM; FDM.	

UNIT – III DIGITAL TRANSMISSION	9
Optimum Receiver for Binary Digital Modulation Schemes; Description of Binary ASK; PSK; and FSK Schemes; Binary PSK Signaling Schemes; M-ary Signaling Schemes; Synchronization Methods.	

UNIT – IV DIGITAL MODULATION TECHNIQUES	9
Digital modulation formats; Coherent Binary Modulation Techniques: BFSK and BPSK; QPSK; MSK; M-ary QAM; Power spectra of BFSK; BPSK; QPSK and MSK.	
UNIT – V SPREAD SPECTRUM AND MULTIPLE ACCESS	**9**

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PN sequences: properties; m-sequence; DSSS; Processing gain; Jamming; FHSS; Synchronization and tracking; Multiple Access: FDMA; TDMA; CDMA.
Total Instructional hours:45

Course Outcomes: Students will be able to	
CO1	Apply principles of basic communication systems to design basic modulation schemes for efficient signal transmission.
CO2	Apply probability and random process principles to analyze noise in communication systems
CO3	Apply knowledge to design and assess optimum receivers for binary digital modulation schemes like ASK, PSK, FSK, and M-ary systems.
CO4	Analyze and differentiate between digital modulation formats and their power spectral.
CO5	Apply and evaluate concepts of PN sequences, DSSS, FHSS, and multiple access techniques

Text Books	
1.	K Sam Shanmugam, Digital and Analog Communication Systems, Wiley, 2019.
2.	Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2018.
3.	Simon Haykin, "Communication Systems", Wiley India, 4th edition, 2014.

Reference Books	
1.	H.Taub, D L Schilling and G Saha, "Principles of Communication", 4th Edition, Pearson Education, 2017.
2.	B.P.Lathi, Zhi Ding, Hari Mohan Gupta "Modern Analog and Digital Communication Systems", 4th Edition, Oxford University Press, 2017.
3.	Sanjay Sharma, "Communication Systems (Analog and Digital)", S.K. Kataria & Sons; Reprint 2013.
4.	B.Sklar, "Digital communications: Fundamentals and Applications", 2nd Edition, Pearson Education, 2012.

Evaluation Pattern:				
Continuous Internal Assessment				**End Semester Examinations**
CIA I (Theory) (100 Marks)		CIA II (Theory) (100 Marks)		
* Alternate Assessment Tool (AAT)	Written Test	* Alternate Assessment Tool (AAT)	Written Test	Theory End Semester Examinations (Examinations will be conducted for 100 Marks)
40 Marks	60 Marks	40 Marks	60 Marks	
40 Marks				60 Marks
Total: 100 Marks				

* AAT - Individual Assignment/ Case Study/ Seminar/ Mini project/ MCQ/ Role Play/ Group Discussion/ Debates/ Oral Presentations/ Poster Presentations/ Technical Presentations can also be provided course coordinator can choose any one/two components based on the nature of the course.

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B.E	B23EEO501- ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of electric vehicle history and components.
2.	To understand properties of batteries.
3.	To understand the electrical machine properties and classifications.
4.	To understand the properties of electric vehicle drive systems.
5.	To understand the concepts of hybrid electric vehicles.

UNIT-I	INTRODUCTION TO ELECTRIC VEHICLES	9

Present scenario of electric vehicles, Need of electric vehicles, economics, environmental impacts of using electric vehicles, challenges faced by electric vehicles in replacing ICE, major requirements of electric vehicles.

UNIT-II	TYPES OF ELECTRIC VEHICLES AND THE CHALLENGES	9

Types of electric vehicles: Plug-in Electric Vehicle (PEV), Battery Electric vehicle (BEV), Fuel Cell electric vehicle (FCEV), Hybrid electric vehicle (HEV), Challenges of battery electric vehicle, hybrid electric vehicle and fuel cell electric vehicle.

UNIT-III	BATTERY ELECTRIC VEHICLE	9

Components of BEV drive train: electric propulsion subsystem - power converter, driving wheels, suspension system, driveshaft, mechanical transmission, electric Motor, power electronics converters (DC-AC/DC-DC), electronic control unit, energy source subsystem, battery pack with battery management system, On board charger, auxiliary subsystem, power steering unit, common parts between ICE drive train and EV drive train.

UNIT-IV	HYBRID AND FUEL CELL ELECTRIC VEHICLE	9

Basic architecture of hybrid drive trains, components of HEV drive train system, classification of HEV: conventional HEV (Micro, Mild and Full hybrid- series hybrid, parallel hybrid, series-parallel hybrid, complex hybrid), Basic architecture of FCEV, components of FCEV drive train system.

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UNIT-V	ENERGY STORAGE	9
Battery-based energy storage, Overview of batteries, Battery parameters, battery charging, regenerative braking, alternative novel energy sources: solar photovoltaic cells, fuel cells, super capacitors, and flywheels.		
		Total Instructional hours:45

Course Outcomes: **Students will be able to**	
CO1	Illustrate the basics of electric vehicle history and components.
CO2	Classify the different types of electric vehicles.
CO3	Apply the battery properties in an electric vehicle.
CO4	Develop the hybrid and fuel cell electric vehicle.
CO5	Illustrate the concept of energy storage devices.

Text Books	
1.	Electric & Hybrid Vehicles – A.K. Babu, Khanna Publishing House, New Delhi, 2018.
2.	Electric & Hybrid Vehicles – Design Fundamentals – Iqbal Hussain, Second Edition, CRC Press, 2011.
3.	Electric Vehicle Battery Systems – Sandeep Dhameja, Newnes, 2000.
4.	Husain, I. (2021). Electric and Hybrid Vehicles: Design Fundamentals (3rd Edition). CRC Press.

Reference Books	
1.	Electric Vehicle Technology Explained - James Larminie, John Wiley & Sons, 2003
2.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals – Mehrdad Ehsani,Yimin Gao, Ali Emadi, CRC Press, 2010.
3.	Chan, C. C., & Chau, K. T. (2001). Modern Electric Vehicle Technology. Oxford University Press.
4.	Larminie, J., & Lowry, J. (2023). Electric Vehicle Technology Explained (3rd Edition). Wiley.

Approved by BoS Chairman

B.E.	B23MEO501 - ROBOTICS	L	P	TU	C
		3	0	0	3

Course Objectives	
1.	To understand the concepts of the basic components of a robot
2.	To apply the distinct drive systems and end effectors to control the robot actuation
3.	To study the role and application of various types of sensors and machine vision system
4.	To make use of the knowledge in the robot kinematics and to write Robot Programs
5.	To identify the social and economic challenges while implementing the robot systems

UNIT - I	FUNDAMENTALS OF ROBOT	9

Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification - Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions- Different Applications - A view on Global and Indian manufacturers of Robots - Need for Robots in Indian environment.

UNIT - II	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9

Drives - hydraulic, pneumatic, mechanical, electrical, Servo motors, Stepper motors - salient features, application; End effectors – types; Grippers - mechanical, pneumatic, hydraulic, magnetic, vacuum - limitations, Multiple grippers.

UNIT - III	SENSORS AND MACHINE VISION	9

Requirements of sensors, principles, types and applications of Proximity (Inductive, Hall effect, Capacitive, Ultrasonic and Optical); – Range (Triangulation, Structured light approach); Speed, Position (resolvers, optical encoders); – Force – Torque – Touch sensors (binary, analog sensor). Introduction to Machine Vision; applications, functions; image processing and analysis; training the vision system.

UNIT - IV	ROBOT KINEMATICS AND ROBOT PROGRAMMING	9

Forward kinematics and Reverse kinematics of manipulators; two, three degrees of freedom, homogeneous transformation matrix; introduction to manipulator dynamics, trajectory generator, manipulator mechanism, Degeneracy and Dexterity; Lead through programming, Robot programming languages; VAL programming, motion commands, sensor commands, end effecter commands, simple programs (for loading, unloading and palletizing operations), introduction to advances in Robot Programming.

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UNIT - V	APPLICATION, IMPLEMENTATION AND ROBOT ECONOMICS	9
Robot cell design; types, application of robots in processing, assembly, inspection, material handling in automobile, medical, Nuclear Industries, RGV, AGV; Implementation of Robots in Industries; Safety considerations for robot operations, safety codes, Economic analysis of robots.		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Explain the concepts of industrial robots, classification, specifications and coordinate systems.
CO2	Illustrate the different types of robot drive systems as well as robot end effectors.
CO3	Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
CO4	Develop robotic programs for different operations and familiarize with the kinematics motions of robot.
CO5	Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

Text Books	
1.	Groover M.P., “Industrial Robotics - Technology Programming and Applications”, McGraw Hill, 2012.
2.	Deb S R and Deb S, Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.
3.	Saha S K, Introduction to Robotics, Tata McGraw Hill Education Pvt. Ltd, 2010, 2nd Ed, 2014.

Reference Books	
1.	Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, Global Edition, 3rd Edition, 2014.
2.	Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3.	Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis, Oxford University Press, Sixth impression, 2010.

Approved by BoS Chairman

B.E / B.TECH	B23CBO501 FRONT END DEVELOPMENT	T	P	TU	C
		3	0	1	3

Course Objectives	
1.	To interpret the basics of front end development and modern development tools.
2.	To device a front end design with HTML Tags.
3.	To work with HTML Forms and Implement Layouts Using Frames and iFrames
4.	To design a dynamic webpage using CSS.
5.	To articulate client side activities on a web site using Javascript.

UNIT- I INTRODUCTION TO FRONT END DEVELOPMENT	9
Introduction to web - WWW - Web server and client, URL, URI,URN-Internet addresses and IP classes Web protocols -TCP/IP,UDP, MIME.SMTP,POP3,HTTP & HTTPS-MVC-Model, View, Controller of Web design-Role of front end developer and Modern Front end Tools.	

UNIT-II HTML (HYPERTEXT MARKUP LANGUAGE)	9
Introduction to HT ML - HTML s HTML5 - Basic HTML Structure - HTML Elements, Attributes and properties - Formatting tags - Lists & symbols -Ordered Lists -Unordered Lists- Descriptive Lists - Hyperlinks- Multimedia: Images, Audio, Video tags	

UNIT- III HTML TABLES & FORMS	9
HTML table :Table border, row, column header, rowspan & colspan, cell spacing and cell padding HTML forms: Form elements- Text, Textarea, Password field, Label-Checkbox, Radio Button. Selection List - Button -Frames & iFrames	

UNIT- IV CSS (Cascading style sheets)	9
Introduction to style sheets: Cascading style sheets-CSS properties - CSS selectors - Pseudo classes and elements - Types of CSS: Inline, Embedded, External style sheet-Case study Talwind CSS	

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UNIT- V CLIENT SIDE SCRIPTING	9
Introduction to Javascript, Javascript features -Datatypes, Variables , Literals & Operators – Control structures -Arrays - Predefine functions & User defined functions – Javascript - DOM objects - Case study- npm, NodeJs.	
Total Instructional hours: 45	

Course Outcomes: Students will be able to	
CO1	**Interpret the working of web sites, web servers and modern front-end**
CO2	Build web pages of a website with HTML
CO3	Develop web site for process and Implement Layouts Using Frames and
CO4	Construct dynamic styles using CSS.
CO5	Build client side activities with Javascript.

Text Books:

1.Uttam K.Roy,"Web Technologies" by, Oxford University Press 2010, First edition, eight impression 2014.

Reference Books :

1.Thomas Powell , "HTML& css: The Complete Reference", Fifth Edition Paperback - 1, Tata McGrawHill, July 2017.

2.. Laurence Lars Svekis , Maaike Van Putten , Rob Percival ," JavaScript from Beginner to Professional: Leam JavaScript quickly by building fun, interactive, and dynamic web apps. games, and pages", Packt, December 2021.

Approved by BoS Chairman

Open Elective - II

B.E.	B23AEO601 – UNMANNED AIRCRAFT SYSTEMS OPERATION AND MRO (Common to all Except AERO)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the working principles of aircraft engine and fuel systems.
2.	To understand the lighting technologies and pressurization system of the aircraft cabin.
3.	To realize the warning and protection systems of the aircraft.
4.	To expose on terrain warning systems of the safety of the aircraft.
5.	To gain knowledge on FDR and anti-fire protection system.

UNIT - I	DRONE RULES & BASIC PRINCIPLES OF FLIGHT	9

International Rules- Regulations, Standards & Practices, Dos and Do not, Civil Aviation Requirements- AIPs, NOTAM, Classification & Categorization of drones, Type Certification of Drones, Registration, Sale & De-Registration of Drones, Operations of Drones, Dos and Donts, Remote Pilot Licensing, Drone Insurance Fundamentals of flight, Aerodynamics, Take-off, flight, and landing. Maneuvers, turns and circuit pattern.

UNIT - II	ATC PROCEDURES & RADIO TELEPHONY (NON FRTOL) WEATHER AND METEOROLOGY	9

Understanding ATC operations, Airspace structure and Airspace, Restrictions with knowledge of no drone zones, RT Phraseology & Communicating with ATC including Position and Altitude Reporting. Flight Planning Procedures including Altimeter setting procedures. Collision avoidance. Radio Telephony (RT) techniques, The standard atmosphere, Measuring air pressure, Heat and temperature, Wind. Moisture, cloud formation, icing and its effects. Effect of atmosphere on RPAS operation & hazardous weather avoidance, Met Terminal Aviation Routine Weather Report (METAR).

UNIT - III	FIXED-WING & ROTORCRAFT OPERATIONS AND AERODYNAMICS	9

Types of fixed wing drones, make, parts, terminology, Operation and maneuvers of fixed wing drones, Flight Performance. Intro to Mission Planning, Instrument Flying & Navigation (GCS). Applications of fixed-wing UAVs. Pros and Cons of Fixed Wing Drones Rotorcraft- Basic drone terminology & parts,

Programme Coordinator

BoS Chairman

Types of drones, material used and size of drones, Drone Anatomy: Different parts of drones, Avionics & C2 Link, Intro to Mission Planning, Instrument Flying & Navigation (GCS). Applications and operations of Multirotor, Flight Performance. Pros and Cons of Rotorcraft Drones.

UNIT - IV	HYBRID OPERATIONS, AERODYNAMICS & EQUIPMENT MAINTENANCE	9
Principles of Aerodynamics, Types of Hybrid Drones & Parts, Intro to Mission Planning, Instrument Flying & Navigation (GCS), Applications of Hybrid UAVs, Comparison with Rotorcraft & Aeroplane Drone Equipment Maintenance- Maintenance of drone, flight control box, ground station, Maintenance of ground equipment, batteries and payloads, Scheduled servicing, Repair of equipment, Fault finding and rectification.		

UNIT - V	SAFETY MANAGEMENT, PAYLOAD, & DATA & ANALYSIS	9
Drothe Emergency & Handling, Loss of C2-link, Fly-aways (Straying), Loss of power, Other Emergencies, Control surface failures, Human Performance & Pilot Incapacitation, Fail-Safe Features, Types of payloads - What to carry, what not to carry, Parts of payloads, Installation, Features of payloads, Utilization, Principles of Observation, Elements of Image & Video Interpretation, Introduction to Photogrammetry, Types of Image & Video Data, Analysis.		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Explain the Basics of Ignition and Fuel System of an Aircraft. (K2)
CO2	Illustrate the Flight Compartment Lighting Technologies and Cabin Air Conditioning system. (K2)
CO3	Identify the Warning and Protection Systems for the Ice Formation and Rain in the Airframe of the Aircraft During Flight. (K3)
CO4	Apply the Terrain Warning Systems to avoid the Terrain Collision of an Aircraft. (K3)
CO5	Examine the FDR and Fire Protection System to Monitor the Flying Performance of the Aircraft. (K4)

Text Books	
1.	“Aircraft Electrical and Electronic Systems”, Principles, operation and maintenance by Mike Tooley and David Wyatt.

Programme Coordinator	**BoS Chairman**

Reference Books	
1.	Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
2.	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.
3.	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.

Programme Coordinator

BoS Chairman

B.Tech.	B23AGO601 - Environmental Management in Agriculture	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To provide knowledge on natural resource use and environmental sustainability in agriculture.
2.	To understand the causes and impacts of pollution from agricultural activities.
3.	To explore the principles and methods of environmental impact assessment (EIA).
4.	To study the role of waste management and resource recycling in agriculture.
5.	To introduce climate-smart agriculture and mitigation strategies for sustainable development.

UNIT I	NATURAL RESOURCES AND SUSTAINABILITY	9

Natural resources – classification and utilization in agriculture – Sustainable use of soil, water, biodiversity – Ecological footprint – Concept of carrying capacity – Environmental indicators – Role of agriculture in environmental degradation – Policies for sustainable agriculture – SDGs related to environment and agriculture.

UNIT II	AGRICULTURE AND POLLUTION	9

Agricultural pollution – causes and effects – Soil pollution due to fertilizers, pesticides and heavy metals – Water pollution: runoff, eutrophication, groundwater contamination – Air pollution: burning of residues, methane, ammonia emissions – Noise pollution from farm machinery – Agrochemical residues and food chain contamination – Preventive strategies.

UNIT III	ENVIRONMENTAL IMPACT ASSESSMENT (EIA)	9

Concept and need for EIA – Components and stages of EIA – Screening, scoping, impact prediction, mitigation – EIA methods (checklist, matrix, network) – Public participation – Environmental Management Plan (EMP) – Environmental audit – Case studies of agricultural projects (dams, irrigation, fertilizer units).

UNIT IV	AGRICULTURAL WASTE AND RESOURCE MANAGEMENT	9

Types of agricultural waste – crop residues, livestock waste, agro-industrial waste – Collection, handling and disposal – Waste minimization – Composting, vermicomposting, biogas production – Biomass energy – Circular economy in agriculture – Integrated farming and nutrient recycling – Wastewater reuse in agriculture.

UNIT V	CLIMATE CHANGE AND SUSTAINABLE FARMING	9

Climate change: causes and impact on agriculture – GHG emissions from agriculture – Carbon sequestration – Climate-smart agriculture – Conservation agriculture – Precision farming – Agroforestry and carbon farming – Green technologies in agriculture – Institutional frameworks (UNFCCC, IPCC, ICAR).

Total Instructional Hours: 45

COURSE OUTCOMES: Students will be able to

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CO1	Understand the sustainable use of natural resources in agriculture.
CO2	Identify environmental pollution sources and their impact from agriculture.
CO3	Apply EIA techniques for environmental planning in agricultural projects.
CO4	Utilize waste management techniques for environmental protection.
CO5	Implement climate-resilient and sustainable agricultural practices.

Text Books	
1.	Rattan Lal and B.A. Stewart, *Soil and Environmental Management*, CRC Press, 2020.
2.	N.T. Kumbhar, *Environmental Management in Agriculture*, Himalaya Publishing House, 2018.
3.	G.N. Tiwari and R.K. Mishra, *Environmental Pollution and Management*, Narosa Publishing House, 2015.

References	
1.	D.W. Sims, *Agricultural Waste Management*, FAO Publications.
2.	Shukla, S.K. & Pandey, P., *Climate Smart Agriculture*, Springer, 2021.
3.	EIA Guidelines – Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India.
4.	NPTEL: https://nptel.ac.in/courses/120108004

Approved by BoS Chairman

B.E/ B.TECH	B23ADO601-HUMAN COMPUTER COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To outline the basic knowledge of HCI.
2.	To classify the design process and rules.
3.	To apply the evaluation techniques and HCI models.
4.	To make use of communications and human factors.
5.	To develop the understanding of user interface.

UNIT - I	INTRODUCTION TO HCI	9

Introduction to HCI - A discipline involved in HCI- Importance of HCI - The psychology of everyday things - Principles of HCI - Input–output channels - Human memory -Thinking: reasoning and problem solving - Conceptual Models – Interface Metaphors – Interaction Types – Paradigms and Frameworks. Cognitive Aspects: Cognition – Cognitive Framework. Social Interaction – Emotional Interaction.

UNIT - II	HCI DESIGN PROCESS AND DESIGN RULES	9

The software design process - User focus – Scenarios - Navigation Design - Screen Design - Prototyping techniques - Wire-Framing - Understanding the UI Layer and Its Execution Framework, Model-View-Controller(MVC) Framework - Principles that support usability, Design standards, Design Guidelines, Golden rules and heuristics, User interface management system (UIMS).

UNIT - III	EVALUATION TECHNIQUES AND HCI MODELS	9

Goals of evaluation - Evaluation Criteria - Evaluation through expert analysis - Evaluation through user participation - Choosing an Evaluation Method - Goal and task hierarchy model - Linguistic model - Physical and device models - Cognitive architectures - Hierarchical task analysis (HTA) - Uses of task analysis - Diagrammatic dialog design notations - Computer mediated communication - Ubiquitous Computing.

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UNIT - IV	COMMUNICATION AND HUMAN FACTORS	9

Face-to-face Communication - Conversation - Text-based Communication - Group working - Dialog design notations - Diagrammatic notations - Textual dialog notations - Dialog semantics - Dialog analysis and design – Groupware - Meeting and decision support systems - Shared applications and artifacts - Frameworks for groupware Implementing synchronous groupware - Mixed - Augmented and Virtual Reality.

UNIT - V	FUTURE OF HCI AND USER INTERFACE	9

The future of HCI - perceptual interfaces, context-awareness and perception –User centered design - Interfaces: Types – Natural User Interfaces, Importance of user Interface and good design - Principles of user interface. - The graphical user interface – popularity of graphics, the concept of direct manipulation - graphical system - Characteristics - Web user – Interface popularity.

Total Instructional hours: 45

Course Outcomes: Students will be able to	
CO1	Illustrate the importance of human computer interaction.
CO2	Explain the design process and design rules.
CO3	Develop the understanding of evaluation techniques and HCI models.
CO4	Demonstrate the concept of communication and human factors.
CO5	Apply the user centered deign methods.

Text Books	
1.	A Dix, Janet Finlay, G D Abowd, R Beale., Human-Computer Interaction, 3rd Edition, Pearson Publishers,2018
2.	Wilbert O. Galitz, "The Essential Guide to User Interface Design: An Introduction to Gui Design Principles and Techniques", Third Edition, John Wiley Sons, 2017..

Reference Books	
1.	Sharp, H., Rogers, Y., and Preece, J, "Interaction Design: Beyond Human – Computer Interaction", Third Edition, John Wiley & Sons, Inc., 2021.
2.	Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson Publishers, 2020.

Approved by BoS Chairman

B.E / B.Tech	B23AMO601 - AI FOR SMART SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To recall the different types of AI based on capabilities and functionality
2.	To discuss the ethical implications of AI and how they affect societal impact
3.	To analyze a case study of AI-enhanced weather forecasting and evaluate its effectiveness in agricultural applications
4.	To evaluate the potential future trends and ethical dilemmas in the integration of AI in healthcare and autonomous systems
5.	To design a functional interactive AI system, such as a food delivery app, integrating AI technologies like voice recognition and user interaction design

UNIT - I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9

Basics of AI: Definition and origins - Intelligence and its measurement - History and evolution of AI technologies - Overview of AI applications in smart systems - Types of AI: Based on Capabilities and Functionality - The Role of Ethics in AI Governance - Symbolic AI vs. Connectionist AI - Autonomous Vehicles and Intelligent Transportation Systems

UNIT – II	AI METHODOLOGIES AND TECHNIQUES	9

Introduction to Robotics and AI – Ethics of AI – Machine learning basics – Supervised learning - Unsupervised learning – AI in smart homes - Impact of AI in society

UNIT – III	ADVANCED AI TOPICS	9

Soft Computing: Overview and applications - Chat Bots and Conversational AI: Design and development - AI in Cyber-Physical Systems: Integration and challenges - AI-enabled IoT: Concepts – Case study : Agriculture: AI-Enhanced Weather Forecasting

UNIT – IV	APPLICATIONS OF AI IN SMART SYSTEMS	9

AI in Healthcare: Diagnostics and personalized medicine - AI in Automotive Systems: Autonomous vehicles - AI in Robotics: Intelligent control and navigation - Ethical considerations and future trends in AI

UNIT – V	INTERACTIVE AI SYSTEM DESIGN	9

Fundamentals of Human-AI Interaction - Role of AI in personal assistants – Interactive AI in customer service – AI in Education – Voice recognition systems - Future Trends in Interactive AI Design - Case Study: Designing an Interactive Food Delivery App

Total Instructional hours: 45

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Recall the definition and origins of AI, including its historical evolution and types based on capabilities and functionality.
CO2	Apply AI methodologies, such as machine learning, to analyze and solve problems in smart home systems.
CO3	Evaluate the effectiveness of AI in solving real-world problems.
CO4	Discuss the ethical considerations and predict future trends in the development of AI technologies.
CO5	Analyze trends in the future of interactive AI design, including advancements in voice recognition systems and their potential impact on different sectors.

Text Books	
1.	Khan, I. U., Ouaissa, M., Ouaissa, M., Fayaz, M., & Ullah, R., Artificial Intelligence for Intelligent Systems: Fundamentals, Challenges, and Applications, CRC Press, 1st Edition, 2024.
2.	Ramana, T. V., Ghantasala, G. S. P., Sathiyaraj, R., & Khan, M., Artificial Intelligence and Machine Learning for Smart Community, CRC Press, 1st Edition, 2023.

Reference Books	
1.	P, M., Kumar, M. V., & Umamaheswari, R., Machine Learning and IoT for Intelligent Systems and Smart Applications, CRC Press, 1st Edition, 2022.
2.	Venkatesh, C., Rengarajan, N., Ponmurugan, P., & Balamurugan, S., Smart Systems for Industrial Applications, Scrivener Publishing, 1st Edition, 2022.
3.	Tanwar, R., Bhatia, S., Sapra, V., & Ahuja, N. J. (Eds.). (2024). Artificial Intelligence and Machine Learning: An Intelligent Perspective of Emerging Technologies. CRC Press.
4.	Kose, U., Prasath, V. B., Mondal, M., Podder, P., & Bharati, S. (Eds.). (2022). Artificial Intelligence and Smart Agriculture Technology. *Auerbach Publications.*

Approved by BoS Chairman

B.E / B.Tech	BM23BMO601- MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the electrode behavior and amplifiers
2.	To gain knowledge of various biopotential measurement
3.	To familiarize various electrical and non-electrical physiological parameters.
4.	To learn biochemical measurement
5.	To learn recent trends for biomedical applications

UNIT - I	BIOPOTENTIAL ELECTRODES AND AMPLIFIERS	9

Cell potential- Resting and Action potential, Electrode Electrolyte Interface, Types of electrodes, Bio signal characteristics– frequency and amplitude ranges, Bioamplifier, isolation amplifiers – transformer and optical isolation, Artifacts and removal.

UNIT - II	BIOPOTENTIAL MEASUREMENT	9

ECG – Einthoven 's triangle, standard 12 lead system, block diagram. Measurement of heart sounds - PCG. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG

UNIT - III	PHYSIOLOGICAL PARAMETER MEASUREMENT	9

Temperature, Respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure measurement-direct and indirect method. Blood flow - Ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method, GSR Measurement, Patient Monitoring system

Program Coordinator

Approved by BOS Chairman

UNIT - IV	BIOCHEMICAL MEASUREMENT	9
Blood gas Analyzer, Blood Glucose measurement, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyser.		
UNIT - V	**RECENT TRENDS**	**9**
Point of care devices, Endoscopy unit, Radio pill, laproscopy, Applications of Laser in medicine, cryogenic application. Biotelemetry, Telemedicine, m-health.		
Total Instructional hours : 45		

Course Outcomes: Students will be able to	
CO1	Understand the electrode behavior
CO2	Comprehend the fundamentals of Bio potential recording.
CO3	Design various bio amplifiers
CO4	Measure various electrical and non-electrical physiological parameters.
CO5	Understand different monitoring system

Text book	
1.	Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”,Pearson Education, 4th Edition, 2014.
	John G.Webster, “Medical Instrumentation Application and Design”, John Wiley and and Sons,New York, 4th Edition, 2009.

Program Coordinator

Approved by BOS Chairman

Reference Books	
1.	Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,3 rd Edition, 2014.
2.	Richard Aston, “Principles of Biomedical Instrumentation and Measurement” Merril PublishingCompany, 1990.
3.	L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3 rd Edition,John Wiley and Sons, Reprint 2008.

Program Coordinator

Approved by BOS Chairman

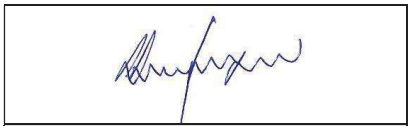
B. Tech.	B23BTO601 – BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To know the knowledge of databases and its maintenance.
2.	To provide the basic concept of various algorithms
3.	To deliver the knowledge on protein designing and its interactions.

Pre-requisite (if any)
Biochemistry, Molecular Biology, Protein Engineering

UNIT 1	INTRODUCTION TO BIOINFORMATICS	9
Scope of Bioinformatics, Databases- DBMS, Biological databases-classification-importance, Sequence Databases- GenBank, NCBI, DDBJ, EMBL, UniProt, SWISS-PROT, PIR, TrEMBL, Structural Databases-PDB, SCOP, CATH, pfam.		
UNIT 2	**SEQUENCE ANALYSIS**	**9**
Sequence Alignment- Sequence Homology Vs Sequence Identity Vs Sequence Similarity, Types of Sequence alignment methods- PSA, MSA, Scoring Function and Substitution Matrices-PAM & BLOSUM, Algorithms-Needleman-Wunch & Smith-Watermann, BLAST and its types, FASTA.		
UNIT 3	**PHYLOGENETIC RELATIONSHIPS**	**9**
Introduction to Phylogenetics-Parts of Phylogenetic Tree-Types of trees, Molecular Clock Theory, Distance Based Method- UPGMA, NJ, Character Based Method- Maximum Parsimony Method, Maximum Likelihood Method, Method of evaluating phylogenetic tree- Bootstrapping, Jackknife resampling, Data perturbation.		
UNIT 4	**STRUCTURAL ANALYSIS**	**9**
Protein Structure Visualization, Structural Prediction- Primary structure & Secondary Structure, tertiary Structure-Homology Modelling, Hidden Markov Model, Threading, Ab-initio method, Validation by Ramachandran plot.		
UNIT 5	**APPLICATIONS**	**9**
System Biology-Introduction and its importance, Microarray Data analysis, Approaches to drug designing and discovery.		
Total Instructional Hours: 45		

Course Outcomes After the successful completion of the course, the students will be able to,		Knowledge Level
CO1	Examine various biological databases.	K4
CO2	Compare genomic and proteomic sequences using various bioinformatics tools.	K5
CO3	Measure the evolutionary relationship using phylogenetic methods	K5
CO4	Compare vast genomic and proteomic dataset.	K5
CO5	Develop basic bioinformatics scripts with Perl programming.	K6

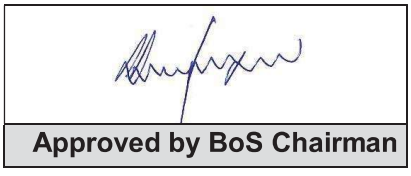


Approved by BoS Chairman

Text Books	
1.	Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press. ,4th edition 2014
2.	Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press. 1999
3.	Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison, Cambridge University Press. 2013
4.	Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press. 2nd edition, 2004.

Reference Books	
1.	Next Generation Sequencing Data Analysis, by Xinkun Wang CRC Press 2016

CO-PO-PSO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	3	3	3	2	3	3	2	3
CO2	3	2	3	3	2	2	2	3	1	3	3	3	3	2
CO3	3	3	2	2	3	3	2	2	2	3	2	2	3	3
CO4	2	3	2	3	3	3	3	3	2	2	2	3	2	3
CO5	3	3	3	2	2	3	2	3	3	3	3	3	2	2
Wt. Avg.	**2.8**	**2.6**	**2.6**	**2.4**	**2.6**	**2.6**	**2.4**	**2.8**	**2.2**	**2.6**	**2.6**	**2.8**	**2.4**	**2.6**



Approved by BoS Chairman

B.E.	B23CSO601- FOUNDATIONS OF WEB DEVELOPMENT (Except CSE)	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the structure of websites and fundamental web technologies such as HTML5 and CSS3.
2.	To understand basic programming concepts using Java for web development.
3.	To explore dynamic client-side functionalities using JavaScript and DHTML.
4.	To identify the role of server-side programming and databases in web applications.
5.	To apply web development knowledge for building basic interactive applications.

UNIT - I	BASICS OF WEB	9

Basics of Internet – Web Clients and Servers – HTTP Protocol – Web Communication. HTML5: Tags, Forms, Tables, Lists, Multimedia Integration (Audio, Video). CSS3: Styling Text and Layout – Inline, Embedded, External Style Sheets – Responsive Layout

UNIT - II	PROGRAMMING CONCEPTS	9

Need for Programming in Web Development – Java Overview – Simple Java Program Structure – Variables, Data Types, Operators, Control Structures – Arrays – Methods – Introduction to Classes and Objects (no inheritance). Use of Java in Web and GUI Applications

UNIT - III	JAVASCRIPT AND DYNAMIC WEB PAGES	9

JavaScript Basics: Variables, Operators, Conditional Statements, Loops – Functions. Working with Forms – Validations – DOM Manipulation – Popups and Events. DHTML: Combining HTML, CSS, JavaScript for Simple Interactions.

UNIT - IV	SERVER-SIDE PROGRAMMING BASICS	9

Overview of Server-Side Scripting – Introduction to Java Servlets – Servlet Lifecycle – Handling Form Data using GET and POST – Session Management – Basics of Cookies. Web Server Setup: Apache Tomcat (Overview and Setup).

UNIT - V	DB CONNECTIVITY AND APPLICATIONS	9

Basics of Database for Web – Introduction to JDBC – Connecting Java Applications to Databases – Sample Data Insertion and Retrieval – Use Cases in Industry and Healthcare Systems. Mini Case Study: Simple Web Application with Form Input and Database Storage.

Total Instructional hours: 45

Approved by BoS Chairman

Course Outcomes: Students will be able to	
CO1	Outline core components of web applications including HTML5 and CSS3.
CO2	Apply basic Java programming for developing interactive functionalities
CO3	Develop dynamic client-side interactions using JavaScript and DHTML
CO4	Explain the workflow of server-side programs and sessions using Java servlets
CO5	Construct a simple web application integrating frontend, server-side logic, and database

Text Books	
1.	Kogent Learning Solutions Inc., Web Technologies Black Book, Dreamtech Press, 2018.
2.	Budi Kurniawan, Servlet & JSP: A Tutorial, 2nd Edition, Brainy Software Inc., 2015.

Reference Books	
1.	Deitel P.J. & Deitel H.M., Internet and World Wide Web How to Program, Pearson Education, 2020.
2.	Jeffrey C. Jackson, Web Technologies: A Computer Science Perspective, Pearson Education, 2011.
3.	Herbert Schildt, Java: A Beginner's Guide, McGraw-Hill, 2018.

CO Mapping with PO & PSO

CO/PO & PSO		PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2														
CO2	K3														
CO3	K3														
CO4	K2														
CO5	K3														
Weighted Average															

3 – Substantial **2- Moderate** **1- Low** **'-' – No Correlation**

Approved by BoS Chairman

B.E / B. TECH	B23ECO601 - WIRELESS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Understand Introduction about wireless Communication.
2.	Study the basic concepts of channel modeling.
3.	Learn the access schemes in wireless communication.
4.	Understand channel capacity in wireless communication system.
5.	Learn evolution of wireless technologies.

UNIT I INTRODUCTION	9
Introduction to wireless communication systems-Cellular concept – system design fundamentals Handoff Strategies- Interference and system capacity, Improving Coverage and Capacity	

UNIT II CHANNEL MODELING	9
Free space propagation model, Reflection- Diffraction — Scattering - Log-normal shadowing. Small-scale multipath propagation, Types of small-scale fading, Rayleigh and Ricean distribution, Input /output model of the wireless channel-Time and frequency coherence-Statistical channel models	
UNIT III ACCESS SCHEMES AND DIVERSITY	**9**
FDMA, TDMA, CDMA, SDMA and CSMA, OFDMA. Diversity Techniques—Frequency diversity, Time diversity, Code diversity, Antenna diversity–RAKE Receiver-SIMO, MISO, MIMO, MIMO-OFDM Technique	
UNIT IV CAPACITY OF WIRELESS CHANNELS	**9**
AWGN channel capacity — capacity of flat fading channels, Frequency-selective fading channels, Multiuser capacity, Downlink channel capacity, Uplink channel capacity, Outage capacity	
UNIT V EVOLUTION OF WIRELESS TECHNOLOGIES	**9**
Mobile Technologies - GSM, 3G, 4G (LTE) and 5G technologies, Wireless LAN Technologies and WLL.	
	Total Instructional hours: 45

Approved by BOS Chairman

Course Outcomes: Students will be able to	
CO1	Learn fundamentals of wireless communication.
CO2	Understand the concepts of channel modeling.
CO3	Study various access schemes in wireless communication.
CO4	Understand channel capacity in wireless networks.
CO5	Learn evolution of wireless technologies.

Text Books	
1.	Andrea Gold smith, " Wireless Communications", Cambridge University Press, 2012.
2.	DavidTse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2015.

Reference Books	
1.	Kamilo Feher,"Wireless Digital Communications, Modulation & Spread Spectrum Applications", PHI, 2015.
2.	William C.Y.Lee, "Mobile Communication Engineering", McGraw Hill, 2014.
3.	Theodore S.Rappaport, "Wireless Communications", Pearson Education,2017
4.	Andreas F.Molisch,"Wireless Communications", Wiley, 2011.
5.	Learn evolution of wireless technologies.

<table>
<tr><th colspan="5">Evaluation Pattern:</th></tr>
<tr><th colspan="4">Continuous Internal Assessment</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">CIA I (Theory)
(100 Marks)</td><td colspan="2">CIA II (Theory)
(100 Marks)</td><td rowspan="2">Theory End Semester Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td><td>* Alternate Assessment Tool (AAT)</td><td>Written Test</td></tr>
<tr><td>40 Marks</td><td>60 Marks</td><td>40 Marks</td><td>60 Marks</td><td></td></tr>
<tr><td colspan="4">40 Marks</td><td>60 Marks</td></tr>
<tr><td colspan="5">Total: 100 Marks</td></tr>
</table>

- AAT - Individual Assignment/ Case Study/ Seminar/ Mini project/ MCQ/ Role Play/ Group Discussion/ Debates/ Oral Presentations/ Poster Presentations/ Technical Presentations can also be provided course coordinator can choose any one/two components based on the nature of the course.

Approved by BOS Chairman

B.E	B23EEO601 – GREEN ELECTRONICS AND SUSTAINABLE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the fundamentals of Green Electronics.
2.	To explain sustainable materials and design practices.
3.	To reveal the renewable energy in Electronics.
4.	To understand the E-Waste management and recycling strategies.
5.	To explain the emerging trends in sustainable technologies.

UNIT-I	Introduction to Green Electronics	9
Overview of Green Electronics and Sustainability-Environmental Impact of Electronic Waste (E-Waste)- Energy Consumption in Electronics Manufacturing-Green Engineering Principles-Life Cycle Assessment (LCA) of Electronic Devices.		

UNIT-II	Sustainable Materials and Design	9
Eco-friendly and Biodegradable Electronic Materials-Sustainable Circuit Design Techniques-Low-power and Energy-efficient Semiconductor Technologies-Flexible and Organic Electronics-Sustainable PCB (Printed Circuit Board) Manufacturing.		

UNIT-III	Renewable Energy for Electronics	9
Solar Energy: Photovoltaics in Electronics-Energy Harvesting Techniques (Piezoelectric, Thermoelectric, etc.)- Battery Technologies and Green Energy Storage Solutions- Supercapacitors and Fuel Cells for Sustainable Electronics-Smart Grid and IoT for Energy Efficiency.		

UNIT-IV	Waste Management and Recycling of Electronics	9
E-Waste Recycling Techniques and Challenges-Circular Economy in Electronics-Regulations and Policies for Electronic Waste Management-Extended Producer Responsibility (EPR)- Case Studies on Successful E-Waste Management.		

UNIT-V	Emerging Trends and Future of Green Electronics	9
AI and IoT for Energy-efficient Systems-Sustainable Computing and Cloud Technologies-Green 5G and Communication Technologies-Carbon Footprint Reduction in Semiconductor Industries-Future Innovations in Sustainable Electronics.		
Total Instructional hours:45		

Approved by BoS Chairman

Course Outcomes: Students will be able to	
CO1	Illustrate the concept of green electronics and sustainability.
CO2	Explain the Sustainable Materials and Design with low-power and energy-efficient semiconductor technologies.
CO3	Demonstrate green energy storage solutions such as batteries, supercapacitors, and fuel cells.
CO4	Interpret the principles of e-waste recycling and the circular economy.
CO5	Infer the advancements in green computing, energy-efficient communication, and semiconductor technologies.

Text Books	
1.	John Lamb, “Green Electronics/Green Bottom Line: A Commonsense Guide to Environmentally Responsible Engineering and Management”, CRC Press, 2007.
2.	Santosh K. Kurinec, Krzysztof Iniewski, “Energy-Efficient Computing and Electronics: Devices to Systems”, CRC Press, 2019.
3.	Sunil Kumar, Vineet Kumar, “Electronic Waste Management: Policies, Processes, Technologies, and Impact”, Wiley Publications, 2023.
4.	Wayne C. W. Chan, Alan C. L. Wong, “Sustainable Electronics and Photonics”, Wiley publications, 2021.

Reference Books	
1.	Mohammad S. Obaidat, Alagan Anpalagan, Isaac Woungang, “Handbook of Green Information and Communication Systems”, Academic Press, 2013.
2.	Kaka Ma, “Sustainable Materials and Green Processing for Energy Conversion”, Trans Tech Publications, Elsevier, 2021
3.	Muhammad Zaffar Hashmi, Ajit Varma, “Environmental Impact of Electronic Waste and Sustainable Recycling Methods”, Springer, 2019.

Approved by BoS Chairman

B.E. / B.Tech	B23MEO601 - 3D PRINTING AND TOOLING	T	P	TU	C
		3	0	0	3

Course Objectives	
1.	To explore the technology used in additive manufacturing.
2.	To develop CAD models for 3D printing.
3.	To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4.	To select a 3D printing process for an application.
5.	To produce a product using 3D Printing or Additive Manufacturing (AM).

UNIT - I	INTRODUCTION TO ADDITIVE MANUFACTURING (AM)	9

Overview – History – Need – classification - Additive Manufacturing Technology in product development – Materials for Additive Manufacturing.

UNIT - II	CAD AND REVERSE ENGINEERING	9

Basic concept – 3D scanning – digitization techniques – Model reconstruction – data processing for reverse engineering - Additive Manufacturing Technology : CAD model preparation – Part orientation and support generation – Model slicing – Tool path generation.

UNIT - III	LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING	9

Classification – liquid based system – stereo lithography apparatus (SLA) – principle, process, advantages and applications – solid based system – Fused Deposition Modeling – principle, process, advantages.

UNIT - IV	LASER BASED ADDITIVE MANUFACTURING SYSTEMS	9

Selective laser sintering – principles of SLS process – process, advantages and applications, 3D Printing - principle, process, advantages - Laser Engineered Net Shaping (LENS).

Approved by BoS Chairman

UNIT - V	RAPID TOOLING AND APPLICATIONS OF ADDITIVE MANUFACTURING	9
Principles and typical process for quick batch production of plastic and metal parts through quick tooling – applications for Aerospace, defence, automobile, Bio-medical and general engineering industries		
		Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Understand the importance of Additive Manufacturing.
CO2	Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO3	Define the various process used in Additive Manufacturing.
CO4	Identify and select suitable process used in Additive Manufacturing.
CO5	Understand the basic concept of quick tooling and additive manufacturing application.

Text Books	
1.	Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies : Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2.	Andreas Gebhardt, “Understanding Additive Manufacturing : Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3.	Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.

Reference Books	
1.	J.D. Majumdar and I. Manna, “Laser-Assisted Fabrication of Materials”, Springer Series in Material Science, 2013.
2.	Dougles Bryden, “CAD and Prototyping for Product Design”, 2014.
3.	CK Chua, Kah Fai Leong, “3D Printing and Rapid Prototyping- Principles and Applications”, World Scientific, 2017.

Approved by BoS Chairman

B.E / B.TECH	B23CBO601 DATA SCIENCE FOR BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the basic concepts of Data Science.
2.	To understand the Analytics Life Cycle.
3.	To understand the process of acquiring Business Intelligence & various types of analytics for Business Forecasting
4.	To model the supply chain management for Analytics.
5.	To apply analytics for different functions of a business

UNIT- I Introduction to Data Science	9
Need for Data Science – Benefits and uses – Facets of data – Types of data- Organization of data - Data Science process- Data Science life cycle- Role of Data Science - Big Data – sources and characteristics of Big Data	

UNIT-II Introduction to Business Analytics	9
Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration	

UNIT- III Business Intelligence & Forecasting	9
Data Warehouses and Data Mart – Knowledge Management –Types of Decisions – Decision-Making Process – Decision Support Systems – Business Intelligence –OLAP – Analytic functions - Introduction to Business Forecasting and Predictive analytics – Logic and Data-Driven Models – Data Mining and Predictive Analysis Modeling –Machine Learning for Predictive analytics.	

Approved by BoS Chairman

UNIT- IV HR & Supply Chain Analytics	9
Human Resources – Planning and Recruitment – Training and Development – Supply chain network – Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain. Apply HR Analytics to make a prediction of the demand for hourly employees for a year.	

UNIT- V Marketing & Sales Analytics	9
Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning – Analytics applications in Marketing and Sales. Do predictive analytics for customers' behaviour in marketing and sales.	
Total Instructional hours: 45	

Course Outcomes: Students will be able to	
CO1	Understand the data science basics and its life cycle.
CO2	Understand the role of data science in business decision-making and strategy formulation.
CO3	Apply business intelligence tools and analytic functions.
CO4	Apply analytics in various HR functions such as recruitment, planning, and training.
CO5	Use predictive analytics to interpret and forecast customer behavior in marketing and sales contexts.

Text Books:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Efrain Turban, Jay E.Aronson, Teng-Peng Liang, Ramesh Sharada "Decision Support Systems and Intelligent Systems" 8th Edition, Pearson Education, 2007.

Reference Books :

1. R. Evans James, Business Analytics, 2017.
2. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2017.
3. R N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2016.

Approved by BoS Chairman

MANDATORY COURSE I

B.E / B.Tech	B23MCT501- Environmental Sustainability (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand ecosystems and the environment**,** including how they work and their importance.
2.	To learn about biodiversity and ways to protect endangered species.
3.	To Identify causes and solutions for pollution and waste management.
4.	To explore natural resources and how human activities affect them.
5.	To discuss global issues like climate change, population growth, and sustainable living.

SYLLABUS:

UNIT - I	ENVIRONMENT AND ECOSYSTEM	6

Scope and importance of environment - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers –energy flow in the ecosystem - food chains and food webs – structure and function of the (a) forest ecosystem (b) desert ecosystem (c) aquatic ecosystems (pond & marine).

UNIT - II	BIODIVERSITY	6

Introduction to Biodiversity: Genetic, species and ecosystem diversity. Value of biodiversity - hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT - III	ENVIRONMENTAL POLLUTION	6

Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) soil pollution - solid waste management: causes, effects and control measures of municipal solid wastes.

Approved by BoS Chairman

UNIT - IV	NATURAL RESOURCES	6
Forest resources: Use and over-exploitation, deforestation - Water resources: Use and over-utilization of surface and ground water - Land as a resource, land degradation, man induced landslides, soil erosion and desertification.		

UNIT - V	HUMAN POPULATION, SOCIAL ISSUES AND THE ENVIRONMENT	6
Population growth, variation among Nations – Population explosion. climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.		
	TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the structure and function of various ecosystems and explain the flow of energy through food chains and food webs.
CO2	Relate the types, values, and threats to biodiversity and differentiate between in-situ and ex-situ conservation methods.
CO3	Summarize the causes and impacts of major types of environmental pollution and suggest appropriate control measures.
CO4	Interpret the usage and over-exploitation of natural resources and analyse their environmental consequences.
CO5	Outline the impact of human population growth and social issues on environmental degradation and global climate phenomena.

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

Reference Books	
1.	G.Tyler Miller and Scott E. Spoolman, —'Environmental Science',Cengage LearningIndia Pvt, Ltd, Delhi, 2014
2.	Erach Bharucha, —Textbook of Environmental Studies‖, Universities Press (I) PVT, LTD, Hydrabad, 2015.

Approved by BoS Chairman

B.E / B.Tech	B23MCT502 - ELEMENTS OF LITERATURE (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand and identify key literary elements in various texts.
2.	To analyze how authors use literary devices to convey themes and messages.
3.	To examine how character, setting, plot, and other elements contribute to the overall meaning of a work.
4.	To appreciate the different forms and genres of literature.
5.	To develop writing and analytical skills through discussions, essays, and presentations.

UNIT-I	INTRODUCTION TO LITERARY ELEMENTS	6

- **Overview of Literary Elements:** Definition and significance of literary elements
- **Introduction to the core components:** plot, setting, character, theme, and conflict
- Understanding literary genres (fiction, poetry, drama, nonfiction)

UNIT-II	PLOT AND STRUCTURE	6

- The five stages: Exposition, Rising Action, Climax, Falling Action, Resolution
- Types of conflict (man vs. man, man vs. self, man vs. nature, etc.)
- Plot devices (foreshadowing, flashbacks, etc.)

UNIT-III	CHARACTERIZATION	6

- **Types of Characters:** Protagonist, antagonist, dynamic, static, round, flat, etc. Direct vs. indirect characterization
- **Character Development:**
- How characters change or grow throughout a story
- Analyzing motivations, conflicts, and relationships

UNIT-IV	SETTING	6

- **Understanding Setting:**
- The time, place, and social environment of a story
- How setting influences plot and character development
- Symbolism and mood created through setting

Approved by BoS Chairman

UNIT-V	ANALYZING LITERARY WORKS	6
• **Close Reading and Analysis:** • Developing analytical skills through in-depth examination of texts • Understanding the role of diction, syntax, and tone in literature • **Comparative Analysis:** • Comparing works of literature across genres or time periods • Drawing connections between themes, characters, and literary devices		
		Total Instructional hours:30

Course Outcomes: Students will be able to	
CO1	Identify and Interpret Literary Elements. (K2)
CO2	Analyze Literary Devices. (K4)
CO3	Evaluate Narrative Structure. (K5)
CO4	Explore various literary forms and genres. (K3)
CO5	Develop Critical Thinking and Writing Skills. (K6)

Text Books	
1.	Narayan RK, “Malgudi Days”, Indian Thought Publications, New York, 2015
2.	Shaw, George Bernard, “Greatest works of George Bernard Shaw”, Maple Press, 2010
3.	Nair, Anita, “Ladies Coupe-A Novel in Parts”, Penguin Books, 2014

Reference Books	
1.	Abram, “A Glossary of Literary Terms”, Thomson India, 2008
2.	Trivedi, “India’s Shakespeare”, Pearson, 2008
3.	Orwell, George “Animal Farm”, Penguin Books Press, India, March 2011.
4.	Shakespeare, William “As You Like It”, Om Books International published, 2025.
5.	Allan Poe, Edgar, “The Raven”, Penguin Books Press, India, Oct 2013
6.	O. Henry, “The Gift Of The Magi”, Arcadia Publishing, December 2024

B.E / B.Tech	B23MCT503 - FOUNDATIONS OF YOGA	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To introduce the fundamental concepts and philosophy of Yoga and its relevance to modern life.
2.	To develop awareness of the physical, mental, and emotional benefits of Yoga through an understanding of its principles.
3.	To impart knowledge about the ethical and moral foundations of Yoga as described in Patanjali's Yoga Sutras (Yama, Niyama, etc.).
4.	To promote a healthy and disciplined lifestyle by integrating Yogic practices and values into daily routines.
5.	To enable students to manage stress and enhance concentration through the theoretical understanding of pranayama, meditation, and yogic relaxation techniques.

SYLLABUS:

UNIT - I	INTRODUCTION TO YOGA	6

- Definition, origin and evolution of Yoga.
- Aim, objectives, and relevance of Yoga in modern life.
- Different schools of Yoga (Raja Yoga, Karma Yoga, Bhakti Yoga, Jnana Yoga, Hatha Yoga).

UNIT - II	HEALTH AND YOGA	6

- Concept of health in Yoga.
- Holistic approach of Yoga to health and well-being.
- Role of Yoga in stress management.
- Yoga as preventive and therapeutic tool.

UNIT - III	YOGIC LIFESTYLE	6

- Yogic principles of food and diet.
- Importance of discipline (Yama, Niyama) in daily life.
- Daily routine and time management.
- Positive thinking and mental hygiene through Yoga.

Approved by BoS Chairman

UNIT - IV	ASANAS	6

- Standing Asanas: Tadasana, Trikonasana, Vrikshasana.
- Sitting Asanas: Padmasana, Vajrasana, Ardha Matsyendrasana.
- Lying Asanas: Bhujangasana, Shalabhasana, Sarvangasana, Savasana.
- Benefits and precautions.

UNIT - V	MEDITATION AND RELAXATION	6

- Basics of Meditation.
- Guided Meditation Techniques.
- Yoga Nidra / Deep Relaxation Technique (DRT).
- Stress management through meditation.

TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Illustrate the origin, definition, and philosophy of Yoga and its significance in holistic well-being.
CO2	Explain the principles and practices of Ashtanga Yoga as outlined by Patanjali.
CO3	Outline the role of Yoga in promoting physical health, mental clarity, and emotional stability.
CO4	Interpret the ethical and lifestyle principles of Yoga (Yama and Niyama) for personal development.
CO5	summarize how Yogic practices help in stress management and enhancing concentration in daily life.

Text Books	
1.	Light on Yoga – B.K.S. Iyengar. Publisher: HarperCollins,1966
2.	Patanjali Yoga Sutras – Swami Vivekananda commentary, Publisher: Advaita Ashrama, 1896.

Reference Books	
1.	Yoga for Health – Swami Kuvalayananda. *Publisher: Kaivalyadhama, Lonavala 1931.*
2.	Common Yoga Protocol – Ministry of AYUSH, Govt. of India, 2015

Approved by BoS Chairman

B.E /B.Tech	B25MCT504- EXPORT IMPORT MANAGEMENT (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To learn the basics of international trade and its importance for businesses.
2.	To understand how goods are transported, paid for, and insured in global trade.
3.	To know how to choose the right products and markets for export.
4.	To get hands-on knowledge of export-import documents and procedures.
5.	To use digital tools and government support to grow your export business.

SYLLABUS:

UNIT - I	Introduction to Export and Import	6

Overview of International Trade, Importance of Export and Import in Business, International Trade Bodies and Local Regulatory Authorities, Export-Import Cycle: Step-by-Step Process, Online IEC (Import Export Code) Application, Myths and Opportunities in Global Trade.

UNIT - II	Logistics, Transportation & Payment Terms	6

Types of Transportation in International Trade, Containers, Packaging, and Shipment Handling, IncoTerms: Delivery Terms, Costs & Risks, Payment Terms: Modes of Payment & Risk Involved, Insurance and Risk Management in Trade.

UNIT - III	Product & Market Selection, Buyer Identification	6

Selecting the Right Product for Export, Market Research and Identifying Potential Markets, Importance of Trade Fairs & Exhibitions, Finding Genuine Buyers & Verification Process, Effective Communication with International Buyers.

UNIT - IV	Export & Import Documentation and Procedures	6

Understanding Proforma Invoice & Letter of Credit (LC), Pre & Post Shipment Documents, GST, Customs Clearance & Compliance Procedures, How to Fill Pre & Post Shipment Documents – Practical Exercise, Import Documentation and Procedures.

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UNIT - V	Marketing, Incentives & Digital Trade Strategies	6
Export Incentives and Government Benefits, Pricing Strategies & Preparing Export Quotations, B2B Listing and Online Marketplaces, Digital Marketing & Social Media for Export Promotion, Buyer Calling, Data Collection & Product Portfolio Development.		

Course Outcomes: Students will be able to	
CO1	Explain the fundamentals of international trade, the role of trade bodies, and the complete export-import process. (K2)
CO2	Outline various transportation methods, Incoterms, packaging, payment terms, and risk management in international trade. (K2)
CO3	Apply knowledge to select suitable products and markets for export, identify genuine buyers, and effectively communicate in global trade. (K3)
CO4	Develop the ability to prepare and process export/import documentation, customs clearance, and GST compliance. (K3)
CO5	Utilize digital marketing, government incentives, and online platforms to develop export strategies and expand business opportunities. (K3)

Text Books	
1.	Thomas E. Johnson & Donna L. Bade, *Export/Import Procedures and Documentation*, 8th Edition, Ashgate Publishing, 2016.
2.	S. Tamer Cavusgil, Gary Knight, John R. Riesenberger, *International Business: The New Realities*, 3rd Edition, Pearson, 2017.
3.	P.K. Khurana, *Export-Import Theory, Practices, and Procedures*, 1st Edition, Atlantic Publishers & Distributors, 2016.
4.	Warren J. Keegan, Mark C. Green, *Global Marketing Management*, 9th Edition, Pearson, 2017.
5.	Francis Cherunilam, *International Trade and Export Management*, 9th Edition, Himalaya Publishing House, 2020

Approved by BoS Chairman

Reference Books	
1.	Anders Grath, *The Handbook of International Trade and Finance*, 3rd Edition, Kogan Page, 2020.
2.	Francis Cherunilam, *International Trade and Export Management*, 9th Edition, Himalaya Publishing House, 2020.
3.	V.K. Bhalla, *International Business: Theories and Practices*, 2nd Edition, Anmol Publications, 2020.
4.	S.K. Bhatia, *Export Management*, 1st Edition, Vikas Publishing House, 2018.
5.	R. Palaniappan, *International Trade and Export Management*, 1st Edition, Oxford University Press, 2019.

Approved by BoS Chairman

MANDATORY COURSE II

B.E / B.Tech	B23MCT601 – EDUCATION PSYCHOLOGY (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To enable students to acquire knowledge about various methods of psychology.
2.	To gain knowledge about the concept of learning and its related theories.
3.	To understand motivation and its influence on human behaviour.
4.	To comprehend in-depth concepts of intelligence and creativity.
5.	To explain the concepts and theories of personality.

SYLLABUS:

UNIT - I	EDUCATIONAL PSYCHOLOGY AND HUMAN GROWTH AND DEVELOPMENT	6
Psychology: Meaning - Educational psychology: Meaning, scope and significance - Dimensions of human growth and development: Physical, cognitive, emotional, social, moral and language.		

UNIT - II	ATTENTION AND MEMORY	6
Attention: Meaning, nature and determinants of attention - Memory: Meaning, types of memory and Strategies for improving memory.		

UNIT - III	MOTIVATION AND LEARNING	6
Motivation: Meaning and definitions - Level of aspiration learning: Theories of learning and its educational implications Cognitive Theory: Jean Piajet, Behaviourist Theory- Pavlov's Classical, Conditioning.		

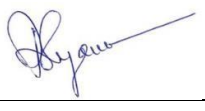
UNIT - IV	INTELLIGENCE AND CREATIVITY	6
Intelligence: Meaning, and types - Theories of Intelligence: Two factor, Thurston's Group factor - Intelligence Quotient (IQ) - Creativity: Concept, factors and process - Strategies for fostering creativity.		

UNIT - V	PERSONALITY	6
Personality: Meaning, definitions, and determinants of personality - Theories of Personality: Type, trait, and psychoanalytic Assessment of personality: Projective and non-projective techniques.		
TOTAL INSTRUCTIONAL HOURS		30

Course Outcomes: Students will be able to	
CO1	Explain various methods of psychology.
CO2	Describe the concept of learning and its related theories.
CO3	Discuss motivation and its influence on human behaviour.
CO4	Summarize the concepts of intelligence and creativity.
CO5	Interpret the concepts and theories of personality.

Text Books	
1.	Bert Laura, E. (2014). Child development. New Delhi: PHI Learning
2.	Chauhan, S. S. (2002). Advanced educational psychology. New Delhi: Vikas Publishing house.
3.	Hurlock, Elizabeth, B. (2015). Child development. New Delhi: McGraw Hill Education.
4.	Mangal, S.K. (2002). Advanced educational psychology. New Delhi: Prentice Hall of India.
5.	Matthews. G., Deary, L. J., & Whiteman, M.C. (2009). (2nd ed.). Personality: Theory and research. New York: Guilford Publications.

Reference Books	
1.	AnithaWoolfolk. (2004). Educational psychology. Singapore: Pearson Education.
2.	Cloninger, S.C. (2008) (5thed.). Theories of personality: Understanding persons. Englewood Cliffs, New Jersey: Prentice Hall.
3.	Schunk, D.H. (2007) (5thed.). Learning theories: An educational perspective. New York: Prentice Hall of India.
4.	Skinner, C.E. (2003) (4thed.). Educational psychology. New Delhi: Prentice Hall of India.
5.	Sprint Hall Norman, A, & Sprint Hall, Richard, C. (1990) (5thed.). Educational psychology: A developmental approach. New Delhi: McGraw Hill.



Approved by BoS Chairman

B.E / B.Tech	B23MCT602- Life Style Education (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand the importance of a healthy lifestyle and its impact on overall well-being.
2.	To learn about balanced nutrition, the role of essential nutrients, and healthy eating habits.
3.	To explore the benefits of regular exercise and different types of physical activities.
4.	To identify common lifestyle diseases and strategies for their prevention.
5.	To develop mental wellness through stress management, mindfulness, and better sleep habits.

UNIT - I	Introduction to a Healthy Lifestyle	6

- Definition & importance of a healthy lifestyle
- Nutrition, exercise, sleep, and mental well-being.
- Assessing current lifestyle habits.

UNIT - II	Nutrition & Balanced Diet	6

- Macronutrients & micronutrients: Their roles and sources.
- Healthy eating habits and meal planning.
- Importance of hydration.
- Harmful effects of processed food and unhealthy eating habits.

UNIT - III	Physical Fitness & Exercise	6

- Benefits of regular exercise on physical and mental health.
- Types of workouts: Cardio, strength training, yoga, and flexibility exercises.
- Designing a personalized fitness routine.

UNIT - IV	Lifestyle Diseases & Prevention	6

- Causes and prevention of obesity, diabetes, heart disease, and hypertension.
- Role of diet, exercise, and mental health in disease prevention.
- Importance of regular health check-ups.

UNIT - V	Mental Health & Stress Management	6

- Understanding stress, anxiety, and depression.
- Techniques for relaxation: Meditation, deep breathing, and mindfulness.
- Importance of sleep for overall health.
- Tips for improving sleep hygiene.

TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the importance of a healthy lifestyle and its key aspects like nutrition, exercise, sleep, and mental well-being.
CO2	Describe the role of nutrients, healthy eating habits, and the effects of processed food.
CO3	Summarize different types of exercises and their benefits for physical and mental health.
CO4	Identify common lifestyle diseases, their causes, and ways to prevent them.
CO5	Discuss stress, anxiety, and sleep issues, along with techniques to manage them.

Text Books	
1.	*Francesc García, Héctor,Miralles*, Ikigai: The Japanese Secret to a Long and Happy Life, Penguin Audio, 2017.
2.	Relationship, wellbeing and behaviour, Harry T. Reis, World Library of Psychological series, Reutledge, Taylor and Francis Group, 2018.

Reference Books	
1.	Shawn Achor, The Happiness Advantage: How a Positive Brain Fuels Success in Work and Life, Crown Currency, 2018.
2.	James Clear, Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones, Penguin Audio, 2018.

Approved by BoS Chairman

B.E / B.Tech	B25MCT603 STARTUP AND VENTURE FUNDING (Common to ALL)	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To understand new venture creation opportunities, its resources, and requirements for Enterprise Start-up
2.	To understand the legal environment.
3.	To learn about the start-up environment and survival.
4.	To study the various funding availabilities for startups.
5.	To analyse the venture capital funding and its stages.

UNIT - I	Start-up An Overview	6

Introduction to start ups - The rise of startup economy – Ideation- Venture Choices - The Start-up Equation – The Entrepreneurial Ecosystem – Entrepreneurship in India. Government Initiatives.

UNIT - II	Start-up Capital Requirements and Legal Environment	6

Identifying startup capital requirements - estimating startup cash requirements - Startup financing metrics – Risk mitigation strategies - The legal framework for startups - Incorporation and commencement of businesses and registration of a company.

UNIT - III	Start-up Survival and Growth	6

Feasibility Study - Stages of growth of start-ups – Reasons for new start up failures- Scaling new ventures – preparing for change - Leadership succession. Support for growth and sustainability of the venture.

UNIT - IV	Funding of Start Up Ventures	6

Financing Opportunities for startups – Equity investment process – Angel Investors - Funding startups with bootstrapping- crowd funding- strategic alliances.

UNIT - V	Venture Capital Funding	6
Venture Capital – Meaning and features – Seed capital – Financing various stages of startup ventures – Exit strategy for venture capital funds.		

Course Outcomes: Students will be able to	
CO1	Implement entrepreneurship concepts in a start-up idea. (K3)
CO2	Use budgeting and legal setup processes for the venture. (K3)
CO3	Demonstrate feasibility through market and financial analysis. (K3)
CO4	Execute funding strategies suited for a new business. (K3)
CO5	Apply suitable funding methods for different stages of a new business using basic financial models and strategies. (K3)

Text Books	
1.	Kathleen R Allen, Launching NewVentures, An Entrepreneurial Approach, Cengage Learning, 2016.
2.	AnjanRaichaudhuri, Managing New Ventures Concepts and Cases, Prentice Hall International, 2010.
3.	S. R. Bhowmik& M. Bhowmik, Entrepreneurship, New Age International, 2007.

Reference Books	
1.	Steven Fisher, Ja-nae' Duane, The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition, Mc Graw Hill Education India Pvt. Ltd, 2016.
2.	Donald F Kuratko, Jeffrey S. Hornsby, New Venture Management: The Entrepreneur's Road Map, 2e, Routledge, 2017.
3.	Vijay Sathe, Corporate Entrepreneurship, 1e, Cambridge, 2009.

Approved by BoS Chairman

B.E / B.Tech	B23MCT604 – INDIAN KNOWLEDGE SYSTEM	L	T	P	C
		2	0	0	0

Course Objectives	
1.	To introduce the scope and significance of Indian Knowledge Systems in the context of modern education and engineering.
2.	To explore ancient Indian contributions in science, mathematics, technology, and architecture.
3.	To understand core Indian philosophies, ethics, and values and their relevance in personal and professional life.
4.	To connect traditional practices with modern innovations through case studies and project-based learning.
5.	To promote sustainable thinking and design approaches inspired by indigenous knowledge and practices.

SYLLABUS:

UNIT - I	INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM	6

- Meaning and scope of IKS
- Importance of IKS in modern education
- Relevance of IKS to science, technology, and engineering.

UNIT - II	SCIENCE AND TECHNOLOGY IN ANCIENT INDIA	6

- Contributions in mathematics (e.g., zero, decimal system, algebra – Aryabhata, Bhaskara)
- Ancient metallurgy (e.g., Iron Pillar of Delhi, zinc extraction)
- Astronomy and calendar systems (e.g., Surya Siddhanta, Jantar Mantar)
- Ayurveda and traditional health sciences.

UNIT - III	ENGINEERING AND ARCHITECTURE	6

- Vastu Shastra and ancient Indian architecture
- Temple construction and civil engineering marvels
- Water management systems (step wells, tanks, canals)
- Town planning in Harappan civilization.

Approved by BoS Chairman

UNIT - IV	INDIAN PHILOSOPHY, ETHICS & VALUE SYSTEM	6

- Core concepts of Indian philosophy (Dharma, Karma, Yoga)
- Ethical principles in Indian tradition
- Role of values in professional and personal life
- Indian view on environmental sustainability.

UNIT - V	ARTS, CULTURE, AND LITERATURE	6

- Overview of Indian classical music and dance
- Ancient literature (Vedas, Upanishads, Ramayana, Mahabharata)
- Sanskrit and its scientific relevance
- Cultural practices and their scientific background.

	TOTAL INSTRUCTIONAL HOURS	30

Course Outcomes: Students will be able to	
CO1	Explain the meaning, scope, and importance of Indian Knowledge Systems in the context of modern education.
CO2	Outline the key scientific and technological advancements of ancient India in fields like mathematics, metallurgy, and astronomy.
CO3	Interpret traditional Indian architectural and engineering practices, including Vastu Shastra and water management systems.
CO4	Illustrate the ethical values and philosophical principles of Indian traditions and their relevance in contemporary life.
CO5	Summarize the applications of IKS in modern innovation, entrepreneurship, and sustainable engineering practices.

Text Books	
1.	Introduction to Indian Knowledge Systems: Concepts and Applications, B. Mahadevan, Publisher: PHI Learning Pvt. Ltd. 2016.
2.	Science and Technology in Ancient India,: Roshen Dalal,Publisher: Penguin Books.2003
3.	Foundations of Indian Culture, Govind Sadashiv Ghurye, Publisher: Popular Prakashan. 1951

Reference Books	
1.	Indian Knowledge Systems – Volume 1, Kapil Kapoor & Michel Danino Publisher: Central Sanskrit University & Bharatiya Vidya Bhavan, 2021.
2.	The Argumentative Indian, By: Amartya Sen, Publisher: Picador, 2005.

Approved by BoS Chairman