K.S. Rangasamy College of Technology

(Autonomous)

Curriculum & Syllabus of B.Tech. Biotechnology

(For the batch to be admitted in 2021 – 2025)

R 2018

Courses Accredited by NBA, Accredited by NAAC A++,
Approved by AICTE, Affiliated to Anna University, Chennai.

KSR Kalvi Nagar, Tiruchengode – 637 215.

Namakkal District, Tamil Nadu, India.

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Rev. No. 4
Passed in BoS Meeting held on 12/05/2023
Approved in Academic Council Meeting held on 03/06/2023

DEPARTMENT OF BIOTECHNOLOGY

The Vision and Mission of the Department of Biotechnology are

Vision

To produce competent Scientists, Technologists, Entrepreneurs and Researchers in Biotechnology through quality education.

Mission

- To be recognized as a place of excellence in teaching-learning through continual improvement process **(Place of excellence** and **continual improvement)**
- To work in close liaison with the industry to achieve socio-economic development through biotechnological ventures **(Socio-economic development)**
- To facilitate students to perform as competent professional Biotechnologists **(Professional Competence)**

The Vision and Mission of K.S.Rangasamy College of Technology are

Vision

To produce the most competent Scientists, Engineers, Technologists, Entrepreneurs,Managers, and Researchers through Quality education.

Mission

To achieve academic excellence in Science, Engineering, Technology, Management, and Research through objective and innovative teaching methods, dedicated and duty-conscious faculty, continual and consistent updating of facilities, welfare and quality improvementof the faculty, and a system of continual process improvement.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Fundamentals: Graduates are professionally competent in Biotechnology to solve problems in environmental, food, biochemical, and biomedical engineering and technology.

PEO2: Career Growth: Graduates demonstrate proficiency and practice biotechniques through life-long learning.

PEO3: Professional Practices: Graduates perform as an individual and or members of a team with professional and ethical behavior.

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PROGRAMME OUTCOMES (POs) Engineering Graduates will be able to:

PO1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design /development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional engineering solutions insocietal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of theengineering practice.

PO9: **Individual and team work**: Function effectively as an individual, and as a member or leader in diverseteams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one ‘s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PROGRAMME SPECIFIC OUTCOMES (PSOs):

Engineering Graduates will be able to:

PSO1: **Developing Technocrats**: Design and execute industry-oriented experiments in biotechnology using modern tools and technology

PSO2: **Research and Technology transfer:** Apply the knowledge of bioengineering and Technology to demonstrate research skills and the technology forcommercialization

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH PROGRAMME OUTCOMES (POs)

The B. Tech, Biotechnology Programme outcomes leading to the achievement of the objectives are summarized in the following Table.

Programme Educational Objectives	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO 1	3	3	2	3	2	3	1	1	2	1	3	1
PEO 2	2	2	3	2	3	1	3	1	2	1	2	3
PEO 3	3	2	3	2	2	2	1	3	3	2	3	2

Contributions: 1- Some contribution, 2-Average contribution, 3- Strong contribution

MAPPING OF COURSE WITH PROGRAMME OUTCOMES (POs)

Year	Semester	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	I	Communication Skills I	1.2	2	1.2	2	1.8	1.8	1.8	1.8	2.8	3	2.6	3
		Calculus and Differential Equations	3	3	2.8	2.4	2.4	0	0	0	0	0	0	0
		Applied Chemistry	3	3	2.8	2.6	2.2	2.4	2.6	2	1.75	1	1.4	2
		Engineering Mechanics	3	2	2	3	0	0	0	0	0	0	0	2
		Programming for Problem Solving	1	3	0	2.4	2.8	0	0	2	0	0	0	1.8
		Constitution of India								2	2	1		2
		Chemistry Laboratory	3	3	3	3	3	3	2.4	2	2	0	2.2	1.6
		Programming for Problem solving Laboratory	1	3	0	2.4	2.8	0	0	2	0	0	0	1.8
	II	Communication Skills II	2	2.2	1.8	2.4	1.8	2.4	2.4	2.4	2.6	3	2.2	3
		Laplace Transform and Complex Variables	3	3	2.4	2.2	2.8	0	0	0	0	0	0	2
		Applied Physics for Biotechnology	3.0	2.8	2.8	2.2	2.2	2.3	1.8	1.6	1.4	2.0	2.7	2.7

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		Basic Electrical Engineering	3.0	3.0	1.7	1.5	2.0	2.0	2.0	2.0	1.7	2.0	2.3	1.5
		Engineering Graphics	3	2.6	3	3	3	1	1	1	0	3	1.4	1.4
		Universal Human Value	3	3	2	2	2	3	3	3	3	3	2	1
		Engineering Physics Laboratory	3	3	2	3	2	2	1	1	2	2	1	3
		Engineering Practices Laboratory	3	2	2	1	3	2	2	3	1	2	2	1
II	III	Transform and Numerical Methods	3	3	2.4	2.4	2	0	0	0	0	0	0	3
		Biochemistry	3.0	2.8	2.6	2.8	2.3	3.0	3.0	0.0	2.0	2.3	3.0	2.8
		Microbiology	2.8	2.8	2.4	2.2	2.6	2.6	2	2.8	2.4	2.4	1.6	2.6
		Cell and Molecular Biology	3	3	2	3	2.6	2.5	2.5	3	2	2.25	3	2
		Principles of Chemical Engineering	2.4	2.6	3	1.8	2.8	2	1.6	3	3	3	2.5	2.6
		Environmental Science	2.8	2.4	2.6	2.6	2.2	2.8	3	3	2.8	2.8	2.5	2.2
		Biochemistry Laboratory	2.6	1.8	2.6	2.25	2.8	2	2.5	3	2	2	1.75	2.8
		Microbiology Laboratory	2.6	2.2	2.2	2.4	2	1.8	2.2	2	1.6	2	2	2.4
		Career Competency Development – I	1	1	1	1	1	2	1	2	3	3	2	3
	IV	Statistical Methods	2.6	1.8	2	2.4	1.8	1.6	1.8	1.2	1.6	2	1.8	2
		Genetic Engineering	3	3	2.6	2.8	3	3	3	3	3	3	2.6	3
		Protein and Enzyme Engineering	2.75	2.8	2.8	2.8	2.75	3	2	1	2	2.5	2.2	3
		Biochemical Thermodynamics	2.8	2.3	2.4	2.6	2.6	2.6	2.2	1.5	1.7	2.4	3.0	1.8
		Startups and Entrepreneurship	2.8	2.6	3	2.4	2.4	2.5	2.5	2.3	2.7	2	2.3	2.4
		Molecular Biology and Genetic Engineering Laboratory	3.0	2.0	2.0	2.0	2.0	2.7	2.5	2.0	1.4	2.0	2.0	2.0
		Protein and Enzyme Engineering Laboratory	2.8	2.8	2.8	2.8	2.6	2.0	2.0	1.0	2.3	2.3	2.2	3.0
		Career Competency Development – II	2	2	1	1	1	2	1	1	2	3	2	3
III	V	Plant and Animal Biotechnology	3	2	2.8	3	2.25	2.5	2.75	2.4	2.4	3	3	2.2
		Bioinformatics	3.0	2.6	2.7	2.2	2.8	3.0	2.3	2.0	2.8	2.3	1.8	2.8
		Bioprocess Technology	2.4	2.8	2.8	2.8	2.8	2.8	2.5	1.3	2.0	3.0	3.0	3.0
		Heat and Mass Transfer Operations	2.8	3.0	2.6	2.6	2.2	2.8	2.4	2.3	2.0	2.8	2.2	2.6
		Plant and Animal Biotechnology Laboratory	3	2	2	2	2.5	2.7	2	2	2	2.5	2.7	2
		Bioprocess Technology Laboratory	2.8	2.6	2.4	2.2	2.4	2.4	2.2	2	2	2.4	2.6	2.6

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		Career Competency Development – III	2	1	2	2	1	1	1	1	2	3	2	3
	VI	Biopharmaceutical Technology	3	2.4	2.6	2	2	2.75	3	2.8	2.4	2	2	3
		Molecular Modeling andDrug Designing	3	2	2.4	2	2.6	2	2.8	3	2.5	2.8	2.3	2.8
		Chemical ReactionEngineering	3	2	2.8	2	2.8	2	2.8	2.5	2.5	2.5	2.5	3
		Bioinformatics and Molecular ModelingLaboratory	2.8	2.2	2.5	2	2.8	2	3	2	2.2	2.6	2.4	2.6
		Chemical Engineering Laboratory	3	2	2	2	2.6	2	2	2	2.5	3	2.7	3
		Career Competency Development – IV	2	1	2	2	1	2	1	1	2	3	2	3
IV	VII	Engineering Economics and Financial Accounting	2.5	2.8	2.5	3	2.8	2	2.25	0	2.75	2.5	2.2	3
		Immunology	2.6	2.2	2.8	2.2	2	2.4	2.4	2	2.4	2.2	2.6	2
		Downstream Processing	3	3	2.4	2.3	2	2.5	2.5	2.5	2.3	2	2.25	2.8
		Research Skill Development-I	3	3	2.5	2.2	2	2	2.5	2	2.25	3	2.25	2.2
		National Cadet Crops (Air wing)	3	2	1	1	3	3	3	3	3	3	3	3
		National Cadet Crops (Army Wing						1		3				
		Internship	2	3	3	3	2	2	1	1	2	2	2	3
		Immunology Laboratory	2	3	3	3	2.8	3	2.25	3	2	2.25	2.2	3
IV	VII	Downstream Processing Laboratory	2.8	3	2.2	3	2.6	2	3	2.7	2.5	2.3	2.5	3
		Project Work - Phase I	2.8	3	2.2	3	2.6	2	3	2.7	2.5	2.3	2.5	3
		Career Competency Development – V	2	1	2	2	1	2	1	1	2	3	2	3
		National Cadet Crops (Air wing)	3	2	1	1	3	3	3	3	3	3	3	3
		National Cadet Crops (Army Wing)						1		3				
IV	VIII	Bioethics and Biosafety	2	3	3	2.6	0	3	3	3	0	0	3	0
		Research Skill Development-II	3	3	3	3	3	0	0	3	3	2	3	3
		Project Work - Phase II	3	3	3	3	3	0	3	3	3	2	3	3
		Internship	2	3	3	3	2	2	1	1	2	2	2	3

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PROFESSIONAL ELECTIVES (PE)

Year	Semester	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ELECTIVE – I														
III	V	Environmental Biotechnology	2.8	2.75	2.4	2.7	2.5	2.3	2.25	3	2.8	2	2	2.5
		Biodiversity and its conservation	3	3	3	2	3	2	3	1				3
		EnvironmentalHazards and Management	1	2	3	1	3	1	3	1	1	1	1	1
		Food Biotechnology		3	3	3	3	2	2	3	2		3	3
		Fermentation Technology	2.4	3	2.2	2.6	2.8	2.8	2.6	2	2.25	2.2	3	2.8
ELECTIVE – II														
III	VI	Cancer Biotechnology		3	2	3	3			1			2	3
		Clinical Immunology		3		3	3						2	3
		Stem Cell Technology		3	2	3	3			2			2	3
		Tissue Engineering	2.8	2.8	2.6	3	2.5	2	2	2.3	3	2.5	2.5	2.5
		Biomedical Instrumentation	3	3	2	3	3						2	3
ELECTIVE – III														
III	VI	Bioresource Technology	3	3	2	3	3						3	3
		Biophysics	3	3	3	2	2	2	2	2	2	1	2	2
		Metabolic Engineering	2	3	2	2	3			1			2	3
		Bioreactor Design	2.6	2.6	2.8	2.6	3	2.6	2.8	2	2	3	2.8	2.8
		Bioprocess Modeling and Simulation	2	3	3	3	3	3	3	1	1	3	3	3
ELECTIVE –IV														
IV	VII	Nanobiotechnology	2.6	2.3	2.8	2.8	2.7	2	2	2	2.7	2	2.2	2.6
		Bioinstrumentation	3	3	3	3	3			1			2	3
		Toxicology		3	2	3	3			2			2	3
		Genomics and Proteomics	3	3	3	3	3			1			3	3
		Agricultural biotechnology	3	3	3	2	3	2	3	1				3
ELECTIVE – V														
IV	VII	Research Design and Analysis	3	2	3	3	3	2		2			2	3
		Marine Biotechnology	2.7	2.5	2.3	2.8	2.5	2	2.3	2	2.3	2	3	3
		Human Physiology and Anatomy		3		3	3			1			2	3
		Biofuel Technology		2		3	2			1			2	3
		Systems Biology	3	3	3	3	3							3

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SEMESTER I

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 EN 001	Communication Skills I	HS	2	1	1	0	2
2.	50 MA 001	Calculus and Differential Equations	BS	4	3	1	0	4
3.	50 CH 001	Applied Chemistry	BS	3	3	0	0	3
4.	50 ME 003	Engineering Mechanics	ES	4	3	1	0	4
5.	50 CS 001	Programming for Problem Solving	ES	3	3	0	0	3
6.	50 MY 001	Constitution of India	MC	2	2	0	0	0
PRACTICALS								
7.	50 CH 0P1	Chemistry Laboratory	BS	4	0	0	4	2
8.	50 CS 0P1	Programming for Problem solving Laboratory	ES	4	0	0	4	2
			Total	**26**	**15**	**3**	**8**	**20**

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 EN 002	Communication Skills II	HS	2	1	1	0	2
2.	50 MA 002	Laplace Transform and Complex Variables	BS	4	3	1	0	4
3.	50 PH 006	Applied Physics for Biotechnology	BS	3	3	0	0	3
4.	50 EE 001	Basic Electrical Engineering	ES	3	3	0	0	3
5.	50 ME 002	Engineering Graphics	ES	6	2	0	4	4
6.	50 MY 004	Universal Human Value	MC	4	2	2	0	3 *
PRACTICALS								
7.	50 PH 0P1	Engineering Physics Laboratory	BS	4	0	0	4	2
8.	50 ME 0P1	Engineering Practices Laboratory	ES	4	0	0	4	2
			Total	**30**	**14**	**4**	**12**	**20**

***** Universal Human Value - extra credit is offered

SEMESTER III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 MA 007	Transform and Numerical Methods	BS	4	3	1	0	4
2.	50 BT 301	Biochemistry	PC	3	3	0	0	3
3.	50 BT 302	Microbiology	PC	3	3	0	0	3
4.	51 BT 303	Cell and Molecular Biology	PC	3	3	0	0	3
5.	50 BT 304	Principles of Chemical Engineering	PC	4	3	1	0	4

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6.	50 MY 002	Environmental Science	MC	2	2	0	0	0
PRACTICALS								
7.	50 BT 3P1	Biochemistry Laboratory	PC	4	0	0	4	2
8.	50 BT 3P2	Microbiology Laboratory	PC	4	0	0	4	2
9.	50 TP 0P1	Career Competency Development - I	EEC	2	0	0	2	0
			Total	**29**	**17**	**2**	**10**	**21**

SEMESTER IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 MA 013	Statistical Methods	BS	4	3	1	0	4
2.	51 BT 401	Genetic Engineering	PC	3	3	0	0	3
3.	50 BT 402	Protein and Enzyme Engineering	PC	3	3	0	0	3
4.	50 BT 403	Biochemical Thermodynamics	PC	4	3	1	0	4
5.	50 ** L**	Open Elective – I	PC	3	3	0	0	3
6.	50 MY 014	Start-ups and Entrepreneurship	MC	2	2	0	0	0
PRACTICALS								
7.	50 BT 4P1	Molecular Biology and Genetic Engineering Laboratory	PC	4	0	0	4	2
8.	50 BT 4P2	Protein and Enzyme Engineering Laboratory	PC	4	0	0	4	2
9.	50 TP 0P2	Career Competency Development – II	EEC	2	0	0	2	0
			Total	**29**	**17**	**2**	**10**	**21**

SEMESTER V

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 BT 501	Plant and Animal Biotechnology	PC	3	3	0	0	3
2.	50 BT 502	Bioinformatics	PC	3	3	0	0	3
3.	50 BT 503	Bioprocess Technology	PC	4	3	1	0	4
4.	50 BT 504	Heat and Mass Transfer Operations	PC	4	3	1	0	4
5.	50 BT E1*	Elective – I	PE	3	3	0	0	3
6.	50 ** L**	Open Elective – II	OE	3	3	0	0	3
PRACTICALS								
7.	50 BT 5P1	Plant and Animal Biotechnology Laboratory	PC	4	0	0	4	2
8.	50 BT 5P2	Bioprocess Technology Laboratory	PC	4	0	0	4	2
9.	50 TP 0P3	Career Competency Development – III	EEC	2	0	0	2	0
			Total	30	18	2	10	24

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SEMESTER VI

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	51 BT 601	Biopharmaceutical Technology	PC	3	3	0	0	3
2.	50 BT 602	Molecular Modelling and Drug Designing	PC	3	3	0	0	3
3.	50 BT 603	Chemical Reaction Engineering	PC	4	3	1	0	4
4.	50 BT E2*	Elective – II	PE	3	3	0	0	3
5.	50 BT E3*	Elective – III	PE	3	3	0	0	3
6.	50 ** L**	Open Elective – III	OE	3	3	0	0	3
7.	50 MY 014	Start-ups and Entrepreneurship	MC	2	2	0	0	0
PRACTICALS								
8.	50 BT 6P1	Bioinformatics and Molecular Modelling Laboratory	PC	4	0	0	4	2
9.	50 BT 6P2	Chemical Engineering Laboratory	PC	4	0	0	4	2
10.	50 TP 0P4	Career Competency Development – IV	EEC	2	0	0	2	0
			Total	**31**	**20**	**1**	**10**	**23**

SEMESTERVII

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	50 HS 001	Engineering Economics and Financial Accounting	HS	3	3	0	0	3
2.	50 BT 701	Immunology	PC	3	3	0	0	3
3.	50 BT 702	Downstream Processing	PC	4	3	1	0	4
4.	50 BT E4*	Elective – IV	PE	3	3	0	2	3
5.	50 BT E5*	Elective – V	PE	3	3	0	0	3
6.	50 ** L**	Open Elective – IV	OE	3	3	0	0	3
7.	50 AC 001	Research Skill Development -I	AC	1	1	0	0	0
8.	50 AB 00*	NCC/NSS/NSO/YRC/RRC/Fine Arts	-	2	2	0	2	3*
PRACTICALS								
9.	50 BT 7P1	Immunology Laboratory	PC	4	0	0	4	2
10..	50 BT 7P2	Downstream Processing Laboratory	PC	4	0	0	4	2
11.	50 BT 7P3	Project Work - Phase I	EEC	4	0	0	4	2
12.	50TP0P5	Career Competency Development – V	EEC	2	0	0	2	0
13.	50 TP 0P6	Internship	EEC	0	0	0	0	1
		Total		**36**	**21**	**1**	**18**	**26**

*NCC/NSS/NSO/YRC/RRC/Fine Arts - 3 credits can be waived or offered as extra credits

$ extra credits will be offered based on the duration of the internship

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SEMESTER VIII

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	51 BT 801	Bioethics and Biosafety	PC	3	3	0	0	3
2.	50 AC 002	Research Skill Development- II	AC	1	1	0	0	0
PRACTICALS								
3.	50 BT 8P1	Project Work - Phase II	EEC	16	0	0	16	8
4.	50 TP 0P6	Internship	EEC	0	0	0	0	1/2/3$
			Total	**20**	**4**	**0**	**16**	**11**

$ extra credits will be offered based on the duration of the internship

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 166

Note: HS- Humanities and Social Sciences including Management Courses, BS- Basic Science Courses, ES- Engineering Science Courses, PE-Professional Core Courses, PE-Professional Elective Courses, OE- Open Elective Courses, EEC-Employability Enhancement Courses, MC- Mandatory Courses, AC – Audit Courses& GE – General

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 EN 001	Communication Skills I	HS	2	1	1	0	2
2.	50 EN 002	Communication Skills II	HS	2	1	1	0	2
3.	50 HS 001	Engineering Economics and Financial Accounting	HS	3	3	0	0	3

BASIC SCIENCE (BS)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 MA 001	Calculus and Differential Equations	BS	4	3	1	0	4
2.	50 CH 001	Applied Chemistry	BS	3	3	0	0	3
3.	50 CH 0P1	Chemistry Laboratory	BS	4	0	0	4	2
4.	50 MA 002	Laplace Transform and Complex Variables	BS	4	3	1	0	4
5.	50 PH 006	Applied Physics for Biotechnology	BS	3	3	0	0	3
6.	50 PH 0P1	Engineering Physics laboratory	BS	4	0	0	4	2
7.	50 MA 007	Transform and Numerical Methods	BS	4	3	1	0	4
8.	50 MA 013	Statistical Methods	BS	5	3	2	0	4

ENGINEERING SCIENCES (ES)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 ME 003	Engineering Mechanics	ES	4	3	1	0	4
2.	50 CS 001	Programming for Problem Solving	ES	3	3	0	0	3

3.	50 CS 0P1	Programming for Problem Solving Laboratory	ES	4	0	0	4	2
4.	50 EE 001	Basic Electrical Engineering	ES	3	3	0	0	3
5.	50 ME 002	Engineering Graphics	ES	6	2	0	4	4
6.	50 ME 0P1	Engineering Practices Laboratory	ES	4	0	0	4	2

PROFESSIONAL CORE (PC)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT 301	Biochemistry	PC	3	3	0	0	3
2.	50 BT 302	Microbiology	PC	3	3	0	0	3
3.	51 BT 303	Cell and Molecular Biology	PC	3	3	0	0	3
4.	50 BT 304	Principles of Chemical Engineering	PC	4	3	1	0	4
5.	50 BT 3P1	Biochemistry Laboratory	PC	4	0	0	4	2
6.	50 BT 3P2	Microbiology Laboratory	PC	4	0	0	4	2
7.	51 BT 401	Genetic Engineering	PC	3	3	0	0	3
8.	50 BT 402	Protein and Enzyme Engineering	PC	3	3	0	0	3
9.	50 BT 403	Biochemical Thermodynamics	PC	4	3	1	0	4
10.	50 BT 4P1	Molecular Biology and Genetic Engineering Laboratory	PC	4	0	0	4	2
11.	50 BT 4P2	Protein and Enzyme Engineering Laboratory	PC	4	0	0	4	2
12.	50 BT 501	Plant and Animal Biotechnology	PC	3	3	0	0	3
13.	50 BT 502	Bioinformatics	PC	3	3	0	0	3
14.	50 BT 503	Bioprocess Technology	PC	4	3	1	0	4
15.	50 BT 504	Heat and Mass Transfer Operations	PC	4	3	1	0	4
16.	50 BT 5P1	Plant and Animal Biotechnology Laboratory	PC	4	0	0	4	2
17.	50 BT 5P2	Bioprocess Technology Laboratory	PC	4	0	0	4	2
18.	51 BT 601	Biopharmaceutical Technology	PC	3	3	0	0	3
19.	50 BT 602	Molecular Modeling and Drug Designing	PC	3	3	0	0	3
20.	50 BT 603	Chemical Reaction Engineering	PC	4	3	1	0	4
21.	50 BT 6P1	Bioinformatics and Molecular Modeling Laboratory	PC	4	0	0	4	2
22.	50 BT 6P2	Chemical Engineering Laboratory	PC	4	0	0	4	2
23.	50 BT 701	Immunology	PC	3	3	0	0	3
24.	50 BT 702	Downstream Processing	PC	4	3	1	0	4
25.	50 BT 7P1	Immunology Laboratory	PC	4	0	0	4	2
26.	50 BT 7P2	Downstream Processing Laboratory	PC	4	0	0	4	2
27.	51 BT 801	Bioethics and Biosafety	PC	3	3	0	0	3

PROFESSIONAL ELECTIVES (PE)SEMESTER V, ELECTIVE I

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT E11	Environmental Biotechnology	PE	3	3	0	0	3
2.	50 BT E12	Biodiversity and its conservation	PE	3	3	0	0	3
3.	50 BT E13	Environmental Hazards and Management	PE	3	3	0	0	3
4.	50 BT E14	Food Biotechnology	PE	3	3	0	0	3
5.	50 BT E15	Fermentation Technology	PE	3	3	0	0	3

SEMESTER VI, ELECTIVE II

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT E21	Cancer Biotechnology	PE	3	3	0	0	3
2.	50 BT E22	Clinical Immunology	PE	3	3	0	0	3
3.	50 BT E23	Stem Cell Technology	PE	3	3	0	0	3
4.	50 BT E24	Tissue Engineering	PE	3	3	0	0	3
5.	50 BT E25	Biomedical Instrumentation	PE	3	3	0	0	3

SEMESTER VI, ELECTIVE III

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT E31	Bioresource Technology	PE	3	3	0	0	3
2.	50 BT E32	Biophysics	PE	3	3	0	0	3
3.	50 BT E33	Metabolic Engineering	PE	3	3	0	0	3
4.	50 BT E34	Bioreactor Design	PE	3	3	0	0	3
5.	50 BT E35	Bioprocess Modeling and Simulation	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE IV

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	51 BT E41	Nanobiotechnology	PE	4	2	0	2	3
2.	51 BT E42	Bioinstrumentation	PE	4	2	0	2	3
3.	51 BT E43	Toxicology	PE	4	2	0	2	3
4.	51 BT E44	Genomics and Proteomics	PE	4	2	0	2	3
5.	51 BT E45	Agricultural Biotechnology	PE	4	2	0	2	3

SEMESTER VII, ELECTIVE V

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT E51	Research Design and Analysis	PE	3	3	0	0	3
2.	50 BT E52	Marine Biotechnology	PE	3	3	0	0	3
3.	50 BT E53	Human Physiology and Anatomy	PE	3	3	0	0	3
4.	50 BT E54	Biofuel Technology	PE	3	3	0	0	3
5.	50 BT E55	Systems Biology	PE	3	3	0	0	3

MANDATORY COURSES (MC)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 MY 001	Constitution of India	MC	2	2	0	0	0
2.	50MY003	Ethics for Engineers	MC	2	2	0	0	0
3.	50 MY 002	Environmental Science	MC	2	2	0	0	0
4.	50 MY 014	Start-ups and Entrepreneurship	MC	2	2	0	0	0

SEMESTER VII & SEMESTER VIII, AUDIT COURSES (AC)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 AC 001	Research Skill Development- I	AC	1	1	0	0	0
2.	50 AC 002	Research Skill Development-II	AC	1	1	0	0	0

GENERAL ELECTIVE (GE)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 GE 00*	National Cadet Corps (Air Wing, Army Wing)*	GE	5	3	0	2	4

OPEN ELECTIVES IV / V / VI (OE)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT L01	Agricultural Engineering	OE	3	3	0	0	3
2.	50 BT L05	Basics of Genetic Engineering	OE	3	3	0	0	3
3.	50 BT L06	Animal Studies in Food Research	OE	3	3	0	0	3
4.	50 BT L07	Basics of Bioinformatics	OE	3	3	0	0	3
5.	50 BT L08	Production Technology of Agricultural and Food Processing Machinery	OE	3	3	0	0	3
6.	50 BT L09	Pollution and its management	OE	3	3	0	0	3

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EMPLOYABILITY
ENHANCEMENT COURSES
(EEC)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 TP 0P1	Career Competency Development - I	EEC	2	2	0	0	-
2.	50 TP 0P2	Career Competency Development - II	EEC	2	2	0	0	-
3.	50 TP 0P3	Career Competency Development - III	EEC	2	2	0	0	-
4.	50 TP 0P4	Career Competency Development - IV	EEC	2	2	0	0	-
5.	50 TP 0P5	Career Competency Development - V	EEC	2	2	0	0	-
6.	50 BT 6P3	Internship $	EEC	0	0	0	0	1/2s
7.	50 BT 7P3	Project Work - Phase I	EEC	4	0	0	4	2
8.	50 BT 8P1	Project Work - Phase II	EEC	16	0	0	16	8

$ Extra credit will be added based on the duration of the internship

ONE CREDIT/ SKIL BASED/ VALUE ADDED COURSE

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1.	50 BT SE01	Medical Coding and Pharmacovigilance	OC	3	3	0	0	1
2.	50 BT SE02	Phytochemical and Natural products	OC	3	3	0	0	1
3.	50 BT SE03	Quality Control in Biotechnology	OC	3	3	0	0	1
4.	50 BT SE04	Bio business Development	OC	3	3	0	0	1
5.	50 BT SE05	Molecular Diagnostics	OC	3	3	0	0	1

SUMMARY

S.No.	Category	Credits Per Semester								Total Credits	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1.	HS	2	2	-	-	-	-	3	-	**07**	**04.22**
2.	BS	9	9	4	4	-	-	-	-	**26**	**15.66**
3.	ES	9	9	-	-	-	-	-	-	**18**	**10.84**
4.	PC	-	-	17	14	18	14	11	3	**77**	**46.38**
5.	PE	-	-	-	-	3	3	3	6	**15**	**09.36**
6.	OE	-	-	-	3	3	3	3	-	**12**	**07.23**
7.	EEC	-	-	-	-	-	1	2	8	**11**	**06.63**
8.	MC	-	MC I	MC II	MC III	-	MC IV	-	-	**-**	**-**
Total		**20**	**20**	**21**	**21**	**24**	**21**	**22**	**17**	**166**	**100**

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Honours Degree Courses (Agriculture Biotechnology)

S.No.	Course Code	Course	Category	L	T	P	C
1	50 BT H01	Agriculture Microbiology	PE	3	0	0	3
2	50 BT H02	Organic Farming for Sustainable Agriculture	PE	3	0	0	3
3	50 BT H03	Crop Production Technology	PE	3	0	0	3
4	50BT H04	Agri Business Management and EDP	PE	3	0	0	3
5	50 BT H05	Green house technology and protected cultivation	PE	3	0	0	3
6	50 BT H06	Farming System and Sustainable Agriculture	PE	3	0	0	3
		Total		18	0	0	18

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K. S. Rangasamy College of Technology – Autonomous R2018								
50 EN 001 – Communication Skills I								
Common to all Branches								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
1	1	1	0	30	2	40	60	100

Objective(s)	• To help learners improve their vocabulary and to enable them to use words appropriately in different academic and professional contexts • To help learners develop strategies that could be adopted while reading texts • To help learners acquire the ability to speak effectively in English in real life and career related • To equip students with effective speaking and listening skills in English • To facilitate learners to enhance their writing skills with coherence and appropriate format effectively
Course Outcomes	**At the end of the course, the students will be able to** CO1: utilize digital literacy tools to develop listening skills and make use of contextual clues to infer meanings of unfamiliar words CO2: able to select, compile & synthesize information using communication strategies for an effective oral presentation CO3: skim & scan the textual content & infer meanings of unfamiliar words to develop reading & vocabulary skills CO4: generate ideas from sources to develop coherent content and support with relevant details in write CO5: recognize the basic phonetic patterns of language & execute it for competent loud reading

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Listening

Listening to Short Audios – Watching Short Videos - answering MCQs and Vocabulary Check- Listening to Short Comprehension Passages – Guided Listening – Listening to songs and cognizing the lyrics. **[6]**

Speaking

Brainstorming – Group Discussion (unstructured) – Self Introduction - Just a Minute (JaM) - Short Narratives – Cue Cards – Picture Cards – Conversational Practices (Preliminary) **[12]**

Reading

Silent Reading – Scanning and Skimming - Reading short and Medium Passages – Cognition of Theme and Inferential Meaning - Academic and Functional Vocabulary List (350 words) – Word Power Check - Loud Reading –Modulation and Pronunciation Check **[6]**

Writing

Functional Vocabulary and Word Power – Data Interpretation - Paragraph Writing – Letter Writing –Email Writing – Conversational Fill Ups **[6]**

Total Hours: 30

Text books:

1. M.Ashraf Rizvi, 'Effective Technical Communication', 2 nd Edition, McGraw Hill Education (India) Private Limited, Chennai, 2018
2. Norman Lewis, 'Word Power Made Easy - The Complete Handbook for Building a Superior Vocabulary Book', Penguin Random House India, 2020

Reference(s):

1. Paul Emmerson and Nick Hamilton, *'Five Minute Activities for Business English',* Cambridge University Press, New York, 2005.
2. Arthur Brookes and Peter Grundy,' *Beginning to Write: Writing Activities for Elementary and Intermediate Learners',* Cambridge University Press, New York, 2003.
3. Michael McCarthy and Felicity O Dell, *'English Vocabulary in Use: Upper Intermediate',* Cambridge University Press, New York, 2012.

Mapping of COs with POs and PSOs

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

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50 MA 001 - Calculus and Differential Equations

Common to all Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	**3**	**1**	**0**	**60**	**4**	**40**	**60**	**100**

Objective(s)

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditionalcalculus.
- The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions.
- Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering.
- This course deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.
- Development of mathematical skills to solve the differential equations.

Course Outcomes

At the end of the course, the students will be able to

CO1: apply Cayley - Hamilton theorem and to reduce quadratic form into canonical form.
CO2: compute the equation of the circle of curvature, evolute and envelope of the curves
CO3: analyze Jacobian methods and constrained maxima and minima functions.
CO4: apply various methods in differential equations to solve linear and simultaneous differential equations.
CO5: evaluate definite and indefinite integrals using different techniques.

Note: The hours given against each topic are indicative. The faculty has the freedom to decide the hours required for each topic based on the importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the number hours indicated.

Matrices

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors – Cayley-Hamilton theorem (without proof) – Orthogonal transformation of a symmetric matrix to diagonal form –Reduction of quadratic form to canonical form by orthogonal transformation - Nature of quadratic form**.** **[8]**

Differential Calculus

Curvature – radius of curvature (Cartesian and polar co-ordinates) – Centre of curvature – Circle of curvature – Involute and evolute– envelope. **[9]**

Function of Several Variables

Partial differentiation – Homogeneous functions and Euler's theorem – Jacobians– Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Constrained maxima and minima: Lagrange's Method of Undetermined Multipliers. **[9]**

Differential Equations

Linear differential equations of second and higher order with constant co-efficient - R.H.S is e^{ax} , $\sin ax, \cos ax, x^n\ n > 0, e^{ax} \sin bx$, $e^{ax} \cos bx$, $e^{ax} x^n$, $x^n \sin ax$ and $x^n \cos ax$ - Differential equations with variable co-efficients : Cauchy's and Legendre's form of linear equation - Method of variation of parameters - Simultaneous first-order linear equations with constant co-efficients. **[9]**

Integral Calculus

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions – Improper integrals. **[10]**

Total Hours: 45 + 15(Tutorial): 60 hours

Text books:

1 Grewal B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014. Web site:https://pvpsitrealm.blogspot.com/2016/09/higher-engineering-mathematics-by-bs.html

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2	Veerarajan.T., “Engineering Mathematics”, for Semesters I and II , Tata McGraw Hill Publishing Co., New Delhi., 2010.
Reference(s):	
1	Kreyszig Erwin, “Advanced Engineering Mathematics”, 10th Edition, John Wiley and Sons (Asia) Limited, New Delhi, 2016.
2	Integral Equations, calculus of variations and its applications- Dr. P. N. Agrawal, Dr. D. N. Pandey, NPTEL online video courses.
3	Matrix Analysis with Applications - Dr. S. K. Gupta Dr. Sanjeev Kumar, Matrix Solvers -Prof.Somnath Roy NPTEL online videocourses.
4	Matrix Analysis with Applications - Dr. S. K. Gupta Dr. Sanjeev Kumar, Matrix Solvers -Prof.Somnath Roy NPTEL online video courses.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3								3	
CO2	3	3	2	2	2								3	
CO3	3	3	3	2	2								3	
CO4	3	3	3	3	2								3	
CO5	3	3	3	2	3								3	

K.S.Rangasamy College of Technology – Autonomous R2018								
50 CH 001 - Applied Chemistry								
Common to all Branches								
Semester	**Hours / Week**			**Total Hours**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
I	**3**	**0**	**0**	**45**	**3**	**40**	**60**	**100**
Objective(s)	• To endow with the periodic properties of elements and molecular orbitals variation of orbitals • To assist the learners to apply the thermodynamic functions to electrochemical reactions and its application • To help the learners analyze the hardness of water and its removal techniques • To endow with various spectroscopy techniques and its applications • To facilitate the students with the basics of stereochemistry and types of chemical reactions with their mechanism							
Course Outcomes	**At the end of the course, the students will be able to** CO1: Rationalize the periodic properties of elements and molecular orbitals variation of orbitals CO2: Apply the thermodynamic functions to electro chemical reactions and its application CO3: Analyze the cause and effects of hardness of water and its removal techniques CO4: Interpret the various spectroscopy techniques and its applications CO5: Infer the types of stereochemistry and chemical reactions with their mechanism							
Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.								

Periodic properties

Effective nuclear charge - atomic and ionic sizes - ionization energies - electron affinity – electro negativity - polarizability oxidation states - penetration of orbitals- variations of s, p, d and f orbital energies of atoms - electronic configurations, ionicdipolar and Vander- waals interactions. Hard soft acids and bases (HSAB). Molecular orbitals of diatomic molecules - plots of the multi centre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbital of butadiene and benzene. **[9]**

Chemical equilibria and corrosion

Thermodynamic functions - energy - entropy - enthalpy- free energy - Gibbs-Helmholtz equation - Van 't Hoff isotherm. Cell potentials - Nernst equation - applications - EMF series - applications - Poteniometric and Conductometric titrations. Corrosion- types of corrosion - chemical and electrochemical corrosion - mechanism - Factors influencing corrosion - Corrosion control methods (impressed current and sacrificial anode methods) –Corrosion inhibitors. **[9]**

Water Chemistry

Sources - Water quality parameters - impurities in water and their effects. Hardness - Estimation of hardness -effect of hard water in various industries-Softening of water- zeolite process- ion-exchange process - reverse osmosis – electro dialysis. Boiler troubles – methods of prevention. **[9]**

Analytical techniques and applications

Absorption laws - Ultra violet spectroscopy (UV) - Principle - Instrumentation (Block diagram) - applications. Infra-red spectroscopy (IR)- Instrumentation (Block diagram) - selection rule - types of fundamental vibrations - applications. Nuclear magnetic resonance spectroscopy (NMR) - Principle - selection rule - Instrumentation (Block diagram) - chemical shift factors influencing the chemical shift -applications. Atomic absorption spectroscopy (AAS) - Principle - Instrumentation (Block diagram)-applications. **[9]**

Concepts in Organic Chemistry

Structural isomerism- types - Stereoisomerism - geometrical (Maleic and Fumaric acids) - optical isomerism (Lactic and Tartaric acids) - symmetry - chirality- enantiomers - diastereomers - optical activity – absolute configurations. Introduction to reactions - substitution - addition - oxidation - reduction - cyclization and ring openings - mechanism. **[9]**

Total Hours: 45 hours

Text books:

1. Jain. P.C. and Monica Jain, "Engineering Chemistry", Dhanpatrai publishing co. New Delhi, 14th edition, 2015.
2. Vairam, S.and Suba Ramesh, "Engineering Chemistry",Wiley India Private Limited , 2 nd edition, January 2013

Reference(s):

1. Puri B. R., Sharma L.R., and Pathania M.S., "Principles of Physical Chemistry", Vishal Publishing Company, Delhi, 2017.
2. Dara. S.S, "A Text Book of Engineering Chemistry", S Chand & co. Ltd., 2014.
3. Bahl B.S. and Arun Bahl, "Advanced Organic Chemistry", S.Chand, New Delhi, 2014
4. Sharma BK. Instrumental methods of chemical analysis, Goel Publishing House Meerut, 23th edition; 2014.

Mapping of COs with POs and PSOs

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

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50 ME 003 – Engineering Mechanics

Common to all Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	**3**	**1**	**0**	**60**	**4**	**40**	**60**	**100**

Objective(s)

- To learn a process for analysis of static objects, concepts of force, moment, and mechanical equilibrium in two and three dimensions.
- To learn the equilibrium of rigid bodies such as frames, trusses, beams.
- To identify the properties of surfaces and solids by using different theorem.
- To impart basic concept of dynamics of particles.
- To understand the concept of friction and elements of rigid body dynamics.

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Course Outcomes	**At the end of the course, the students will be able to** CO1: use scalar and vector analytical techniques for analyzing forces in statically determinate structures. CO2: apply basic knowledge of scientific concepts to solve real-world problems. CO3: calculate the properties of surfaces and solids using various theorems. CO4: analyse and solve problems on kinematics and kinetics. CO5: draw a shear force and bending moment diagrams, analysis of rigid body dynamics and calculation of frictional forces on contact surfaces.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Basics and Statics of Particles

Introduction -Units and Dimensions-Laws of Mechanics–Principle of transmissibility-Lame's theorem, Parallelogram and Triangular Law of Forces–Vectors–Vectorial representation of forces and moments.

Vector Operations

Addition, subtraction, dot product, cross product-Coplanar Forces–Resolution and Composition of forces– Equilibrium of a particle–Force in space-Equilibrium of a particle in space-Equivalent systems of forces-Single equivalent force.

Equilibrium of Rigid Bodies **[12]**

Free body diagram–Types of supports and their reactions–requirements of stable equilibrium–Static determinacy, Moments and Couples–Moment of a force about a point and about an axis–Vectorial representation of moments and couples–Varignon's theorem- Equilibrium of Rigid bodies in two dimensions. **[12]**

Trusses: Introduction, axial members, calculation of forces on truss members using method of joints-Method of sections.

Properties of Surface and Solids

Determination of Areas and Volumes-Centroid, Moment of Inertia of plane area (Rectangle, circle, triangle using Integration Method; T section, I section, Angle section, Hollow section using standard formula) - Parallel axis theorem and perpendicular axis theorem- Polar moment of inertia -Mass moment of inertia of thin rectangular section -Relation between area moment of inertia and mass moment of inertia. **[12]**

Dynamics of Particles

Displacement, Velocity, acceleration and their relationship–Relative motion -Projectile motion in horizontal plane– Newton's law– Work Energy Equation — Impulse and Momentum. **[12]**

Elements of Rigid Body Dynamics, friction and Beams

Translation and Rotation of Rigid Bodies: Velocity and acceleration–General Plane motion: Crank and Connecting rod mechanism.

Friction

Frictional force–Laws of Coloumb friction–Simple contact friction–Ladder Friction-Rolling resistance–Ratio of tension in belt.

Transverse bending on beams

Types of beams: Supports and loads – Shear force and bending moment in beams – Cantilever, simply supported and overhanging beams. **[12]**

Total Hours: 45 + 15 (Tutorial): 60 hours

Text books:

1. Rajasekaran, S, Sankarasubramanian, G., Fundamentals of Engineering Mechanics, Vikas PublishingHouse Pvt. Ltd.,3rd Edition, 2017.
2. Beer, F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", Statics and Dynamics, McGraw-HillInternational, 11th Edition, 2016.

Reference(s):

1. Jayakumar, V. and Kumar, M, Engineering Mechanics, PHI Learning Private Ltd, New Delhi, 2012
2. Hibbeller, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt.Ltd., 2016.
3. Bansal R.K," Engineering Mechanics" Laxmi Publications (P) Ltd, 2011.
4. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, Pearson Education Asia Pvt. Ltd, 4 Edition, 2003.

Mapping of COs with POs and PSOs

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

Chairman - BOS

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BOS- Chairman

K.S.Rangasamy College of Technology – Autonomous R2018

50 CS 001 - Programming for Problem Solving

Common to all Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100

Objective(s)

- To learn the evolution of computers and examines the most fundamental element of the C language
- To examine the execution of branching, looping statements, arrays and strings.
- To understand the concept of functions, pointers and the techniques of putting them to use
- To apply the knowledge of structures and unions to solve basic problems in C language
- To enhance the knowledge in file handling functions for storage and retrieval of data

Course Outcomes

At the end of the course, the students will be able to

CO1: infer the evolution, generation, representation of problem and recognize the concepts of data types and expressions

CO2: annotate the concept of console Input and output features and examine the execution of branching, looping statements, arrays and strings

CO3: recognize the concepts of functions, recursion, storage class specifies and pointers with its features

CO4: Comprehend basic concepts of structures, unions, user defined data types and preprocessor

CO5: Interpret the file concepts using proper standard library functions

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Computer and Programming

Introduction to Computers - Evolution of computers - Generations of computers and Programming Languages– Introduction to components of a computer system -Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart– Pseudocode with examples. From algorithms to programs– variables (with data types)– Type Qualifiers - Constants – Operators –expressions and precedence **[9]**

I/O ,Branching ,Loops and Arrays

Console I/O– Unformatted and Formatted Console I/O – Conditional Branching and Loops -Writing and evaluation of conditionals and consequent branching -Iteration and loops - Arrays (1-D, 2-D), Character arrays and Strings **[9]**

Functions and Pointers

Functions: Scope of a Function – Library Functions and User defined functions - Function Prototypes – Function Categorization - Function Arguments - Arguments to main function - The return Statement -Recursion - Passing Arrays to Functions– Storage class Specifiers. Introduction to Pointer Variables - The Pointer Operators - Pointer Expressions - Pointers and Arrays - Generating a Pointer to an Array - Indexing Pointers– Dynamic memorial location **[9]**

Structures, Unions, Enumerations, Typedef and Preprocessors

Structures - Arrays of Structures- Arrays and Structures within Structures - Passing Structures to Functions – Structure Pointers - Unions – Bit Fields - Enumerations – type def – The preprocessor and comments. **[9]**

File

File: Streams –Reading and Writing Characters - Reading and Writing Strings -, File System functions – Random Access Files. **[9]**

Total Hours: 45 hours

Text books:

1. Herbert Schildt, “The Complete Reference C”, Fourth Edition, Tata McGraw Hill Edition, 2010.
2. Byron Gottfried, “Programming with C”, Third Edition, McGraw Hill Education, 2014.

Reference(s):

1. Balagurusamy E. “Programming in ANSI C”, Seventh Edition, Tata McGraw Hill Edition, New Delhi, 2016.
2. Brian W. Kernighan and Dennis M. Ritchie, “C Programming Language”, Prentice-Hall.
3. Reema Thareja, “Computer Fundamentals and Programming in C”, Second Edition, Oxford Education, 2016.
4. King K N. “C Programming: A Modern Approach”, Second Edition, W.W.Norton, New York, 2008.

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Mapping of COs with POs and PSOs

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

Modules	Suggested Activities	Suggested Evaluation Methods
1.	Knowing the history of computers	Group Discussion on Introduction to Computers and its generation
	Developing Pseudocodes and flowcharts for real life activities	
	Developing algorithms for basic mathematical expressions using arithmetic operations.	Assignments on pseudocodes and flowcharts
2.	Simple programs using I/O statements, arithmetic operations	Tutorial for the above activities
	Implementation of simple programs using Branching, Loops and Arrays	
	Performing String operations	Group discussion on role of Branching, loop and Arrays in Programming Language
3.	Develop simple applications like Calculator, Various Conversion Process using functions	Tutorial for the above activities
	Develop a simple program by applying pointer concepts	Group discussion on Function and Pointers
4.	Develop simple programs using Structures, Unions, Enumerations, Typedef and Preprocessors	Tutorial for the above activities
5.	Develop simple applications to apply files operations	Tutorial for the above activities Group discussion on Files Concepts

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K.S.Rangasamy College of Technology – Autonomous R2018								
50 MY 001 - Constitution of India								
Common to all Branches								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	2	0	0	30	-	100	-	100

Objective(s)	• To know the premises informing the twin themes of liberty and freedom from a civil rights perspective. • To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. • To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917and its impact on the initial drafting of the Indian Constitution. • To gain knowledge on bill passing • To acquire knowledge on function of election commission
Course Outcomes	**At the end of the course, the students will be able to** CO1: discuss the growth of the demand for civil rights in India for the bulk of fns before the arrival of Gandhi in Indian politics. CO2: discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. CO3: discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct CO4: Discuss the passage of the Hindu Code Bill of 1956. CO5: Explain the functions of Election Commission

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

History of Making of the Indian Constitution

History - Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution

Preamble - Salient Features **[6]**

Contours of Constitutional Rights & Duties

Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation -Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy - Fundamental Duties. **[6]**

Organs of Governance

Parliament - Composition - Qualifications and Disqualifications - Powers and Functions Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions. **[6]**

Local Administration

District's Administration head: Role and Importance, - Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation - Pachayat raj: Introduction, PRI: Zila Pachayat - Elected officials and their roles, CEO Zila Pachayat: Position and role- Block level: Organizational Hierarchy (Different departments) -Village level: Role of Elected and Appointed officials - Importance of grass root democracy. **[6]**

Election Commission

Election Commission: Role and Functioning- Chief Election Commissioner and Election Commissioners- State Election Commission: Role and Functioning- Institute and Bodies for the welfare of SC/ST/OBC and women. **[6]**

Total Hours: 30 hours

Text books:

1. The Constitution of India, 1950 (Bare Act), Government Publication
2. S.N, Busi, Ambedkar, B.R.," Framing of Indian Constitution", 1st Edition, 2015.

Reference(s):

1. Basu, D D., "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. M.P Jain, "Indian Constitution Law", 7th Edition, Lexis Nexis, 2014.
3. S R Bhansali, Textbook on The Constitution of India, Universal Publishers, 2015
4. M P Jain, Outlines of Indian Legal and Constitutional History, Lexisnexis, 2014

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								2	2	1		2		
CO2								2	2	1		2		
CO3								2	2	1		2		
CO4								2	2	1		2		
CO5								2	2	1		2		

K.S.Rangasamy College of Technology – Autonomous R2018

50 CH 0P1 – Chemistry Laboratory

Common to all Branches

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
I	0	0	4	60	2	60	40	100

Objective(s)

- To test the knowledge of theoretical concepts.
- To develop the experimental skills of the learners.
- To facilitate data interpretation.
- To enable the learners to get hands-on experience on the principles discussed in theory sessions.
- To expose the learners to various industrial and environmental applications

Course Outcomes

At the end of the course, the students will be able to

CO1: estimate the amount of hardness, alkalinity, chloride ion and dissolved oxygen in water sample
CO2: estimate the amount of barium chloride and mixture of acids by conductometry
CO3: Infer the amount of acid by pH metry and ferrous ion by potentiometry
CO4: Examine the amount of ferrous ion by spectrophotometry
CO5: Determine the percentage of corrosion by weight loss method

LIST OF EXPERIMENTS

Any ten Experiments

1. Estimation of hardness of water by EDTA method.
2. Estimation of alkalinity of water sample.
3. Estimation of chloride content in water sample (Argentometric method).
4. Determination of dissolved oxygen in boiler feed water (Winkler's method).
5. Estimation of barium chloride by conductometric precipitation titration.
6. Estimation of mixture of acids by conductometric titration.
7. Estimation of ferrous ion by potentiometric titration.
8. Estimation of HCl, beverages and other biological samples by pH meter.
9. Estimation of iron content by spectrophotometry method.
10. Determination of corrosion rate and inhibitor efficiency by weight loss method.

Total Hours: 60

Lab Manual:

1. Vairam S and Suba Ramesh, "Engineering Chemistry", Wiley India Private Limited, Delhi, 2nd edition,January 2013.
2. Dara S.S. "A Text Book on Experiments and Calculations Engineering", S.Chand & Co., Ltd., 2nd edition,2003

References:

1. Mendham. J, Denney. R.C, Barnes. J.D, and Thomas. N.J.K, "Vogel's Text Book of Quantitative ChemicalAnalysis", Pearson Education, 6th edition, 2009.
2. Vermani, O P., and A K Narula, "Applied Chemistry : Theory And Practice, New Age International (P) Ltd.,Publishers, 2nd edition, January 2020
3. Gary D. Christian, "Analytical Chemistry", John Wiley & Sons, 6th edition, 2007.
4. Chatwal Anand, "Instrumental Methods of Chemical Analysis", Himalaya Publications, 5th Edition, 2019.

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 CS 0P1 - Programming for Problem Solving Laboratory

Common to all Branches

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
I	**0**	**0**	**4**	**60**	**2**	**60**	**40**	**100**

Objective(s)

- To enable the students to apply the concepts of C to solve simple problems
- To use selection and iterative statements in C programs
- To apply the knowledge of library functions in C programming
- To implement the concepts of arrays, functions, structures and pointers in C
- To implement the file handling operations through C

Course Outcomes

At the end of the course, the students will be able to

CO1: apply how to read, display basic information and use selection and iterative statements

CO2: demonstrate C program to manage collection of related data

CO3: design and implement different ways of passing arguments to functions, Recursion and implement pointers concepts

CO4: develop a C program to manage collection of different data using structures, Union, user- defined data types and preprocessor directives

CO5: demonstrate C program to store and retrieve data using file concepts

LIST OF EXPERIMENTS

Any ten Experiments

1. Implementation of Simple computational problems using various formulas.
2. Implementation of Problems involving Selection statements.
3. Implementation of Iterative problems e.g., sum of series.
4. Implementation of 1D Array manipulation.
5. Implementation of 2D Array manipulation.
6. Implementation of String operations.
7. Implementation of Simple functions and different ways of passing arguments to functions and Recursive Functions.
8. Implementation of Pointers
9. Implementation of structures and Union.
10. Implementation of Bit Fields, Typedef and Enumeration.
11. Implementation of Preprocessor directives.
12. Implementation of File operations.

Total Hours: 60

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 EN 002 – Communication Skills II

Common to all Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	**1**	**1**	**0**	**30**	**2**	**40**	**60**	**100**

Objective(s)

- To help learners improve their vocabulary and enable them to use words appropriately in different academic and professional contexts.
- To help learners develop strategies that could be adopted while reading texts.
- To help learners acquire the ability to speak and write effectively in English in real life and career related situations.
- Improve listening, observational skills, and problem-solving capabilities
- Develop message generating and delivery skills

Course Outcomes

At the end of the course, the students will be able to

CO1: identify speaker's purpose and tone, comprehend relationship between ideas and respond to the listening content

CO2: use communication strategies, vocabulary and appropriate grammatical structures for effective or interactions

CO3: make inferences and predictions, develop reading speed, build academic vocabulary by utilizing digital literacy tools on textual comprehension

CO4: use a variety of accurate sentence structures with functional vocabulary, apply the conventions of academic writing and use peer and teacher feedback for effective writing.

CO5: demonstrate proficiency in communication skills in academic and professional contexts.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Advanced English Listening Module

Extended Listening to Podcasts – Listen and Watch Video Clips - answering Inferential Multiple-Choice Questions and Vocabulary Check- Listening to Lengthy Discourses – Structured Listening – Listening to Songs and Cognizing the Lyrics- Listening to popular speeches, news briefs and stories **[6]**

Oral Communication

Debates – Group Discussion (Structured) and rotate roles – Elevator Speech – Prepared Talk – Extempore – Brief Technical presentations- Spin-a-Yarn – Short Film reviews – talk on silent videos – Dialogues and Role plays (Intermediate & Higher Level)–Interviews**[12]**

Critical Reading Process

Silent Reading – Scanning and Skimming - Reading comprehension with logical reasoning questions – Cognition of Theme and Inferential Meaning – advanced Academic and Functional Vocabulary List (1000words) – word webs and semantic threads - Loud Reading – Modulation and Pronunciation Check – Mind maps – Note making – Deep Reading Skills **[6]**

Academic Writing Practices

Sentence Equivalence and Text completion tasks – Data Interpretation - Essay Writing – Letter Writing – Business Emails – Conversational Fill Ups-Rewordify (select a text and simplify/enhance the language)- Reports on events **[6]**

Total Hours: 30 hours

Text books:

1. M.Ashraf Rizvi, 'Effective Technical Communication', 2 nd Edition, McGraw Hill Education (India) Private Limited, Chennai, 2018
2. Norman Lewis, 'Word Power Made Easy - The Complete Handbook for Building a Superior Vocabulary Book', Penguin Random House India, 2020

Reference(s):

1. PaulEmmerson and Nick Hamilton , *'Five Minute Activities for Business English',* CambridgeUniversityPress, N.York, 2005
2. Ruth Wainryb, '*Stories: Narrative Activitiess for The Language Classroom',* Cambridge UniversityPress,N.York, 2005
3. Stuart Redman, *'English Vocabulary in Use: Upper Intermediate',* Cambridge University Press, N.York,2006
4. https://www.khanacademy.org/test-prep/sat/sat-reading-writing-practice

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Chairman - BOS
BOS Chairman

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 MA 002 - Laplace Transform and Complex Variables

Common to All Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	1	0	60	4	40	60	100

Objective(s)

- Multiple integration is used to solve problems involving volume and surface area.
- Vector calculus can be widely used for modeling the various of physics.
- Introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of complex analysis such as analytic function and complex integral.
- Identify and construct complex - differentiable function.
- Laplace Transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

Course Outcomes

At the end of the course, the students will be able to

CO1: Evaluate double and triple integrals, analyze Beta and Gamma functions.
CO2: Analyze the basic concepts of vector calculus to verify Green's, Stoke's and Gauss divergence theorems.
CO3: Construct the analytic function and bilinear transformation.
CO4: Apply Cauchy's integral formula and Cauchy's residue theorem to evaluate the complex integrals.
CO5: Apply Laplace transform techniques for solving differential equations.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Multiple Integrals

Double integration – Cartesian and polar coordinates – Change of order of integration – Area between two curves –Area as double integral – Triple integration in Cartesian coordinates. Beta and Gamma functions**:** Relationship between Beta and Gamma functions – Properties–Problems**.** **[9]**

Vector Calculus

Introduction - gradient of a scalar point function - directional derivative - angle of intersection of two surfaces — divergence and curl (excluding vector identities) - solenoidal and irrotational vectors - Green's theorem in the plane - Gauss divergence theorem - Stokes' theorem (without proof)- verification of the above theorems and evaluation of integrals using them. **[9]**

Analytic Functions

Analytic functions – Necessary conditions (Cauchy–Riemann equations)- Polar form of Cauchy–Riemann equations Sufficientconditions(withoutproof)–Propertiesofanalyticfunctions–Harmonicfunction– harmonic conjugate Construction of analytic functions– Conformal mapping: w = z + a, az, 1/z-Bilinear transformation. **[9]**

Complex Integration

Cauchy's Integral theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent's series (without proof) – Classification of singularities – Cauchy's residue theorem – Contour integration – Circular and semi-circular contours (excluding poles on real axis). **[8]**

Laplace Transforms

Conditions for existence – Transform of elementary functions – Basic properties – Shifting theorems- Derivatives and integrals of transforms –– Transform of unit step function – Dirac's delta function- Initial and final value theorem– Transform of periodic functions. Inverse Laplace transform – Convolution theorem (excluding proof) – Solution of second order ordinary differential equation with constant co-efficients – simultaneous equations of first order with constant co-efficients. **[10]**

Total Hours: 45 + 15 (Tutorial): 60 hours

Text books:

1. Grewal B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons (Asia), New Delhi,2016.

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Chairman - BOS
BOS Chairman

Reference(s):	
1	Bali.N.P and Dr.Manish Goyal,"A text book of Engineering Mathematics",8th edition,Laxmi Publications (P)LTD,2011
2	Veerarajan.T., "Engineering Mathematics", for Semesters I and II , Tata McGraw Hill Publishing Co., New Delhi., 2010.
3	Kandasamy, P., Thilagavathy,K., Gunavathy, K., "Engineering Mathematics -II", S.Chand & Company Ltd,NewDelhi.
4	SWAYAM online video courses.(www.swayamprabha.gov.in)

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3							2	3	
CO2	3	3	2	2	3							2	3	
CO3	3	3	3	2	2							2	3	
CO4	3	3	2	2	3							2	3	
CO5	3	3	2	3	3							2	3	

K.S.Rangasamy College of Technology – Autonomous R2018

50 PH 006 - Applied Physics For Biotechnology

B.Tech Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Objective(s)

- To Explain the principles of laser, types of laser and demonstrate the applications of laser.
- To study the basics of ultrasonics', production of ultrasonic waves and non-destructive techniques.
- To explain Quantum Mechanics to understand wave particle dualism. Evaluate the Eigen values and Eigenfunctions of a particle.
- To obtain fundamental concepts and current knowledge of biomaterials and their biomedical applications.
- To introduce advanced materials and nanotechnology for engineering applications.

Course Outcomes

At the end of the course, the students will be able to

CO1: outline the different types of lasers and applications of lasers.

CO2: explain the principle, production, properties and applications of ultrasonic waves.

CO3: apply the knowledge of basic quantum mechanics, to set up one dimensional Schrodinger's wave equation and its application to a matter wave system.

CO4: reproduce the properties of natural and synthetic biomaterials to fabricate medical devices, Implants with tissue engineering principles.

CO5: gain broad view on advanced materials, nano technology and their engineering applications

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Laser Technology

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion- different types of lasers: gas lasers (CO2), solid-state lasers (Nd: YAG), dye lasers, Semiconductor laser (Homojunction and Hetero junction)-Properties of laser beams-applications of lasers in science and engineering. **[8]**

Ultrasonics and Applications

Introduction-Properties-Production: Magnetostriction effect, Magnetostriction generator- piezoelectric effect, piezoelectric generator – Ultrasonic detection- acoustical grating-Applications: Cavitation, cleaning, SONAR– Nondestructive testing: Pulse echo system, through transmission, resonance system- Medical applications: cardiology, neurology, ultrasonic imaging (A, B and TM-Scan). **[9]**

Quantum Physics

Introduction to Quantum Mechanics-Wave nature of Particles- de-Broglie hypothesis –Matter waves - Time- dependent and time independent Schrodinger equation for wave function- Applications: Particle in a box (one dimensional and three dimensional)- Uncertainty principle and its applications- Electron microscope: Scanning electron microscope. **[10]**

Bio Materials

Introduction-Biocompatibility -Biofunctionality-Metals and Alloys in biomaterials- Ceramic biomaterials- Composite biomaterials- polymer biomaterials-biopolymers-tissue grafts-soft tissue applications- biomaterials in ophthalmology-Dental materials. **[9]**

Advanced Materials and Nanotechnology

New Engineering Materials: Metallic glasses–preparation, properties and applications–Shape memory alloys (SMA) –characteristics, properties of NiTi alloy applications – advantages and disadvantages of SMA

Nano Materials: Nanomaterials: Properties- Top-down process: Ball Milling method, Bottom-up process: Vapor Phase Deposition method-Carbon Nanotube (CNT): Properties, preparation by electric arc method, Applications. **[9]**

Total Hours: 45 hours

Text books:

1	Rajendran, V., "Engineering Physics", Tata McGraw Hill, New Delhi. 2000.
2	Arumugam M, "Engineering Physics II" Anuradha Publications, Kumbakonam, 2010.

Reference(s):

1	Dattuprasad , Ramanlal Joshi. "Engineering Physics" Tata McGraw Hilleducation, 2016.
2	Sharma, B.K., "Spectroscopy", Goel Publishing House, Meerut,UP. 2001.
3	Palanisamy, P.K., "Physics of Materials", ScitechPublications,Chennai. 2012.
4	Pillai, S.O. "Solid State Physics", 5th edition, New Age International (P) Ltd Delhi. 2002

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 EE 001 - Basic Electrical Engineering

Common to all branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Objective(s)

- To familiarize the basic DC and AC networks used in electrical circuits.
- To explain the concepts of electrical machines and their characteristics.
- To explore the sources of electric power generation and various types of power plant.
- To identify the various components of low voltage electrical installation
- To describe various energy conservation methods useful in industry and commercial purpose.

Course Outcomes

At the end of the course, the students will be able to

CO1: apply the basic laws of electric circuits to calculate the unknown quantities.
CO2: acquire knowledge about the constructional details and principle of operation of DC machines and AC machines
CO3: impart the knowledge of generation of electricity based on conventional and non-conventional energy sources
CO4: recognize the significance of various components of low voltage electrical installations.
CO5: create awareness of energy conservation and electrical safety

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

DC and AC Circuits

Electrical circuit elements (R, L and C), Voltage and current sources - Kirchhoff's current and voltage laws - Serial and parallel circuits - Analysis of simple circuits with DC excitation. Representation of sinusoidal waveforms, Peak and RMS values, Phasorrepresentation, Real power, Reactive power, Apparent power, Power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations. **[12]**

DC & AC Machines

Construction, Types and Operation-Faraday's laws of electromagnetic induction - Transformers: Construction, Working principle, Types, Losses in transformers, Regulation, Efficiency and applications-Simple Problems - Applications Generation of rotating magnetic fields - Three phase induction motor: Construction, working principle, Characteristics, Starting - Single phase induction motor: Construction, working principle and applications - Synchronous generators: Construction, Working principle and applications. **[14]**

Electrical Power Generation Systems

Sources of electrical energy: Renewable and non-renewable - Principles and schematic diagram of Hydroelectric power plant, Thermal power plant, Nuclear power plant, Solar PV system and Wind energy conversion systems. **[5]**

Electrical Installations and House Wiring

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB - Types of Batteries, Important Characteristics for Batteries -

UPS. Single phase and three phase systems: Three phase balanced circuits, Phase sequence, voltage and current relations in standard delta connections - Basic house wiring tools and components - Domestic wiring: Service mains, meter board, distribution board, energy meter. Different types of wiring: staircase, fluorescent lamp and ceiling fan. **[8]**

Electrical Energy Conservation & Safety

Elementary calculations for energy consumption - BEE Standards – Electrical energy conservation - Methods. Electric shock, Precautions against shock, Objectives of earthing, Types of earthing - Basic electrical safety measures at home and industry **[6]**

Total Hours: 45 hours

Text books:

1	Kothari, D. P. and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2017.
2	Kulshreshtha, D. C., "Basic Electrical Engineering", McGraw Hill, 2017.

Reference(s):

1	Bobrow, L. S., "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2	Hughes, E., "Electrical and Electronics Technology", Pearson, 2016.
3	Toro, V. D., "Electrical Engineering Fundamentals", Prentice Hall India, 2015.
4	Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall, 2006.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 ME 002– Engineering Graphics

Common to EEE, ECE, E&I, CSE, IT, Bio-Tech, NST and FT branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	**2**	**0**	**4**	**90**	**4**	**50**	**50**	**100**

Objective(s)

- To learn Computer Aided Drawing skills to enable graphical communication.
- To learn drawing formats and conversion of pictorial views into orthographic views.
- To emphasize skills to project simple solids and sectional views.
- To impart the knowledge on use of drafting software to draw the isometric projection.
- To acquire graphical skills to illustrate design project.

Course Outcomes

At the end of the course, the students will be able to

CO1: demonstrate the Impact of computer technologies on graphical communication

CO2: convert the pictorial views in to orthographic views using drafting software

CO3: draw the projection of simple solids and true shape of sections

CO4: construct the isometric projections of objects using drafting software

CO5: demonstrate a design project illustrating engineering graphical skills

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for eachtopic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Computer Aided Drafting (CAD) software

Theory of CAD software – Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension) – Drawing Area (Background, Crosshairs, Coordinate System) – Dialog boxes and windows – Shortcut menus (ButtonBars) – The Command Line and Status Bar – Different methods of zoom as used in CAD – Select and erase objects**.** **[5+12**]

Orthographic Projection

Theory of projection – Terminology and Methods of projection – first angle and third angle projection – Conversion of pictorial views into orthographic views**.** **[6+12]**

Projection of Solids and Sections of Solids

Projections of simple solids: prism, pyramid, cylinder and cone (Axis parallel to one plane and perpendicular to other, axis inclined to one plane and parallel to other).

Sections of simple solids: prism, pyramid, cylinder and cone in simple positions (cutting plane is inclined to one of the principal planes and perpendicular to the other) ── True shape of sections. **[6+12]**

Isometric Projection

Principles of Isometric projection – Isometric scale, Isometric views, Conventions – Isometric views of lines, Planes, Simple and compound Solids ─ Conversion of Orthographic views in to Isometric view**.** **[6+12]**

Application of engineering graphics

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2Dblueprint form and as 3D wire-frame and shaded solids – Geometric dimensioning and Tolerancing– Use of solid modeling software for creating associative models – Floor plans: windows, doors, and fixtures such as water closet (WC), bath sink, shower, etc. – Applying color coding according to building drawing practice ─ Drawing sectional elevation showing foundation to ceiling – Introduction to Building Information Modelling (BIM**).** **[7+12]**

Total Hours: 90 hours

Text books:

1. Bhatt N.D., "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd Edition, Gujarat, 2014.
2. Venugopal K., "Engineering Graphics", New Age International (P) Limited, 2014.

Reference(s):

1. Shah M.B., Rana B.C., and V.K.Jadon., "Engineering Drawing", Pearson Education, 2011.
2. Natarajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2014.
3. Agrawal B. & Agrawal C. M., "Engineering Graphics", TMH Publication, 2012.
4. Narayana, K.L. & P Kannaiah, "Text book on Engineering Drawing", Scitech Publishers, 2008.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 MY 004 - Universal Human Values

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	2	1	0	45	3	40	60	100

Objective(s)

- To identify the essential complementarily between 'values' and 'skills'
- To ensure core aspirations of all human beings
- To achieve holistic perspective towards life and profession
- To acquire ethical human conduct, trustful and mutually fulfilling human behaviour
- To enrich interaction with Nature.

Rev.No.4
Passed in the BOS Meeting Held on 12/ 05/ 2023
Approved in Academic Council Meeting held on 03/06/2023

Chairman - BOS
BOS Chairman

Course Outcomes	**At the end of the course, the students will be able to** CO1: Become more aware of themselves, and their surroundings CO2: Responsible in life, and in handling problems with sustainable solutions CO3: Maintain human relationships and human nature CO4: Committed towards human values, human relationship and human society CO5: Improve critical ability and apply it day-to-day life

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to value Education

Understanding value Education-Self exploration as the process for value education-Continuous Happiness and prosperity-the basic human aspirations-right understanding-relationship and physical facility –happiness and prosperity - current scenario – method to fulfill the basic human aspirations **[9]**

Harmony in the Human Being

Understanding Human being as the Co-Existence of the self and the Body-Distinguishing between the needs of the self and the body- the body as an instrument of the self-understanding harmony in the self-harmony of the self with the body — Programme to ensure self-regulation and health **[9]**

Harmony in the Family and Society

Harmony in the Family –the basic unit of human interaction-values in human- to - human relationship –'Trust' the foundation value in relationship –'Respect'- as the right evaluation-understanding harmony in the society — vision for the universal human order. **[9]**

Harmony in the Nature/Existence

Understanding harmony in the Nature-Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature – realizing existence as co-existence at all levels –the holistic perception of harmony in existence. **[9]**

Implications of the Holistic Understanding

Natural Acceptance of human values- definitiveness of human conduct- a basis for humanistic education, humanistic constitution and universal human order- competence in professional ethics –holistic technologies, production systems and management models-typical case studies — strategies for transition towards value **[9]**

Total Hours: 45 hours

Text books:

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria,2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference(s):

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	5	3	3	3	2	3	3	1			
CO2	3	3	3	2		3	3	3	2	3	2	1			
CO3	3	3	2			3	3	3	3	3	2	1			

K.S.Rangasamy College of Technology – Autonomous R2018

50 PH 0P1 Engineering physics Laboratory

Common to - MECH, MCT, TXT, FT, BT, NST, CIVIL

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
II	0	0	4	2	60	40	100	

Objective(s)

- To infer the practical knowledge by applying the experimental methods to correlate with the Physics theory
- To demonstrate an ability to make physical measurements and understand the limits of precision in measurements
- To introduce different experiments to test basic understanding of physics concepts applied in optics and electronics
- To enable the students to correlate the theoretical principles with application-oriented studies
- To analyze the behavior and characteristics of various materials for its optimum utilization

Course Outcomes	**At the end of the course, the students will be able to** **CO1:** know the concept stress, strain and elastic limit of a given sample. (1-3) **CO2:** grasp the knowledge of dependency of viscosity and surface of a liquid. (4-6) **CO3:** have a knowledge of diffraction property of light through grating and fiber optic cable (7-8) **CO4:** gain the dielectric constant of a given material. (9) **CO5:** acquire the knowledge of semiconductor photovoltaic solar cells. (10)

LIST OF EXPERIMENTS

Any ten Experiments

1. Determination of Young's modulus of a steel bar by uniform bending method
2. Determination of Young's modulus of a cantilever (Pin & Microscope method).
3. Determination of rigidity modulus of a wire by torsional pendulum.
4. Comparison of co-efficient of viscosity of two different liquids by Poiseuille's method.
5. Co-efficient of viscosity of highly viscous liquids.
6. Comparison of surface tension of two different liquids by capillary rise method.
7. Determination of NA, acceptance angle, and wave length of a given laser by using optical fiber
8. Determination of wavelength of mercury spectral lines – spectrometer grating.
9. Determination of dielectric constant.
10. V-I characteristics of solar cell.

Total Hours : 60

Lab Manual:

"Physics Lab Manual", Department of Physics , KSRCT

K.S.Rangasamy College of Technology – Autonomous R2018

50 ME 0P1 - Engineering Practices Laboratory

Common to All branches

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
II	0	0	4	60	2	60	40	100

Objective(s)	• To acquire skills in basic engineering practices. • To identify the hand tools and instruments. • To provide hands on experience in Fitting, Carpentry, Sheet metal, Welding and lathe shop. • To provide practical training on house hold wiring and electronic circuits. • To offer real time activity on plumbing connections in domestic applications.
Course Outcomes	**At the end of the course, the students will be able to** CO1: perform facing, plain turning, drilling. CO2: make a model of fitting and carpentry: Square, Dovetail and Cross lap joints CO3: fabricate the models of sheet metal and welding joints. CO4: construct and demonstrate electrical and electronic wiring circuit. CO5: construct the water pipe line in plumbing shop.

LIST OF EXPERIMENTS

Machine shop

Safety aspects in machine shop, Study of Lathe and Radial drilling machine, Turning, Facing and Drilling.

Fitting and Carpentry

Safety aspects in Fitting and Carpentry, Study of tools and equipment's, Preparation of models- Square, Dove tail joint, Cross Lap.

Sheet Metal and Welding

Safety aspects in Sheet metal and Welding, Study of tools and equipment's, Sheet metal models - Scoope, Cone, Tray, Preparation weld joints -Lap, butt, T-joints. Study of Gas Welding and equipments.

Electrical Wiring & Electronics

Safety aspects of Electrical wiring, Study of Electrical Materials and wiring components, wiring circuit for a lamp using single and stair case switches. Wiring circuit for fluorescent lamps, Basic electronic circuit.

Plumbing

Study of plumbing tools, assembly of G.I. pipes/ PVC and pipe fittings, Cutting of threads in G.I.Pipes/PVC by thread cutting dies. **Smithy, Plastic moulding and Glass cutting**

Safety aspects in smithy, plastic moulding and glass cutting, Study of tools and equipment's.

Total Hours: 60

Lab Manual:

"Engineering Practices Lab Manual", Department of Mechanical Engineering, KSRCT.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 MA 007 - Transform and Numerical Methods

Common to B.Tech Biotechnology and B.Tech Food Technology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	1	0	60	**4**	40	60	100

Objective(s)

- To teach students how to use Fourier series and Fourier transform for engineering discipline.
- To acquire analytical skill in the areas of one-dimensional boundary value problems.
- To familiarize the students with the concepts of Fourier transform
- To describe the concepts of solving system of equations.
- To solve initial value problems of ordinary differential equations numerically.

Course Outcomes

At the end of the course, the students will be able to

CO1: obtain the Fourier series expansion for the periodic functions.

CO2: compute the solution for one-dimensional wave equation and one-dimensional heat equation.

CO3: apply Fourier transform techniques for the continuous functions.

CO4: analyze various iteration techniques to solve the algebraic, transcendental and linear equations.

CO5: apply different integration techniques to evaluate single definite integrals and compute the solution for initial value problem using single and multi-step methods

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Fourier Series

Dirichlet's conditions – Fourier series – Odd and Even functions – Half range Fourier series – Root mean square value of a function — Parseval's identity –Harmonic analysis. **[9]**

Boundary Value Problems

Classificationofsecondorderquasi-linearpartialdifferentialequations–Solutionofone-dimensionalwaveequation– Solution of one- dimensional heat equation. **[9]**

Fourier Transform

Fourier transform pair – Fourier transform of simple functions – Fourier sine and cosine transform – Properties – Convolution theorem –Parseval's identity**.** **[9]**

Solution of Equations and Eigen Value Problem

Newton-Raphson method – Regulafalsi method – Horner's method – Solution of linear system: Gauss elimination method – Gauss-Jordan method – Iterative methods: Gauss-Jacobi method – Gauss-Seidel method – Eigen values of a matrix by power method. **[9]**

Numerical Integration and Differentiation

Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Single step methods: Taylor seriesmethod – Euler and modified Euler methods – Fourth order Runge-Kutta method for solving first order equation – Multi step methods: Milne's predictor and corrector method – Adam's predictor and corrector method. **[9]**

Total Hours: 45 + 15 (Tutorial): 60 hours

Text books:

1. Grewal B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons (Asia) Limited, New Delhi, Reprint 2012.

Reference(s):

1. GrewalB.S and Grewal J.S,"Numerical methods in Engineering and Science",9th Edition,Khanna Publishers, New Delhi,2007.
2. Veerarajan T, "Engineering Mathematics-III", 2nd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
3. Kandasamy P, Thilagavathy K and Gunavathi K, "Numerical Methods", 3rd Edition, S. Chand & Company Ltd, New Delhi, 2003.
4. Bali N.P and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Lakshmi Publications Pvt. Ltd.22, New Delhi, 2014.
5. Numerical methods – Dr. Ameeya Kumar Nayak, Dr. Sanjeev Kumar, NPTEL online video courses.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2							3	2		
CO2	3	3	2	2	2							3	2		
CO3	3	3	2	2	2							3	2		
CO4	3	3	3	3	2							3	2		
CO5	3	3	3	3	2							3	2		

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 301 - Biochemistry

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Objective(s)

- To learn the basic chemical structure and biological functions of biomolecules.
- To impart knowledge on role of biomolecules for orderly structures of the cells/tissues.
- To illuminate the metabolism of essential biomolecules that are indispensable for life.
- To dissipate the knowledge on formations of specialized products from biomolecules.
- To learn the principles of bioenergetics and redox reactions of the cell.

Course Outcomes

At the end of the course, the students will be able to

CO1: identify the structure of carbohydrates and understand their classification, synthesis, essential Chemical characteristics that make them indispensable for life.

CO2: explore the structure, classification, biological functions of lipids and their metabolism

CO3: interpret the structure and classification of amino acids, proteins, vitamins and its vital functions inthe humanbody.

CO4: validate the metabolism of the essential building blocks of life and its conversion to specialized products.

CO5: justify the purpose of electron transport chain and how cellular ATP:ADP ratio regulates the rare of ATP production by oxidative phosphorylation

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Carbohydrates

Carbohydrates: Basic chemical structure, Classification - Monosaccharide, Disaccharides, polysaccharides structure and function - Anaerobic pathway of glucose metabolism: Glycolysis - Aerobic pathway of glucose metabolism: Citric acid cycle - Alternate pathways of carbohydrate metabolism: Pentose phosphate pathway - Synthesis of carbohydrates from various sources: Gluconeogenesis. **[9]**

Lipids

Lipids: structure and function of fatty acids and lipids, classification, major lipid subclasses - phospholipids, glycolipids, sphingolipids and steroids - Lipoproteins: Types and functions - Lipid metabolism: Biosynthesis of Fatty acid, Oxidation of fatty acids - Beta oxidation, Other types of fatty acid oxidation - Alpha and omega oxidation - Biosynthesis of lipid and cholesterol. **[9]**

Proteins and Vitamins

Amino acids: Structure and Classification. **Proteins:** Structure and Classification: Primary, Secondary, Tertiary and Quaternary structure. Properties - Denaturation and Renaturation. Oxidative degradation of amino acids: Transamination, oxidative deamination, decarboxylation, Biosynthesis of urea, conversion of amino acids in to specialized products: DOPA, Dopamine, Epinephrine and Nor epinephrine. **Vitamins:** Classification, sources, functions and deficiency diseases**.** **[9]**

Nucleic Acids

Nucleic acids: Structure of nitrogenous bases: purines and pyrimidines, nucleosides, nucleotides, formation of phosphodiester bonds - Structure of DNA and RNA - Biosynthesis of Purine and pyrimidine nucleotides: Denovo and salvage pathway – Purine and pyrimidine in degradation. **[9]**

Bioenergetics

Electrochemical potential and redox reaction, Mitochondrial electron transport chain: electron carriers, sites of ATP production, inhibitors of electron transport chain - Oxidative phosphorylation: structure of ATPase complex, chemiosmotic theory, un couplers and inhibitors of oxidative phosphorylation. **[9]**

Total Hours: 45 hours

Text books:

1. Lehninger, “Principles of Biochemistry”, David L. Nelson and Michael M. Cox. Palgrave Macmillan,Freeman, Low Price Edition, 7th edition, 2017.
2. Harpers “Illustrated Biochemistry” , Victor Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony WeilMcG Lange, International edition, 30th edition, 2015.

Reference(s):

1. Koolman J. and Roehm K.H. Color Atlas of Biochemistry, Georg ThiemeVerlag publishers, 2nd Edition, 2005.
2. Berg Jeremy M.; John L. Tymoczko; Lubert Stryer, “Biochemistry”, W. H. Freeman and Co., New York, USA, 7th edition,2010
3. Voet Donald and Judy G Voet, “Biochemistry”, 4th edition, John Wiley & Sons Inc., 2012.
4. Denise R. Ferrier, “Biochemistry-Lippincott Illustrated Reviews Series”7th edition, Wolters Kluwer Law & Business, 2017.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT 302 – Microbiology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Objective(s)	• To impart the knowledge and development of microbiology • To impart the knowledge about the microorganisms and its classifications • To understand the cellular organization of microbes and its identification system • To study the nutritional requirements for the growth of microbes • To learn about the basics of microbial growth, development and its control
Course Outcomes	**At the end of the course, the students will be able to** CO1: explore the history of microbiology and structural organization of various microorganisms and its multiplication CO2: identify the various classification systems and know the basics of microscopy techniques and microbial identification by staining methods CO3: validate the microbial nutritional requirements and its growth pattern CO4: justify the different processes of sterilization, disinfection and action mechanism of antimicrobial agents CO5: prioritize the various industrial application of microorganisms and role in bioremediation

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Microbiology

History and scope of microbiology - basic concepts, spontaneous generation, contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff and Fleming - Classification systems - phenetic, numerical, phylogenetic, major characteristics used in taxonomy, Bergey's manual of determinative bacteriology. **[9]**

Microscopy and Identification of Microbes

Microscopy-Simple and compound microscope, Phase contrast, Dark field, Fluorescent, Electron microscope - Identification of bacteria - Stain and staining techniques - Simple, Differential (Gram's, spore and AFB) and special (capsule staining, flagellar staining) -fungal staining. **[9]**

Structural Organization and Multiplication of Microbes

Morphology and reproduction - Bacteria (cell wall, flagella, pili, capsule, endospore) - mycoplasma – Actinomycetes – archaea bacteria - viruses - bacteriophage (lytic and lysogeny) - algae - microalgae - fungi - yeast - lichens- protozoan. **[9]**

Microbial Nutrition and Growth

Nutritional requirements of bacteria - Nutritional classification of bacteria - Media preparation - solid and liquid, Types of media - Pure culture techniques - anaerobic culture techniques - Kinetics of growth - generation time, mean generation time (g) and mean growth rate constant (k) - calculations- Influence of environmental factors on microbial growth - pH, temperature, pressure, oxygen and salt- measurement of microbial growth - cell mass and cell numbers. **[9]**

Control of Microorganisms

Diseases caused by bacteria (Typhoid) - sterilization and disinfection - Physical methods and Chemical methods; assessment of chemical disinfectant - phenol co-efficient test, sterility testing- preservation and maintenance of microorganisms. Mechanism and mode of actions of anti-bacterial, anti-fungal and anti-viral agents - drug resistance – antibiotic sensitivity test. **[9]**

Total Hours: 45 hours

Text books:

1. Prescott, L.M., Harley, J.P. and Klein, D.A. "Microbiology", 7th Edition, Tata McGraw-Hill Publications, New Delhi, India,2010.
2. Pelczar, M.J., Chan, E.C.S. and Krieg, M.R. "Microbiology: An application Based Approach". Tata McGraw- Hill Publications, New Delhi, India, 2005.

Reference(s):

1. Black, J.G. "Microbiology: Principles and Explorations". 6th Edition. John Wiley and Sons, Inc, Singapore, 2004.
2. Kamal, Rao, G.P. and Modi, D.R. "Concepts of Microbiology". International Book Distributing Co., Lucknow, India, 2005.
3. Gerard J. Tortora Berdell R. Funke Christine L. Case Derek Weber Warner Bair, "Microbiology: An Introduction", 4thedition, Pearson Education (US), 2019.
4. Surinder Kumar, "Essentials of Microbiology", First edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, 2016

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
51 BT 303 - Cell and Molecular Biology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	**3**	**0**	**0**	**45**	**3**	**40**	**60**	**100**

Objective(s)	• To build on the knowledge of cell structure and functions of prokaryotes and eukaryotes at Molecular level • To provide an insight into the process of eukaryotic cell division, regulation of cellular processes via signaling molecules. • To impart the concept of base pairing rule, its underlying reason and its effect on the DNA structure and mechanism of replication. • To learn the flow of information from genes to proteins and the molecular events of prokaryotic and eukaryotic gene transcription. • To understand the concepts genetic code, gene expression and its regulation.
Course Outcomes	**At the end of the course, the students will be able to** CO1: discuss the cell wall, cell membrane and types involved in the transport of molecules across membrane CO2: explain the process of cell cycle and cell division in prokaryotes and eukaryotes, illustrate the major intracellular and extracellular signaling receptors and its pathways. CO3: apply the knowledge of DNA structure, base pairing rule and sequence to measure super helicity and chromosomal organization in prokaryotes and eukaryotes. CO4: describe the molecular mechanism of DNA replication and transcription in prokaryotes and eukaryotes CO5: justify the importance of ribosome in phylogenetic analysis and explain the decoding process of Translation and its regulation in prokaryotic and eukaryotes

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Cell Structure Permeability and Transport

Present day prokaryotes, Development of multicellular organisms, cell as experimental models, Cell wall structure of plants, Plasma membrane structure and models, cell permeability - concentration gradient and partition coefficient, transport of small molecules - active, passive, ion channels and facilitated diffusions. **[9]**

Cell Division, Cell Signaling and Protein localization

Process of cell cycle and its regulation, Bacterial cell division, Eukaryotic cell division, Cell signaling-signaling molecules, G protein coupled receptors, Ion-channel receptors, enzyme linked receptors, protein sorting, nuclear localization, mitochondria and chloroplast import and export mechanism. **[9]**

Molecular Structures of Genes And chromosomes

Structure and physiochemical properties of elements in DNA and RNA, Primary and Secondary structure: base pairing rule, Watson & Crickmodel, stabilizing forces, Hogsteen base pairing, Tertiary structure: super twisting, mathematical description of super twisting, levels of DNApackaging, molecular events of prokaryotic and eukaryotic chromosome organization, exon- intron structure, CpG islands and its importance**.** **[9]**

Replication And transcription

Basic rules of replication, replication genes and enzymology of replication, processivity and fedility of DNA replication, rolling circle replication.DNA mutation and repair mechanism. Molecular events of Prokaryotic and Eukaryotic Transcription - initiation, elongation and termination. Post transcriptional modification. **[9]**

Gene Expression and Regulation

Genetic code, Ribosome of prokaryote and eukaryote - evolutionary importance, mechanism of translation: initiation, elongation and termination. Inhibitors of Translation. Post translational modification. Regulation of gene expression - lac operon, trp operon and ara operon.

[9]

Total Hours: 45 hours

Text books:

1. Lodish, H., Berk, A., Zipurursky, S. L., Matsudaria, P., Baltimore D, and Darnell, J, "Molecular Cell Biology",W. H. FreeMan andCompany, England, 2000.
2. Freifielder, Essentials of Molecular Biology, 4thedition by Malacinski, Jones &Barlett, 2015.

Reference(s):

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P, "Molecular Biology of the Cell", Garland Science., New York, 2002
2. Benjamin Lewin, "Gene IX", Oxford University Press, New Delhi, India, 2000.
3. Jacobs M., "Cell And Molecular Biology" Vol.1., CBS Publishers and Distributors, 2016
4. Vyas S.P. and Mehta A., "Cell And Molecular Biology" CBS Publishers and Distributors, 2020

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3	2			2	3		2	2	3
CO2	3	3	2	3	3		2			2		2	2	3
CO3	3	3	2		3			3			3	2	2	3
CO4	3	3	2	3	2	3			2	2		2	2	3
CO5	3	3	2	3	2		3			2		2	2	3

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 304 - Principles of Chemical Engineering

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	1	0	60	4	40	60	100

Objective(s)

- To impart basic knowledge on unit conversion, and basic chemical calculations.
- To learn about material balance calculations.
- To impart the basics of energy balance calculations.
- To understand the basic concept of fluids and fluid flow
- To know fluid transport and flow through columns.

Course Outcomes

At the end of the course, the students will be able to

CO1: review the basis of unit conversion, unit operations and unit processes
CO2: execute material balance calculations with and without chemical reactions
CO3: interpret energy balance calculations and enthalpy changes accompanying chemical reactions
CO4: summarize the basics of fluid flow and its applications
CO5: demonstrate the principle of fluid transportation devices and flow through columns

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Fundamentals of Chemical Engineering

Over view of process industries, units and dimensions, basic laws, unit conversion, methods of expressing composition of mixtures and solutions, average molecular weight of gas mixture, unit operations and unit processes. **[9]**

Material Balance Calculations

Guidelines for material balance calculations - material balance with and without chemical reactions - stoichiometry of microbial growth and product formation - Recycling and bypass operations. **[9]**

Energy Balance Calculations

Basics energy balance calculations, first law of thermodynamics, sensible and latent heat, heat capacities, mean molal heat capacities, enthalpy changes accompanying chemical reactions, adiabatic process, heat of solution and mixing**.** **[9]**

Flow of Fluids

Nature of fluids, classification of fluids; concept of viscosity, laminar and turbulent flow, equation of continuity, Bernoulli's equation and its applications, friction factor, multiphase flow. **[9]**

Fluid Transport and Flow through Packed and Fluidized Bed

Pumps: Centrifugal pump and positive displacement pumps; compressor; Packed bed: flow through porous media- pressure drop calculations, Erguns equation, Fluidization: principle; types, minimum fluidization velocity and applications. **[9]**

Total Hours: 45 + 15(Tutorial) : 60 hours

Text books:

1. Bhatt, B.I. and Vora S.M., "Stoichiometry", 5th Edition, Tata McGraw-Hill Publication, New Delhi, 2004.
2. Gavhane K.A., "Introduction to Process Calculation", Niraliprakashan Publication, New Delhi, 2008.

Reference(s):

1. Salil K. Ghosal, Shyamal K. Sanyal and Siddhartha Datta, "Introduction to Chemical Engineering", TataMcGraw - HillPublication, New Delhi, 2011.
2. Geankoplis C.J., "Transport Processes and Unit Operations", Prentice Hall India, New Delhi, 2002.
3. McCabe, W.L., Smith, J.C and Harriot, P., "Unit Operations In Chemical Engineering", 7th Edition, McGraw – HillInc., New Delhi, 2004.
4. Vikas Zaveri and P. Vishwanathan, "A textbook of Chemical Engineering", Medtec, 2014

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 MY 002 - Environmental Science

Common to all Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	**2**	**0**	**0**	**30**	**0**	**100**	**-**	**100**

Objective(s)

- To help the learners to analyze the importance of ecosystem and biodiversity.
- To familiarize the learners with the impacts of pollution and control.
- To enlighten the learners about waste and disaster management.
- To endow with an overview of food resources and human health.
- To enlighten awareness and recognize the social responsibility in environmental issues.

Course Outcomes

At the end of the course, the students will be able to

CO1: Recognize the concepts and issues related to environment, ecosystem and biodiversity.
CO2: Analyze the source, effects, and control measures of pollution.
CO3: Enlighten of solid waste and disaster management.
CO4: Awareness about food resources, population and health issues.
CO5: Analyze the social issues and civic responsibilities.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Environment, Ecosystem and Biodiversity

Environmental studies - Scope and multidisciplinary nature - Need for public awareness - Ecosystem - Food chain - Food web- Structure and function. Biodiversity - Values of biodiversity - Endangered and endemic species - Hot spots - India a mega biodiversity nation - Threats - Conservation - In-situ and ex-situ - Case studies.

Environmental Pollution

Pollution - Air, water, soil, noise and nuclear - sources, effects and control measures - Impacts of mining. - Environment protection act- bio accumulation and bio magnification - Case studies.

Waste and Disaster Management

Waste – wealth from waste - carbon foot print - Solid waste - e-waste - sources, effects and control measures. Disaster management - Earth quakes - Landslides - Floods - Cyclones - Tsunami - Disaster preparedness - Case studies.

Food Resources, Human Population and Health

World food problems - over grazing and desertification - effects of modern agriculture. Population - Population explosion and its impacts - HIV/AIDS - Cancer- Role of IT in environment and human health - Case studies.

Social Issues and The Environment

Unsustainable to sustainable development - Use of alternate energy sources - Wind - Geothermal - Solar - Tidal - energy calculation and energy audit - Rain water harvesting - Water shed management - Deforestation - Greenhouse effect - Global warming - Climate change - Acid rain - Ozone layer depletion - Waste land reclamation. Consumerism and waste products - Role of an individual in conservation of natural resources - Case studies.

Total Hours: 30 hours

Text books:

1. Anubha Kaushik and C P Kaushik, 'Perspectives in Environmental Studies ', New Age International Publishers, New Delhi, 6th Edition , January 2018.
2. Tyler miller. G, "Environmental Science", 15th Edition Cengage Publications, Delhi, 2016.

Reference(s):

1. Gilbert M.Masters and Wendell P. Ela,"Environmental Engineering and Science", Phi learning private limited, New Delhi, 3rd Edition, 2013. Learning private limited, New Delhi, 3rd Edition, 2013.
2. Rajagopalan. R, "Environmental Studies" Oxford University Press, New Delhi, 2nd Edition, 2012.
3. Deeksha Dave and Katewa. S.S, "Environmental Studies" 2nd Edition, Cengage Publications, Delhi, 2013.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	2	3	3		3		2	2	2	3
CO2	3	3	3	3	2	3	3	3		3	2	2	3	3	3
CO3	3	3	3	3	2	3	3	3		3	2	2	1	2	3
CO4	2	2	2	3	3	3	3	3		2	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3		3	3	3	2	2	3

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 3P1 - Biochemistry Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
III	0	0	4	60	2	60	40	100

Objective(s)

- To learn the fundamental approaches for experimental investigation.
- To learn the theoretical foundations for the methods used for biochemical analysis.
- To determine the characteristics features of various molecules with reference to its analytical characters.
- To evaluate and estimate the biological molecules through various methods.
- To analyze the level of various elements through suitable standards.

Course Outcomes

At the end of the course, the students will be able to

CO1: describe the calibration of glass-wares and understand the preparation of solutions and buffers

CO2: elucidate the fundamental analysis of carbohydrates and lipids qualitatively

CO3: estimate the amount of carbohydrate, protein, cholesterol, creatinine, urea and uric acid quantitatively

CO4: examine and interpret the results by estimating the amount of DNA using diphenylamine method

CO5: analyze the amount of microelements in soil sample using Flame photometer

LIST OF EXPERIMENTS

Any ten Experiments

1. Calibration of glass wares- pipettes, burettes and volumetric flasks (demonstration) and Preparation of solutions:1) percentage solutions, 2) molar solutions, 3) normal solutions
2. Standardization of pH meter (demonstration) and preparation of buffer of a given pH and molarity
3. Qualitative analysis of Carbohydrates
4. Qualitative analysis of Lipids - Determination of Acid number of an edible oil (coconut oil)
5. Determination of total Carbohydrate content in cereals by Anthrone method
6. Estimation of protein by Lowry's method
7. Estimation of cholesterol by Zak'smethod
8. Estimation of creatinine by Jaff'smethod
9. Estimation of sugars by Nelsson's somogy method
10. Estimation of A/G ratio of protein by Biuret method
11. Extraction and estimation of lipids by Folch *et al*., method
12. Determination of urea in the urine sample by Dam method Evaluation of uric acid by Caraway's method
13. Estimation of DNA by diphenylamine method Estimation of microelements by Flame photometer

Total Hours : 60

References :

1. Shawney, S.D., "An Introduction to Practical Biochemistry", Narosa Publishing Home, New Delhi, 1996.
2. Palanivelu, P., "Analytical Biochemistry and Separation Techniques", Kalaivani Printers, Tamil Nadu, 2001.
3. Soundravally Rajendiran, Pooja Dhiman, "Biochemistry Practical Manual", RELX (Elsevier) India Pvt. Ltd., New Delhi,2019.
4. Benjamin F,Lasseter, "Biochemistry in the Lab: A Maual for Undergraduates", CRC Press, Taylor & Francis Group,FL, 2019

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 3P2 - Microbiology Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
III	0	0	4	60	2	60	40	100

Objective(s)

- To understand the growth and development of microbes through various culturing methods
- To observe the differences in staining reactions in bacteria and fungi
- To learn the culture conditions of anaerobic microbes
- To understand the concept of quality analysis of water and milk samples
- To identify the effective method to control microbes

Course Outcomes

At the end of the course, the students will be able to

CO1: perform the aseptic methods to be followed in laboratory and preparation of liquid and solid media and cultivation of microorganisms

CO2: interpret the differential staining techniques for identification of bacteria and fungi

CO3: demonstrate anaerobic microbe culture techniques

CO4: analysis for physiological identification of microorganisms

CO5: examine the quality of water and milk, and carry out the antibiotic sensitivity test

LIST OF EXPERIMENTS

Any ten Experiments

1. Laboratory Precautions, principles of aseptic techniques
2. Preparation of Liquid and solid nutrient media
3. Preparation and observation of bacteria by using various selective media
4. Cultivation of microorganisms - Pour plate, spread plate and streak plate
5. Gram's staining - Gram positive and Gram-negative bacteria
6. Fungal staining - Lacto phenol cotton blue staining of Mold
7. Determination of Microbial growth-viable count and turbidity method
8. Cultivation of anaerobic bacteria
9. Physiological characterization of microbes - Carbohydrate fermentation test and catalase test
10. Starch and casein hydrolysis test
11. IMViC test
12. Enumeration of Bacteria, fungi and Actinomycetes (Design experiment)
13. Rapid detection of bacteriological quality of water - Most Probable Number test
14. Quality analysis of Milk samples - Methylene Blue Reduction Test
15. Antibiotic resistance / sensitivity test

Total Hours : 60

References :

1. Cappuccino, J.G. and Sherman, N. "Microbiology: A Laboratory Manual", 11th Edition. Pearson Education,New Delhi, India, 2018.
2. Amita Jain, Vimala Venkatesh, Jyotsna Agarwal, "Microbiology Practical Manual, (ELSEVIER) RELX India Pvt.Ltd., 2018
3. James G, Cappuccino, Natalie Sherman, "Microbiology: A Laboratory Manual", Seventh Edition, PearsonEducation, Inc. and DorlingKindersley Publishing, Inc., 2012
4. Kalaichelvan, P.T., "Microbiology and Biotechnology: A Laboratory Manual, MJP Publishers, Chennai, 2019.

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 TP 0P1 - Career Competency Development I

Common to all branch

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	**0**	**0**	**2**	**30**	**0**	**100**	**00**	**100**

Objective(s)

- To help learners to enrich their grammatical correctness and vocabulary efficacy in the academic and professional contexts.
- To help the learners to frame syntactical structures of sentences and comprehend the meaning of reading passages effectively
- To help learners to adeptly sequence the information, draft letters and correct usage of foreign words with correct spelling and punctuation.
- To help the learners to introduce themselves and involve in situation conversations professionally
- To help learners to make various modes of presentations and express their opinion in a conducive way.

Course Outcomes

At the end of the course, the students will be able to

CO1: Reinforce the essential grammatical correctness and vocabulary efficacy in the academic and professional contexts

CO2: Generate syntactical structures and infer the semantics in the reading passages effectively

CO3: Reorganize and compose the sequential information, letter drafts, and interpret the appropriate usage offoreign words with correct spelling and punctuation

CO4: Demonstrate their introduction and relate to situational conversations adeptly

CO5: Exhibit various modes of presentations and organize their opinions in an expressive way

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Written Communication–Part1

Usage of noun, pronoun, adjective (Comparative Forms), Verb, Adjectives, Adverb, Tenses, Articles and Preposition - Change of Voice - Change of Speech - Synonyms & Antonyms - One Word Substitution- Using the Same Word as Different Parts of Speech- Odd Man Out

Materials: Instructor Manual, Word Power Made Easy Book **[8]**

Written Communication –Part2

Analogies - Sentence Formation - Sentence Completion - Sentence Correction - Idioms & Phrases -Jumbled Sentences, Letter Drafting (Formal Letters) - Reading Comprehension (Level 1) - Contextual Usage- **Materials:** Instructor Manual, Word Power Made Easy Book **[6]**

Written Communication –Part3

Jumbled Sentences, Letter Drafting (Formal Letters)- Foreign Language Words used in English—Spelling & Punctuation (Editing)

Materials: Instructor Manual, News Papers **[4]**

Oral Communication–Part1

Self-Introduction-Situational Dialogues/Roleplay (Telephonic Skills)- Oral Presentations-Prepared-'Just A Minute 'Sessions (JAM)

Materials: Instructor Manual, Newspapers **[6]**

Oral Communication–Part2

Describing Objects / Situations /People,InformationTransfer-PictureTalk-NewsPaper and Book Review

Materials: Instructor Manual, Newspapers **[6]**

Total Hours: 30 hours

Evaluation Criteria

S.No.	Particular	Test Portion	Marks
1	Evaluation 1 Written Test	Total – 50 Questions– 30 Questions from Unit1&2, 20 Questions from Unit3, (External Evaluation)	50
2	Evaluation 2 - Oral Communication	Self-Introduction, Role Play & Picture Talk from Unit-4 (External Evaluation by English and MBA Dept.)	30

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3	Evaluation 3 – Oral Communication	Book Review & Prepared Speech from Unit- 5(External Evaluation by English and MBA Dept.)	20
		Total	100

Reference(s):

1	Aggarwal,R.S."A Modern Approach to Verbal and Non verba lReasoning", Revised Edition 2008, Reprint 2009, S.Chand & Co Ltd.,New Delhi.
2	Word Power Made Easy by Norman Lewis W.R.GOYAL Publications
Note:	• Instructor can cover the syllabus by Class room activities and Assignments (5 Assignments/week) • Instructor Manual has Class work questions, Assignment questions and Rough work pages • Each Assignment has 20 questions from Unit 1,2 and Unit 5 and 5 questions from Unit 3 and 4 • Evaluation has to be conducted as like Lab Examination

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1		2	1	2	3	3	2	3	3	1	3
CO2	1	1	1	1	1	2	1	2	3	3	3	3	3	2	3
CO3	1	1	1	1	1	2	1	2	3	3	2	3	3	1	3
CO4	1	1	1	1		2	1	1	3	3	2	3	3	1	3
CO5	3	1	1	1	1	2	1	2	3	3	2	3	3	1	3

K. S. Rangasamy College of Technology – Autonomous R2018

50 MA 013 - Statistical Methods

Common to B.Tech., Biotechnology and B.Tech., Food Technology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	1	0	60	4	40	60	100

Objective(s)

- To acquire skills in handling situations involving one random variable and distributions.
- To teach the students in handling situations involving more than one random variable and functions of random variables.
- To familiarize the students with various methods in hypothesis testing
- To get exposed to statistical methods designed to make scientific judgments in the face of uncertainty and variation.
- To learn basic statistics and how to use control charts to monitor discrete data.

Course Outcomes

At the end of the course, the students will be able to

CO1: apply discrete and continuous distributions concepts to calculate the probability.

CO2: compute marginal and conditional distributions, and calculate correlation and regression.

CO3: test the statistical hypothesis using Student's t test, F test and Chi-square test.

CO4: analyze the design of experiments using CRD, RBD and Latin square.

CO5: apply the concepts in descriptive statistics to calculate measures of central tendency and measures of dispersion, and analyse the control charts.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Probability and Distributions

Random variable – Discrete random variable – Continuous random variable – Moment generating function – Standard Distributions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions. **[10]**

Two Dimensional Random variables

Joint distribution – Marginal distribution – Conditional distribution – Covariance – Correlation – Rank Correlation – Regression**.[8]**

Testing of Hypothesis

Test of significance of small samples – Student's 't' test – Single mean and Difference of means – F- test – Chi- square test – Goodness of fit – Independence of attributes. **[9]**

Design of Experiments

Analysis of variance – One way classification – Completely randomized design – Two way classification – Randomized block design –Latin square. **[8]**

Statistics and Quality Control

Measures of Central tendency – Mean – Median – Mode – Measures of Dispersion – Quartile deviation – Mean deviation – Standard deviation – Coefficient of variation – Skewness – Kurtosis – Control charts – Mean ($\bar{X}$) chart – Range (R) chart – P chart – nP chart –C chart. **[10]**

Total Hours: 45 + 15(Tutorial): 60 hours

Text books:

1. Gupta S.C and Kapoor V.K., "Fundamentals of Mathematical Statistics", 11th Edition, S Chand & Company Ltd, New
2. Richard A Johnson, "Miller & Freund's Probability and Statistics for Engineers", 7th Edition, Pearson Education, New Delhi,

Reference(s):

1. Veerarajan T., "Probability, Statistics and Random Process", 2nd Edition, Tata McGraw-Hill Publishing Company Ltd, New
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye., "Probability and Statistics for Engineers and
3. Sheldon Ro " A first course in Probability", 8 Edition, Pearson Education, New Delhi, 2010.,
4. Lipschutz, Seymour, Schiller, John. J., "Schaum's outlines – Introduction to Probability and Statistics", Taata McGraw
5. Probability and Statistics - Dr. Somesh Kumar, NPTEL online video courses.

Mapping of COs with POs and PSOs

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

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51 BT 401 - Genetic Engineering

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	0	45	3	40	60	100

Objective(s)

- To discuss the methods, tools and techniques involved in genome analysis, expression of cloned genes indifferent host system.
- To understand the production of recombinant proteins, mutation analysis and the importance of PCR in genome analysis.
- The student would learn about various aspects of Genetic Engineering, its application and ethical issues.
- To determine the strategies involved in gene cloning with the help of genomic libraries, cDNA libraries and other libraries.
- To discuss the production of useful molecules like cytokines, vaccines and antibiotics and define the safety guidelines for recombinant.

Course Outcomes

At the end of the course, the students will be able to

CO1: describe restriction and modification system and their role in genetic engineering and illustrate the different types of blotting techniques.

CO2: characterize the cloning vectors used in manipulation of genes like plasmids, phagemids, cosmids, artificial chromosomes, plant and animal vectors.

CO3: determine the strategies involved in gene cloning with the help of DNA libraries and methods involved in screening of cloned genes to identify the target gene from the library.

CO4: illustrate the PCR based techniques involved in genetic manipulation including mutagenesis and demonstrate various sequencing techniques

CO5: comprehend the applications of rDNA technology and describe the role of knock out and RNA Interference technology in gene expression studies.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Fundamental Techniques of Gene Manipulation

Restriction enzymes: types and mechanisms, DNA modification systems, Restriction mapping, Design of linkers and adapters, Joining of DNA molecules, Basics of cloning. **[9]**

Biology of Cloning Vectors

Characteristics of cloning vectors, Types of vectors, Selectable markers, and Experimental applications of vectors: Plasmids- pBR322, pUC, λ vectors, cosmids, M13 vectors, Phagemids, Artificial Chromosomes: YAC, PAC, BAC, HAC, Expression vectors, Insect, Yeast and Mammalian vectors. **[9]**

Gene Cloning Strategies And screening

Cloning of genes: Genomic libraries, cDNA libraries, Directional cDNA cloning, PCR based libraries-RACE, Subtraction libraries, Screening: Nucleic acid probe hybridization, Immuno screening and Functional screening. **[9]**

Amplification and Sequencing Of DNA

PCR: Mechanism, Types- Nested, Hot start, colony PCR, Taqman assay, Molecular beacons, Site directed mutagenesis: primer extension - Strand selection -Cassette mutagenesis - PCR based, Methods of nucleic acid sequencing: Sanger's method, Automated sequencing. Next Generation sequencing method: Illumina and Ion Torrent. **[9]**

Applications of RDNA Technology

Differential display, Microarrays, FISH, Knock-out analysis, Antisense and RNA interference, Yeast two hybrid system, RAPD, RFLP, VNTRs and SSR; Production of useful molecules: cytokines, vaccines and antibodies, improving agronomic traits. Safety guidelines for recombine ant DNA technology **[9]**

Total Hours: 45 hours

Text books:

1. Smita Rastogi and Neelam Pathak, "Genetic Engineering", Oxford Publication, 2010.
2. Ragagopal K., "Recombinant DNA Technology and Genetic Engineering", Tata McGraw Hill Education Private Ltd., 2012.

Reference(s):

1. Primrose S.B. &Twyman R.M., "Principles of Gene Manipulation and Genomics", 7th Edition, Blackwell Publishing. 2006.
2. Richard J. Reece., "Analysis of Genes and Genomes", John Wiley and Sons Ltd., Singapore, 2004.
3. Desmond S.T. Nicholl, "An Introduction to Genetic Engineering", Third Edition Cambridge University Press NewYork,2008.
4. Gyana Ranjan Rout, K,V, Peter, " Genetic Engineering of Horticultural crops" Academic Press An imprint of Elsevier, 2018

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3			3		3	2	3	3	3
CO2	3	3	2	3		3	3	3		3		3	3	2
CO3	3	3	3	3				3	3		3	3	3	2

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CO4	3	3	3	3	3	3	3			3		3	3	2
CO5	3	3	3	3		3			3		3	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 402 - Protein and Enzyme Engineering

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	0	45	3	40	60	100

Objective(s)

- To impart basic concept about Protein and Enzyme structures.
- To know the basics of enzyme substrate interaction and its product formation
- To learn basic principles of enzyme purification.
- To comprehend the various methods of protein and enzyme engineering
- To analyze the application of proteins and enzymes in various industries

Course Outcomes

At the end of the course, the students will be able to

CO1: know the basic, types and structural confirmation of proteins and enzymes
CO2: identify the enzyme active site and its catalysis
CO3: illustrate the protein/ enzyme purification methods and factors affecting immobilization
CO4: demonstrate the protein/ enzyme engineering strategies
CO5: identify the applications of protein/ enzymes in various domain

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Proteins and Enzymes

Introduction - Basic structural principles: amino acids and their conformational accessibilities - Motifs of protein structures and their packing - Structural characterization of proteins: Primary and three-dimensional structure determination - Ramachandran Plot - Protein folding: Structure of chaperones and role of chaperones in protein folding
- Enzymes: definition, nomenclature and types (constitutive and induced enzyme), intracellular and extra cellular enzymes**.** **[9]**

Mechanism and Kinetics of Enzyme Catalysis

Concept of active site -Mechanism of enzyme action - specificity of enzyme action - Enzyme inhibition - Mechanism and kinetics of single substrate reaction: Michaelis Menton equation and its Transformations, turn over number - Mechanism and kinetics of Multi substrate reaction MCW model - Analytical problems in single substrate reactions, turnover number, transformations of MM equations, MC Wmodel. **[9]**

Production and Purification of Proteins And Enzymes

Production and Purification of enzyme from plant, animal and microbial source: extraction, precipitation, dialysis, Ion exchange chromatography, Hydrophobic interaction chromatography, Gel filtration chromatography. Types of Enzyme immobilization. **[9]**

Strategies for Protein and Enzyme Engineering

Protein engineering cycle, protein splicing, random and site directed mutagenesis, pepti domimetics, *in vitro* protein evolution (DNA shuffling, Error prone PCR), cell surface display technology - Rational enzyme Design: Reshaping enzyme specificity, reengineering catalytic mechanisms, engineering by molecular assembling. **[9]**

Application of Proteins and Enzymes

Importance of recombinant enzymes and proteins, Industrial applications of enzymes, design of enzyme electrodes - Case studies on protein engineering applications in food, detergent, environment and health care industries. **[9]**

Total Hours: 45 hours

Text books:

1. Palmer, T. and Bonner, P., "Enzymes: Biochemistry, Biotechnology and Clinical chemistry", Affiliated East - West Press Pvt. Ltd., New Delhi, India, 2008.
2. Devasena T., "Enzymlogy", Second Edition, Oxford University Press, New Delhi, India, 2014.

Reference(s):

1. Branden, C. and Tooze, J., "Introduction to Protein structure", Second Edition, Garland Publishing, New York, US,1999.
2. Anton Torres, "Handbook of Protein Engineering" Calisto Reference, 2015.
3. Preethi Kartan, "Enzyme Engineering", Arcler Education Incorporated, 2017.
4. Allan Svendesen, "Understanding Enzymes – Function, Design, Engineering and Analysis" Pan Stanford Publishing, 2016.

Mapping of COs with POs and PSOs

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

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K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT 403 - Biochemical Thermodynamics								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	1	0	60	4	40	60	100

Objective(s)	• To impart basic thermodynamic principles and relations. • To understand partial molar properties of solutions. • To understand the phase equilibrium concepts and its applications. • To learn about chemical reaction equilibrium principles. • To know the applications of thermodynamics in biological systems.
Course Outcomes	**At the end of the course, the students will be able to** CO1: interpret laws of thermodynamics to predict the thermodynamic properties of pure fluids CO2: review various thermodynamic properties of solutions CO3: analyze the criteria of phase equilibria for single and multicomponent systems CO4: apply the concept of chemical reaction equilibria and equilibrium conversion CO5:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Thermodynamic Properties of Pure Fluids

Basic concepts and laws of thermodynamics - basics of entropy - volumetric properties of fluids - estimation of thermodynamic properties using equations of state, calculations involving actual property changes, Maxwell's relations and applications, residual properties,refrigeration cycles. **[9]**

Solution thermodynamics

Partial molar properties - concept of chemical potential and fugacity in solutions - activity - activity coefficients - effect of pressure and temperature - Gibbs-Duhem equations - property changes of mixing - heat effects of mixing in biological broths. **[9]**

Phase Equilibria

Criteria for phase equilibria - phase equilibria in single and multicomponent systems - Duhem's theorem. V-L-E calculations for binary and multi component systems. Liquid-liquid equilibria and solid-liquid equilibria. **[9]**

Chemical Reaction Equilibria

Chemical reaction equilibrium: evaluation of equilibrium constant, effect of temperature and pressure on equilibrium constant, equilibrium conversion for single and multiple reactions. **[9]**

Biochemical thermodynamics

Thermodynamics and energetics of metabolic pathways, oxygen requirement and heat generation in aerobic growth, energy coupling (NADH and ATP), Thermodynamics of oxidation-reduction reactions, Energetics of DNA-protein interactions, Protein folding and receptor-ligand binding. **[9]**

Total Hours: 45 + 15(Tutorial): 60 hours

Text books:

1. Smith J.M., Van Ness H.C., Abbot M.M. Chemical Engineering Thermodynamics, Sixth edition, McGraw-Hill, 2001.
2. Narayanan K.V., "AText Book of Chemical Engineering Thermodynamics", Second Edition, Prentice Hall of India,New Delhi, 2016.

Reference(s):

1. Gopinath Halder, "Introduction to Chemical Engineering Thermodynamics", PHI Learning Pvt. Ltd., New Delhi,2009.
2. Sandler S. I., Chemical, Biochemical and Engineering Thermodynamics, Fourth Edition, John Wiley & Sons Inc., 2006.
3. Gavhane K.A, "Chemical Engineering thermodynamics-1", Nirali Prakasan Publications, Pune, 2013.
4. Alberty, "Biochemical Thermodynamics Applications of Mathematica with CD (HB)", John Wiley, 2006.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	3	3	1	1	2	3	1	3	2	
CO2	3	2	3	3	3	3	3			3	3	2	2	3	
CO3	2	3	3	3	2	2	2	2		3	3	2	3	2	
CO4	3	2	2	3	2	2	2		2	2	3	2	3	2	
CO5	3		2	2	3	3	1		2	2	3	2	2	3	

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K.S.Rangasamy College of Technology – Autonomous R2018								
50 MY 014 - Start-ups and Entrepreneurship								
B. Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	2	0	0	30	-	100	-	100

Objective(s)	• To provides practical proven tools for transforming an idea into a product or service that creates value for others. • To build a winning strategy, how to shape a unique value proposition, prepare a business plan • To impart practical knowledge on business opportunities • To inculcate the habit of becoming entrepreneur • To know the financing, growth and new venture & its problems
Course Outcomes	**At the end of the course, the students will be able to** CO1: transform ideas into real products, services and processes, by validating the idea, testing it, and turning to a growing, profitable and sustainable business. CO2: identify the major steps and requirements in order to estimate the potential of an innovative idea as the is of an innovative project. CO3: reach creative solutions via an iteration of a virtually endless stream of world changing ideas and tegies, integrating feedback, and learning from failures along the way. CO4: apply the 10 entrepreneurial tools in creating a business plan for a new innovative venture. CO5: apply methods and strategies learned from interviews with startup entrepreneurs and innovators.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Entrepreneurship & Entrepreneur

Meaning and concept of Entrepreneurship, the history of Entrepreneurship development, Myths of Entrepreneurship, role of Entrepreneurship in Economic Development, Agencies in Entrepreneurship Management and Future of Entrepreneurship. The Entrepreneur: Meaning, the skills required to be an entrepreneur, the entrepreneurial decision process, Role models, Mentors and Support system. **[5]**

Business Opportunity Identification and Preparing A Business Plan

Business ideas, methods of generating ideas, and opportunity recognition, Idea Generation Process, Feasibility study, preparing a Business Plan: Meaning and significance of a business plan, components of a business plan. **[5]**

Innovations

Innovation and Creativity - Introduction, Innovation in Current. Environment, Types of Innovation, School of Innovation, Analysing the Current Business Scenario, Challenges of Innovation, Steps of Innovation Management, Experimentation in Innovation Management, Participation for Innovation, Co-creation for Innovation, Proto typing to Incubation. Blue Ocean Strategy-I, Blue Ocean Strategy-II. Marketing of Innovation, Technology Innovation Process. **[5]**

Financing & Launching the New Venture

Importance of new venture financing, types of ownership, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks. Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and formation of the new venture. **[5]**

Managing Growth & Rewards in New Venture

Characteristics of high growth new ventures, strategies for growth, and building the new ventures. Managing Rewards: Exit strategies for Entrepreneurs, Mergers and Acquisition, Succession and exit strategy, managing failures – bankruptcy. **[5]**

Total Hours: 30 hours

Text books:

1. Stephen Key, "One Simple Idea for Startups and Entrepreneurs: Live Your Dreams and Create Your Own Profitable Company" 1st Edition, Tata McGrawhill Company, New Delhi, 2013.
2. Charles Bamford and Garry Bruton, "ENTREPRENEURSHIP: The Art, Science, and Process for Success", 2nd Edition, Tata McGrawhill Company, New Delhi, 2016.

Reference(s):

1. Philip Auerswald, The Coming Prosperity: How Entrepreneurs Are Transforming the Global Economy, Oxford University Press, 2012.
2. Janet Kiholm Smith; Richard L. Smith; Richard T. Bliss, Entrepreneurial Finance: Strategy, Valuation, and Deal Structure, Stanford Economics and Finance, 2011.
3. Edward D. Hess, Growing an Entrepreneurial Business: Concepts and Cases, Stanford Business Books, 2011.
4. Howard Love, The Start-Up J Curve: The Six Steps to Entrepreneurial Success, Book Group Press, 2011.

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 GE 001 – National Cadet Corps-Air wing

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	2	60	4	50	50	100

Objective(s)

- Develop character, camaraderie,
- Inculcate discipline, secular outlook
- Enrich the spirit of adventure, sportsman spirit
- Ideals of selfless service amongst cadets by working in teams
- Improve qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.

Course Outcomes

At the end of the course, the students will be able to

CO1: Display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.

CO2: Demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling

CO3: Illustrate various forces and moments acting on aircraft

CO4: Outline the concepts of aircraft engine and rocket propulsion

CO5: Design, build and fly chuck gliders/model airplanes and display static models

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

NCC Organization & National Integration

NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF-Indo-Pak War-1971-Operation Safed Sagar. National Integration- Unityin diversity- contribution of youth in nation building- national integration council- Images and Sloganson National Integration. **[9]**

Drill & Weapon Training

Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing (WITH PRACTICE SESSION) **[9]**

Principles of Flight

Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition. **[9]**

Aero Engines

Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments- Modern trends. **[9]**

Aero Modeling

History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models- Radio Control Models-Building and Flying of Aero-models. **[9]**

Total Hours: 45 hours

Text books:

1 "National Cadet Corps- A Concise handbook of NCC Cadets" by Ramesh Publishing House, New Delhi,2014.

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2	**"NCC OTA Precise" by DGNCC, New Delhi,2014**
Reference(s):	
1	"Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi,2019
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi,2017

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3	3	3	3	3		3			
CO2					3						3	2			
CO3	3	2	1	1											
CO4	3	2	1	1											
CO5	3	2	1	1											

K.S.Rangasamy College of Technology – Autonomous R2018								
50 GE 002 – National Cadet Corps (Army Wing)								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	2	60	4	50	50	100
Objective(s)	• Develop character, camaraderie, • Inculcate discipline, secular outlook • Enrich the spirit of adventure, sportsman spirit • Ideals of selfless service amongst cadets by working in teams • Improve qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.							
Course Outcomes	**At the end of the course, the students will be able to** CO1: Display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion. CO2: Demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders. CO3: Basic knowledge of weapons and their use and handling. CO4: Aware about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils CO5: Acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles							
Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.								

NCC Organization & National Integration

NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt.

National Integration - Unity in diversity- contribution of youth in nation building- national integration council- Images and Slogans on National Integration. **[9]**

Basic Physical Training & Drill

Basic physical Training – various exercises for fitness (with Demonstration)-Food – Hygiene and Cleaniness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting (WITH DEMONSTRATION) **[9]**

Weapon Training

Main Parts of a Rifle- Characteristics of .303 rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing (WITH PRACTICE SESSION) - Characteristics of 5.56mm rifle- Characteristics of 7.62mm SLR- LMG- carbine machine gun – pistol. **[9]**

Social Awareness and Community Development

Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY- JGSY- NSAP-PMGSY- Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility **[9]**

Total Hours: 45 hours

Text books:	
1	National Cadet Corps- A Concise handbook of NCC Cadets by Ramesh Publishing House, New Delhi, 2014
2	Cadets Handbook- Specialized Subjects SD/SW published by DG NCC, New Delhi ,2014
Reference(s):	
1	"Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi,2019
2	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi,2017

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		3							
CO2								2							
CO3						1		3							
CO4								2							
CO5								3							

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 4P1 - Molecular Biology and Genetic Engineering Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
IV	0	0	4	60	2	60	40	100

Objective(s)

- To understand steps involved in the isolation of DNA form Bacteria, Fungi and Plant.
- To understand the concepts of plasmid DNA extraction and transformation
- To provide hands-on experience in performing basic recombinant DNA techniques
- To develop the ability to design, conduct, analyze and interpret data related to genetic engineering experiments
- To inculcate the research aptitude and technical skills to fulfill the need of both industry and research requirements.

Course Outcomes	**At the end of the course, the students will be able to** CO1: apply the knowledge of DNA extraction to isolate DNA from different sources. CO2: analyse and interpret the data obtained from the agarose gel using graphical, UV spectrophotometric and software methods. CO3: isolate the plasmid DNA and select the correct restriction enzymes to digest the vector DNA that give cohesive ends, ligate it to make recombinant DNA and transform it with *E.coli* DH5αcells CO4: mix the reaction components of PCR at appropriate concentration and operate the thermocycler to amplify the DNA CO5: apply the knowledge of restriction digestion, ligation, transformation and PCR to design experiment to insert gene of interest into to a vector and confirm its presence either by PCR or by cloning and screening and interpret the data obtained from the results.

LIST OF EXPERIMENTS

Any ten Experiments

1. Isolation of genomic DNA from bacterial cells
2. Isolation of genomic DNA from fungal cell
3. Isolation of DNA from Blood by high salt method
4. Quantification of DNA by UV spectrometer and agarose gel electrophoresis
5. Extraction of Plasmid DNA
6. Isolation of total RNA from prokaryotes
7. Extraction of DNA from Agarose gel
8. Restriction Enzyme Digestion of Vector and genomic DNA
9. Ligation of restricted DNA to construct rDNA
10. Competent cell preparation- Calcium Chloride method
11. Transformation by heat-shock induction method
12. PCR- 16S rDNA amplification
13. Random Amplification of Polymorphic DNA
14. Isolate DNA from any five different sources, quantify it and interpret your result by comparing the data obtained.
15. Make a recombinant DNA of your own gene of interest using the given vector and confirm it by the any one of the following techniques: (I)Transformation and blue-white screening Colony PCR

Total Hours : 60

References :

1. Sambrook, J., Russsel, D.W., “Molecular cloning - A laboratory manual”, Third edition, Cold Spring
2. Ansubel, F.M., Brent, R., Kingston, R.E. and Moore, D.D., “Current Protocols in Molecular Biology”,
3. Isil Aksan Kurnaz, “ Techniques in Genetic Engineering”, CRC Press, Taylor & Francis Group, New York,
4. Gupta P.K., “Molecular Biology and Genetic Engineering”, Rastogi Publications, Meerut, India, 2008

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT 4P2 - Protein and Enzyme Engineering Laboratory								
B.Tech. Biotechnology								
Semester	**Hours/week**			Total Hours	**Credit**	**Maximum marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
IV	0	0	4	60	2	60	40	100

Objective(s)	• To impart basics of intra and extra cellular protein and enzyme extraction. • To enable the biochemical characterization of enzymes • To learn basic principles of enzyme and protein purifications. • To know the active site amino acids using chemical modification method. • To evaluate the molecular mechanism of protein using various tools.
Course Outcomes	**At the end of the course, the students will be able to** CO1: analyze the extraction and estimation of intra cellular proteins CO2: find out effect of pH, temperature and K_m &V_{max} for the given enzyme CO3: elucidate the purification pattern through SDS-PAGE and its nativity by NATIVE-PAGE CO4: identify the method of production, estimation and immobilization of enzyme CO5: analyze the active site modification of an enzyme using western blotting

LIST OF EXPERIMENTS

Any ten Experiments

1. Extraction and estimation of extra cellular proteins from bacteria and fungi
2. Production and estimation of protease
3. Digestion of milk protein into amino acids with quantification
4. Effect of pH and Temperature on Acid phosphatase activity
5. Kinetic characterization (K_m &V_{max}) of Acid phosphatase - LB plot
6. Identification of inhibition types of Acid phosphatase
7. Purification of protein by ion exchange chromatography
8. SDS PAGE analysis for partial purification of protein sample
9. Identification of isozyme pattern of Peroxidase by Native-PAGE analysis
10. Immobilization of enzymes using gel entrapment method
11. Comparative kinetic characterization of free and immobilized enzymes
12. Engineering the active site using chemical modification method
13. Western blot - Analysis of protein expression pattern
14. Fabrication of enzyme sensors and demonstration of their functions
15. Quantification of purified protein in High Performance Liquid Chromatography

Total Hours : 60

Lab Manual:

1. Simpson R. J, “Proteins and Proteomics: A lab manual”, Cold Spring Harbor, US 2003
2. Hans Bisswanger and Leonie Bubenheim, “Enzyme Kinetics: Principles and Methods”, April 2002
3. Richard F. Taylor, “Protein Immobilization: Fundamentals and applications” 1991.
4. Tuck Seng Wong, “A Practical Guide to Protein Engineering”, Springer Nature, ISBN: 9783030568986 ,2020

Mapping of COs with POs and PSOs

	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	3	3
CO2	3	3	3	3	3		2	1	2		2	3	3	3
CO3	3	3	3	3	3	2		1		2	2	3	3	3
CO4	3	3	3	3	3		3	1	3		2	3	3	3
CO5	2	2	2	2	2		2			3	2	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018								
50 TP 0P2 - CAREER COMPETENCY DEVELOPMENT II								
COMMON TO ALL BRANCH								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	**0**	**0**	**2**	**30**	**0**	**100**	**00**	**100**

Objective(s)	• To help the learners to paraphrase the reading passages, to draft continuous writing and review texts in the academic and professional contexts • To help the learners to acquire the phonetic skills of the language and express themselves precisely for effective professional presentations • To help the learners to enrich their verbal reasoning and ability to match the employability requirements of the corporates • To help the learners to comprehend the preliminary level of aptitude skills required to attend placement and competitive online exams • To help the learners to comprehend the Pre - Intermediate level of aptitude skills required to attend placement and competitive online exams.
Course Outcomes	**At the end of the course, the students will be able to** **CO1:** Interpret and infer the meaning in the reading passages, organize continuous writing and review texts both academically and professionally. **CO2:** Adapt to and demonstrate the phonetic skills accurately for effective presentations professionally. **CO3:** Interpret the various concepts of verbal reasoning and relate for the concepts to the requirements of thecompetitive exams and employability **CO4:** Infer the concepts of preliminary level of aptitude skills pertaining to competitive exams and company recruitments. **CO5:** Infer the concepts of pre-intermediate level of aptitude skills pertaining to competitive exams and company recruitments.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Written Communication–Part 3

Reading Comprehension Level 2 (Paraphrasing Poems) - Letter Drafting - Email Writing – Paragraph Writing - Newspaper and Book Review Writing - Skimming and Scanning - Interpretation of Pictorial Representations. **Practices:** Sentence Completion-Sentence Correction- Jumbled Sentences – Synonyms & Antonyms - Using the Same Word as Different Parts of Speech -Editing

Materials: Instructor Manual, Word power Made Easy Book, News Papers **[6]**

Oral Communication–Part 3

Self-Introduction- Miming (Body Language)- Introduction to the Sounds of English-Vowels, Diphthongs & Consonants,Introduction to Stress and Intonation - Extempore - News Paper and Book Review- Technical Paper Presentation. **Material:** Instructor Manual, News Papers

[4]

Verbal Reasoning–Part 1

Analogies- Alphabet Test-Theme Detection – Family Tree - Blood Relations (Identifying relationships among group of people) - Coding & Decoding - Situation Reaction Test -Statement & Conclusions

Material: Instructor Manual, Verbal Reasoning by R.S. Aggarwal **[8]**

Quantitative Aptitude –Part 1

Problem on Age s- Percentages- Profit and Loss – Simple &Compound Interest- Averages - Ratio ,Proportion

Material: Instructor Manual, Aptitude Book **[6]**

Unit–5

Quantitative Aptitude –Part 2

Describing Objects / Situations /People, Information Transfer-Picture Talk-News Paper and Book Review

Materials: Instructor Manual, News Papers **[6]**

Total Hours: 30 hours

Evaluation Criteria

S.No.	Particular	Test Portion	Marks
1	Evaluation1 – Written Test	15 Questions EachfromUnit1,3,4&5(External Evaluation)	50
2	Evaluation2 – Oral Communication	Extempore Miming–Unit 2 (External Evaluation by English, MBA Dept.)	30
3	Evaluation3 - Technical Paper Presentation	Internal Evaluation by the Dept.	20
		Total	100

Reference(s):

1 Aggarwal,R.S. “A Modern Approach to Verbal and Non-verbal Reasoning”, Revised Edition 2008, Reprint 2009,S.Chand & Co Ltd., New Delhi.

2.	Abhijit Guha,"QuantitativeAptitude",TMH,3rd edition
3.	Objective Instant Arithmetic by M.B.Lal & Goswami Upkar Publications
4.	Word Power Made Easy by Norman Lewis W.R.GOYAL Publications
Note:	• Instructor can cover the syllabus by Class room activities and Assignments (5 Assignments/week) • Instructor Manual has Class work questions, Assignment questions and Rough work pages • Each Assignment has 20 questions from Unit 1,2 and Unit 5 and 5 questions from Unit 3 and 4 • Evaluation has to be conducted as like Lab Examination

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT 501 - Plant and Animal Biotechnology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)	• To develop the skills of the students in the area of Plant Biotechnology and its wide applications. • To widen the knowledge about the production and applications of Transgenic plants and its uses. • To produce potential biofertilizers using valuable native microbial strains for sustainable agriculture. • To widen the knowledge about production and applications of transgenic animals. • To understand the importance of ethical issues involved in the production of transgenic animals.
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe the concepts of plant tissue culture, media preparation in the field of *in vitro* culture of plants. CO2: investigate the process of conservation of plants for future posterity and Production of Hybrid plants. CO3: learn the prospects and problems of GM crops along with the guidelines as well as safety Regulations for transgenic plants. CO4: depict the crucial animal cell culture techniques and types of media used in animal cell cultures CO5: exemplify the concept of cytotoxic and viability assessment using different assays.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

PLANT TISSUE CULTURE

History of Plant tissue culture, preparation of Plant tissue culture media and Plant growth regulators, Sterilization of explants, Callus and suspension cultures, Micropropagation, meristem culture, organogenesis, regeneration of shoots and roots. Embryo culture, Somatic embryogenesis, Synthetic seeds, Haploid plant production: Anther, pollen and ovary culture, Protoplast culture, Somatic hybrids and Cybrids, Transfer and establishment of whole plants to greenhouse and field**.**

[9]

TRANSGENIC PLANTS

Organization and expression of chloroplast genome and mitochondrial genome- Gene transformation techniques: Direct gene transformation: Electroporation, particle gun method, Lipofection, Microinjection, Fiber mediated DNA delivery and Laser induced DNA delivery. Biological gene transfer: Agrobacterium mediated gene transformation Transgenic plants: Disease resistance; Insect resistance, virus resistance, Biotic and abiotic stress resistance, GM Crops- Prospects and problems**.**

[9]

APPLICATIONS OF PLANT BIOTECHNOLOGY

Production of antibodies and biodegradable plastics in plants. Applications of secondary metabolites: Isolation, characterization and drug development, Plant derived vaccines: Edible vaccines and Plantigens. Applications of Antisense RNA technology. Organic agriculture, precision farming and hydrophonics. Phytoremediation.

[9]

INTRODUCTION TO ANIMAL CELL LINE

Introduction to Animal cell culture, Basic tissue culture techniques, Animal cell culture media and its preparations, Types of primary culture – Chicken embryo fibro blast culture – Chicken liver and kidney culture- Secondary culture –Trypsinization, Suspension cultures, dependent culture, Continuous flow cultures, Immobilized cultures, Role of serum and supplements, Mass transfer in mammalian cell culture. Maintenance and preservation of animal cell cultures; Measurement of viability and cytotoxicity**.**

[9]

TRANSGENIC ANIMALS AND APPLICATIONS OF ANIMAL BIOTECHNOLOGY

Cloning techniques in animals, Gene transformation techniques in animals. Transgenic animals: Transgenic mice, transgenic rabbits, Transgenic cattle, Transgenic Pig and Transgenic Fish, Ethical issues related to transgenic animals. Organ culture technology- production of complete organ. Biotechnology in animal production, manipulation of growth hormone, somatotropic hormone. **[9]**

Total Hours: 45 hours

Text books:

1. Singh, B.D., “Biotechnology”, First Edition, Kalyani Publishers, New Delhi, India, 2015.
2. Ranga, M.M., “Animal Biotechnology”, Third Edition, Agrobios India limited, Jodhpur. India, 2013.

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Chairman - BOS
BOS Chairman

3	Ian freshney, R., "Culture of Animal Cells", Fifth th Edition, Wiley Publications, New Delhi, India, 2006.
4	Suresh Kumar Gahlawat, Joginder Singh Duhan, Raj Kumar Salar, Priyanka Siwach, Suresh Kumar, Pawan Kaur, " Advances in Animal Biotechnology and its Applications", Springer Nature Singapore Pvt. Ltd., 2018

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3			3	3	2		3	3	**3**	**3**
CO2	3	2	3	3	3			2	2	3		2	**3**	**3**
CO3	3	2	3	3	2	2	3	3	3		3	2	**3**	**3**
CO4	3	2	2	3	2	3	3	2	3		3	2	**3**	**3**
CO5	3	2	3	3	2		2	2	2		3	2	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 502 – Bioinformatics

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)

- To develop inter disciplinary skills in the application of computers in biotechnology and learn about the biological databases and machine learning techniques
- To learn about the bioinformatics databases, databanks, data format and data retrieval from the online sources.
- To Analyze the structure and functions of protein and DNA using *in silico* tools
- To understand the concepts involved in biological macromolecular structures and structure prediction methods.
- To apply the acquired programming Knowledge in *in silico* Biology

Course Outcomes

At the end of the course, the students will be able to

CO1: get acquainted with various biological primary databases, secondary databases and different sequence formats.

CO2: characterize the optimal alignment of sequences either by local or global algorithm and apply BLAST and FASTA algorithms in similarity search.

CO3: classify the phylogenetic analysis, and categorize the protein and RNA structure prediction algorithms.

CO4: describe and deduce soft computing algorithms that are applied in gene prediction and in protein structure patterns.

CO5: write, compile, and run Perl programs, Analyze the effects of using Perl structures that implement decisions, loops and store arrays

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO BIOINFORMATICS

Introduction to Operating Systems, Linux Commands, File transfer protocols, telnet. Definition, Scope of Bioinformatics, Biological Sequences, Characteristics and categories of Biological databases, Data file formats, Data life Cycle and Database Management System models.

[9]

PATTERN MATCHING

Pairwise sequence alignment: Dot matrix analysis, Local vs global alignment; Substitution matrices: PAM and BLOSUM, Dynamic programming: Needleman Wunch and Smith waterman algorithm; BLAST-PSI and PHI, FASTA; Multiple sequence alignment, Generating motifs and profiles.

[9]

PHYLOGENY AND HOMOLOGY MODELING

Phylogenetic analysis: Distance based method; Character based method, Boot Strapping, Protein Secondary structure and tertiary structure prediction methods. Homology modelling, ab initio approaches, Threading, CASP and Structural genomics**.** **[9]**

MACHINE LEARNING AND APPLICATIONS OF BIOINFORMATICS

ANN in protein secondary structure prediction. HMM for gene finding, Decision trees, Support Vector Machines. Introduction to System Biology and Synthetic Biology, Microarray data analysis, DNA computing, Molecular Docking**.** **[9]**

PERL PROGRAMMING

Basics of PERL programming for Bioinformatics: Datatypes, scalars and collections, operators, Program control flow constructs Library Functions: String specific functions, User defined functions and File handling. **[9]**

Total Hours: 45 hours

Text books:

1	Arthur K. Lesk,"Introduction to Bioinformatics" Oxford University Press. ,4th edition 2014
2	Rastogi, S.C., "Bioinformatics – Concepts, skills and applications", CBS Publishers and Distributors, New Delhi, India, 2003.

Reference(s):

1	David W. Mount., "Bioinformatics Sequence and Genome Analysis", 2nd Edition, Cold Spring Harbor Laboratory Press,New York, US, 2004.
2	EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss and Garry Wong,"RNA-Seq Data Analysis: A Practical Approach", CRC Press, 2014
3	Xinkun Wang,"Next Generation Sequencing Data Analysis", CRC Press, 2016
4	Durbin R., Eddy S., Krogh A., Mitchison G.,"Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids", Cambridge University Press, 2013

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 503 – Bioprocess Technology

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	1	0	60	4	40	60	100

Objective(s)

- To learn the historical development in bioprocess technology of production and recovery process.
- To design a bioreactors and the strategy of scale up reactor for commercial prospects.
- To develop and predict the construction of ancillaries for fermentor system.
- To enable the knowledge of fluid behavior and analyze the biodynamic property.
- To understand the important concepts of software's in monitoring and validation of Bioprocess Technology

Course Outcomes

At the end of the course, the students will be able to

CO1: enumerate the historical development, types of fermentation process and bioproduct recovery

CO2: design a kinetic parameters of cell growth of structured and unstructured model

CO3: illustrate the concept of design and construction of reactor with its controlling strategies

CO4: determine the scale up of the bioreactors with respect to mixing and power consumption

CO5: simulate and validate the protocol of bioprocess technology through soft wares.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO BIOPROCESS TECHNOLOGY

Introduction to Bioprocessing: Historical development of Bioprocess technology, General requirements and types of fermentation processes, Designing of media for fermentation process, aerobic and anaerobic fermentation process. Bio-product recovery process: Filtration, sedimentation, centrifugation, precipitation, cell disruption, chromatography, crystallization, lyophilization and drying**. [9**]

FERMENTATION PROCESSES

Medium requirements for fermentation processes, batch growth, balanced growth, effect of substrate concentration. Monod model. Determining cell kinetic parameters from batch data. Kinetics of cell growth- Structured and unstructured models. Growth associated (primary) and non-growth associated (secondary) product formation kinetics **[9]**

PROCESS DESIGN AND CONTROL OF BIOREACTORS

Bioreactor design and construction - Reactor Engineering in perspective. Types of Reactors (Batch, Fed Batch and Continuous). Designof Stirrers and impellers. Principles and Strategies for Control of Bioreactors (feedback, feed forward, adaptive and statistical, fuzzy logic control). Bioprocess design for Plant and Animal cell reactor **[9]**

RHEOLOGY AND SCALE UP OF FERMENTATION

Newtonian and Non Newtonian fluids, Effect of scale on oxygenation, mixing, sterilization, nutrient availability and supply. Bioreactor scale up based on constant power consumption per volume, mixing time, impeller tip speed (shear), Oxygen transfer in bioreactors, Measurement of volumetric mass transfer coefficient, Scale-up criteria for bioreactors based on oxygen transfer **[9**]

SIMULATION AND VALIDATION IN BIOPROCESS TECHNOLOGY

Simulation techniques (Software): Reactor design (Autocad, ANSYS Fluent,) and evaluation of Design of experiments (DOE), Steady state material and energy balance programs (FLOWTRAN); Dynamic simulation of the bioreactor. Simulation of CSTR in continuous and batch reactor using MATLAB. Application of modelling and Simulation in bioprocess industries **[9]**

Total Hours: 45 + 15(Tutorial) : 60 hours

Text books:

1. Rao, D.G., "Introduction to Biochemical Engineering", Second Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, India, 2010.
2. Ashok Kumar verma, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Publication press. 2014.

Reference(s):

1. Shuler,M.L. and Kargi, F.," Bioprocess Engineering Basic Concepts", Prentice Hall of India, Pvt. Ltd., New Delhi, India,2003.
2. Chien Wei Ooi, Pau Loke Show, Tau Chuan Ling, "Bioprocess Engineering Downstream Processing", CRC Press, 2019
3. Kim Gail Clarke, "Bioprocess Engineering An Introductory Engineering and Life Science Approach", Elsevier Science, 2013.
4. Elsevier Science, "Bioprocess Technology Kinetics and Reactors", Springer New York, 2012

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT 504 - Heat and Mass Transfer Operations								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	1	0	60	4	40	60	100

Objective(s)	• To impart basic principles of heat transfer operations. • To understand the heat transfer principles with phase change operations. • To learn mass transfer principles for diversified applications. • To understand different types of mass transfer operations. • To apply heat and mass transfer principles for biological systems.
Course Outcomes	**At the end of the course, the students will be able to** CO1: demonstrate the different modes of heat transfer and estimation of heat transfer coefficient. CO2: quantify heat transfer for phase change operations and know types of heat exchangers and flow arrangements. CO3: Intrepret the principle of molecular diffusion, continuous rectification and gas absorption. CO4: demonstrate the operations of extraction, leaching, adsorption and drying. CO5: highlight the heat and mass transfer correlations and applications in bioreactors.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Basics of Heat Transfer Operations

Modes of heat transfer operation: Fourier's law of heat conduction, heat transfer resistance and conductance, thermal conductivity, steady state conduction, heat flow through plane wall, composite wall, cylindrical surface and sphere; convection; individual heat transfer coefficient and overall heat transfer coefficient.

[9]

Heat Transfer with Phase Change and Heat Exchangers

Heat exchangers-shell and tube and double pipe heat exchangers, flow arrangements in heat exchangers, energy balance, LMTD, single and multiple effect evaporators; natural and forced circulation evaporators; heat transfer with phase change. Case studies. **[8]**

Diffusion, Vapour-liquid and Gas-liquid operations

Molecular diffusion in gas, liquid and solids, mass transfer coefficients, Interphase mass transfer, diffusivity and flux calculations; Simple distillation, Continuous rectification- Binary systems, McCabe Thiele analysis and calculations. Absorption: principle; minimum liquid-gas ratio; Industrial absorbers. Case studies. **[10]**

Liquid-liquid, Solid-liquid and Solid-fluid operations

Liquid-liquid extraction-distribution co-efficient, Solvent selection criteria for extraction, extraction equipment. Solid-liquid extraction – principle, operation and equipment. Adsorption: principle; batch and fixed bed adsorption. Drying: basic principle, drying curve and industrial dryers. **[10]**

Applications of Heat and Mass Transfer in Biological Systems

Heat transfer in bioreactors, Relationship between heat transfer, cell concentration and stirring conditions; Role of diffusionin bioprocess, Factors affecting oxygen transfer in fermenters, Mass transfer correlations for oxygen transfer. Case studies. **[8]**

Total Hours: 45 + 15(Tutorial) : 60 hours

Text books:

1. McCabe, W.L., Smith, J.C., and Harriott, P. "Unit Operations of Chemical Engineering", 7th Edition., McGraw Hill International Edition, 2005.
2. Kern, D.Q., "Process Heat Transfer" McGraw -Hill International Book Company,1999.

Reference(s):

1. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer" New Age Science, 2009.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice Hall Inc.,1993.
3. Pauline M. Doran "Bioprocess Engineering Principles" 2nd edition, Academic Press, 2005.
4. Kurt Rolle, "Heat and Mass Transfer", 2nd edition, Cengage Learning, 2015

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	3	2	3		3	2	3	**3**	**3**
CO2	2	3	3	3	2	3	2		2	2	2	2	**2**	**3**
CO3	3	3	3	3	2	3	3	2	2	3	2	3	**3**	**3**
CO4	3	3	2	2	2	2	3			3	3	3	**3**	**3**
CO5	3	3	3	3	3	3	2	2		3	2	2	**3**	**2**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 5P1 – Plant and Animal Biotechnology Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
V	0	0	4	60	2	60	40	100

Objective(s)

- The student would have learnt about animal cell culture, molecular diagnostic of animal diseases and transgenic animal production.
- To experiment the techniques involved in Plant tissue culture.
- To understand the applications of genetic engineering in plants and to develop transgenic plants.
- To experiment the techniques in sterilization and maintenance of various Animal cell culture for molecular diagnostic of Animal diseases and transgenic Animal production.
- To discuss about animal cell culture, molecular diagnostic of animal diseases and transgenic animal production.

Course Outcomes

At the end of the course, the students will be able to

CO1: adapt the preparation of plant tissue culture media for plant cell, tissue and organ culture with effective and safe operation.

CO2: illustrate the steps involved in developing a reliable protocol and required hormonal combination for *in vitro* culturing of plants.

CO3: experiment the aseptic explant production through *in vitro* seed germination and micro propagation.

CO4: adapt the preparation of animal cell culture media and to know about trypsinization, sub culturing process for various applications in animal Biotechnology.

CO5: experiment the process of subculturing without and contamination and isolation of Primary cells from Chicken fibroblast.

LIST OF EXPERIMENTS

Any ten Experiments

PLANT BIOTECHNOLOGY

1. Preparation of stock solutions of MS basal medium and plant growth regulator stocks and safety regulations.
2. Aseptic culture techniques for establishment and maintenance of cultures
3. Micropropagation of plants through meristematic explants.
4. Multiplication of plant through Micropropagation using phytohormones
5. Micropropagation of Rice by indirect organogenesis from embryo
6. Haploid plant production (Ovary and Pollen culture)
7. *Agrobacterium* mediated gene transformation and hairy root culture
8. Preparation of synthetic seed

ANIMAL BIOTECHNOLOGY

9. Basic Animal handling methods

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Approved in Academic Council Meeting held on 03/06/2023

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BOS Chairman

10. Preparation of various animal cell line media
11. Sterilization procedures followed in cell line laboratory
12. Cytotoxicity assay (MTT assay)
13. Cell counting method using heamocytometer
14. Isolation of Primary cells from Chicken fibroblast
15. Scaffold preparation for 3-D culture (Bovine pericardium)

Total Hours : 60 hours

References :

1	Gamborg, O.L. and Philips G.C., "Plant Cell, Tissue and Organ Culture fundamental Methods", Narosa Publishing House, New Delhi, India, 2018.
2	Ian Freshney, R., "Culture of Animal Cells", Fifth Edition, Wiley Publications, New Delhi, India, 2006.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2		2	2	2	2	2	**3**	**3**
CO2	3	2	2	2		3		2	2			2	**3**	**3**
CO3	3	2	2	2		3	2	2	2		3	2	**3**	**3**
CO4	3	2	2	2	3			2	2	3		2	**3**	**3**
CO5	3	2	2	2				2	2		3	2	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 5P2 – Bioprocess Technology Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
V	0	0	4	60	2	60	40	100

Objective(s)

- To understand the industrial requirement of fermentation process for bio-product.
- To study the different factors affecting the yield and biomass of product.
- To empower the knowledge of mixed flow reactor and its estimation of KLa value.
- To illustrate the various unit operation involved in product development.
- To demonstrate the aspects of modelling and simulation in Bioprocess Technology.

Course Outcomes

At the end of the course, the student can able to

CO1: handle the techniques of media optimization and determine the Kla for bioprocess
CO2: illustrate the concept of microbial growth and its thermal death kinetics
CO3: demonstrate the kinetics of mixed flow reactor and the role of Kla through sodium oxidation method
CO4: validate the biomass coefficient of yeast and demonstrate the simulation software for bioreactor
CO5: demonstrate the production of industrial enzymes through modelling in the system

LIST OF EXPERIMENTS

Any ten Experiments

1. Media optimization – Plackett Burman design
2. Determination of Kla value by gassing out method
3. Evaluation of parameters on Monod model for growth of microorganism
4. Thermal Death Kinetics of microorganisms
5. Study of Mixed flow reactor and its kinetics design of reaction
6. Determination of Kla by sodium sulphide oxidation method
7. Determination of yield and biomass coefficient of Yeast on glucose
8. Simulation of Batch and continuous Reactor by SIMULINK
9. Modelling of Batch, Fed Batch and Continuous using Berkeley Madonna software.
10. Solid state fermentation process of production of industrial enzymes.
11. Production of secondary metabolites in synthetic media using fermentor
12. Extraction and Production of protease enzyme activity from microbial source
13. Solvent extraction technique for product recovery
14. Production and estimation of bioethanol from different sources
15. Residence time distribution

Total Hours : 60 hours

References :

1	Ponmurugan. P., Nithya Ramasubramanian and M. Fredimoses., "Experimental Procedures in BioprocessTechnology and Downstream Processing", Anjanaa Book House, Chennai, India, 2012.
2	Ashok Kumar verma, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Publication press. 2014.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	2	2	2		3	2	2	**3**	**3**
CO2	2	3	2	3	2	2	3			2	2	3	**3**	**3**
CO3	3	3	2	2	2	3	2		2	2	3	3	**3**	**3**
CO4	3	2	3	2	3	3	2			2	3	2	**3**	**3**
CO5	3	3	3	2	2	2	2	2		3	3	3	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50TP0P3 - CAREER COMPETENCY DEVELOPMENT III

COMMON TO ALL BRNACHES

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	**0**	**0**	**2**	**30**	**0**	**100**	**0**	**100**

Objective(s)

- To help the learners to enrich the written and oral communication skills in the academic and professional contexts
- To help the learners to enrich their verbal and logical reasoning ability to meet out the employability requirements of the companies
- To help the learners to comprehend the Intermediate level of aptitude skills required to attend placement and competitive online exams
- To help the learners to enhance their knowledge in the quantitative aptitude skills in algebraic and linear equations.
- To help the learners to augment the core technical and coding skills of their respective domains to compete in coding contests

Course Outcomes

CO1: Examine the written and oral communication skills in the academic and professional contexts
CO2: Interpret the concepts of verbal reasoning and relate for the concepts to the requirements of the competitive exams and employability
CO3: Infer the concepts of intermediate level of aptitude skills pertaining to competitive exams and company recruitments.
CO4: Assess their comprehension in the quantitative aptitude skills in algebraic and linear equations.
CO5: Review the core technical and coding skills of their respective domains to compete in coding contests

Note: Instructor can cover the syllabus by class room activities and assignments (5A assisgments/week) instructor manual has class work questions, assisgment questions and rough work pages.
Each assisgnment has 20 questions from unit 1,2,3,4 and5 and 5Questions from unit 1 evaluation has to be conducted as lie lab examination

Written and Oral Communication
Reading Comprehension Level 3 - Self Introduction - News Paper Review - Self Marketing - Debate- Structured and Unstructured GDs Psychometric Assessment – Types & Strategies to answer the questions **Practices:** Sentence Completion
- Sentence Correction - Jumbled Sentences - Synonyms & Antonyms - Using the Same Word as Different Parts of Speech-Interpretation of Pictorial Representations – Editing - GD- Debate.
Materials: Instructor Manual, Word power Made Easy Book, News Papers [6]

Verbal & Logical Reasoning
Syllogism - Assertion and Reasons - Statements and Assumptions - Identifying Valid Inferences – identifying Strong Arguments and Weak Arguments – Statements and Conclusions-Cause and Effect- Deriving Conclusions from Passages - Seating Arrangements. **Practices:** Analogies - Blood Relations - Statement & Conclusions
Materials: Instructor Manual, Verbal Reasoning by R.S. Aggarwal [8]

Quantitative Aptitude
Probability-Calendar-Clocks-Logarithms –Permutations and Combinations
Materials: Instructor Manual, Aptitude Book [6]

Quantitative Aptitude
Algebra-Linear Equations-Quadratic Equations –Polynomials, **Practices:** Problem on Numbers -Ages-Train
-Time and Work -Sudoku–Puzzles.
Materials: Instructor Manual, Aptitude Book [6]

Technical & Programming Skills
Practices: Questions from Gate Material. **Materials:**TextBook, Gate Material [4]

Total Hours : 30 hours

Evaluation Criteria

S.No.	Particular	Test Portion	Mark s
1	Evaluation1WrittenTest	15Questions each from Unit1,2,3,4&5(External Evaluation)	50
2	Evaluation2- Oral Communication	GD and Debate (External Evaluation by English, MBA Dept & External Trainers)	30
3	Evaluation3– Technical Paper Presentation	Internal Evaluation by the Dept.	20
		Total	**100**

Reference(s) books:

1. Aggarwal,R.S."A Modern Approach to Verbal and Non-verbal Reasoning",Revised Edition 2008, Reprint 2009,S. Chand & Co Ltd., NewDelhi.
2. Abhijit Guha,"QuantitativeAptitude",TMH, 3rd edition
3. Objecti veInstant Arithmetic by M.B.Lal & Goswami Upkar Publications
4. Word Power Made Easy by Norman Lewis W.R.GOYAL Publications

Mapping of COs with POs and PSOs

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

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Chairman - BOS
BOS Chairman

K.S.Rangasamy College of Technology – Autonomous R 2018								
51 BT 601 – Biopharmaceutical Technology								
B. Tech. Biotechnology								
Semester	**Hours / Week**			**Total Hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VI	3	0	0	45	3	40	60	100

Objective(s)	• To Understand the basics concepts of pharmacology • To know about the drug manufacturing process • To learn about the pharmacokinetics and biotransformation • To understand the concepts of dosage forms • To distinguish the roles and responsibilities of different regulatory bodies in manufacturing of drugs.
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe the classification of drugs and the different routes for drug administration and patenting of drugs. CO2: illustrate the manufacturing facilities of drugs and and quality control in drug manufacturing process. CO3: explicate the concepts of adsorption, distribution, biotransformation process and bioavailability of drugs. CO4: designate the classification of pharmaceutical dosage forms, use of semi- solid dosage form and inhalants. CO5: determine the role of Quality assurance and regulatory affairs in biological evaluation of the drug.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO PHARMACOLOGY

Drug- definition, Classification, physiochemical properties, pharmaceutical substances of plant origin, Pharmaceuticals of animal origin, pharmaceutical substances of microbial origin, Routes of administration of drug. **[9]**

THE DRUG MANUFATURING PROCESS

The manufacturing facility, Cleaning, decontamination and sanitation (CDS), Documentation, Specifications, Records. Compression and granulation of tablets, Coating of pharmaceutical dosage forms- film coating, modified release film coating-coating procedure and equipment. Quality control and practice. **[9]**

PHARMACOKINETICS AND BIOTRANSFORMATION

Basic concepts of pharmacokinetics: Absorption- Mechanism of drug absorption, Distribution- Biotransformation of drug-Non synthetic and synthetic reaction Elimination, Organ clearance- hepatic clearance, renal clearance, Bioavailability and Bioequivalence **[9]**

PHARMACEUTICAL DOSAGE FORMS

Definition of Dosage forms, Classification of dosage forms -solid unit dosages – Tablets, capsules, pills, troches, cachets, liquids – solutions, lotions, suspension, elixirs, emulsions, ointments - semi-solid – ointments, creams, gels. Inhalations and inhalants. Extracts- Tinctures and fluid extracts. **[9**

BIOPHARMACEUTICALS QUALITY ASSURANCE

The role of FDA (food and drug administration process)-role of centre for biological evaluation and research (CBER)- role of centre for drug evaluation and research -Global harmonization of regulatory affairs-European medicine evaluation agency (EMEA)-Indian pharmacopeia (IP)-United states pharmacopeia (USP). **[9]**

Total Hours:= 45 hours

Text book(s):

1	Remington, "The Science and Practice of Pharmacy". Lippincott Williams and Wilkins, 20th edition, 2001.
2	Gary Walsh, "Biopharmaceuticals", John Wiley & Sons Ltd, UK, Second Edition, 2003.

Reference(s):

1	Goodman & Gilman's "The Pharmacological Basis of Therapeutics",11th edition, Mc Graw-Hill MedicalPublishing Division New York, 2006.
2	Gunter Jagschies, Eva Lindskog, Karol Lacki, Parrish Galliher, "Biopharmaceutical Process: Development, Design and Implementation of Manufacturing Processes", Elsevier Publications, 2018
3	Gary Walsh, "Biopharmaceuticals: Biochemistry and Biotechnology", Second edition, Wiley, 2013
4	Kenneth E. Acis, Vincent L. Wu, "Biotechnology and Biopharmaceutical Manufacturing, Processing and Preservation", Drug Manufacturing Technology series-Vol.2, CRC Press, 2020

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2		3		3	3	2	2	3	**3**	**3**
CO2	3	3	2	2	2	2	3	3	2	2	2	3	**3**	**3**
CO3	3	2	3	2	2	3		2	3	2		3	**3**	**3**
CO4	3	3	2	2			3	3	2		2	3	**3**	**3**
CO5	3	2	3	2		3		3	2	2		3	**3**	**3**

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Chairman - BOS
BOS Chairman

K.S.Rangasamy College of Technology – Autonomous R 2018								
50 BT 602 - Molecular Modelling and Drug Designing								
B. Tech. Biotechnology								
Semester	**Hours / Week**			**Total Hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VI	3	0	0	45	3	40	60	100

Objective(s)	• To understand the molecular behaviour of proteins, nucleic acids and small molecules in the biological system. • To understand the drug stereochemistry drug design and molecular modeling in drug design. • To learn the different force field methods and analysing the dynamics and stable conformation of molecules. • To comprehend the knowledge on the basic concepts of QSAR and expound the details on the structure based de novo ligand design. • To apply the modelling skills to understand the analog and structure based drug design concepts for synthesizing new potent drugs.
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe the basic concepts of coordinate systems and the components needed for molecular and quantum mechanics. CO2: determine the features of force field calculations with their basic laws on the behaviour of bonded and non-bonded interactions. CO3: understand the different models of molecular dynamics and the simulation process under constant temperature and pressure. CO4: analyze the methods concerned in docking studies and the principle involved in ligand designing . CO5: identify the methods and principle of QSAR and descriptors used for pharmacophore Mapping .methods and principle of QSAR and descriptors used for pharmacophore mapping.

Note: The hours given against each topic are of indicative. The faculty has the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shallnot depend on the numbers hours indicated.

CONCEPTS IN MOLECULAR MODELLING

Introduction, Coordinate System, potential energy surfaces, Introduction of molecular mechanics and quantum mechanics, Schrodinger wave equation - Born-Oppenheimer approximation, Components of Molecular Graphics hardware and software; Mathematical concepts.[9]

MOLECULAR MECHANICS AND ENERGY MINIMIZATION

Features of molecular mechanics, force fields; Bond structure and bending angles — electrostatic, Vander Waals and non- bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Calculating thermodynamic properties using force field; Transferability of force field parameters, treatment of delocaliised pi system; Force field for metals and inorganic systems – Application of energy minimization. [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 and Monte Carlo Simulation. [9]

MOLECULAR MODELING IN DRUG DESIGN

Membrane Proteins, Deriving and using 3D pharmacophore; Molecular Docking; Structure-based methods to identify lead compounds, de novo ligand design; Mechanism – drug and target; Applications of 3D Database Searching and Docking, and Virtual Screening. [9]

STRUCTURE ACTIVITY RELATIONSHIP

QSARs and QSPRs, QSAR Methodology, QSAR Models, Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors and ADME Modeling. [9]

Total Hours :45 hours

Text book(s):

1	Andrew R. Leach “Molecular Modelling – Principles and Applications”; Second Edition, Pearson Education Ltd., UK,2010.
2	Hans Pieter Heltje and GerdFolkens, Molecular Modelling, VCH, 2001.

Reference(s):

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1	Fenniri, H., “Combinatorial Chemistry – A practical approach”, Oxford University Press, UK, 2000.
2	Swatz, M.E., “Analytical techniques in Combinatorial Chemistry”, Marcel Dekker Publishers, New Delhi, India, 2000.
3	Vinter, J.G. and Mark Gardner, “Molecular Modelling and Drug Design”, Springer, Palgrave, London, 1994
4	Anand Solomon K., “Molecular Modelling and Drug Design”, MJP Publishers, 2015.

Mapping of COs with POs and PSOs

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

K.S. Rangasamy College of Technology – Autonomous R 2018

50 BT 603 - Chemical Reaction Engineering

B. Tech. Biotechnology

Semester	Hours / Week			Total Hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	1	0	60	4	40	60	100

Objective(s)

- To learn chemical kinetics for different reactions
- To impart knowledge on design of single and multiple reactors
- To acquire knowledge to analyze non-ideal reactors
- To understand catalysis and multiphase reactor systems
- To apply reaction engineering concepts in various biochemical reaction systems

Course Outcomes

At the end of the course, the students will be able to

CO1: develop rate equation and to know concentration and temperature dependence of rate equation

CO2: design single and multiple reactors and understand performance analysis of reactors.

CO3: identify the basics aspects, models and performance of non-ideal reactors.

CO4: demonstrate the mechanism of catalytic reactions and design of multiphase reactors

CO5: apply various modes of fermentors in microbial and enzyme fermentation.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING

Broad outline of chemical kinetics; rate equation; concentration and temperature dependence of rate equation; development of rate equation for Irreversible unimolecular first- order reactions, Irreversible bi-molecular second -order reactions; Zero order reactions; autocatalytic reactions. [9]

IDEAL REACTORS

Design of ideal reactors - performance equation of batch reactor, semi batch reactor, mixed flow reactor, plug flow reactor, recycle reactor; Performance comparison of single reactors; Multiple-reactor systems. [10]

NON-IDEAL FLOW

Basic aspects of non-ideal flow, Residence time distribution; C, E and F curves; Reactor performance with non-ideal flow; Conversion in non-ideal flow reactors; Non- ideal flow models-Tank in series Model, Dispersion Model; Mean concentration and conversion in non-ideal reactors. Case studies. [9]

HETEROGENEOUS CATALYSIS

Catalytic reactions-mechanism, surface reaction rate, film diffusion resistance, thiele modulus, effectiveness factor, pore diffusion resistance combined with surface kinetics, performance equation of porous catalytic reactors; experimental methods of finding rates, heat effects; Multiphase reactors: design of fluidized bed, slurry reactor and trickle bed reactor. [9]

BIOCHEMICAL REACTION SYSTEMS

General reaction kinetics for biological systems; Enzyme fermentation- batch, plug flow and mixed flow fermentors; Microbial fermentation- batch, plug flow and mixed flow fermentors. Case studies. [8]

Total Hours: 45 + 15(Tutorial) : 60 hours

Text book(s):

1 Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition. John Wiley and Sons, 1999.

2 Fogler, H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall Inc, 2005.

Reference(s):

1 Gavhane, K.A., "Chemical Reaction Engineering", Vol I &Vol II, NiraliPrakashan, 2011.

2 Hayes, R.E., Mmbaga, J.P., "Introduction to Chemical Reactor Analysis", 2nd Edition, CRC Press, 2013.

3 Dawande, S.D., "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.

4 Martin Schmal, "Chemical Reaction Engineering: Essentials, Exercises and Examples", CRC Press, Taylor & FrancisGroup, 2014

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	2	3				2	3	**3**	**3**
CO2	3	2	3	2	3	2	3	3			2	3	**3**	**2**
CO3	3	2	3	2	3		3		3	3	3	3	**3**	**2**
CO4	3	2	3	2	2	2	3	2				3	**2**	**3**
CO5	3	2	3	2	3		2		2	2	3	3	**2**	**3**

K. S. Rangasamy College of Technology – Autonomous R2018

50 BT 6P1 - Bioinformatics and Molecular Modelling Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
VI	0	0	4	60	2	60	40	100

Objective(s)

- To learn about the bioinformatics databases, databanks and data format data retrieval from the online sources.
- To make students understand the essential features of the interdisciplinary field of science for better understanding biological data.
- To apply the modelling skills to understand the analogy and structure based drug design concepts for synthesizing new potent drugs.
- To understand the retrieval of chemical information form PUBCHEM and Ligand data bases using data mining
- To probe the interaction of the proteins with ligands and predict the orientation of the molecule bound with each other

Course Outcomes

At the end of the course, the students will be able to

CO1: annotate the various biological data from different biological database and basic Linux commands.

CO2: analyze the arrangement of sequences like Genome, DNA, RNA or protein and to probe the regions of similarity and identity among them.

CO3: evaluate the evolutionary relationships among the organisms through phylogentic tools and Configure the structural conformations of proteins

CO4: elucidate the 3D structure of the target protein from its amino acid sequence and perform Molecular dynamic on the target protein using GROMACS.

CO5: read, analyze and visualize genomic, proteomic and microarray data using MATLAB®

LIST OF EXPERIMENTS

Any ten Experiments

1. Basic Linux commands , Retrieval of biological sequences: Protein and Nucleotide from database and 3-Dstructure of Proteins- viewing and analysis
2. Data Base Searching Tools – BLAST and FASTA
3. Sequence Alignment
   a. Pairwise alignment – Global and Local
   b. Multiple Sequence Alignment – ClustalX
   c. Whole Genome Alignment
4. Phylogenetic Analysis – Phy lip.
5. Structure Visualization Tool
6. Homology Modelling – Modeller 9v7
7. 2D Structure Drawing Tools and Lead Optimization Studies
8. Molecular Dynamics Simulation of target protein using GROMACS
9. Molecular Docking – Argus lab
10. MATLAB® - Bioinformatics Tool box, Computational biology tool box
11. Perform PERL script to translate the given DNA sequence to protein sequence
12. Perform a PERL script to Retrieve a sequence file and search for a given pattern.
13. Gene Prediction using GENSCAN and RNA structure prediction using IPknot.
14. Primer Designing tools – Primer3 4.0.
15. Microarray data import from GEO and Affymetrix and expression analysis and normalization using MATLAB®

Total Hours : 60 hours

References :

1	Shui Qing Ye. "Bioinformatics: A practical approach" Edited by Chapman and Hall/ CRC. 1st Edition, Tylor &Francis 2019
2	Bioinformatics: A practical guide to the analysis of genes & proteins, Edited by Baxevanis & Outlette,3rdedition, John Wiley & Sons, inc. publication, 2004.
3	Molecular Modelling for Beginners, Alan Hinchliffe, 2nd Edition, John Wiley & Sons, inc. publication 2008.

Mapping of COs with POs and PSOs

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Chairman - BOS

BOS Chairman

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2		3	2		2	2	2	3	2	**3**	2
CO2	2	2	3	2	3	2		2	2	3	2	3	**3**	2
CO3	3	3	3	2	3	2	3		3	3	3	2	**3**	2
CO4	3	2	2	2	3	2		2	2	3	2	3	**3**	2
CO5	3	2		2	2	2	3	2	2	2	2	3	**3**	2

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 6P2 - Chemical Engineering Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
VI	0	0	4	60	2	60	40	100

Objective(s)

- To understand the kinetic analysis of various mode of reactors.
- To analyze non-ideality in real reactors.
- To study the principles of fluid flow and flow measuring devices
- To learn the operation of size reduction equipment.
- To know the principles of heat and mass transfer operations.

Course Outcomes

At the end of the course, the students will be able to

CO1: demonstrate kinetic studies and performance analysis of various reactors

CO2: interpret non-ideal flow and residence time distribution in real reactors

CO3: operate fluid flow operations and flow measuring devices.

CO4: characterize mean particle size by size reduction and size separation operations.

CO5: illustrate heat and mass transfer operations and estimation of heat and mass transfer co-efficients

LIST OF EXPERIMENTS

Any ten Experiments

1. Kinetic studies in batch reactor
2. Kinetic studies in semi batch reactor
3. Performance characteristics of flow reactors
4. Residence time distribution studies in flow reactors
5. Determination of co-efficient of discharge in Orifice meter and Venturi meter
6. Studies on Flow through Packed Column
7. Determination of minimum fluidization velocity
8. Friction factor studies in straight pipes
9. Size reduction and size separation by crushing and sieve analysis
10. Studies on filtration
11. Studies on diffusivity measurement
12. Analysis of Liquid-Liquid extraction
13. Studies on adsorption equilibrium
14. Simple distillation
15. Heat transfer studies

Total Hours : 60 hours

References :

1	Levenspiel, O., “Chemical Reaction Engineering”, 3rd Edition. John Wiley and Sons, 1999.
2	McCabe, W.L., Smith J.L., and Harriott, P. “Unit Operations of Chemical Engineering”, 7th Edition, McGraw Hill, 2005.
3	Geankoplis, C.J. “Transport Processes and Unit Operations”, Third edition, Prentice Hall Inc, 1993.

Chairman - BOS

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BOS Chairman

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	2			3	3	**3**	**2**
CO2	3	2	2	2	2		2			3		3	**2**	**3**
CO3	3	2	2	2	3	2	2	2			2	3	**2**	**3**
CO4	3	2	2	2	3		2		3			3	**3**	**2**
CO5	3	2	2	2	3	2	2		2		3	3	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 TP 0P4 - CAREER COMPETENCY DEVELOPMENT IV

COMMON TO ALL BRNACHES

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	**0**	**0**	**2**	**30**	**0**	**100**	**0**	**100**

Objective(s)

- To help the learners to enrich the advanced written and oral communication skills in the academic and professional contexts
- To help the learners to augment their advanced verbal and logical reasoning ability to meet out the employability requirements of the companies
- To help the learners to comprehend the advanced level of aptitude skills in the concepts of Geometry
- To help the learners to enhance the data interpretation and analytical skills in varied methods.
- To help the learners to enrich the technical and programming skills to be focused on better employability, codeathons and hackathons

Course Outcomes

CO1: Examine and correlate the written and oral communication skills in the academic and professional contexts
CO2: Predict and discriminate advanced verbal and logical reasoning ability to meet out the employability requirements of the companies .
CO3: Infer the concepts of advanced level of aptitude skills on Geometry pertaining to competitive exams and company recruitments.
CO4: Illustrate the data interpretation and analytical skills in varied methods.
CO5: Formulate the technical and programming skills to be focused on better employability, codeathons and hackathons

Note:

- Instructor can cover the syllabus by class room activities and assignments (5A assisgments/week)
- instructor manual has class work questions, assisgment questions and rough work pages.
- Each assisgnment has 20 questions from unit 1,2,3,4 and5 and 5Questions from unit 1(oral communication) & unit 5(programms)
- evaluation has to be conducted as lie lab examination

Written and Oral Communication– Part2

Self-Introduction–GD–Personal Interview Skills

Practices on Reading Comprehension Level 2 – Paragraph Writing – Newspaper and Book Review Writing – Skimming and Scanning–Interpretation of Pictorial Representations– Sentence Completion-Sentence Correction– Jumbled Sentences– Synonyms & Antonyms–Using the Same Word as Different Parts of Speech –Editing.

Materials: Instructor Manual ,Word power Made EasyBook, NewsPapers [4]

Verbal & Logical Reasoning –Part2

Total Hours : 30 hours

Evaluation Criteria

S.No.	Particular	Test Portion	Mark s
1	Evaluation1WrittenTest	15Questions eachfrom Unit1,2,3,4&5(ExternalEvaluation)	50
2	Evaluation2– OralCommunication	GDandHRInterview (ExternalEvaluationbyEnglish,MBADept.)	30
	Evaluation 3 — TechnicalInterview	InternalEvaluationbytheDept.–3CoreSubjects	

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Chairman - BOS

BOS Chairman

3			20
		Total	**100**

Reference(s) books:	
1	Aggarwal,R.S."A Modern Approach to Verbal and Non-verbal Reasoning",Revised Edition 2008, Reprint 2009,S. Chand & Co Ltd., NewDelhi.
2	Abhijit Guha,"QuantitativeAptitude",TMH, 3rd edition
3	Objecti veInstant Arithmetic by M.B.Lal & Goswami Upkar Publications
4	Word Power Made Easy by Norman Lewis W.R.GOYAL Publications

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 HS 001 - Engineering Economics and Financial Accounting

Common to All Branches

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)

- TomaketheEngineeringstudenttoknowaboutthebasicofeconomics&howtoorganizea business
- To know the financial aspects related to business.
- To know about functions of banks.
- To understand the different methods of appraisal of projects
- To know about the pricing & capital techniques

Course Outcomes

At the end of the course, the students will be able to

CO1: know the suitable demand forecasting techniques and prevailing market structure.

CO2: recognize the importance of forms of business and differentiate between proprietorship and partnership

CO3:apprehend the kinds of banks and illustrate the Balance sheet with suitable example

CO4: interpret fixed cost and variable cost and realize the process of technical feasibility and economic feasibility.

CO5: know about break even analysis and summarize & apply the managerial uses of breakeven analysis

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Basic Economics

Definition of economics – nature and scope of economics – basic concepts of economics – factors of production – demand analysis – definition of demand – Law of demand – Exception to law of demand – Factors affecting demand – elasticity of demand – demand forecasting – definition of supply – factors affecting supply – elasticity of supply – market structure –perfect competition – imperfect competition - monopoly – duopoly – oligopoly and bilateral monopoly. [9]

Organization and Business Financing

Forms of business – proprietorship – partnership - joint stock company - cooperative organization - state Enterprise - mixed economy - Money and banking – kinds of banking - commercial banks - central banking functions - control of credit – monetary policy - credit instrument – Types of financing - Short term borrowing - Long term borrowing - Internal generation of funds - External commercial borrowings -

Assistance from government budgeting support and international finance corporations. [9]

Financial Accounting and Capital Budgeting

The balance Sheet and related concepts – The profit and loss statement and related concepts – Financial ratio analysis –Cash flow analysis – fund flow analysis – Capital budgeting– Average rate of return – Payback period – Net present value and internal rate of return. [9]

Cost Analysis

Types of costing – traditional costing approach - activity based costing - Fixed Cost – variable cost – marginal cost – cost output relationship in the short run and in long run – pricing practice – full cost pricing – marginal cost pricing – going rate pricing – bid pricing – pricing for a rate of return – appraising project profitability - cost benefit analysis – feasibility reports – appraisal process – technical feasibility - economic feasibility – financial feasibility. [9]

Break Even Analysis

Basic assumptions – break even chart – managerial uses of breakeven analysis - applications of breakeven analysis in engineering projects. **[9]**

Total Hours: 45 hours

Text books:

1. Khan, M Y, Jain, 'Basic Financial Management ', 3rd Edition, McGraw Hill Education, 2017.
2. Maheshwari K. L., Varshney R.L., 'Managerial economics',2nd Edition, S Chand and Co., New Delhi, ,2014.

Reference(s):

1. Samuelson P.A, 'Economics - An Introductory', New Age Publications, New Delhi, 2009.
2. Barthwal R.R., 'Industrial Economics - An Introductory', New Age Publications, New Delhi, 2010.
3. Bhattacharyya, S.K., John Deardon and Y.K.Koppikar, Accounting for Management Text and Cases.
4. Mote,Samuel V.L.and G.S.Gupta, 'Managerial Economics - Concepts and Cases', Tata McGraw Hill, 2011.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	3		3		2		2	3	**2**	**3**
CO2	3	2	3	3	2		2		3	2	3	3	**2**	**3**
CO3	2	3		3	3		2		3		2	3	**2**	**3**
CO4	3	3		3	3	2			3		2	3	**3**	**3**
CO5	2	3	2	3	3		2			3	2	3	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 701 - Immunology

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)

- To learn the basic concepts of immune response towards various antigens in mammalian host system
- To impart the knowledge of various cells involved in immunity
- To study the mechanism and reactions of immunity towards infectious diseases
- To understand the interaction of immune cells during transplantation procedures
- To emphasize their significance in developing therapeutic modalities for immunological disorders of human beings.

Course Outcomes

At the end of the course, the students will be able to

CO1: interpret the features of cells, tissues, organs of immune system and nature ofantigens

CO2: analyze the developmental behavior of B cells and features of antigen and antibody interaction

CO3: explore various stages in development of T cells and biology of antigen processing and presentation.

CO4: identify the immune response against infectious diseases and immune deficiency diseases

CO5: justify the mechanism of transplant acceptance, rejection and functions of tumor antigens

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

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Immune System

An overview of the immunology- Classification of the immune response; clonal selection theory. Cells and tissues of the immune system. Haematopoiesis: Origin and differentiation of Lymphocytes and phagocytic cells. Primary and secondary lymphoid organs. Immunogens and antigens- haptens, adjuvants. [9]

Humoral Immunity

Development, maturation, activation and differentiation of B-lymphocytes; Antibody: structure, classes and subclasses; antibody diversity- Antigen and antibody interaction. Complement pathways — Classical and alternate complement pathway; Hybridoma technology for production of monoclonal antibody and applications. [9]

Cellular Immunity

Thymus derived (T) Lymphocytes: Classification and stages of development- T cell receptor - Major histocompatibility complex –structure, classification and genetic organization of MHC; mechanism of phagocytosis - the cell biology of antigen processing and presentation. [9]

Immunity To Infections and Hypersensivity Reactions

Injury and inflammation; immune responses to infections: immunity to viruses, bacteria, fungi and parasites; cytokines; immunosuppression, tolerance; allergy and hypersensitivity; AIDS and other Immuno deficiencies; Immunization; Vaccines. [9]

Transplantation, Autoimmunity and Immunology of Tumors

Transplantation: types, immunological mechanisms of graft rejection- immunological strategies to prevent graft rejection- roleof immune suppressive drugs. Autoimmunity: Mechanism – autoimmune diseases. Tumors: Immune response to tumors- typeof tumor antigens. [9]

Total Hours: 45 hours

Text books:

1. Owen, J., Punt, J and Strandford, S. "Kuby Immunology", 7th Ed., W. H. Freeman Publication, New York, USA, 2012.
2. Talwar, G. P. and Gupta, S. K. A., "Handbook of Practical and Immunology" CBS Publishers &Distributors, New Delhi, 2004.

Reference(s):

1. Abbas, K. A., Litchman, A. H. and Pober, J. S. "Cellular and Molecular Immunology", 4th Ed., W. B. Saunders Co.,Pennsylvania, USA, 2005.
2. Roitt, I., Brostoff, J. and David, M. "Immunology", 6th Ed., Mosby publishers Ltd., New York, USA, 2001.
3. Tizard, R.I. "Immunology", 4 th Ed., Saunders college publishing, Chennai Microprint Pvt. Ltd., Chennai, 2004.
4. Ravi, M. And Paul, S.F.D., "A practical manual for basic immune techniques", Samanthi Publications Pvt. Ltd, Chennai, 2008

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	2	3	2	2	2	**3**	**3**
CO2	3	2	3	2	2	2	2	2	3	2	3	2	**3**	**3**
CO3	2	2	2	2	2	3	3	2	2	3	2	2	**3**	**3**
CO4	3	2	3	3	2	2	2	2	2	2	3	2	**3**	**3**
CO5	2	2	3	2	2	3	2	2	2	2	3	2	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT 702 – Downstream Processing

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	1	0	60	4	40	60	100

Objective(s)

- To learn various unit operations and their applications in downstream processing of bioproducts.
- To emphasis the need for separation techniques in downstream processing
- To acquire knowledge in recovery, purification and formulation of bioproducts of commercial interest.
- To provide knowledge on downstream processing economics
- To introduce sequential stages of downstream processing

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Course Outcomes	**At the end of the course, the students will be able to** CO1: review cost cutting strategies and bioproduct release kinetics CO2: interpret the design and principle of filtration and centrifugation CO3: identify suitable unit operation for product recovery and concentration CO4: demonstrate the principles and operation of chromatographic techniques CO5: discuss the operational requirements of industrial crystallizers and lyophilizer

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to downstream and intracellular product release

Introduction to downstream processing - characteristics of biomolecules - economics of downstream processing - cost cutting strategy - physico chemical basis of bioseparation - location of products and product release kinetics - cell disruption methods: mechanical, chemical and enzymatic process; pretreatment and stabilization of bioproducts. [8]

Primary separation and isolation

Principle of batch filtration - pretreatment of fermentation broth, design of industrial filters: plate and frame filter press, leaf filter, continuous filtration: rotary drum filter - calculations in batch and continuous filtration - centrifugation: principle, design and types of industrial centrifuges - scale up of centrifugation – Calculations in settling velocity, sigma factor and number of discs in centrifugation. [9]

Product recovery and concentration

Adsorption: Isotherms, batch, continuous operations- problems in adsorption isotherms and break point time in fixed bed adsorption - principle of cloud point, aqueous two phase and supercritical fluid extraction - membrane separation processes: microfiltration, ultrafiltration, reverse osmosis and dialysis, precipitation of proteins by different methods. [10]

Product purification by chromatography

Principle and practice, ion exchange, size exclusion, bioaffinity, hydrophobic interaction, reverse phase, pseudo affinity chromatography, high performance liquid chromatography, flash chromatography and gas chromatographic techniques. [9]

Final product purification and polishing

Crystallization: nucleation, crystal growth, crystal size distribution, kinetics of crystallization, population density, industrial crystallizers, recrystallization; drying - drying terminologies, drying curve, industrial dryers, freeze drying principles and applications. Case studies.[8]

Total Hours: 45 + 15(Tutorial) : 60 hours

Text books:

1. Belter P. A., Cussler E.L. and Wei-Houhu, “Bioseparations - Downstream Processing For Biotechnology”, Wiley IntersciencePub.,
2. Sivasankar B., “Bioseparations - Principles and Techniques”, Prentice Hall of India Private Limited, New Delhi, 2006.

Reference(s):

1. Nooralabettu Krishna Prasad, “Downstream Process Technology - A New Horizon In Biotechnology”, PHI Learning PrivateLimited, New Delhi, 2012.
2. Roger.G, Harrison, Paul Todd, Scott R.Rudge and Demetri P.Petrides, “Bioseperation Science and Engineering” OxfordUniversity Press, Newyork , 2003.
3. R.O. Jenkins, (Ed.), Product Recovery in Bioprocess Technology – Biotechnology, Open Learning Series,Butterworth- Heinemann, 1992.
4. Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). Bioseparations Science and Engineering. 2nd Edition. Oxford University Press.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3		2	3			2		3	3	**3**	**3**	3
CO2	3	3	3		2		3	2		2	2	3	**3**	**3**	3
CO3	3	3	2	3	2			3			2	2	**3**	**2**	3
CO4	3	3	2	2			2		3		2	3	**2**	3	3
CO5	3	3	2	2	2	2			2	2		3	**3**	**3**	3

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K.S.Rangasamy College of Technology – Autonomous R2018								
50 AC 001 - Research Skill Development - I								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	1	0	0	10	0	100	-	100

Objective(s)	• To learn about the effective usage of power point presentation • To prepare presentation with various effects • To visualize the data in the presentation • To acquire knowledge about data sources • To investigate the research articles based on various applications
Course Outcomes	**At the end of the course, the students will be able to** CO1: Develop presentation with visual effects CO2: Prepare a presentation with supporting data CO3: Attain the importance of research and data collection CO4: Analyze the various sources of research articles CO5: Interpret the tools and methods in preparing manuscript

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Preparing a Presentation

Presenting data using Power Point- Power Point preparation and presentation, Design principles for creating effectivePower Point slides with visuals displaying data. - Profile, - Problem, and a set of basic Excel charts, use to create a presentation. [3]

Creating effective slides using PowerPoint

Create effective slides using PowerPoint. Tools within Power Point, structure story line, create story boards, identify primary elements of slide design, display data and finalize slide presentation. [2]

Research Designs and Data Sources

Overview of the topics: process of data collection and analysis. Starting with a research question - Review of existingdata sources-Survey data collection techniques- Importance of data collection- Basic features affect data analysis when dealing with sample data. Issues of data access and resources for access. [3]

Measurements and Analysis Plan

Importance of well-specified research question and analysis plan: various data collection strategies - Variety ofavailable modes for data collection – review of literature - Tools at hand for simple analysis and interpretation. [2]

Total Hours: 10 hours

Text books:

1. Judy Jones Tisdale. Effective Business Presentations. Gulf Coast Books LLC. ISBN-13: 978-0130977359,2004
2. Frauke Kreuter. Framework for Data Collection and Analysis,2018. https://www.coursera.org/learn/data- collection-framework

Reference(s):

1. Kothari, C.R. andGaurav Garg, “Research Methodology: Methods and Techniques”, New Age InternationalPublishers, 2013
2. Srivastava, T.N. and Rego, S., "Business Research Methodology", Tata McGrawHill Education Pvt. Ltd., Delhi,2019.

Mapping of COs with POs and PSOs

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

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K.S.Rangasamy College of Technology – Autonomous R2018								
50 GE 001 – National Cadet Corps- Air wing								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	2	60	4	50	50	100

Objective(s)	• Develop character , camaraderie, • Inculcate discipline, secular outlook • Enrich the spirit of adventure, sportsman spirit • Ideals of selfless service amongst cadets by working in teams • Improve qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets
Course Outcomes	**At the end of the course, the students will be able to** CO1: Display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion. CO2: Demonstrate the sense of discipline with smartness and have basic knowledge of weapons and their use and handling CO3: Illustrate various forces and moments acting on aircraft CO4: Outline the concepts of aircraft engine and rocket propulsion CO5: Design, build and fly chuck gliders/model airplanes and display static models

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

NCC Organization & National Integration **[9]**

NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt. History and Organization of IAF-Indo-Pak War-1971-Operation Safed Sagar. National Integration- Unityin diversity- contribution of youth in nation building- national integration council- Images and Sloganson National Integration.

Drill & WeaponTraining **[9]**

Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION). Main Parts of a Rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing (WITH PRACTICE SESSION)

Principles of Flight **[9]**

Laws of motion-Forces acting on aircraft–Bernoulli's theorem-Stalling-Primary control surfaces – secondary control surfaces-Aircraft recognition.

Aero Engines **[9]**

Introduction of Aero engine-Types of engine-piston engine-jet engines-Turboprop engines-Basic Flight Instruments- Modern trends.

Aero Modeling **[9]**

History of aero modeling-Materials used in Aero-modeling-Types of Aero-models – Static Models-Gliders-Control line models- Radio Control Models-Building and Flying of Aero-models.

Total Hours: 45 hours

Text books:

1. "National Cadet Corps- A Concise handbook of NCC Cadets" by Ramesh Publishing House, New Delhi,2014.
2. **"NCC OTA Precise" by DGNCC, New Delhi,2014**

Reference(s):

1. "Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi,2019
2. "Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi,2017

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Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 GE 002 – National Cadet Corps (Army Wing)

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
IV	3	0	2	60	4	50	50	100

Objective(s)

- Develop character , camaraderie,
- Inculcate discipline, secular outlook
- Enrich the spirit of adventure, sportsman spirit
- Ideals of selfless service amongst cadets by working in teams
- Improve qualities such as self-discipline, self-confidence, self-reliance and dignity of labour in the cadets.

Course Outcomes

At the end of the course, the students will be able to

CO1: Display sense of patriotism, secular values and shall be transformed into motivated youth who will carry out nation building through national unity and social cohesion.

CO2: Demonstrate Health Exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders.

CO3: Basic knowledge of weapons and their use and handling.

CO4: Aware about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils

CO5: Acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

NCC Organization & National Integration **[9]**

NCC Organization – History of NCC- NCC Organization- NCC Training- NCC Uniform – Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honors' and Awards – Incentives for NCC cadets by central and state govt.

National Integration - Unity in diversity- contribution of youth in nation building- national integration council- Images andSlogans on National Integration. **[9]**

Basic Physical Training & Drill

Basic physical Training – various exercises for fitness(with Demonstration)-Food – Hygiene and Cleaniness .Drill- Words of commands- position and commands- sizing and forming- saluting- marching- turning on the march and wheeling- saluting on the march- side pace, pace forward and to the rear- marking time- Drill with arms- ceremonial drill- guard mounting.(WITH DEMONSTRATION) **[9]**

Weapon Training

Main Parts of a Rifle- Characteristics of .303 rifle- Characteristics of .22 rifle- loading and unloading – position and holding- safety precautions – range procedure- MPI and Elevation- Group and Snap shooting- Long/Short range firing(WITH PRACTICE SESSION) - Characteristics of 5.56mm rifle- Characteristics of 7.62mm SLR- LMG- carbine machine gun – pistol. **[9]**

Social Awareness and Community Development

Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY- JGSY- NSAP-PMGSY- Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility

Specialized Subject (ARMY)

Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews. **[9]**

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	Total Hours: 45 hours
Text books:	
1.	National Cadet Corps- A Concise handbook of NCC Cadets by Ramesh Publishing House, New Delhi, 2014
2.	**Cadets Handbook- Specialized Subjects SD/SW published by DG NCC, New Delhi ,2014**
Reference(s):	
1.	"Cadets Handbook – Common Subjects SD/SW" by DG NCC, New Delhi,2019
2.	"Cadets Handbook – Specialised Subjects SD/SW" by DG NCC, New Delhi,2017

Mapping of COs with POs and PSOs

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

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50 BT 7P1 –Immunology Laboratory								
B.Tech. Biotechnology								
Semester	**Hours/week**			Total Hours	**Credit**	**Maximum marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VII	0	0	4	60	2	60	40	100

Objective(s)	• To learn the basics of blood grouping antigens and its relation • To know the components present in of blood and its separation • To identify and understand the concept of various immune cells present in blood • To learn the significance of immune diffusion technique • To understand the concepts of specific antigen and antibody reaction in identifying diseases
Course Outcomes	**At the end of the course, the students will be able to** CO1: examine different blood groups, cells in human beings. CO2: perform the different types of blood cells and know about their functions. CO3: elucidate the presence of antigen and antibody in sample and its related functions based on immune diffusion technique CO4: perform the identification methodology for typhoid and syphilis infections. CO5: elucidate the binding of antigen and antibodies and their interaction through ELISA technique.

LIST OF EXPERIMENTS

Any ten Experiments

1. Immunology laboratory Safety and role of equipment's.
2. Blood collection, identification of blood grouping and Rh typing.
3. Separation of Serum and plasma from whole blood.
4. Preparation of blood smear and identification of blood cells.
5. Determination of haemoglobin.
6. Ouchterlony double immune diffusion (ODID) test.
7. Immunoelectrophoresis.
8. Radial immuno diffusion.
9. Rapid Plasma Reagin (RPR) test.
10. WIDAL - slide and tube agglutination test.
11. ELISA – Sandwich.
12. Separation of Peripheral Blood Mononuclear Cells and Trypan Blue Assay for Live Cell
13. Coombs test.
14. Identification of HCG hormone - Pregnancy test.
15. Identification of T cells.

Total Hours : 60 hours

References :

1	Talwar, G. P. and Gupta, S. K. A., "Handbook of Practical and Immunology" CBS Publishers & Distributors, New Delhi, 2004.
2	Ravi, M. And Paul, S.F.D., "A practical manual for basic immune techniques", Samanthi Publications Pvt. Ltd, Chennai, 2008

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3		2		2	2	2	3	2	**3**
CO2	2	3		3	3	3		3			2	3	2	**3**
CO3	2	3	3	3	3		2			2	2	3	2	**3**
CO4	3		3	3	2		3	3		2	3	3	**3**	**3**
CO5	2	3	3	3	3		2			3	2	3	**3**	**3**

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50 BT 7P2 – Downstream Processing Laboratory

B.Tech. Biotechnology

Semester	Hours/week			Total Hours	Credit	Maximum marks		
	L	T	P		C	CA	ES	Total
VII	0	0	4	60	2	60	40	100

Objective(s)

- To acquire knowledge on purification strategies of bioproducts
- To design separation processes for the recovery and purification of bioproducts.
- To provide hands on knowledge on bioproduct concentration and recovery
- To understand the working principle of various unit operations involved in bioseparation
- To demonstrate sequence of downstream processing operations for bioproduct recovery

Course Outcomes

At the end of the course, the student can able to

CO1: determine cell disruption kinetics for intracellular release kinetics by ultrasonication and know the principle of solid-liquid separation techniques.

CO2: execute and verify the adsorption isotherms and understand leaching characteristics.

CO3: discuss the principle of ammonium sulphate, isoelectric and aqueous two-phase extraction methods for recovery.

CO4: analyze separation of biomolecules by chromatographic techniques.

CO5: demonstrate the operating procedure of freeze dryer and final purification strategies.

LIST OF EXPERIMENTS

Any Ten Experiments

1. Studies on cell disruption by ultrasonication
2. Design of thickener for batch sedimentation
3. Studies on filtration – Plate and frame filter press/Leaf filter
4. Solid-Liquid separation by centrifugation
5. Product recovery by Cross current leaching
6. Biosorption studies - Verification of Freundlich Isotherm
7. Liquid-liquid extraction - Ternary liquid equilibrium
8. Aqueous two-phase extraction of biomolecules
9. Enzyme purification by isoelectric precipitation and acetone precipitation
10. Studies on ammonium sulphate precipitation
11. Studies on product purification by column chromatography
12. Studies on crystallization of product
13. Product polishing by freeze drying
14. Studies on drying characteristics
15. Analysis of bioactive compounds using HPLC

Total Hours : 60 hours

References :

1	Roger.G . Harrison, Paul Todd, Scott R. Rudge and Demetri P.Petrides,"Bioseperation Science and Engineering", Oxford University Press, New York, 2003.
2	Desai, M. Downstream Processing of Proteins: Methods and Protocols, Humana Press, 2000.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2				2	2	3	3	**3**	**3**
CO2	3	3	3		2		3				2	3	**3**	**3**
CO3	3	3	2	3	2	2		3		2	2	2	**3**	**2**
CO4	3	3	2	2	2			3	2		2	3	**2**	**3**
CO5	3	3	2	2		2		2		2		3	**3**	**3**

K.S.Rangasamy College of Technology - Autonomous R2018								
50 BT 7P3 -Project Work - Phase I								
B.Tech. Biotechnology								
Semester	**Hours / Week**			**Total hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VII	**0**	**0**	**4**	**60**	**2**	**50**	**50**	**100**
Objective (s)	• To prepare the students to adapt to the research environment • To understand how projects are executed in a research laboratory • To learn practical aspects of research on their domain • To train students in the art of data interpretation • To practice the students to analyze the results and thesis writing							
Course Outcomes	**At the end of the course, the students will be able to** CO1: Identify the problem and select a topic of the research CO2: competence in research design and planning CO3: create, analyse and critically evaluate different technical solutions. CO4: interpret the obtained research data and conclude the experiment CO5: develop skills of project management, report writing, problem solving, communication and interpersonal.							

- Three reviews have to be conducted by the committee that constitutes minimum of three members oneof which should be guide.
- Research problem should be selected.
- Students have to collect and bound about 50 research papers related to their work.
- Objectives and title of the work has to be finalized at the end of the Project Work - Phase I.
- Preliminary Implementation can be done if possible.
- Report has to be prepared as per the format and submitted by the students
- Internal evaluation has to be done for 100 marks

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	3	2	3	3	2			3			3	**3**	**3**
CO2	3	3	3	3	3	2		2		2	2	3	**3**	**3**
CO3	3	3	2	3	3	2	3		2			3	**3**	**3**
CO4	3	3	2	3	2	2		3		2		3	**3**	**3**
CO5	2	3	2	3	2	2		3		3	3	3	**3**	**3**

K.S. Rangasamy College of Technology – Autonomous R 2018

50 TP 0P5 - Career Competency Development V

Common to all branch

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	**0**	**0**	**2**	30	2	100	00	100

Objective(s)

- To help the learners to practice the written and oral communication skills in the academic and professional contexts
- To help the learners to practice the verbal and logical reasoning ability to meet out the requirements of both competitive exams and companies
- To help the learners to practice effectively the aptitude modules for company based recruitments and competitive exams
- To help the learners to practice effectively the data interpretation and analysis modules for company based recruitments and competitive exams
- To help the learners to hone the technical and programming skills for better employability

Course Outcomes

At the end of the course, the student will be able to

CO 1: Reinforce the written and oral communication skills in the academic and professional contexts

CO 2: Discriminate and assess the verbal and logical reasoning ability to meet out the employability requirements of the companies

CO 3: Relate the aptitude modules for company based recruitments and competitive exams effectively

CO 4: Compare and illustrate the data interpretation and analysis modules effectively for company based recruitments and competitive exams

CO 5: Formulate and integrate the technical and programming skills to be focused on better employability and code contests

Written and Oral Communication

Self-Introduction–GD–HR Interview Skills–Corporate Profile Review- Practices on Company Based Questions and Competitive Exams

Materials: Instructor Manual [6]

Verbal & LogicalReasoning

Practices on Company Based Questions and Competitive Exams

Materials: Instructor Manual [6]

Quantitative Aptitude

Practices on Company Based Questions and Competitive Exams

Materials: Instructor Manual [6]

Data Interpretation and Analysis

Practices on Company Based Questions and Competitive Exams

Materials : Instructor Manual [6]

Programming &Technical Skills–Part3

Data Structure- Arrays–Linked List–Stack–Queues –Tree–Graph. Practices on Algorithms and Objective Type Questions.

Materials : Instructor Manual [6]

Total hours: 30 hours

Evaluation Criteria

S.NO				
1	Evaluation1 – Written Test	15Questions	eachfromUnit1,2,3,4&5(External	60

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		Evaluation)	
2	Evaluation2- Oral Communication	GD and HR Interview (External Evaluation by English, MBA Dept.)	20
3	Evaluation3– Technical Interview	Internal Evaluation by the Dept.–3 Core Subjects	20
		Total	100
Reference books:			
1	Aggarwal ,R.S."A Modern Approach to Verbal and Non- verbal Reasoning", Revised Edition 2008, Reprint 2009, S.Chand & CoLtd.,New Delhi.		
2	Abhijit Guha,"Quantitative Aptitude",TMH,3rd edition		
3	Objective Instant Arithmetic by M.B.Lal & Goswami Upkar Publications		
4	Word Power Made Easy by Norman Lewis W.R.GOYAL Publications		

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	1	1	2	3	2	3	1	1	1
CO2	2	1	2	2	1	2	1	1	2	3	3	3	2	2	2
CO3	2	1	2	2	1	1	1	1	2	3	2	3	2	2	2
CO4	2	2	2	2	2	1	1	1	2	3	3	3	2	2	2
CO5	2	2	2	2	2	2	2	2	2	3	2	3	3	3	2

K.S. Rangasamy College of Technology – Autonomous R 2018

50 TP OP6 – Internship

B.Tech. Biotechnology

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	0	0	0	0	1/2/3	100	00	100

Objective(s)

- To expose the students to understand the processes at industry and R&D
- To identify the existing and evolving problems at industry
- To solve the problems at industry and environment need
- To prepare the report of solved problems for further action
- To summarize the data in a presentation mode

Course Outcomes

At the end of the course, the students will be able to

CO1: Identify the root causes and problem solving process

CO2: design the experiment from literature survey

CO3: execute and trouble shoot through pilot study

CO4: interpret the raw and calculated data to conclude the problem

CO5: writing the reports and documenting the data for publication.

1) Students undergo internship during sixth semester summer vacation (minimum of two weeks)
2) Students should submit an internship / innovation project report along with observation note book in the beginning of seventh semester
3) The observation note book of the students after the training with their personal comments / suggestions and attested by the trainer at industry or R&D
4) A technical presentation to be done by the students to the committee, immediately after submission of the report at the beginning of seventh semester
5) A committee constitute a senior faculty, HoD and along with industry person

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2			3			3	3	3	3
CO2	3	3	3	3	3	2						3	3	3	3
CO3	3	3	2	3	3	2						3	3	2	3
CO4	3	3	2	3	2	2						3	3	2	3
CO5	2	3	2	3	2	2		3		3	3	3	3	2	2

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51 BT 801 – Bioethics and Biosafety

B.Tech. Biotechnology

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VIII	3	0	0	45	3	40	60	100

Objective(s)

- To learn about Intellectual Property and related Rights.
- To acquire knowledge on various conventions in protection of IP
- To provide knowledge on patent law and patent application process
- To learn various database for the search of patent
- To summarize the need for biosafety and their management

Course Outcomes

At the end of the course, the students will be able to

CO1: review the types of IPR and their importance
CO2: critique the different theories related to IPR.
CO3: formulate a patent according to the patent law and procedures for filing a patent
CO4: practice the database for searching the patents
CO5: investigate the role of GMOs and LMOs and their risk assessment and management

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide the number of hours for each unit depending upon the concepts and depth. Questions need not be asked based on the number of hours notified against each unit in the syllabus**.**

Introduction to Intellectual Property Rights

IPR: definition, role and importance - types of IPR: Patents, Trademarks, Trade secrets, Copyright and Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications - Protection of GMO's IPR in R&D. [8]

Theoriesand Conventions

Indian theory, Constitutional Protection of Property and IP - Western theory - Locke's Labour, Hegel's Personality and Marxian Theory - Berne Convention, Universal Copyright Convention, the Paris Convention, TRIPS, the WIPO and the UNESCO. [9]

Patent Filing

Patent Law - Rights under Patent Law and its Limitations - Patent Requirements - Ownership and Transfer – Patentable and Non patentable inventions - Patent Application Process and Granting of Patent - Patent Infringement and Litigation International Patent Law - Double Patenting, Patent Searching - Patent Cooperation Treaty - New developments in Patent Law. [10]

IPR Database

Patent database - National, International, Country-wise patent searches (USPTO, EPO), PATENT Scope (WIPO, IPO) - commercial and free patent databases - search tools and functions - database for trademark and industrial design -data security, confidentiality, privacy - International aspects of Computer and Online Crime. [9]

Biosafety

Introduction to Biological safety cabinets - primary containment for biohazards - biosafety levels - biosafety levels of specific microorganisms - biosafety guidelines - Government of India; definition of GMOs & LMOs - roles of Institutional Biosafety committee,GMO applications in food and agriculture - environmental release of GMOs - Risk analysis, risk assessment, risk management and communication. [8]

Total Hours : 45

Text book(s):

1 Gopalakrishnan N.S. and Ajitha T.G, "Principles of Intellectual Property", 2nd edition, Eastern Book Company,2014.

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2	BAREACT, Indian Patent Act, 1970, Acts and Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi, 2007.
Reference(s):	
1	Subbaram N.R. "Handbook of Indian Patent Law and Practice ", S.Viswanathan Printers and Publishers Pvt.Ltd., 1998.
2	Tzotzos, G.T., "Genetically modified organisms - A guide to Biosafety", CAB International, Walling ford, U.K.213p.1995
3	R.O. Jenkins, (Ed.), Product Recovery in Bioprocess Technology – Biotechnology, Open Learning Series, Butterworth-Heinemann, 1992.
4	Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). Handbook of Biosafety Science and Engineering. 2nd Edition. Oxford University Press.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**3**	**3**	2		**3**	**3**	**3**			**3**		**3**	**3**
CO2	**2**	**3**	**3**	2		**3**	**3**	**3**			**3**		**3**	**3**
CO3	**2**	**3**	**3**	3		**3**	**3**	**3**			**3**		**3**	**3**
CO4	**2**	**3**	**3**	3		**3**	**3**	**3**			**3**		**3**	**3**
CO5	**2**	**3**	**3**	3		**3**	**3**	**3**			**3**		**3**	**3**

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50 AC 002 - Research Skill Development II

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VIII	1	0	0	15	0	100	0	100

Objective(s)

- To identify the ethics in preparing research paper
- To organize manuscript for submission
- To attain knowledge for filing Patent
- To apply for copy right
- To develop and deploy Mobile App. in play store

Course Outcomes

At the end of the course, the students will be able to

CO1: prepare a manuscript for journal publication.
CO2: apply the manuscript for publication
CO3: interpret the process of obtaining copyright and patent
CO4:analyze the various provisions to share the application
CO5:create and publish the mobile application in the digital store

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide the number of hours for each unit depending upon the concepts and depth. Questions need not be asked based on thenumber of hours notified against each unit in the syllabus**.**

Preparation of Manuscript

Data necessary before writing a paper: the context in which the scientist is publishing. Learning and identification of research community - advantages of scientific journal publication and manuscript preparation - ethical values in publishing. [3]

Writing the paper

Writing research paper - structure of the paper - usage of bibliographical tools - abstract preparation and to do a peer review for the abstract of the others, as in real academic life. Plagiarism of the prepared manuscript.
[2]

Copyright

Copyright law in India-Meaning of copyright-Classes of works for copyright protection -Ownership of Copyright-Assignment of copyright- Intellectual Property Rights (IPR) of Computer Software-Copyright Infringements-Procedure for registration. [2]

Patents

Patent System In India -Types of Patent Applications-patentable invention - Not patentable-Appropriate office for filing

-Documents required Publication and Examination of Patent Applications -Grant of Patent-Infringement of Patents -E-filing of Patent applications. [3]

Deploying Mobile App. in play store Introduction to Application Stores – Play Store, AppStore, Microsoft Store, Creating App – Android, iOS, UWP, Defining Manifest, Certifying App, Create Store Listing, Sharing Screenshots, Sharing App Credentials for Testing. [5]	
Total Hours: 15	
Text Book(s):	
1.	Mathis Plapp. How to Write and Publish a Scientific Paper (Project-Centered Course). https://www.coursera.org /learn/how-to-write-a-scientific-paper# instructors
2.	Rajkumar S. Adukia ,Handbook On Intellectual Property Rights In India,2007
3	Dr. M. Kantha Babu ,"Text book on Intellectual Property Rights",2019.
Reference(s)	
1.	Kothari, C.R. andGaurav Garg, "Research Methodology: Methods and Techniques", New Age International Publishers, 2013
2.	Srivastava, T.N. and Rego, S., "Business Research Methodology", Tata McGrawHill Education Pvt. Ltd., Delhi, 2019.
3.	https://support.google.com/googleplay/android-developer/answer/9859152
4.	https://developer.apple.com/ios/submit/
5.	https://docs.microsoft.com/en-us/windows/uwp/publish/app-submissions

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**3**	**3**	**3**			**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**			**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**			**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**			**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**			**3**	**3**	**2**	**3**	**3**	**3**	**3**

K.S.Rangasamy College of Technology - Autonomous R 2018								
50 BT 8P1 -Project Work - Phase II								
B.Tech. Biotechnology								
Semester	**Hours / Week**			**Total hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VIII	0	0	16	240	8	50	50	100
Objective(s)	• To prepare the students to adapt to the research environment • To understand how projects are executed in a research laboratory • To learn practical aspects of research on their domain • To train students in the art of data interpretation • To practice the students to analyze the results and thesis writing							
Course Outcomes	**At the end of the course, the students will be able to** CO1: identify the problem and select a topic of their research CO2: competence in research design and planning CO3: create ,analyse and critically evaluate different technical solutions. CO4: interpret the obtained research data and conclude the experiment CO5: develop skills of project management, report writing, problem solving, communication and interpersonal.							

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- Three reviews have to be conducted by the committee that constitutes minimum of three members and oneamong them should be the guide.
- Each review has to be evaluated for 100 marks
- Attendance is compulsory for all reviews. If a student fails to attend the review with proper permission, onemore chances may be given.
- The student should publish the paper in the journals.
- Final review will be conducted by the committee that constitutes one external expert examiner (outside thecollege) along with an internal examiner.
- The report should be submitted as per the format by the students.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**

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50 TP 0P6 – Internship

B.Tech. Biotechnology

Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	0	0	0	45	1	100	-	100

Objective(s)

- To expose the students to understand the processes at industry and R&D
- To identify the existing and evolving problems at industry
- To solve the problems at industry and environment need
- To prepare the report of solved problems for further action
- To summarize the data in a presentation mode

Course Outcomes

At the end of the course, the students will be able to

CO1: Identify the root causes and problem solving process

CO2: design the experiment from literature survey

CO3: execute and trouble shoot through pilot study

CO4: interpret the raw and calculated data to conclude the problem

CO5: writing the reports and documenting the data for publication.

1. Students undergo internship during sixth semester summer vacation (minimum of two weeks)
2. Students should submit an internship / innovation project report along with observation note book in the beginning of seventh semester
3. The observation note book of the students after the training with their personal comments / suggestions and attested by the trainer at industry or R&D
4. A technical presentation to be done by the students to the committee, immediately after submission of the report at the beginning of seventh semester
5. A committee constitute a senior faculty, HoD and along with industry person

Chairman - BOS

BOS Chairman

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2			3			3	3	3	3
CO2	3	3	3	3	3	2						3	3	3	3
CO3	3	3	2	3	3	2						3	3	2	3
CO4	3	3	2	3	2	2						3	3	2	3
CO5	2	3	2	3	2	2		3		3	3	3	3	2	2

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Chairman - BOS

BOS Chairman

K.S. Rangasamy College of Technology

(Autonomous)

Curriculum & Syllabi
for Honours Degree

B.Tech., Biotechnology
Honours - Agriculture Biotechnology

R 2018

Courses Accredited by NBA, Accredited by NAAC A++,
Approved by AICTE, Affiliated to Anna University, Chennai.

KSR Kalvi Nagar, Tiruchengode – 637 215.

Namakkal District, Tamil Nadu, India.

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Chairman - BOS

BOS Chairman

DEPARTMENT OF MECHANICAL ENGINEERING

AGRICULTURE BIOTECHNOLOGY (HONOURS)

CURRICULUM & SYLLABI

S.No.	Course Code	Course	Category	L	T	P	C
1	50 BT H01	Agriculture Microbiology	PE	3	0	0	3
2	50 BT H02	Organic Farming for Sustainable Agriculture	PE	3	0	0	3
3	50 BT H03	Crop Production Technology	PE	3	0	0	3
4	50BT H04	Agri Business Management and EDP	PE	3	0	0	3
5	50 BT H05	Green house technology and protected cultivation	PE	3	0	0	3
6	50 BT H06	Farming System and Sustainable Agriculture	PE	3	0	0	3
		Total		18	0	0	18

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Chairman - BOS

BOS Chairman

B.Tech. Biotechnology								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100
Objective(s)	• To Understand the significance of microorganisms in agricultural systems. • To Comprehend the diversity and roles of microorganisms in soil ecosystems. • To Analyze the various interactions between microorganisms and plants. • To Evaluate the impact of microorganisms on crop health and disease management. • To Explore the applications of microorganisms in promoting sustainable agriculture practices.							
Course Outcomes	**At the end of the course, the student will be able to** CO1: Explain the historical context and importance of agriculture microbiology. CO2 Identify and describe key microbial processes in soil ecosystems. CO3: Analyse the mechanisms and benefits of plant-microbe interactions. CO4: Evaluate strategies for managing crop diseases using microbial agents. CO5: Propose microbial-based solutions for sustainable agricultural practices.							

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide the number of hours for each unit depending upon the concepts and depth. Questions need not be asked based on thenumber of hours notified against each unit in the syllabus**.**

Introduction to Agriculture Microbiology

Historical overview of agriculture microbiology, Importance of microorganisms in agriculture, Microbial diversity in agricultural ecosystems, Microbial roles in nutrient cycling, Techniques in agriculture microbiology, Microbialinteractions in soil ecosystems, Beneficial and detrimental microbes in agriculture, Microbial biotechnology in agriculture, Microorganisms and climate change, Ethical considerations in agriculture microbiology. [09]

Soil Microbiology

Soil as a microbial habitat, Microbial populations and diversity in soil, Soil microbial interactions and communitydynamics, Role of microorganisms in soil structure and aggregation, Nitrogen fixation by soil bacteria, Phosphorussolubilization and mobilization, Symbiotic and non-symbiotic mycorrhizal associations, Bioremediation using soilmicroorganisms, Biocontrol of soil-borne pathogens, Soil microbial enzyme activities. [09]

Plant-Microbe Interactions

Rhizosphere and rhizoplane microorganisms, Plant growth-promoting rhizobacteria (PGPR), Induced systemic resistance (ISR), Plant-mycorrhizal interactions, Nitrogen-fixing symbioses with legumes, Pathogenic interactions: Bacterial, fungal, and viral plant pathogens, Mechanisms of plant defence against pathogens, Molecular signalling in plant-microbe interactions, Biofertilizers and biopesticides, Biotechnological applications of plant-microbe interactions. [09]

Microbial Aspects of Crop Health

Seed-borne and soil-borne diseases, Fungal, bacterial, and viral plant diseases, Disease diagnosis and detectionmethods, Epidemiology and disease management, Integrated pest and disease management6. Microbial antagonists for disease control, Antibiotics and bioactive compounds from microbes, Host resistance and breedingfor disease resistance, Emerging challenges in crop health, Case studies of microbial disease management. [09]

Microorganisms in Sustainable Agriculture

Microbial contribution to organic matter decomposition, Composting and vermicomposting Microbial bioconversionof agricultural waste, Biogas production and anaerobic digestion, Microbial-enhanced nutrient uptake by plants, Phytoremediation and microbial-assisted phytoremediation, Microbial contribution to soil carbon sequestration.Microbial diversity and resilience in agroecosystems, Role of microbiome in precision agriculture, Future prospectsof sustainable agriculture microbiology. [09]

Total Hours : 45

Text books:

1	"Soil Microbiology, Ecology, and Biochemistry" by Eldor A. Paul, university of wiscosin – Madison, Unitedstate - 2014
2	"Agricultural Microbiology" by R. Michael Cook, University of Missouri, 1994.

References:

1.	"Microorganisms in Sustainable Agriculture and Biotechnology" by R. Zothanpuia et al., India,2012
2.	"Plant-Microbe Interactions" by Hiroshi Hashimoto et al., 2009.
3.	"Principles of Plant-Microbe Interactions: Microbes for Sustainable Agriculture" edited by Ben Lugtenberg,netherland,2015

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	1	1	2	2	2	1	2	1	2
CO2	2	3	2	2	2	1	2	2	2	1	1	1
CO3	2	2	3	2	2	2	22	1	2	3	1	1
CO4	1	2	3	3	1	1	1	2	1	2	2	1
CO5	2	1	2	1	2	1	1	1	1	2	1	2

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Chairman - BOS

BOS- Chairman

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT H02 - Organic Farming for sustainable agriculture								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)	• To impart the principles and importance of organic farming for sustainable agriculture • To learn about the soil fertility and manures • To learn the production technology of organic compost and to practice the its design criteria. • To provide the better understanding about organic standard certificates • To discuss about the future perspectives of organic farming
Course Outcomes	**At the end of the course, the student will be able to** CO1: Understand the principles, various types of farming and the challenges for organic agriculture. CO2 comprehend the various components of soil fertility and the techniques to manage the soil fertility. CO3: illustrate the production of organic compost and the method of its spreading. CO4: Understand the history and development of organic standards and certification CO5: analyse the future perspective of organic farming for sustainable agriculture.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Overview of Organic farming

Origin and principles for organic farming - Indian Agriculture before the Green Revolution - The Green Revolution - Impact of Green Revolution on the environment - types of farming: pure organic, integrated and mixed farming system - needs and challenges for organic agriculture- Key indicators of sustainable agriculture. [09]

Soil Fertility and production of organic compost

Components of soil fertility - physical, chemical and biological - managing soil fertility in organic farming systems - organic manures: farmyard, compost sheep and goat, poultry, oil-cakes, sewage, sludge and sullage manure. Composting - importance of composting - method of spreading compost - microbes involved in composting - design criteria - rate and time of application - kinetics of composting - type and amount of compost - practical method of making compost. [09]

Sustainable Agriculture

SWOT Analysis of Organic Farming- Sustainable Agriculture- Key Indicators of Sustainable Agriculture- Organic Farming and Climate Change. [09]

Organic standards and certification

History and development of organic standards and certification - organic standards setting processes - conformityassessment processes (international verification processes) - key challenges for the future of organic regulation. [09]

Perspectives of Organic Farming

Economic management in organic agriculture - Understanding the market for organic food-Supply chain management.Social responsibility in organic agriculture: learning, collaboration and regulation - Organic fertilizer:Supplementary nutrient source for rice, sugarcane, sorghum and banana - Marketing of Organic Products- Pest Management. [09]

Total Hours: 45 hours

Text books:

1	Gupta, M. (2004). *Organic agriculture development in India*. ABD publishers, Jaipur, India.
2	Kristensen, P., Taji, A. and Reganold, J., "Organic Agriculture: A Global Perspective", CSIRO Press, Victoria,Australia, 2006.

Reference(s):

1	APEDA (2001). *Guidelines for Production of Organic Rice in India*, Agricultural and Processed Food ProductsExport Development Authority, New Delhi.
2	Yadav, A.K. (2015). *Organic Agriculture (Concept, Scenario, Principals and Practices),* National Centre of Organic Farming Department of Agriculture and Cooperation, Ministry of Agriculture, Govt of India, CGO-II,Kamla Nehru Nagar Ghaziabad, 201 001, Uttar Pradesh.
3	Shiva, V., Pande, P. and J. Singh (2004). *Principles of Organic Farming: Renewing the Earth's Harvest*.Navdanya, New Delhi.

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Chairman - BOS

BOS- Chairman

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3			3		3	2	3	3	3
CO2	3	3	2	3		3	3	3		3		3	3	2
CO3	3	3	3	3				3	3		3	3	3	2
CO4	3	3	3	3	3	3	3			3		3	3	2
CO5	3	3	3	3		3			3		3	3	3	3

K.S.Rangasamy College of Technology – Autonomous (R2018)

50 BT H03 - Crop Production Technology

B.Tech. Biotechnology

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To introduce the students to principles of agricultural and horticultural crop production .
- To understand the crop selection and establishment procedures.
- To learn about the different management practices during crop establishment and growth.
- To introduce the production practices of agricultural and horticultural crops.
- To delineate the role of agricultural engineers in relation to various crop productionpractices.

Course Outcomes

he student will be able to

CO1: extend the knowledge on basic principles of crop production.
CO2 identify suitable crops and decide upon its establishment procedures.
CO3: express the knowledge on the different crop management practices.
CO4: discuss about the area of production of agricultural and horticultural crops.
CO5: discriminate their role in relation to various crop production practices.

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide thenumber of hours for each unit depending upon the concepts and depth. Questions need not be asked based on the number of hours:notified against each unit in the syllabus.

Principles of crop production and crop classification

Concepts in crop production; geographical distribution of crops and cropping systems; economic importance. Cereals, pulses, oilseeds, fiber crops, forage crops, medicinal and aromatic crops and horticultural crops. [09]

Crop selection and establishment

Regional and seasonal selection of crops; Systems of crop production; Competition among crop plants; Spacing andarrangement of crop plants; Field preparation for crops including systems of tillage; Establishment of an adequate crop stand and ground cover, including selection and treatment of seed, and nursery growing. [09]

Crop management

Crop water Management; Crop nutrition management - need for supplementation to soil supplied nutrients, sources, generalized recommendations, methods and timing of application of supplemental nutrients including fertigation scheduling; Crop protection including management of weeds, pests and pathogens; Integrated methods of managing water, nutrients and plant protection; Types and methods of harvest. [09]

Production practices of agricultural crops

Generalized management and cultivation practices for important groups of field crops in TamilNadu: cereal crops, grain legumes, oil seed crops, sugarcane, and fiber crops, and special purpose crops such as those grown for greenmanure and fodder. [09]

Production practices of horticultural crops

Important groups of horticultural crops in Tamil Nadu such as vegetable crops, fruit crops, flower crops; Cultivation practices of representatives of each group; Special features of production of horticultural crops - green house cultivation. [09]

Total Hours : 45

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Text books:	
1	Gupta, M. (2004). *Organic agriculture development in India*. ABD publishers, Jaipur, India.
2	Kristensen, P., Taji, A. and Reganold, J., "Organic Agriculture: A Global Perspective", CSIRO Press, Victoria,Australia, 2006.
References:	
1.	APEDA (2001). *Guidelines for Production of Organic Rice in India*, Agricultural and Processed Food ProductsExport Development Authority, New Delhi.
2.	Yadav, A.K. (2015). *Organic Agriculture (Concept, Scenario, Principals and Practices),* National Centre of Organic Farming Department of Agriculture and Cooperation, Ministry of Agriculture, Govt of India,CGO-II, Kamla Nehru Nagar Ghaziabad, 201 001, Uttar Pradesh.
3.	Shiva, V., Pande, P. and J. Singh (2004). *Principles of Organic Farming: Renewing the Earth's Harvest*.Navdanya, New Delhi.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3			3		2	3	3	3	3
CO2	3	3	2	3		3	3	3			3	3	2	3
CO3	3	3	3	3				3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3				3	3	2	3
CO5	3	3	3	3		3			3	3	3	3	3	3

K.S.Rangasamy College of Technology – Autonomous(R2018)

50BT H04 - Agri Business Management and EDP

B.Tech. Biotechnology

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P	45	C	CA	ES	Total
VI	3	0	0		3	40	60	100

Objective(s)

- To provide a comprehensive understanding of agricultural business management principlesand practices.
- To develop entrepreneurial skills and mindset among participants for venturing into agriculturalenterprises.
- To enable participants to apply modern technology and techniques for effective agri-businessmanagement.
- To enhance participants' knowledge of market trends, value chains, and sustainable practicesin agriculture.
- To equip participants with the ability to formulate and execute business plans in the agriculturalsector.

Course Outcomes

At the end of the course, the student will be able to

CO1: Demonstrate a deep understanding of agricultural business management concepts andstrategies

CO2 Identify and evaluate potential agri-business opportunities, demonstrating entrepreneurialthinking.

CO3: Apply modern digital tools and technology to optimize agri-business processes.

CO4: Analyse market trends, consumer behaviour, and sustainability factors in agriculturalcontexts.

CO5: Develop comprehensive agri-business plans considering financial, operational, andmarketing aspects.

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide thenumber of hours for each unit depending upon the concepts and depth. Questions need not be asked based on the number of hours notified against each unit in the syllabus**.**

Introduction to Agri-Business Management and Entrepreneurship Development

Definition and Scope of Agri-Business Management, Importance of Entrepreneurship in Agriculture, Characteristics of Successful Agri-Entrepreneurs, Role of Innovation and Creativity in Agri-Business, Business Ethics and Corporate Social Responsibility in Agriculture, Challenges and Opportunities in Agri-Business Sector, Government Policies and Support for Agri-Entrepreneurship, Market Research and Identification of Agri-Business Ideas, Feasibility Analysis and Risk Assessment in Agri-Business and Developing an Entrepreneurial Mindset in Agriculture.

[09]

Agricultural Production and Operations Management

Crop and Livestock Production Planning, Sustainable Farming Practices and Precision Agriculture,Irrigation andWater Management in Agriculture, Soil Health Management and Fertilization Strategies, Pest and DiseaseManagement in Agriculture, Post-Harvest Handling and Storage of Agricultural Produce, Quality Control and Assurance in Agri-Products, Supply Chain Management in Agriculture,

Machinery and Equipment Selection in Agri-Operations and Labor Management and Human Resource Development in Agriculture. [09]

Marketing and Value Chain Management in Agri-Business

Agricultural Market Channels and Trends, Consumer Behavior and Agri-Product Marketing, Branding and Packaging for Agri-Products, Pricing Strategies in Agricultural Markets, Distribution and Retail Management in Agri-Business, E-Commerce and Online Platforms in Agricultural Marketing, Value Addition and Agro-Processing Industries, Exportand Import Procedures for Agri-Products, Agri-Tourism and Direct Marketing Concepts and Sustainable Marketing Practices in Agriculture. [09]

Financial Management and Agri-Business Economics

Basics of Financial Management in Agri-Business, Capital Budgeting and Investment Analysis in Agriculture, Farm Accounting and Record Keeping, Financial Ratios and Performance Analysis, Credit and Financing Options for Agri-Entrepreneurs, Risk Management and Insurance in Agriculture, Cost Analysis and Cost-Volume-Profit Relationships, Agricultural Commodity Markets and Price Risk Management, Economic Policies and Agricultural Trade and Agri- Business Sustainability and Triple Bottom Line. [09]

Entrepreneurship Development and Business Plan Formulation

Business Model Canvas for Agri-Startups, Developing a Comprehensive Agri-Business Plan, Market Feasibility andTarget Audience Analysis, Operations and Production Plan in Agri-Business, Financial Projections and Budgeting for Agri-Startups, Marketing and Sales Strategies for Agri-Enterprises, Risk Mitigation and Contingency Planning, Legal and Regulatory Considerations in Agri-Business, Presentation Skills for Business Plan Pitches and Scaling Upand Growth Strategies for Agri-Startups. [09]

Total Hours:45

Text books:

1	"Soil Microbiology, Ecology, and Biochemistry" by Eldor A. Paul, university of wiscosin – Madison, United state - 2014
2	"Agricultural Microbiology" by R. Michael Cook, University of Missouri, 1994.

References:

1.	"Microorganisms in Sustainable Agriculture and Biotechnology" by R. Zothanpuia et al., India,2012
2.	"Plant-Microbe Interactions" by Hiroshi Hashimoto et al., 2009.
3.	"Principles of Plant-Microbe Interactions: Microbes for Sustainable Agriculture" edited by Ben Lugtenberg,netherland,2015

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3			3		3	2	3
CO2	3	3	2	3		3	3	3		3		3
CO3	3	3	3	3				3	3		3	3
CO4	3	3	3	3	3	3	3			3		3
CO5	3	3	3	3		3			3		3	3

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50 BT H05 - Green House Technology and Protected Cultivation

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To understand the basic principles, and types of greenhouse technology
- To familiarize planning, design and materials used for the construction of green house
- To provide the knowledge about different protected structures such as green house, playhouses and shade net house.
- To impart the knowledge on protected cultivation of vegetables, fruits and flower crops

To discuss about the hi-tech production technology

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Course Outcomes	At the end of the course, the student will be able to CO1: Understand the principles, various types of greenhouse farming CO2 Summarize the design criteria and, various materials used for greenhouse techniques CO3: illustrate the production of organic compost and the method of its spreading. CO4: Understand the knowledge on the protected cultivation of vegetables, fruits and flower crops. CO5: Examine the precision farming techniques and its application

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Overview of Greenhouse Farming

Green house technology: Introduction, History of green house, Advantages of green house, Greenhouse effect; Types of Greenhouses: Greenhouse type based on Shape, Utility, Construction and Covering materials; Plant response to Greenhouse environment : Light, Temperature, Relative Humidity, Ventilation and Carbon di-oxide. [09]

Planning and Design of green house

Planning and Design of green house: Site selection and orientation, structural design and covering materials; Materials of construction - Materials of construction for traditional and low cost green house: Wood, G.I., aluminum, steel, R.C.C. and Glass; Design criteria of green house for Cooling and Heating purposes: Cooling - Natural ventilation, forced ventilation Heating- Heating system, solar heating system, Water & Rock storage. [09]

Protected cultivation and its types

Importance and methods of protected culture in horticultural crops - Importance and scope of protected cultivation – different growing structures of protected culture viz., green house, poly house, net house, poly tunnels, screen house, protected nursery house - study of environmental factors influencing greenhouse production – cladding / glazing / covering material – ventilation systems – cultivation systems including nutrient film technique / hydroponics / aeroponic culture – growing media and nutrients – canopy management – micro irrigation and fertigation systems. [09]

Protected Cultivation of Vegetables, Fruits and Flower Crops

Protected cultivation technology for Vegetables- Hi-tech protected cultivation techniques for tomato, capsicum nursery, cucumber, gherkins strawberry and melons, Fruits - fruit crops: mango, banana, citrus, papaya, guava, sapota, jackfruit, pineapple, annonas, avocado, aonla, pomegranate, ber, apple, pear, quince, grapes, plums, peach, apricot, cherries, litchi, loquat, persimmon, kiwifruit, strawberry and Flower Crops- Hi-tech protected cultivation of cut roses, cut chrysanthemum, carnation, gerbera, asiatic lilies, anthurium, orchids, cut foliages and fillers; integrated pest and disease management – post harvest handling. [09]

Precision Farming Techniques

Concept and introduction of precision horticulture – Importance, definition, principles and concepts – Role of GIS and GPS - Mobile mapping system and its application in precision farming – design, layout and installation of drip and fertigation in horticultural crops - role of computers in developing comprehensive systems needed in site specific management (SSM) – georeferencing and photometric correction – Sensors for information gathering – geo statistics – robotics in horticulture - postharvest process management (PPM) – remote sensing - information and data management and crop growth models-GIS based modelling. [09]

Total Hours: 45 hours

Text books:

1	Salokhe, V. M., & Sharma, A. K. (2006). Greenhouse technology and applications. Agrotech Publishing Academy.
2	Prasad S and Kumar U Greenhouse Management for Horticultural Crops (2nd Ed.), Agrobios, India 2018.

Reference(s):

1.	Kumar.N, Introduction to Horticulture(7 th Ed.),Oxford &IBH , 2017
2.	David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA.
3.	Singh Brrahma and Balraj Singh. 2014. Advances in Protected Cultivation, New India PublishingCompany
4.	Hakravarthy,A. Post Harvest Technology of cereals, pulses and Oil seeds. Oxford and IBH Publishing Co. Ltd., New Delhi

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3			3		3	2	3	3	3
CO2	3	3	2	3		3	3	3		3		3	3	2
CO3	3	3	3	3				3	3		3	3	3	2
CO4	3	3	3	3	3	3	3			3		3	3	2
CO5	3	3	3	3		3			3		3	3	3	3

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K.S.Rangasamy College of Technology – Autonomous (R2018)

50 BT H06 - Farming System and Sustainable Agriculture

B.Tech. Biotechnology

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)	• To impart knowledge on farming system and components. • To become familiar with cropping system and pattern efficiencies. • To provide knowledge on agricultural and its techniques for sustainability. • To let know the existing integrated farming system. • To sensitize about the necessity on resource use efficiency
Course Outcomes	At the end of the course, the student will be able to CO1: Understand the farming system and their maintenance CO2 Recognize cropping and patterning in farming system CO3: Differentiate the types of sustainable agriculture and their conservative techniques CO4: Gain knowledge of integrated farming system and components on development the models for different climates CO5: Practice optimization techniques and resource cycling in different farming systems

Note: Hours notified against each unit in the syllabus are only indicative but are not decisive. Faculty may decide the number of hours for each unit depending upon the concepts and depth. Questions need not be asked based on the number of hoursnotified against each unit in the syllabus.

Introduction to Farming System

Farming System-scope, importance, concept, Types, & systems of farming system and factors affecting types of farming**.** Farming system components, and their maintenance. [09]

Cropping system

Cropping system & pattern, multiple cropping systems, efficient cropping system and their evaluation - Allied enterprises & their importance, Tools for determining production & efficiencies in cropping and farming system. [09]

Sustainable agriculture

Introduction to sustainable agriculture- problems and their impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture - HEIA, LEIA, and LEISA and its techniques for sustainability. [09]

Integrated farming system

Integrated farming system-historical background, objectives & characteristics, components of IFS & its advantages, Site-specific development of IFS model for different agro-climatic zones. [09]

Resource use efficiency

Resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming systems - Farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and a farmers field. uptake by plants, Phytoremediation and microbial-assisted phytoremediation, Microbial contribution to soil carbon sequestration. Microbial diversity and resilience in agroecosystems, Role of microbiome in precision agriculture, Future prospects of sustainable agriculture microbiology. [09]

Total Hours :45 hours

Text books:

1	Thomas Edens ."Sustainable Agriculture and Integrated Farming Systems" by published by Michigan State Univ Pr, 1984.
2	SS Reddy .“Farming System and Sustainable Agriculture”,published by kalyani, 2016.

References:

1.	Alberda and H van Keulen ."Food from dry lands: An integrated approach to planning of agricultural development (System Approaches for Sustainable Agricultural Development)" published by Springer, 2013.
2.	K.A.Rasure. Sustainable Agricultural Development , oxford publication, 2010.
3.	Shikhar Verma .A Textbook of Integrated Farming Systems for Sustainable Agriculture, published by BPInternational , India, 2023.
4.	Shawn Jadrnicek. "The Bio-Integrated Farm and Home" by Published by Chelsea Green Publishing Co 2016.

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BOS- Chairman

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	3	2	3	2	3	3	2	3
CO2		1		1	2	2	2	2	3	3	2	3
CO3	2		2		3	1	2	2	3	3	2	3
CO4	2	2	2	2	2	3	3	2	3	3	2	3
CO5	2	3		3	1	2	2	2	3	3	2	3

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Chairman - BOS

BOS- Chairman

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E11- Environmental Biotechnology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)	• To familiarize the learners with the impacts of pollution on the environment and human health. • To enable students to learn the basic concepts of interactions of radiation with environment. • To enlighten the learners about waste management. • To comprehend different forms of bioremediation and biodegradation available to treat waste. • To understand the importance of monitoring the environment and its necessity for implementation.
Course Outcomes	**At the end of the course, the students will be able to** CO1: summarize the types, sources of pollution and to analyze pollution control measures. CO2: appraise the interactions of nuclear radiation in the environment. CO3: relate the different techniques involved in solid waste management. CO4: employ the use of microbes and plants in bioremediation of oil spilled and salt affected soils along with the usage of biofertilizers for poor soil management. CO5: inspect the consequence of pesticides and its degradation pathways.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

ENVIRONMENTAL POLLUTION

Types, sources and monitoring of air, water, noise and soil pollution, Pollutant categories: Metals, Organics and nuclear. Impact of pollution and pollutant on human health, environment and climate change; role of regulatory bodies in pollution control. [9]

SOLID WASTE MANAGEMENT

Solid waste management: Introduction, management of municipal, agricultural, industrial, mining, hazardous (biomedical) waste-treatment methods (Incineration, pyrolysis) and Solid waste management methods (composting, vermiculture, methane production and landfill). [9]

IMPACT OF NUCLEAR RADIATION

Ionizing and Non-Ionizing Radiation- Types/sources of ionizing radiation (e.g. X- rays, gamma rays), Measurement of ionizing radiation, Health effects of ionizing radiation (burns, mutations, cancers), sources of environmental exposur eto ionizing and non- ionizing radiation, Environmental hazards of disposal of ionizing wastes. Non-ionizing radiation and its impact on health (UV light, electromagnetic radiation, cell-phone radiation). [9]

BIOREMEDIATION TECHNOLOGIES

Bioventing-biosparging and bioslurping-Phytoremediation-Biosorption and Bioleaching of heavy metals (Cadmium, Lead, Mercury), Metal binding targets and organisms, Metal-microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbents. Remediation of degraded ecosystems, degradation of xenobiotics in environment, decay behavior & degradative plasmid, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides and heavy metals degradation pathways [9]

TECHNOLOGIES FOR ENVIRONMENTAL MONITORING

Application of various technologies - Data bases, RDBMS, Management Information systems and decision support system - geographic information systems, Intranets and extranets - video teleconferencing and Remote sensing technology - contribution of remote sensing and GIS in management. Low cost sensor adoption for RT air, water and particulatedepositiondue to emissions from industries, agricultural and municipal wastes. [9]

Total Hours: 45 hours

Text books:

1. Baird, C. and Cann, M. Environmental Chemistry. W.H. Freeman and Company 2008.
2. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007

Reference(s):	
1	Environmental Biotechnology. Concepts and Applications.Edited by H.-J. Jördening and J. Winter 2015
2	Friis, Robert H.Essentials of Environmental Health. Jones and Bartlett, Inc., Sudbury, MA 2014
3	Theodore, L. & Dupont, R. R. Environmental Health and Hazard Risk Assessment. Environmental Health andHazardRisk Assessment (2017).
4	S. B. Utham Kumar, Fundamentals of Environmental Biotechnology, Lambert Academic Publishing, New Delhi,2011

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E12- Biodiversity and its conservation

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)

- To develop the knowledge the knowledge of students in Biodiversity and its management
- To widen the knowledge about the sustainable utilization of natural resources
- To understand the regulatory authorities and their role about Biodiversity and its conservation
- To recognize the threats to the Biodiversity.
- To distinguish the roles and responsibilities of the regulatory authorities in Biodiversity and its conservation

Course Outcomes

At the end of the course, the students will be able to

CO1: describes the concepts and types of Biodiversity and its management.
CO2: annotate the losses of biodiversity and conservation measures by agency. CO3: learn the significance and aesthetic uses of Biodiversity.
CO4: exemplify the threats to the biodiversity through population exposure and other ways.
CO5: appraise the sustainable management and conservation of Biodiversity:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO BIODIVERSITY

Biodiversity - Definition-Types, Diversity of genes (genetic diversity), species (species diversity and ecosystems (ecosystem diversity); Goals and constraints of Biodiversity Science. Genetic Diversity - Nature and origin of Genetic Variation, Measuring Genetic Variation by Allozyme, Species Diversity – Measurement, Concepts of species richness, abundance, and turnover, species/area relationships, global distribution of species richness; Hot Spot analysis; A general account on Ecosystem diversity. [9]

LOSS OF BIODIVERSITY AND HUMAN INFLUENCE ON BIODIVERSITY

Species Extinction- Fundamentals causes, Deterministic and Stochastic processes, Current and Future Extinction rates; methods of estimating loss of biodiversity- Threatened species, The IUCN threat Categories (Extinct, Endangered, Vulnerable, Rare, Intermediate and Insufficiently known). [9]

BIODIVERSITY AND HUMAN WELFARE

A very general account on uses of Bioresources- plant uses: food, timber, medicinal ornamental and other uses- animal uses: food animals (terrestrial and aquatic), nonfood uses of animals, Domestic livestock- uses of microbes. Valuing Biodiversity- Instrumental (Goods, Services, and Information and Psychospiritual values) and Inherent or Intrinsic values, ethical and aesthetic values-An outline account on methods of valuing biodiversity. [9]

THREATS TO BIODIVERSITY

Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems Invasive Species: their introduction pathways, biological impacts of invasive species on terrestrial and aquatic systems Pollution: Impacts of Pesticide pollution, Water pollution and Air Pollution on biodiversity Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems. [9]

SUSTAINABLE MANAGEMENT AND CONSERVATION OF BIODIVERSITY AND BIORESOURCES

Sustainable management - National polices and Instruments relating the protection of the wild/ domesticated flora and fauna as well as habitats; International policies and Instruments - A general account on multilateral treaties- the role of NBAI, CBD, IUCN, GEF, IBPGR, NBPGR, WWF, FAO, UNESCO and CITES. Conservation *In situ* and *Ex situ* Conservation. [9]

Total Hours: 45 hours

Text books:

1	Groombridge, B, "Global Biodiversity – Status of the Earth's Living Resources", Groombridge, B (ed.). Chapman and Hall, London. 1992. 2. Virchow, D, "Conservation and Genetic Resources", Springer – Verlag, Berlin. 1998
2	Krishnamurthy, K. V. Textbook of Biodiversity. Science Publication. 2003.

Reference(s):

1	Antoine Guisan , Habitat sustainability and Distribution Models, Cambridge University Press , 2017
2	Primack, R. Essentials of Conservation Biology. Sinauer Associates, Inc., USA2006.
3	Friis, Robert H.Essentials of Environmental Health. Jones and Bartlett, Inc., Sudbury, MA 2014
4	Theodore, L. & Dupont, R. R. Environmental Health and Hazard Risk Assessment. Environmental Health and Hazard Risk Assessment (2017).

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E13-Environmental Hazards and Management								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)	• To understand the concepts of environmental hazards and the causative agents • To differentiate the potential hazards and disaster • To identify the suitable framework followed by a national and international agency to mitigate the hazards and disasters • To comprehend the different aspects of technology for reducing and managing the risk • To create awareness about hazards management.
Course Outcomes	**At the end of the course, the students will be able to** CO1: recite the concepts of environmental hazards and its impacts CO2: distinguish the potential role of elements causing health risk CO3: categorize the types of environmental hazards and disasters. CO4: express the management and framework of hazards and disaster management CO5: choose the technologies that can be employed in the risk reduction and management

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

ENVIRONMENTAL HAZARDS

Concepts of environmental hazards, environmental disasters and environmental stress – hazard approaches in relation with human ecology – taxonomy of environmental hazards – Metals, Organics and nuclear – health and hazard risk. [6]

TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS

Natural hazards and disasters: planetary and extra planetary hazards – exogenous hazards and endogenous hazards. Man induced hazards: Nuclear accidents, Industrial accidents, environmental impacts of hazards and disasters. [10]

FRAME WORK AND MANAGEMENT (HAZARDS AND DISASTER)

Environmental Framework: Regulatory system- laws and regulation – role of state and central bodies. Hazard Management – hazard risk identification, probability, consequences, characterization. Disaster Management: Effect to migrate natural disaster – international strategy for disaster reduction – concept of disaster management – national disaster management framework – financial arrangements – role of government and media – disaster response. [10]

TECHNOLOGY IN RISK REDUCTION

Application of various technologies – Data bases, RDBMS, Management Information systems and decision support system -geographic information systems, Intranets and extranets – video teleconferencing and Remote sensing technology – contribution of remote sensing and GIS in management. Low cost sensor adoption for RT air, water and particulate deposition due to emissions from industries, agricultural and municipal wastes. [10]

AWARENESS TOWARDS RISK MANAGEMENT

Risk reduction by education – Network – risk management through public awareness – implication of development planning emergency response – case study on Tsunami, cyclone Thane, Sikkim earthquake, nuclear plant accident and nanopowder industry outbreak, Ghaziabad air pollution and Bhopal gas accident. [9]

Total Hours: 45 hours

Text books:

1. Theodore, L. & Dupont, R. R. Environmental Health and Hazard Risk Assessment. Environmental Health and Hazard Risk Assessment (2017).

Reference(s):

1. Shroder, J. F. Hazards and Disasters Series Biological and Environmental Hazards , Risks , and Disasters. (2016).
2. Ragazzi, M. Air Quality Monitoring, Measuring, and Modeling Environmental Hazards. (2004).
3. Bennett, G. Bioremediation of hazardous wastes. Journal of Hazardous Materials 34, 269–270 (1993).

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3			3	3	2	3	3	3	3
CO2	3	3	3	3	3			3	3	2	3	3	3	3
CO3	3	3	3	3	3			3	3	2	3	3	3	3
CO4	3	3	3	3	3			3	3	2	3	3	3	3
CO5	3	3	3	3	3			3	3	2	3	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E14 – Food Biotechnology

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)

- To gain basic knowledge in select various aspects of food processing principles, equipments and food engineering operations in food industries .
- To interpret the characteristics of various for preservation techniques.
- To Recognize and label the role of various agencies applied in food processing
- To gain knowledge in various aspects of Food processing and its importance for industrial applications.
- To take up higher studies in the area of Food technology and to become an entrepreneur.

Course Outcomes

At the end of the course, the students will be able to

CO1: illustrate the basic concepts of food processing technology and quality improvement.

CO2: appraise the types of various food processing techniques in milk and milk products.

CO3: categorize vegetables, fruits and processing of meat.

CO4: understand the different operations involved in food conversion.

CO5: identify the Sensory evaluation of food quality and various organizations dealing with inspectionand food safety standards.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Principles of Food Processing

Principles and methods of food preservation; thermal processing of food - 12D concept - blanching - pasteurisation canning; freezing - evaporation - dehydration - radiation, pulse electric field - ultra high pressure - Modified atmosphere storage and packing, Food additives [9]

Food Engineering Operations

Properties of foods and processing theory - liquid, solid and gases: density, specific gravity, viscosity, surface activity rheology and texture, flavour. Storage and transport, Raw material preparative operation - theory and equipment's used: cleaning, grading, peeling. Food conversion operation - size reduction, mixing, emulsification, filtration, membrane separation, extraction, crystallization. [9]

Application of Food Processing

Technology of milk and milk products - processing of market milk: Types of milk products: paneer, butter, Ice cream, Vegetables and Fruits processing technology - Jam, jelly, squash, sauce and fruit juice powders. Recent trends in meat processing - post-mortem changes- meat tenderization - poultry processing. Baking technology: Bread, Cake and Biscuit preparation. [9]

Fermentation Technology

Food fermentation-general principles-culture maintenance.Production process offer mented foods-Cheese, Yoghurt, sauerkraut, pickles; Industrial production of alcoholic beverages: beer and wine - non-alcoholic beverages - tea. Oriental fermented foods. Microorganisms as food: probiotics and prebiotics, single cell protein. Applications of enzymes in food processing. [9]

Food Quality and Management	
Sensory evaluation of food quality: appearance, textural, flavour factors - Nine hedonic scale - Food safety --- Organizations dealing with inspection, Certification and quality assurance, Food safety standards: WHO, FPO, MMPO, HACCP, GMP, FSSAI. [9]	
Total Hours: 45 hours	
Text books:	
1	WulfCruger and AnnelieseCrueger., "Biotechnology: A Textbook of Industrial Microbiology", Panima Publishing Corporation, New Delhi. 2003.
2	Pierre-Yves Bouthyette, "Fermentation Technologies", 2nd edition, Rai University, Ahmedabad, 2005.
Reference(s):	
1	Presscott, D. "Industrial Microbiology", CBS Publishers, New Delhi. 1999.
2	Peter F. Stanbury, Allan Whitaker and Stephen J, Hall, "Principles of Fermentation Technology", Third edition, Butterworth-Heinemann Publishers, 2017.
3	Arindam Kuila and Vinay Sharma, "Principles and Applications of Fermentation Technology", Wiley Publications, 2019
4	Modi, H.A., " Fermentation Technology", Vol-2, Pointer Publishers, 2015

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E15 - Fermentation Technology

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V	3	0	0	45	3	40	60	100

Objective(s)

- To understand the important concepts and stages in fermentation engineering
- To learn the production of primary and secondary metabolites for various industrial applications.
- To identify the various upstream and product recovery techniques of metabolites production
- To acquire knowledge on the kinetics and bioconversion studies
- To illustrate the production process of different fermented products and identify its industrial application

Course Outcomes

At the end of the course, the students will be able to

CO1: determine the industrial fermentation process, types and different stages

CO2: elucidate the concept of organic feed stock production and various product recovery techniques

CO3: narrate the strategies for secondary metabolite production and process optimization

CO4: investigate the concept of growth kinetics, the applications of bioconversion and transformation of steroid and non- steroid compounds

CO5: illustrate the concept of production of microbial fungicides and pesticides, chemicals andpharmaceuticals by fermentation technology

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO FERMENTATION TECHNOLOGY

Industrial Fermentation, Substrates used for Industrial Fermentation (Carbon and Nitrogen Sources), Methods of Fermentation: Batch, Fed Batch and Continuous, Different stages of fermentation process, Fermentation medium, Isolation and screening of industrially important microorganisms − primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology. [9]

PRODUCTION OF PRIMARY METABOLITES

Product Recovery: Centrifugation, Filtration, Chromatography, Sedimentation, Precipitation and Crystallization, Organic feed stocks produced by Fermentation – Ethanol, Acetone, Organic acids (Citric acid, Lactic acid), Amino acids – L-Glutamic acid and Tryptophan, Calculations for Product recovery and yield. [9]

PRODUCTION OF SECONDARY METABOLITES AND PROCESS OPTIMIZATION

Mechanism of secondary metabolite production, Examples-Antibiotics (Penicillin, Cephalosporin), Vitamins (Vitamin B12, Riboflavin), Ergot alkaloids, Nucleotides and Nucleosides. Antimicrobial agents. Role of metabolic engineeringin process improvement, Computersin fermentation processes. [9]

GROWTH KINETICS AND MICROBIAL TRANSFORMATION

Growth kinetics in fermentation, Kinetics of batch, fed batch and continuous fermentation, Introduction to Microbial transformation, Types and applications of bioconversion, Procedures for biotransformation, Transformation of steroid and non-steroid compounds, SCPproduction from microbes and algae. [9]

MODERN FERMENTATION TECHNOLOGY

Microbial fungicides and Pesticides, Chemicals and Pharmaceuticals made by fermentation, Fermented foodproducts – Beer, Wine, Genetically Modified Organisms, Biopolymers. Microbial leaching, Effluent treatment using microbes, Future of fermentation technology and its products. [9]

Total Hours: 45 hours

Text books:

1. WulfCruger and AnnelieseCrueger., "Biotechnology: A Textbook of Industrial Microbiology", Panima PublishingCorporation, New Delhi. 2003.
2. Pierre-Yves Bouthyette, "Fermentation Technologies", 2nd edition, Rai University, Ahmedabad, 2005.

Reference(s):

1. Presscott, D. "Industrial Microbiology", CBS Publishers, New Delhi. 1999.
2. Peter F. Stanbury, Allan Whitaker and Stephen J, Hall, "Principles of Fermentation Technology", Third edition, Butterworth-Heinemann Publishers, 2017.
3. Arindam Kuila and Vinay Sharma, "Principles and Applications of Fermentation Technology", Wiley Publications, 2019
4. Modi, H.A., " Fermentation Technology", Vol-2, Pointer Publishers, 2015

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	2	2	3	2	3	3	**3**	**3**	3
CO2	2	3	2	2	3	3	3		2	3	3	3	**3**	**3**	2
CO3	2	3	2	3	3	3	3	2		2	3	3	**3**	**3**	2
CO4	2	3	1	3	3	3	3	2	2	2	3	2	**3**	**3**	2
CO5	3	3	3	3	2	2	2		2	2	3	3	**3**	**3**	3

K.S.Rangasamy College of Technology – Autonomous R 2018								
50 BT E21- Cancer Biotechnology								
B. Tech. Biotechnology								
Semester	**Hours / Week**			**Total Hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VI	3	0	0	45	3	40	60	100
Objective(s)	• To impart knowledge on fundamentals of cancer biology. • To determine the root causes and identifications of various cancer. • To understand various molecular tools for diagnosis and treatment of cancer. • To evaluate the origin and metastatic colonization and angiogenesis of cancer. • To describe the various diagnostic and treatment procedure for the cancer disease.							
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe the cancer, modulation of cell cycle and importance of diets in cancer CO2:interpret the mechanism of chemical and physical agents causing carcinogenesis CO3:explain the importance of DNA damage and cross link repair and activation of kinases. CO4:explore the clinical significance of invasion and heterogeneity of metastatic colonization CO5:exhibit the various form of diagnostic tools and therapy in cancer research							
Note: The hours given against each topic are of indicative. The faculty has the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.								

FUNDAMENTALS OF CANCER BIOLOGY

Introduction to human cancers, Regulation of cell cycle- check points, mutations that cause changes in signal molecules,effects on receptor, signal switches, tumour suppressor genes - P53, Rb, BRCA1 and BRCA1; Oncogenes/proto oncogene, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. [9]

CARCINOGENESIS

Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis,Ultraviolet radiation, x-ray radiation-mechanisms of radiation carcinogenesis. [9]

MOLECULAR CELL BIOLOGY OF CANCER

Tumor genetics: - DNA Damage and repair: damage during replication and crosslink repair, Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Molecular Mechanisms of Apoptosis, Cell Proliferation, Growth factors related to transformation, Telomerases. [9]

CANCER METASTASIS

Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, Metastatic colonization, Angiogenesis, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion. [9]

NEW MOLECULES FOR CANCER THERAPY (CANCER SCREENING, DIAGNOSIS AND THERAPY)

Advances in cancer detection - Biochemical assays, tumor markers, molecular tools for early diagnosis of cancer, Different forms of therapy-chemotherapy, radiation therapy, Use of signal targets towards therapy of cancer; Modern Therapy -
Gene therapy, Drug therapy, Immunotherapy, Nano therapy. [9]

Total Hours: 45 hours

Text book(s):

1	Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.
2	Kewal K. Jain, “Applications of Biotechnology in Oncology”, Springer, New York. 2013.

Reference(s):

1	Tannock I. and Hill. R.P. The basic science of oncology, 3rd ed. McGraw-Hill, 1998
2	Stella Pelengaris and Michael Khan. The Molecular Biology of Cancer, 2nd edition. Wiley –Blackwell, 2013
3	Francesco Pezzella, MahvashTavassoli, and David Kerr, Oxford Textbook of Cancer Biology, Oxford UniversityPress, 2019
4	David J. Kerr, Francesco Pezzella, Mahvash Tavassoli, David Kerr, “Cancer Biology” Oxford University Press,2019

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R 2018								
50 BT E22 Clinical Immunology								
B.Tech. Biotechnology								
Semester	**Hours / Week**			**Total Hrs**	**Credit**	**Maximum Marks**		
	L	**T**	**P**		**C**	**CA**	**ES**	**Total**
VI	3	0	0	45	3	40	60	100

Objective(s)	• To provide a comprehensive understanding of techniques involved in clinical immunology • To provide in depth knowledge in cellular and molecular mechanisms of immune regulation. • To learn the immunological aspects of autoimmunity, stem cell and gene therapy. • To impart comprehensive knowledge on screening and laboratory testing's • To acquire knowledge on immune mediated pathophysiological conditions.
Course Outcomes	**At the end of the course, the students will be able to** CO1: analyse the techniques used for diagnosis of immunological aspects of diseases**.** CO2: validate the tools and techniques involved in immune regulation of various diseases CO3: outline the laboratory testing for transplantation and prevention of reject during transplantation CO4: explore the outcomes of solid organ transplantations and prevention of allograft rejection CO5: interpret the immunological aspects of organ specific diseases.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

IMMUNOLOGICAL TECHNIQUES

Introduction to clinical immunology, measurement of immunoglobulins- Radio immuno assay, ELISA, immunoblots. Complement assay, lymphocytic assay- Fluorescein-Activated Cell Sorter, Lymphocyte Proliferation assays, DNA Technology assays-PCR assays, major histocompatibility (MHC) assays, Microarray assays. [9]

IMMUNE REGULATION

Immunosuppression- immunosuppressive drugs, Antibodies and other immunosuppressive methods, Immunopotentiation, Cytokine therapy, Adoptive immunotherapy –cytokine immunomodulation, cellular vaccines and modulations- Dendritic Cell Vaccines. [9]

AUTOIMMUNITY

Autoimmunity versus autoimmune disease, T-cell versus B-cell-mediated autoimmune disease, Mechanisms of autoimmune tissue injury and examples- Type IIA Autoimmune reaction, Treatment of autoimmune disease- Anti T lymphocyte therapy, Anti B Lymphocytetherapy, Intravenous immunoglobulins, Autologous Hematopoietic Stem Cell Transplantation (HSCT), Future aspects- Gene therapy and stem cell therapy [9]

IMMUNOLOGICAL ASPECTS OF TRANSPLANTATION

Laboratory testing for compatibility- HLA Typing, ABO Blood typing, Screening for performed antibodies-Cross matching,Types of solid organ allograft rejection- Hyper acute rejection, acute rejection and chronic rejection, Prevention of solid organ allograft rejection, solid organ transplantation outcomes. [9]

IMMUNOLOGICAL ASPECTS OF DISEASES

Skin diseases- Alopecia areata, Antibody-induced bullous skin lesions -Pemphigus Vulgaris , cardiac diseases- Rheumatic fever, Changas disease, immune mediated diseases of GI tract — Gluten-Sensitive Enteropathy, Liver diseases- Primary biliary cirrhosis, Autoimmune Hepatitis, specific Immune related renal diseases - Berger's disease
Endocrine disease- IDDM, Neurological disorders- Multiple Sclerosis, SLE [9]

Total Hours : 45 hours

Text book(s):

1	John B. Zabriskie, "Essential clinical immunology", 2nd Ed., Cambridge University Press, 2009.
2	Vladimir V. Klimov, "From Basic to Clinical Immunology", Springer International Publishing, 2019.

Reference(s):

1	Abbas, K. A., Litchman, A. H. and Pober, J. S. "Cellular and Molecular Immunology", 4th Ed., W. B. SaundersCo., Pennsylvania, USA, 2005.
2	Roitt, I., Brostoff, J. and David, M. "Immunology", 6th Ed., Mosby publishers Ltd., New York, USA, 2001.
3	Tizard, R.I. "Immunology", 4 th Ed., Saunders college publishing, Chennai Microprint Pvt. Ltd., Chennai, 2004.
4	Mark Peakman, Diego Vergani, "Basic and Clinical Immunology", Elsevier Science, 2009

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3		3	3						2	3	2	3
CO2		3		3	3						2	3	2	3
CO3		3		3	3						2	3	2	3
CO4		3		3	3						2	3	3	3
CO5		3		3	3						2	3	3	3

K.S.Rangasamy College of Technology – Autonomous R 2018

50 BT E23- Stem Cell Technology

B. Tech. Biotechnology

Semester	Hours / Week			Total Hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To familiarize the basic knowledge on embryology and developmental biology.
- To learn the different developmental phases of stem cells and establishment of stem cell banks.
- To develop the skills in the area of stem cell research and its applications.
- To widen the knowledge about the isolation.
- To develop the culturing procedure and applications of stem cells to treat diseases.

Course Outcomes

At the end of the course, the students will be able to

CO1: highlight the origin, types, sources, characterization and applications of stem cells.

CO2: explain the sources, properties and challenges in establishing the human embryonic stem cell banks.

CO3: interpret the isolation neural stem cells, preparation of complete neuroculture and Immunolabeling procedures.

CO4: identify the novel stem cell based gene therapy and genetically engineered stem cells in animal cloning.

CO5: demonstrate role of stem cells in cellular assay, drug discovery and hematopoietic stem cell Transplantation

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO STEM CELLS

Introduction to stem cells, embryogenesis, differentiation and types of stem cells, origin and characterization of human stem cells and its applications-plasticity of human somatic stem cells-sources of stem cells: cord blood and bone marrow-scientific and technical obstacles of novel human stem cell based therapy-stem cell marker. [9]

HUMAN EMBRYONIC STEM CELL

Sources for human embryonic stem cells (hESC)-growing of hESC in laboratory-animal stem cells-current advantages and limitations of hESC and human somatic cells-properties of embryonic stem cells-developments regarding establishment of human stem cell banks and registries-regulations in European member and Non-European countries regarding hESC research. [9]

ISOLATION AND IDENTIFICATION OF STEM CELLS

Neural diseases-preparation of complete neuroculture, culturing and subculturing human neurospheres -differentiation of human neurospheres and neurons, astrocytes and oligodendrocytes-immuno-labelling procedure- mesenchymal stem cells-retinal stem cells- bone marrow. [9]

STEM CELL THERAPY

Novel stem cell based gene therapy, genetically engineered stem cells-stem cells and animal cloning-transgenic animals and stem cells- stem cell therapy vs cell protection-stem cell in cellular assays for screening-stem cell based drug discovery and toxicological studies-hematopoietic stem cell transplantation. [9]

APPLICATIONS OF STEM CELLS

Clinical applications of hematopoietic stem cells from cord blood, treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease-treatment of cardiac arrest-repair of damaged organs such as theliver and pancreas- application of stem cells in bone regeneration. [9]

Total Hours: 45 hours

Text book(s):

1	Robert Lanza and Antony Atala " Essentials of stem cell biology" 3rd edition, Elesvier academic press, 2014.
2	Jane E. Bottenstein. "Neural Stem Cells, Development and Transplantation", Springer India Pvt. Ltd.New Delhi, 2010.

Reference(s):

1	Gary S Stein et al., "Human stem cell Technology and Biology" a Research guide and Laboratory manualWiley-Blackwell(2011
2	Thomas C.G. Bosch. "Stem Cells, from Hydra to Man", Springer India Pvt. Ltd., New Delhi, 2009.
3	Raul Delgado-Morales, "Stem Cell Genetics for Biomedical Research: Past, Present and Future", Springer International Publishing, 2018.
4	Aditya Bharadwaj, "Global Perspectives on Stem Cell Technologies", Springer International Publishing, 2017.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E24 – Tissue Engineering

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To learn the basics of tissue structure and its organization in human and other animals.
- To widen the knowledge about the culturing of tissues.
- To develop the skills of the students in the area of tissue engineering.
- To impart the knowledge on tissue transplantation.
- To develop the skills related to molecular interactions in tissue engineering.

Course Outcomes

At the end of the course, the students will be able to

CO1: detail the basic concepts of tissue engineering such as its origin, triad and a cellular prosthesis

CO2: explore the concept of vascularisation and organization of cells into higher ordered structures.

CO3: demonstrate the transport porperties and diffusion of simple metabolites through tissues and its limitations

CO4:describe the recent advancement of 3D cultures in tissue engineering and the applications of growth factors

CO5:highlight the application of tissue engineering for renal function replacement, bone regeneration and skin tissue replacement

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO TISSUE ENGINEERING

History and scope of tissue engineering - definition - scientific challenges, general scientific issues – tissue engineering in perspectives - origin, triad, a cellular prosthesis - stem cells: basic principles, cell culture techniques in tissue engineering. [9]

STRUCTURE AND ORGANIZATION OF TISSUES

Vascularisation of *in vitro* and *in vivo* - organization of cells into higher ordered structures - EMT and MET transformation - composition and delivery of ECM - receptors for extracellular matrix molecules. [9]

TRANSPORT PROPERTIES OF TISSUES

Mass transfer in tissue, diffusion of simple metabolites, diffusion and reaction of proteins-carrier protein and channel- molecular and cell transport through tissues, cell-cell interaction and cell-matrix interaction – transport limits in 3D culture. [9]

GENERAL ASPECTS OF CELLS IN CULTURE

Cell migration and control of cell migration - differential cell adhesion and tissue organization - growth factor delivery in tissue engineering - scaffolds and tissue engineering – synthesis, properties and fabrication - transplantation immunology - applications of growth factors: VEGF/angiogenesis. [9]

APPLICATION OF TISSUE ENGINEERING

Liver organization and development, designing of bioreactors for liver tissue engineering, hepatic liver support system - tissue engineering approach to renal function replacement - bone regeneration by mesenchymal stem cells - skin tissue engineering and its replacement. [9]

Total Hours: 45 hours

Text books:

1. Samuel E., Lynch L.L. and Be Roberts J. Geng, “Tissue Engineering”, Wiley Black well, Singapore, 2010.
2. Ravi Birla, “Introduction to Tissue Engineering: Application and Challenges”, Wiley & Sons, New Jersey, 2014.

Reference(s):

1. Clemens A. van Blitterswijk and Jan de Boer, “Tissue Engineering” 2nd Edition, Academic Press, UK, 2014
2. Lanza L. and Langer P., “Principle and Applications of Tissue Engineering”, Wiley Black well, Singapore,2010.
3. MasoudMozafari, FarshiSefat and Anthony Atala, “Hand book of Tissue Engineering scaffolds: Volume Two”,Woodhead Publishing series in Biomaterials, Cambridge, US, 2019
4. Lijie Grace Zhang, John P Fisher, Kam Leong, “3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine”, Elsevier Science, 2015.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	2	2		2		2		3	**3**	**3**
CO2	3	3	3	3	2		2	2	3		3	2	**3**	**3**
CO3	3	3	2	3	3	2		2		3	2	2	**3**	**3**
CO4	3	2	3	3		2		3		2	3	3	**3**	**3**
CO5	3	3	2	3	3		2		3	3	2	3	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E25 - Biomedical Instrumentation

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To learn about the instrumental analysis of human physiology and anatomy.
- To familiarize about the various electrical and non-electrical measurements aids
- To identify the applications of chemicals in the synthesis of implant materials.
- To understand the concepts of imaging in diagnosis and monitoring effectiveness of the treatments.
- To acquire knowledge on the existing life assisting and robotic devices.

Course Outcomes

At the end of the course, the students will be able to

CO 1: reproduce the basic bio- potential and biochemical rhythm of human physiology with its characteristics
CO 2: quantify the electrical parameters measurement in correlation to the instruments and the role of physiological signals and transducers
CO 3: report the role of non- electrical parameters measurement in correlation to the human physiology
CO 4: categorize various biomaterials for various biomedical applications
CO 5: demonstrate and interpret the imaging equipment principles and output signals

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

BASIC ELECTRO-PHYSIOLOGY AND BIOMECHANICS OF HUMAN SYSTEM

Electrical Potentials in the human body and the origin of Bio-mechanics. Neuromuscular system: neurons, synapses and muscles, electrical properties of nerves and muscles. Basic components of a biomedical system- Cardiovascular systems- Respiratory systems -Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs. [9]

ELECTRICAL PARAMETER MEASUREMENTS

Bio-potential electrodes, biological amplifiers, ECG, EEG, EMG, ERG, lead systems and recording methods, typical waveforms and signal characteristics. Physiological signals and transducers - Transducers – selection criteria – Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors. [9]

NON-ELECTRICAL PARAMETER MEASUREMENTS

Measurement of blood pressure; Cardiac output, Heart rate and Heart sound. Pulmonary function measurement: spirometer, Photo Plethysmography and Body Plethysmography – Blood Gas analysers: pH of blood: measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements. [9]

BIOMATERIALS

Definition and classification of bio-materials, wound healing process, body response to implants, blood compatibility. Implant materials: Metallic implant materials. Polymeric implant materials: Polymerization, polyamides, Acrylic polymers, rubbers. Bio polymers: Collagen and Elastin. Medical Textiles: Silica, Chitosan, PLA composites, Sutures and wound dressings. [9]

DIAGNOSTIC IMAGING AND THERAPEUTIC DEVICES

Ionizing radiation, Diagnostic x-ray equipment, use of Radio Isotope in diagnosis, medical image modalities: MRI, PET, SPECT and CT. Endoscopy: bronchoscope, gastro scope, colonoscope – Ultrasonography –Thermography – Different types of biotelemetry systems and patient monitoring system. Therapeutic Devices**:** Pacemakers, Defibrillators, Ventilators, Diathermy – Dialysers and Lithotripsy.

Nano robots: surgery – 3D surgical techniques and orthopedic prostheses fixation. **[9]**	
Total Hours: 45 hours	
Text books:	
1	Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2014.
2	Anandanatarajan, R., "Biomedical Instrumentation and Measurements", PHI Learning, New Delhi, 2011.
Reference(s):	
1	Webster, J. G. Biomedical instrumentation. in Handbook of Research on Biomedical Engineering Education and Advanced Bioengineering Learning: Interdisciplinary Concepts, 2012.
2	Cromwell, L., Weibell, F. J., Pfeiffer, E. A. &Usselman, L. B. Biomedical instrumentation and measurements. Biomed InstrumMeas, 1973.
3	Marcus, R. T. Colorometry. Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, 2014.
4	John G. Webster, John William Clark. " Medical Instrumentation: Application and Design", Wiley Publishers, 2010

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					3						3	2	2	3
CO2	3	3	3	3	3						3	3	3	3
CO3	3	3	3	3	2						2	3	3	2
CO4	3	3	2	3	2						3	3	3	3
CO5	3	3	2								2	2	3	3

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E31- Bioresource Technology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)	• To make the students to understand about the bio resource and its sustainable utilization. • To familiarize the bioenergy production methods though cost effective methods. • To understand the role of microorganisms in bioenergy production • To equip the students to use the resource wisely through advanced technologies. • To facilitate the students to adopt the sophisticated technology for bio resource management..
Course Outcomes	**At the end of the course, the students will be able to** CO1: explore the different types of bioresources and the roles of bioprospecting, ecotourism and biodiversity policies CO2: design a bioreactor for efficient bio-energy production and scaling-up procedures CO3: analyze the cell growth and the kinetics of product formation and enzymatic conversions CO4: interpret and analyse the optimization yield, recycle and minimize the waste generation CO5: elucidate the concepts of activated sludge, digestion, biodegradation and bio filtration:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

INTRODUCTION TO BIORESOURCES

Bioresources and its types - availability of different organic wastes - characteristics of solid and liquid wastes - consumptive use: logging, fishing, quarrying and Non-consumptive use: bioprospecting, ecotourism, research - biodiversity policies: importance of natural resources economic development policies, environmental and natural resources policies. [9]

BIOENERGY

Different bioenergy generation processes: biomethanation, biohydrogen, bioethanol, biodiesel – bioreactor design for bio-energy - comparative analysis on different bioenergy generation processes - scaling up problems - economic analysis of the process. [9]

MICROBIAL RESOURCES

Cell growth and product formation kinetics, enzymatic conversion and treatment of cellulose and lignocelluloses - algalcultivation and harvesting for Microbial Fuel Cells - biocatalysis - biopolymers - biosurfactants. [9]

NATURAL RESOURCE MANAGEMENT AND CONSERVATION

Sustainable yield management - reduction and minimization of waste - recycling of solid, liquid and gaseous wastes - integrated development planning and integrated coastal zone management - environmental impact assessments - protected area systems - community based natural resource - Remote sensing and GIS. [9]

BIORESOURCE UTILISATION

Activated sludge - aerobic and anaerobic digestion - biodegradation of toxic compounds - biofiltration - biological nutrients removal - bioremediation – biosorption and bioleaching of heavy metals – constructed wetlands for industrial effluents - membrane technology. [9]

Total Hours: 45 hours

Text books:

1. Ashok Pandey, “Concise Encyclopedia of Bioresource Technology”, CRC Press, 2009.
2. Goodbody, I. and Thomas-Hope, E. “Natural Resource Management for Sustainable Development oftheCaribbean”, Canoe Press, University of the West Indies, Mona, 2002.

Reference(s):

1. Cunningham W. and Saigo B., “Environmental Science, A Global Concern”, McGraw Hill, New York,2001.
2. Sangeetha, Jeyabalan, Thangadurai, D, “Industrial biotechnology: sustainable production and bioresourceutilization”, Apple Academic Press, 2016.
3. Yoram Krozer, Michael Narodoslawsky “Economics of Bioresources: Concepts, Tools, Experiences” SpringerInternational Publishing, 2019
4. Ashok Pandey, Christian Larroche, Ram Sarup Singh, Reeta Rani Singhania, “Biomass, Biofuels, Biochemicals:Advances in Enzyme Technology”, Elsevier Science Publishing, 2019.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E32- Biophysics

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To impart fundamental knowledge about biomaterials and advanced materials.
- To learn bioinstrumentation of ultrasound scan and radio isotope measuring instruments.
- To know the instrumentation of spectroscopic methods like UV-VIS, RAMAN, NMR, ESR and FTIR.
- To correlate the theoretical principles with application oriented studies.
- To acquire knowledge on medical bio instruments

Course Outcomes

At the end of the course, the students will be able to

CO1: recognize the properties of natural and synthetic biomaterials to fabricate medical devices/implants

CO2: apply the properties of metallic glasses, Shape Memory Alloys(SMA) and Microelectro Mechanical Systems(MEMS)

CO3: understand the principles and properties of ultrasound in scanning and outline phono Cardio Gram (PCG)to monitor human body functions

CO4: describe and apply the principles of UV- VISIBLE spectroscopy

CO5: describe and apply the principles of RAMAN-NMR spectroscopy

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

BIOMATERIALS

Introduction-Biocompatibility –Biofunctionality-Metals and Alloys in biomaterials- Ceramic biomaterials- Composite biomaterials- polymer biomaterials-biopolymers-tissue grafts-soft tissue applications-biomaterials in ophthalmology-Dental materials. [9]

ADVANCED MATERIALS

Metallic glasses: preparation, properties and applications – Shape memory alloys (SMA):Characteristics, properties of NiTi alloy, application- MEMS — Nanomaterials: Properties- Top-down process: Ball Milling method — Bottom-up process: Vapour Phase Deposition method- Carbon Nano Tube(CNT): Properties, preparation by Electric arc method-Applications.[9]

Total Hours: 45 hours

Text books:

1. Palanisamy P.K.,"Physics of Materials", Scitech Publications,Chennai-2012
2. Murugesan,R., "Modern Physics" S.Chand Publications, New Delhi, 2010.

Reference(s):

1. Willard, B. and Merit, "Instrumental methods of Analysis", CBS Publishers and Distributors Pvt.Ltd., New Delhi,1986.
2. Sharma, B.K., "Spectroscopy", Goel Publishing House, Meerut, UP-2001
3. Jay L. Nadeau "Introduction to Experimental Biophysics, Second Edition: Biological Methods for PhysicalScientists" CRC Press, 2018
4. Andrey B. Rubin "Fundamentals of Biophysics" Wiley-Scrivener, 2014

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E33-Metabolic Engineering

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To learn basics about the metabolism and feedback regulation
- To make the student to understand synthesis of metabolites
- To explore the bioconversion reactions and their applications
- To impart the role of enzymes in metabolic pathway
- To apply the knowledge of bioinformatics in metabolic engineering

Course Outcomes

At the end of the course, the students will be able to

CO1:explain the concepts of feedback regulation, importance, scope and future of metabolic engineering.
CO2: identify and validate the regulation of secondary metabolite pathways and catabolite regulation.
CO3:explore mixed or sequential bioconversions and applications of bioconversions.
CO4:elucidate the fermentation and modify metabolic pathways for improved yield.
CO5:create algorithms for metabolic pathway synthesis and structure the metabolic networks.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

COMPONENTS OF METABOLIC ENGINEERING

Basic concepts of metabolic engineering - overview of cellular metabolism - different models for cellular reactions - JacobMonod model - catabolite, camp deficiency - feedback regulation - regulation in branched pathways, concerted and cumulative feedback regulation – scope and future of metabolic engineering. [9]

SYNTHESIS OF PRIMARY METABOLITES AND SECONDARY METABOLITES

Alteration of feedback regulation - limiting accumulation of end products - resistant mutants - alteration of permeability - amino acid synthesis pathways and its regulation at enzyme and whole cell level - regulation of secondary metabolite pathways - precursor effects - prophophase, idiophase relationships, catabolite regulation by passing control of secondarymetabolism. [9]

BIOCONVERSIONS

Advantages of bioconversions - specificity - yields - factors important to bioconversions - regulation of enzyme synthesis - mutation - permeability - co-metabolism - avoidance of product inhibition - mixed or sequential bioconversions - conversion of insoluble substances - applications of bioconversions. [9]

REGULATION OF ENZYME PRODUCTION

Strain selection and its genetic improvement - gene dosage - metabolic pathway manipulations to improve the fermentation - optimization and control of the metabolic activities - improving fermentation - modification of the existing or theintroduction of entirely new metabolic pathways. [9]

ROLE OF COMPUTER MODELING IN METABOLIC ENGINEERING Experimental determination method of flux distribution - metabolic flux analysis and its applications — metabolic engineering withbioinformatics - metabolic pathway modeling - analysis of metabolic control and the structure metabolic networks - metabolic pathway synthesis algorithms - modeling of individual metabolic pathway with computer network. [9]	
Total Hours: 45 hours	
Text books:	
1	Cortassa S., Aon M.A., Iglesias A.A, Aon J.C. and Lloyd D., "An introduction to metabolic and cellular engineering",2nd edition,World Scientific, 2011.
2	George Stephanopoulos, Aristos A. Aristidou and Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, 1998.
Reference(s):	
1	John Villadsen, Jens Nielsen and Gunnar Lidenn (Eds), "Bioreaction Engineering Principles", 3rd edition, SpringerNew York, 2011.
2	Christina Smolke, "The Metabolic Pathway Engineering Handbook: Fundamentals", CRC Press, 2009
3	P Gunasekaran, Santosh Noronha, Ashok Pandey, "Current Developments in Biotechnology and Bioengineering.Functional Genomics and Metabolic Engineering", Elsevier, 2016
4	Arindam Kuila, Vinay Sharma, "Genetic and Metabolic Engineering for Improved Biofuel Production fromLignocellulosic Biomass", Elsevier, 2010

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E34- Bioreactor Design

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To understand the basic concepts of bioreactor and design of bioreactors.
- To design and analyse the biochemical reactors and their process stability.
- To identify various kinetic models and the mechanical aspects of reactor design.
- To study about the hydrodynamics and mass transfer in bioreactors.
- To make the students to undertake research / project work in designing of novel bioreactor forcommercial aspects.

Course Outcomes

At the end of the course, the students will be able to

CO1: elaborate the types of bioreactors such as aerobic, anaerobic, stirred tank and bubble column reactors.
CO2: design and analytic dynamics of biochemical reactors ,membrane and hollow fiber reactors
CO3: develop bioreactor geometry, calculation and measurement of mass transfer coefficient.
CO4: demonstrate the importance of hydrodynamic regime ,mixing power dissipation and gas hold up in bioreactors.
CO5: intrepret and analyse the design consideration and process strategies for plant and animal bioreactors.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

TYPES OF BIOREACTORS

General types of bioreactors: aerobic and anaerobic - conventional stirred tank and bubble columns – airlift loop, fixed bed, fluidized bed, immobilized whole cell and immobilized enzyme bioreactors. [9]

BIOREACTOR ANALYSIS AND DESIGN

Analysis of bioreactor dynamics - design solutions of biochemical reactors: airlift and rotary bioreactors - membrane reactors for enzymatic processes - hollow-fiber bioreactors - process stability of microbial reactors - analysis of mixed microbial population - microbial reactors with and without cell recycle. [9]

DESIGN OF BIOREACTORS

Bioreactor geometry, constants and variables, dependence of parameters - process calculations, overall mass transfer coefficient, power per volume concept, kinetic models and their effects in correlation development - mechanical aspects of reactor design. [9]

HYDRODYNAMICS AND MASS TRANSFER IN BIOREACTORS

Hydrodynamic regime, mixing and back mixing, transitional zones - power dissipation and gas holdup in bioreactors -mass transfer coefficient - significance and determination - isometric turbulence model in bioreactors - rheology of culture broths, modes and models for bioreactor operation. [9]

NOVEL BIOREACTORS

Photo-bioreactors - mammalian and plant cell bioreactors - inverse fluid flow units - microbial and mammalian cell hollowfiber - Frosch reactor - centrifugal field reactors. [9]

Total Hours: 45 hours

Text books:

1. Stanbury F P, Whitaker A and Hall S G, “Principles of Fermentation Technology”, Aditya Books, Pvt, Ltd., NewDelhi, 2013.
2. Bailey J.A and Ollis D.F., “Fundamentals of Biochemical Engineering”, McGraw Hill - New York, 1986.

Reference(s):

1. Karl Schrrugal, “Bioreaction Engineering”, John Wiley, UK, 1983.
2. Atkinson B and Mavitona F., “Biochemical Engineering - An Biotechnology Handbook, McGraw Hill,UK, 1991.
3. Carl-Fredrik Mandenius, “Bioreactors : design, operation and novel applications”, Wiley-VCH Verlag GmbH & Co,2016
4. Qin Ye, Jie Bao, Jian-Jiang Zhong (eds.) “Bioreactor Engineering Research and Industrial Applications I: CellFactories”, Springer-Verlag Berlin Heidelberg, 2017

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	3	3	2		3	3	2	**3**	**3**
CO2	3	2	3	2	3	2	3	2		3	2	3	**3**	**3**
CO3	3	3	3	3	3	3	2		2	3	3	3	**3**	**3**
CO4	3	2	2	3	3	2	3	2		3	3	3	**3**	**3**
CO5	2	3	3	2	3	3	3	2	2	3	3	3	**3**	**3**

K.S. Rangasamy College of Technology – Autonomous R2018

50 BT E35- Bioprocess Modelling and Simulation

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VI	3	0	0	45	3	40	60	100

Objective(s)

- To understand the basics of modeling principles for the implementation in the biochemical systems.
- To impart the knowledge of mathematical models and the numerical models for the modeling of a bioreactor.
- To develop and apply the modeling approaches for the thermal death kinetics.
- To demonstrate and validate the aspects of modeling process and simulation of a bioreactor.
- To provide the better understanding about the modeling approaches and the application of MATLAB and SIMULINK.

Course Outcomes

At the end of the course, the students will be able to

CO1: review energy equations, equilibrium states and chemical kinetics.

CO2: illustrate the modeling of the continuous and batch distillation system.

CO3: solve the problems related to the numerical integration.

CO4: demonstrate thermal death kinetics models and stochastic model for thermal sterilization.

CO5: execute MATLAB and SIMULINK in the bioprocess systems and simulation of CSTR in series and batch reactor.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

BASIC MODELING PRINCIPLES

Basic modeling principles - types of models - uses of mathematical modeling - classification of modeling techniques - fundamental laws - energy equations - continuity equation - equations of motion – transport equations - equations of state equilibrium states and chemical kinetics - examples. [9]

MATHEMATICAL MODELS

Reactor modeling: batch reactor - continuous stirred tank reactors with cooling and heating jacket or coil — fed batch reactor - steam jacketed vessel - bubble column system - airlift reactor - boiling of single component liquid: open and closed vessel - continuous boiling system - batch distillation. [9]

NUMERICAL METHODS

Solution of linear algebraic equations by Gauss elimination, Gauss siedel iterative method - solution of nonalgebraic equations by Bisection method, Newton Raphson Method - Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Euler's method and RungaKutta method. [9]

MODELING APPROACHES

Growth kinetic models - structured and unstructured systems - compartment models - deterministic and stochastic approaches for modeling structured systems - thermal death kinetics models - stochastic model for thermal sterilization of medium. [9]

APPLICATION OF MATLAB AND SIMULINK

Basics - data analysis - curve fittings - input and output in MATLAB - application in bioprocess systems: solving problems using MATLAB and SIMULINK for dynamic systems by numerical integration and Euler methods - simulation of CSTR in series and batch reactor. [9]

Total Hours: 45 hours

Text books:

1. Jain, M. K., S. R. K. Iyengar, and R. K. Jain, "Numerical Methods", 6th Edition, New Age International Publishers, New Delhi, 2012
2. Wayne Bequette, B., "Process Dynamics: Modeling, Analysis and Simulation", Prentice-Hall, 1998.

Reference(s):

1. Said S.E.H. Elnashaie and Parag Garhyan, "Conservation Equations and Modeling of Chemical and Biochemical Processes", Marcel Dekker, 2003.

2	Shuler, M.L. and Kargi, F., “Bioprocess Engineering - Basic concepts”, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
3	Bernhard Sonnleitner (auth.), Carl-Fredrik Mandenius, Nigel J Titchener-Hooker (eds.) “Measurement, Monitoring, Modelling and Control of Bioprocesses” Springer-Verlag Berlin Heidelberg, 2013
4	Pablo A. López Pérez, Ricardo Aguilar López, Ricardo Femat “Control in Bioprocessing: Modeling, Estimation and theUse of Soft Sensors”, Wiley, 2020

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
51 BT E41 – Nanobiotechnology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	2	0	2	45	3	50	50	100

Objective(s)	• Todevelopthefundamentalunderstandingofbasicconceptsofnanoparticles. • To learn the various methods to prepare different types of nano materials. • To know the various techniques to characterize the nano materials. • To widen the knowledge about the applications of nano particles in environment and pollution control system. • To apply the nano materials in medical and food industry.
Course Outcomes	**At the end of the course, the students will be able to** CO1: recall the basic concepts, systems and synthesize of different types of nano particles. CO2: classify the methods for the preparation of nano scale materials and its characterization. CO3: interpret the mechanism and role of biomolecules as nano materials. CO4: restate the application of transducing elements in bio nanotechnology and understand the mechanism of nanomaterials as drug delivery systems. CO5: employ nanotechnology for human health, environmental remediation, waste water treatment and food industry.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Nanobiotechnology and Synthesis

Introduction - types and properties of nanoparticles, Carbon nanotubes, Quantum dots, fullerenes, Nanopores, Nanoshells, Nanocomposites; synthesis of nanoscale materials - top down and bottom up approaches, physical method: ball milling -plasma arcing - laser ablation method, chemical method: sol gels — chemical vapour deposition, green synthesis of nanoparticles, nanoparticle synthesis by fungi, bacteria and actinomycetes. **[9]**

Nano molecules in biosystems

Introduction-lipids as nano bricks and mortar -lipid structure-self organizing supramolecular structures, proteins-S Layer proteins, nanoscale motors - based on bacteriorhodopsin - ion channels as sensors, DNA - DNA based artificial nanostructures - DNA as nanowires - DNAas Molecular tweezers. **[9]**

Nano biotechnological detection systems

Types of transducing element and its applications in bio-nanotechnology – electrochemical transducer, optical transducer, nano biosensor, quantum dots, gold nanoparticels, DNA detection, small scale systems of drug delivery - Pills, stent, gels and magnets.**[9]**

Characterization of Nanomaterials

Types of characterization, optical probe - CLSM, SNOM, 2PFM, DLS, electron probe - SEM, TEM, HRTEM, AES, STEM, scanning probe - AFM, CFM, MFM, STM, APM, spectroscopy probe - UPS, UVVS, AAS, LSPR, ion-particle probe - XRD, EDX, NMR, thermodynamic - TGA, DSC, BET. **[9]**

Synthesis, Characterization and application of nano particles

Green synthesis of nanoparticles, nanoparticle synthesis by fungi, bacteria and actinomycetes – characterization of nano particles— Applications of nano particles. Soft nanotechnology for drug deliverysystems [**9]**

Total Hours: 45 hours

Text books:

1. Mick Wilson, Kamali Kannangara, Geoff Smith and Michelle Simmon sons, “Nanotechnology Basic science and emerging technologies”, Overseas Press India Private Limited, New Delhi, India, 2005.
2. Niemeyer C. M. and Mirkin C. A., “Nanobiotechnology - Concepts, applications and perspectives” Wiley VCH Publishers, New Delhi, India, 2004.

Reference(s):

1. Ralph S. Greco, Fritz B. Prinz and Lane R., “Nanoscale Technology in biological systems”, Smithm CRC Press, California, USA, 2005.
2. Chad A Mirkin and Christof M. Niemeyer (Eds), “Nanobiotechnology - II more concepts and applications”, Wiley VCH, 2007.
3. Arunava Goswami and Samrat Roy Choudhury, “Nanobiotechnology basic and applied aspects”, Union Bridge Books,2017.
4. Jesus M. de la Fuente, V. Grazu, “Nanobiotechnology Inorganic Nanoparticles Vs Organic Nanoparticles”, Elsevier Science, 2012.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2		2	3		2	3	**3**	**3**
CO2	3	2	3	3	3	2	2			2	2	3	**3**	**3**
CO3	2	2	3	3		2		2	2		3	3	**3**	**3**
CO4	3	2	2		2	2		2		2	2	2	**3**	**3**
CO5	2			2		2		2	3		2	2	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

51 BT E42 - Bioinstrumentation

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	2	0	2	45	3	50	50	100

Objective(s)

- To know the basics of ions in buffer system and sedimentation of particles
- To separate the biomolecules using different techniques
- To partition the genetic materials using electrophoretic techniques.
- To widen the knowledge about spectroscopic techniques in macromolecule separation.
- To apply the theoretical knowledge to understand the practical's.

Course Outcomes

At the end of the course, the students will be able to

CO1: recall the electrochemistry and types of centrifugation techniques
CO2: classify the chromatographic techniques for biomolecule separation
CO3: interpret the electrophoretic banding pattern
CO4: recite the spectroscopic techniques in molecule separation
CO5: learn the biomolecule separation techniques

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Electrochemical and centrifugation techniques

Measurement of pH and its significance – Definition, Buffers and pH control weak acid and weak acid equilibrium. Principle, operation and Glass electrode and pH measurements; Determination of pH by using the pH meter Centrifugation- Basic principles centrifuge and its applications in biological science –Types of centrifugation - Preparative, analytical, ultra centrifuge and its application and sedimentation, coefficient. [9]

Chromatographic techniques

Definition, principle, performance parameters, retention, resolution, types of chromatography principles and application of Paper, Column, Affinity, Adsorption, Partition chromatography, TLC, ion exchange, GC and HPLC. Types of exchangers,DNA cellulose chromatography.[9]

Electrophoresis

Physical basis of Electrophoresis, development, principles, types of moving boundary, gel starch, polyacrylamide, non- denaturing and denaturing, electro — blotting. 2D-SDS PAGE and isoelectric focusing. Agaraose gel — applications in DNA analysis, capillary electrophoresis, PFGE, electrophoresis of RNA. Radio Immuno Assay. [9]

Spectroscopic techniques

Measurement of transmittance and absorbance- Beer- Lambert's Law — nature of interaction of electromagestic radiation with molecular of elements — Transitions in spectroscopy. Physical basis and applications of atomic and molecular spectroscopy: Absorption (UV, Visible, IR, NMR and ESR) and emission (Fluorescence, phosphorescence and chemi-luminance) spectroscopy, Mass spectroscopy, Turbidimetry and Nephelometry. [9]

Biomolecules analysis

Extraction of biomolecules form plants, bacteria, fungi – cold extraction, hot extraction, extract drying – rota vapour, Lyophilizer, spectrophotometric analysis of biomolecules, Biomolecule separation - Paper, Column, Affinity, Adsorption, Partition chromatography, TLC [9]

Total Hours: 45 hours

Text books:

1	Upadhyay, A., Upadhyay, K. and Nath, N., "Biophysical Chemistry: Principles and Techniques", 4th Edition, Himalaya Publishing House, New Delhi, 2007.
2	Wilson, K. and Walker, J., "Practical Biochemistry", 5th Edition, Cambridge University Press, Cambridge, UK, 2003.
Reference(s):	
1	Willard, H. H., Merritt, Jr. L., Dean, J. A. and Settle, Jr. F. A., "Instrumental Methods Analysis", 7th Edition, CBC Publishers andDistributors, New Delhi, 2007.
2	Ewing, G.W., "Instrumental Methods of Chemistry Analysis", McGraw Hill Publication, New Delhi, 1989.
3	Veerakumari L. "Bioinstrumentaion", MJP Publishers, Chennai, 2015
4	Prakash M. "Understanding BIOINSTRUMENTATION", Discovery Publishing House Pvt. Ltd., New Delhi, 2009.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			1			2	3	3	3	3
CO2	3	3	3	3	3			1			2	3	3	3	3
CO3	3	3	3	3	3			1			2	3	3	3	3
CO4	3	3	3	3	3			1			2	3	3	3	3
CO5	3	3	3	3	3			1			2	3	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018

51 BT E43 - Toxicology

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	2	0	2	45	3	50	50	100

Objective(s)	• To describe basic toxicological phenomena in the light of normal cellular and biochemical conditions • To explain the central principles regarding scientific communication, philosophy of science and bioethics • To identify and discuss strengths and limitations of different methods to study toxicological effects, and theirareas of application. • To analyse and critically review scientific articles in the field of toxicology. • To use the structure and language style appropriate for a scientific article.
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe basic toxicological principles and describe how different chemicals are taken up by processed in and eliminated from the body CO2: differentiate the importance of different organs for detoxification/ toxification of chemicals,and describe mechanisms for chemically induced neurotoxicity and endocrine toxicity CO3: describe different behaviour tests and their importance to discover of different neurological and endocrinological disturbances CO4: describe when different chemicals are most toxic, and mechanisms behind the effects CO5: apply different toxicological frameworks within the professional disciplines

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

General toxicological principles and overview of toxic substances

The part includes basic description how substances are absorbed by, distributed and eliminated from the body. The part contains awareness about toxicokinetic models and the processes of biotransformation. **[9]**

Toxicity in specific target organs, effects and mechanisms:

Basic toxicological knowledge of the effect of chemicals on central organs that are of significance for the uptakes/elimination and detoxification/toxification. Basic knowledge about how the communication systems of the body, the nervous system andthe endocrine system is influenced of chemicals. **[9]**

Behaviour toxicology:

basic behaviour toxicological knowledge, how behavioural techniques can reveal chemicals that give functional disturbances. **[9]**

Development toxicology:

basic knowledge of different developmental phases; embryonic and embryonic development, development during the neonatal period. Critical developmental phases then teratogenic injuries and functional disturbances are induced **[9]**

Toxicology and its application

Preparation of drugs from plants, bacteria, fungus – drug concentration optimization through in vitro and in vivo studies and Animal Experiments. **[9]**

Total Hours: 45 hours

Text books:

1. Ernest Hodgson. “A Text book of Modern Toxicology”, Wiley Publishing House, New Delhi, 2011.
2. Vij Krishan. “Text book of Forensic Medicine and Toxicology- Principles and Practice”, 4th Edition, Elsevier, Elsevier India PVt. Ltd., India

Reference(s):

1. *Casarett, Louis J.; Doull, John* Casarett and Doull's “Toxicology: the basic science of poisons” *Klaassen, Curtis D.* 8th ed. : New York : McGraw-Hill, 2013.
2. *Hayes, A. Wallace; Kruger, Claire L.* Hayes' “Principles and methods of toxicology”6. ed. 2015
3. Balram Pani. “Text book of Toxicology”. I.K. International Publishing House Pvt. Ltd., New Delhi, 2010.
4. Wallace Hayes, A., Tao Wang, Darlene Dixon. “Essentials of Toxicology”, 5th Edition, Academic Press, 2020

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	2	3	3			2			2	3	3	3
CO2		3	2	3	3			2			2	3	3	3
CO3		3	2	3	3			2			3	3	3	3
CO4		3	2	3	3			2			2	3	3	3
CO5		3	2	2	2			2			2	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018

51 BT E44 - Genomics and Proteomics

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	2	0	2	45	3	50	50	100

Objective(s)

- To know the overview of Genome and genetic analysis.
- To learn the implication of genome sequencing by learning the techniques.
- To impart idea on tools available for proteomic and genomic approaches.
- To have wide knowledge on applications of functional genomics and proteomics.
- To update the latest development in the field of genetics.

Course Outcomes

At the end of the course, the students will be able to

CO1: acquire knowledge on genome sequence and structure through genetic mapping, analysis and its expression

CO2: detail the precise order of nucleotides by sequencing methods and it leads to predict mutations.

CO3: analyze the information of gene expression and similarity among protein sequences and mine data from Different database..

CO4: handle the functional genomics in disease diagnosis and probe the interaction among proteins and ligands.

CO5: interpret and analyze the proteins with reference to 2D, IEF, MALDI-TOF and protein mass Fingerprinting

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Structural Genomics

Overview of genome - genome sequence acquisition and analysis - genetic elements that control gene expression: constitutive and inducible gene expression - genetic analysis: linkage mapping and analysis - high resolution chromosome maps - physical mapping: hybrid mapping strategies, sequence specific tags (SST), sequence-tagged sites (STS) and ISH. [9]

DNA Sequencing

Variations in sequencing methods - ladder, fluorescent, shotgun, transposon-mediated, automated sequencing - finding genes and mutations, genome wide measurement of gene expression, parallel signature sequencing, implications of DNA and genomes sequencing. Parallel signature sequencing, implications of DNA and genomes sequencing. [9]

Functional Genomics and its application

Comparative genomics of mitochondrial genome and eukaryotes, orthologs and paralogs, serial analysis of gene expression (SAGE), SAGE adaptation for downsized extracts (SADE), GEO dataset analysis - role of genomics in polygenic disorders, functional genomic analysis using forward and reverse genetics - pharmacogenomics. [9]

Proteomics

Overview of analytical proteomics, analytical protein and peptide separations, protein digestion techniques, SALSA: An Algorithm for Mining Specific Features of Tandem MS Data - applications of proteomics - mining proteomes - protein expression profiling - identifying protein-protein interactions and protein complexes - protein modifications and mapping protein - new directions inproteomics. [9]

Tools for Proteomics and Genomics

Isolation of DNA, RNA & Protein - Denaturing and Agarose gel electrophoresis – Western blotting – Southern blotting – Electroelution – Functional genomic tools, Structural proteomic tools. [9]

Total Hours: 45 hours

Text books:	
1	Sandor S., "Genomics and Proteomics: Functional and Computational Aspects", 1st edition, Springer, 2013.
2	Primrose S.B and Twyman R., "Principles of Genome Analysis and Genomics", Blackwell Publishers, 3rd edition, 2007.
Reference(s):	
1	Sandor Suhai, "Genomics and Proteomics", Springer US, 2007.
2	Saraswathy N, P Ramalingam, "Concepts and Techniques in Genomics and Proteomics", Elsevier Science, 2011.
3	Devarajan Thangadurai, Jeyabalan Sangeetha, "Genomics and Proteomics", Apple Academic Press, 2015
4	Daniel C. Liebler and John R. Yates, "Introduction to Proteomics", Humana press, New Jersey, 2002.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3			2		2	3	3	3	3
CO2	3	3	3	3	3	2	2	3	2		3	3	3	3
CO3	3	3	3	3	3	2		2	2	2	3	3	3	3
CO4	3	3	3	2	3		2	2			3	3	3	3
CO5	2	2	3	3	3		2	2	2	2	2	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018								
51 BT E45 – Agricultural Biotechnology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	2	0	2	45	3	50	50	100

Objective(s)	• To lean the basic concepts in the current practices of Agronomy. • To discuss the importance of agricultural structures and irrigation methods. • To understand the post-harvest procedures for the improvement of marketing strategy. • To facilitate the knowledge for Post-harvest technology development • To empower the students to became agro pruners.
Course Outcomes	**At the end of the course, the students will be able to** CO1. determine the principles of agronomy for managing the environmental impact of agriculture and tilth practices. CO2. outline the design and construction of farm shed, fences and structures for plant environment. CO3. elaborate the design and construction of canals, pipeline systems to moderate depression created to channel water. CO4. clarify the concept of designing, operation and testing of various machines used in post harvesting and storage practices. CO5. design the industrial oriented agro products production plant and project report preparation

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Principles of agronomy

Definition of agriculture and agronomy – Factors affecting crop growth – climate and weather parameters – Soil fertility and productivity–tillage and tilth - objective and principles –different kinds of tillage, Agricultue and climate Change. [9]

Basic Horticulture

Horticulture -Definition–scope and importance –Propagation –definition –propagation methods –seed propagation-vegetative propagation - cutting, layering, grafting and budding methods –specialized plant parts for propagation –micro propagation. [9]

Agricultural Structures

Site selection, design and construction of farmstead - farm house, cattle shed, dairy bam, poultry shed, hog housing, machinery and implement shed, storage structures for food grains, feed and forage. Design and construction of fences and farm roads. Structures for plant environment - green houses, poly houses and shade houses. [9]

Irrigation and drainage

Sources of water for irrigation - methods of irrigation - surface, sprinkler and drip, fertigation - Irrigation efficiencies and their estimation - design and construction of canals, field channels, underground pipelines system, Agriculture drainage, Darcy's law, design of surface and subsurface drainage, recycling of drainage water for irrigation. [9]

Agriculture Biotechnology techniques

Plants raise through tissue culture techniques, Hardening, Green house construction, Field plantation, Irrigation, Production of Biofertilizer& Biocontrol agents, Azolla cultivation, Spirulina cultivation and Mushrrom cultivation, Agro entrepreneurship technologies. **[9]**

Total Hours: 45 hours

Text books:

1. Sharma R.K.and Co., "Basics of Agriculture", Daya publishers, New Delhi, 2014.
2. Jagdishwar Sahay. "Elements of Agricultural Engineering", Standard Publishers Distributors, Delhi, 2006.

Reference(s):

1. George Acquaah, "Horticulture-principles and practices" Prentice-Half of India Pvt. Ltd., New Delhi, 2002.
2. Michael, A.M., "Irrigation -Theory and Practice" Vikas publishing house, New Delhi, 1990.
3. Michael and Ojha. "Principles of Agricultural Engineering" Jain brothers, New Delhi, 2005.
4. Harry L. Field, John M. Long, " Introduction to Agricultural Engineering Technology: A Problem Solving Approach", 4th Edition, Springer International Publishing AG, Switzerland, 2018

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E51 - Research Design and Analysis

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)

- To understand the types of research and various methods of sampling in research
- To learn the measurements and scales in applied research.
- To design the research work and methodology using literature review.
- To impart the knowledge on the interpretation of results from raw data.
- To enhance the knowledge on analysis of report and its compilation

Course Outcomes

At the end of the course the student would be able to learn

CO1: apply the research methodology and research process of theoretical knowledge in research design.

CO2: analyze the measurement of the collected samples and validate the research design.

CO3: illustrate the various research design and single case research design.

CO4: identify the research problem from the survey research and design the solution.

CO5: interpret the research findings and conclude the research hypothesis with scientific report writing and presentations

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Research Methodology

Definition, types - exploratory, conclusive, modeling and algorithmic research - research process: steps -datacollection methods: primary data - observation method, personal interview, telephonic interview, mail survey, questionnaire design and secondary data - internal and external sources. [9]

Measuring, sampling and validity

Measurement - scales of measurement, psychometric properties of good measurement - sampling: random, and nonrandom, random selection and random assignment, research validity - statistical conclusion, construct, internal and external validity. [9

Methods of research

Steps in survey research, qualitative research: characteristics, research validity - descriptive, interpretive, theoretical, internal and externa validity, methods - phenomenology, ethnography, case study research and grounded theory; mixed methods research. [9]

Experimental methods

Control techniques in experimental research - randomization, matching, counter balancing, control of participant and experimenter effects, experimental research design, quasi experimental designs - time-series and regression discontinuity, single-case designs and its methodological considerations. [9]

Analysis, interpretation and report

Introduction to discriminate analysis, factor analysis, cluster analysis, multidimensional scaling, conjoint analysis - report writing: types of report, guidelines to review report, typing instructions, poster and oral presentation. [9]

Total Hours: 45 hours

Text books:	
1	Larry B. Christensen, R. Burke Johnson and Lisa A. Turner, “Research Methods, Design and Analysis”, 12th edition, Pearson Education, Inc., New Jersey, 2014.
2	Leslie D. Rosenstein.“Research Design and Analysis”, Wiley, 2019.
Reference(s):	
1	Kothari C R, “Research Methodology - Methods and techniques”, New Age Publications, New Delhi, 2009.
2	Panneerselvam R, “Research Methodology”, Prentice-Hall of India, New Delhi, 2004.
3	Kamden K. Strunk, Mwarumba Mwavita, “Design and Analysis in Educational Research”, Taylor & Francis, 2020.
4	Larry B. Christensen, Burke Johnson, Lisa Anne Turner, “Research Methods, Design, and Analysis”, Pearson Education Limited, 2014.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	3	2		2						2	3	3
CO2	3	2	2	3	3			2			2	3	3	3
CO3	3	2	3	3	3			2			2	3	3	3
CO4	3	3	3	3	3			2			2	3	3	3
CO5	2	3		2	3			2			3	3	3	3

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E52 - Marine Biotechnology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)	• To provide the knowledge about the marine diversity • To know about the marine microbes and the aquatic animals • To impart the biomedical importance of marine organisms. • To learn the bioproducts derived from marine biodiversity • To understand the environmental impacts of the aquatic biotechnology.
Course Outcomes	**At the end of the course, the students will be able to** CO1: explain the different habitats of marine biodiversity and its nutrient requirements. CO2: describe the aquaculture related to artificial insemination, eye stalk ablation, transgenic fish technology and the role of probiotic bacteria in aquaculture. CO3: justify the use of bioactive compounds from different marine organisms. CO4: identify the marine sources that produces the biopolymers, biomaterials, antifouling compounds and biopotential uses of halophilic bacteria. CO5: interpret the bioremediation using microbes, environmental risks and benefits.:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Marine Biodiversity

Marine microbial diversity: symbiotic, free-living, biofilm, proximity to ocean surface or sediments: Euphotic, Mesopelagic, Bathopelagic, Benthos - concentration of nutrients and growth substrates: Oligotrophic, Mesotrophic, Eutrophic, algal blooms - hydrothermal vents: vent biodiversity - applications of extremozymes. [9]

Marine aquaculture

Shellfish and crustacean culture: shrimps, edible mussels, pearl oyster, crabs, fish aquaculture: artificial insemination,eyestalkablation-transgenicfishtechnology,transgenicfisheswithgrowthhormone(GH)and antifreeze genes, development of healthy fish diets, probiotics bacteria and their importance in aquaculture, vaccines foraquaculture.[9]

Biomedical importance of marine organisms

Marine pharmacology: pharmaceutical and bioactive natural products - microalgae as a source of bioactive molecules - new antibiotics and medicines from marine organisms – unculturable bacteria, occurrence, characteristics and exploitation. [9]

Biomaterials and Bioprocessing

Polymers and biomaterials: properties and production of agarose - agar - alginates - carrageenans - chitin - chitosan - carotene - heparin - marine flavourants - environmentally friendly antifouling compounds, biopotential uses of halophilic organisms. [9]

Environmental impacts of Aquatic biotechnology

Control of oil spills and bioremediation-Genetically Engineered Marine Organisms- sea weeds for removal of heavy metal pollutants - introduction of coral bleaching - biosphere reserve - Gulf of mannar, impact of invasive organisms, environmental and economic risks and benefits. [9]

Total Hours: 45 hours

Text books:

1. Bright Singh I.S, Somnath Pai S., Rosamma Philip and Mohan Das A., “Aquaculture Medicine”, 1 edition, Paico Printing Press, India, 2003.
2. Advances in Biochemical Engineering/Biotechnology- Marine Biotechnology I &II ; Y. LeGal, R. Ulber,Springer Verlag Berlin Heidelberg, 2005.

Reference(s):

1. Attaway, D. H., Zaborsky, O. R. (Ed.), “Marine Biotechnology: Volume I, Pharmaceuticals and Bioactive Natural Products”, New York, USA, 1993.
2. Y.K. Lee and S. Salminen, “Handbook of probiotics and prebiotics”, 2nd edition, Wiley, A John Wiley and sons publication, 2009.
3. Antonio Trincone, “Grand Challenges in Marine Biotechnology”, Springer International Publishing, 2018
4. Se-Kwon Kim, “Encyclopedia of Marine Biotechnology”, Wiley publisher, 2020

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2	2			3		2			3	**3**	**3**
CO2		2		3		2	2		2	2	3		**3**	**3**
CO3	3	2		3	2	2		2					**3**	**3**
CO4	2	3	3	3	3	2	2	2	3	2		3	**3**	**3**
CO5	3	3	2	3			2		2		3	3	**3**	**3**

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT E53 - Human Physiology and Anatomy

B.Tech. Biotechnology

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)

- To know the basic structural organization of human body
- To understand the parts involved to support and movement of human.
- To impart the knowledge of essential integration and control system.
- To learn the system involved for the regulation and maintenance of human body.
- To impart the concept of reproductive organ development.

Course Outcomes

At the end of the course, the students will be able to

CO1: describe the basic structural organization of the human body.

CO2: identify the human parts involved in anatomy and physiology

CO3: recall the structural and functional organization of nervous and special senses.

CO4: explore the function of circulatory, respiratory, digestive and urinary system.

CO5: outline the reproduction system and developmental process of human.:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Organization of the Human Body

The Human Organism: structural and functional organization of the human body- homeostasis – Cell Biology: functions of the cell- plasma membrane- membrane lipids and proteins- movement through the plasma membrane- cytoplasm– Tissues: types, tissue membranes, damage and its repair. [9]

Support and Movement

Integumentary System: physiology and functions - Skeletal System: functions of the skeletal system, Bone anatomy, development, growth, remodeling and repair - Joints and Movement: classes of joints and types of movement — Muscular System: functions of the muscular system, skeletal muscle structure and its general properties. [9]

Integration and Control Systems

Nervous Tissue: Function and Organization – Integration of Nervous System Functions: control of skeletal muscles, higher brain functions — The Special Senses: olfaction, taste, visual system, hearing and balance — Endocrine Glands: organization and its function. [9]

Regulation and Maintenance

Cardiovascular System: Blood, Vessels and Circulation – Functional organization: Respiratory System, Digestive System and Urinary System. [9]

Reproduction and Development

Reproduction system: anatomy and physiology of male and female – Development, Growth, Aging and Genetics: prenatal development, parturition and the newborn [9]

Total Hours: 45 hours

Text books:	
1	Vanputte C., Regan J.,, Russo A. “Anatomy & Physiology” 10th Edition, Mc Graw Hill Publisher, 2015
2	BhiseS. B., “Anatomy Physiology And Health Education”, Nirali Prakashan Publisher, 2008.
Reference(s):	
1	Rizzo D, “Fundamentals of Anatomy & Physiology”, 3rd edition, Clifton Park, NY: Thomson Delmar. ISBN: 1-1110-3869-4, 2010.
2	Linda L, French and Marilyn Takahashi Fordney, “Medical Insurance Billing and Coding An Essentials Work text, Saunders Publications, UK, 2002.
3	Eldra Pearl Solomon, “Introduction to Human Anatomy and Physiology”, Saunders/Elsevier, 2009
4	J. Gordon Betts, Peter Desaix, Edward W. Johnson, Jody E. Johnson, Oksana Korol, Dean Kruse, Brandon Poe, OpenStax College, James Wise, Mark D. Womble, Kelly A. Young, “Anatomy & Physiology” OpenStax College, Rice University publisher, 2013

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E54 - Biofuel Technology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)	• To impart the fundamentals and concepts of biofuels and its usage. • To learn the technology and advancements in the production of biofuel • To know the difference among the production of biodiesel, bioethanol and biohydrogen. • To enlighten the important and essential need of biofuel. • Toprovidethebetterunderstandingaboutthedesignandrecenttrendsofmicrobialfuelcells
Course Outcomes	**At the end of the course, the students will be able to** CO1: understand the fundamentals of biofuels and the various types offeed stocks for biofuel production. CO2: comprehend the sources, production process and quality assessment of biodiesel. CO3: illustrate the sources, bioconversion and applications of biogas CO4: know the sources, various technologies that are implemented in biohydrogen production and its quantification. CO5: outline the biochemical basis and fuel cell design of Microbial Fuel Cells**.**

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Overview of biofuels

Biofuels: energy use and efficiency - biofuel production - I and II generation biofuels - alternative energies - biochemical pathways review for organoheterotrophic, lithotrophic and phototrophic metabolism - biofuel feeds tocks: starch, sugar, lingo cellulosic, agro and industrial byproducts - biomass production for fuel - yeast and algal cultures - biomass conversion to heat and power. [9]

Production technology of Biodiesel and Bioethanol

Biodiesel: algae, edible and non edible oils as sources - production technologies: conventional and lipase mediated process - quality control aspects - ASTM (D-6751) and Indian standards (IS15607) - environmental and economic aspects of B100 and B20. Bioethanol: sugar, starch, lingo cellulosic substrates and byproducts of biodiesel industry as sources - production process - purification - uses of bioethanol - advances in bioethanol production. [9]

Biogas Production

Biogas: cow dung, agricultural and municipal waste as substrate - types of digesters and their suitability - aerobic and anaerobic bioconversion processes - factors affecting the biogas generation process - gas storage systems - application of biogas in domestic, industry and vehicles - advantages and disadvantages. [9]

Biohydrogen Production

Biohydrogen: Carbon sources and culture parameters - enzymes involved in the production process - production technologies: biophotolysis, photo fermentation and batch fermentation - reactors design - factors affecting the production process - detection and quantification - advances in biohydrogen production technology. [9]

Microbial Fuel Cells

Biochemical basis - fuel cell design: anode & cathode compartment - microbial cultures - redox mediators - exchange membrane - power density - MFC performance methods: substrate and biomass measurements - basic power calculations - wastewater treatment effectiveness - advances in MFC. [9]

Total Hours: 45 hours

Text books:	
1	Jonathan R.M, “Biofuels - Methods and Protocols (Methods in Molecular Biology Series)”, Humana Press, New York, 2009.
2	Caye M. Drapcho, N.P. Nhuan and T. H. Walker, “Biofuels Engineering Process Technology”, Mc Graw Hill Publishers,New York, 2008.
Reference(s):	
1	Lisbeth Olsson (Ed.), “Biofuels (Advances in Biochemical Engineering/Biotechnology Series)”, Springer- Publishers, Berlin, 2007.
2	Glazer and Nikaido, “Microbial Biotechnology - Fundamentals of Applied Microbiology”, 2nd ,Ed Cambridge University Press, 2007.
3	Vijai Kumar Gupta, Maria G. Tuohy, “Biofuel TechnologiesRecent Developments”, Springer Berlin Heidelberg, 2013
4	Hwai Chyuan Ong, Keat Teong Lee, Wei-Hsin Chen, “Biofuel and Bioenergy Technology”, MDPI AG Publisher, 2019.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT E55 - Systems Biology								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
VII	3	0	0	45	3	40	60	100

Objective(s)	• To understand the biological structure as well as network architecture of the system. • To learn the interactions between protein and ligand • To know the qualitative and quantitative dynamics of the system supported by predicted modeling • To identify the control points in the system • To design methodologies for the system.
Course Outcomes	**At the end of the course, the students will be able to** CO1: know the overview of the gene regulations, gene expression. CO2: identify the kinetics, identical and independent binding sites, interacting and non-interacting binding sites. CO3: distinguish the genetic switches and amplifiers for gene expression. CO4: define the principle of quorum sensing and Drosophila development. CO5: recite the basic concepts in gene expression networks and relate the aspects of multi-stability in Gene networks.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Fundamentals of Systems Biology

Overview of gene control - working of genetic switches - introductory systems biology the biochemical paradigm, genetic paradigm and the systems paradigm. [9]

Protein-ligand Interactions

Equilibrium binding and co-operativity - Michaelis-Menten Kinetics - identical and independent binding sites- Identical and interacting binding sites, non interacting binding sites. [9]

Gene Expression

Genetic switch in Lambda phage - Noise-based switches and amplifiers for gene expression - synthetic genetic switches - *E.coli* chemotaxis - biological oscillators - genetic oscillators - the origin and consequences of noise in biochemical systems. [9]

Developmental Systems Biology

Building an organism starting from a single cell **-** quorum sensing - programmed population control by cell- cell communication and regulated killing - Drosophila development - establishment of the developmental precision and proportions in the early Drosophila embryo. [9]

Gene expression networks

Generegulationatasinglecelllevel-transcriptionnetworks-basicconcepts- coherent Feed Forward Loop (FFL) and delay gate - the incoherent FFL - temporal order, signaling networks and neuron circuits - aspects of multi-stability in the gene networks. [9]

Total Hours: 45 hours

Text books:

1. Uri Alon, "An Introduction to Systems Biology: Design Principles of Biological Circuits", 2nd edition, CRC Press, 2006.
2. Edda Klipp, Wolfram Liebermeister, Christoph Wierling and Axel Kowald, "Systems Biology: A Textbook", 2nd Edition, Wiley-Blackwell, 2016.

Reference(s):	
1	Kitano *et al.,* "Systems Biology: A Brief Overview, Science", Vol.295, pp.1662-1664, 2002.
2	John Ross et al., "Complex Systems: From Chemistry to Systems Biology", PNAS, Vol.106, pp.6433- 6434, 2009.
3	Job Dekker, Marc Vidal, Marian Walhout, "Handbook of Systems Biology", Elsevier Science, 2012
4	Uri Alon, "An Introduction to Systems Biology", Taylor & Francis, 2007

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3			2							2	2	2
CO2	3	3	3	3	3							3	2	2
CO3		3	3	3	3							3	3	3
CO4		3	3	3	3							3	3	3
CO5		2										2	2	2

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT L01 - Agricultural Engineering								
B.Tech. Biotechnology								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	3	0	0	45	3	40	60	100

Objective(s)

- To lean the basic concepts in the current practices of Agronomy.
- To discuss the importance of agricultural structures and irrigation methods.
- To understand the post-harvest procedures for the improvement of marketing strategy.
- To facilitate the knowledge for Post-harvest technology development
- To empower the students to became agro pruners.

Course Outcomes

At the end of the course, the students will be able to

CO1. determine the principles of agronomy for managing the environmental impact of agriculture and tilth practices.
CO2. outline the design and construction of farm shed, fences and structures for plant environment.
CO3. elaborate the design and construction of canals, pipeline systems to moderate depression created to channel water.
CO4. clarify the concept of designing, operation and testing of various machines used in post harvesting and storage practices.
CO5. design the industrial oriented agro products production plant and project report preparation

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

PRINCIPLES OF AGRONOMY

Definition of agriculture and agronomy- Branches and scope of Agriculture - Factors affecting crop growth -Soil fertility and productivity - tillage and tilth - different kinds of tillage: Earth moving equipment - their construction and working principles viz Bulldozer, Trencher, Excavators etc. [9]

AGRICULTURAL STRUCTURES

Site selection, design and construction of farmstead - farm house, cattle shed, poultry shed, hog housing, machinery and implement shed, Design and construction of fences and farm roads. Structures for plant environment - green houses, poly houses and shade houses, Storage structures of food grains and feeds. [9]

IRRIGATION AND DRAINAGE

Sources of water for irrigation - methods of irrigation - surface, sprinkler and drip, fertigation - Irrigation efficiencies and their estimation - design and construction of canals, field channels, underground pipelines system, Agriculture drainage,Darcy's law, design of surface and subsurface drainage, recycling of drainage water for irrigation. [9]

POST HARVEST AND STORAGE ENGINEERING

Harvest - Post harvest Threshing machines - design, principles, operations, maintenance and testing -winnovers, cleaners and graders & separators, design principles, operation, maintenance and testing - Dehuller, dehusker and packing unit - storage bins, long term storage container and cold storage design. [9]

PLANT INSTALLATION AND REPORT PREPARATION

Industrial layout planning and installation, power and power transmission, sanitation, cost analysis, detailed project report preparation, design and requirement of industrial production plant - Case studies for design of modern rice plant and layout - Bank statement and audited returns.[9]

Total Hours: 45 hours

Text books:

1	Sharma R.K.and Co., "Basics of Agriculture", Daya publishers, New Delhi, 2014.
2	Jagdishwar Sahay. "Elements of Agricultural Engineering", Standard Publishers Distributors, Delhi, 2006.

Reference(s):

1	George Acquaah, "Horticulture-principles and practices" Prentice-Half of India Pvt. Ltd., New Delhi, 2002.
2	Michael, A.M., "Irrigation -Theory and Practice" Vikas publishing house, New Delhi, 1990.
3	Michael and Ojha. "Principles of Agricultural Engineering" Jain brothers, New Delhi, 2005.
4	Harry L. Field, John M. Long, " Introduction to Agricultural Engineering Technology: A Problem Solving Approach", 4th Edition, Springer International Publishing AG, Switzerland, 2018

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT L05 – Basics of Genetic Engineering

Common to All

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	3	0	0	45	3	40	60	100

Objective(s)

- To discuss the methods, tools and techniques involved in genome analysis, expression of cloned Genes in different host system.
- To understand the production of recombinant proteins, mutation analysis and the importance of PCR ingenome analysis.
- The student would learn about various aspects of Genetic Engineering, its application and ethical issues.
- To determine the strategies involved in gene cloning with the help of genomic libraries, cDNA libraries andother libraries.
- To discuss the production of useful molecules like cytokines, vaccines and antibiotics and define the safetyguidelines for recombinant.

Course Outcomes

At the end of the course, the students will be able to

CO1: describe restriction and modification system and their role in genetic engineering and illustrate the different types of blotting techniques.

CO2: characterize the cloning vectors used in manipulation of genes like plasmids, phagemids, cosmids, artificial chromosomes, plant and animal vectors.

CO3: determine the strategies involved in gene cloning with the help of DNA librarites and methods involved in screening of cloned genes to identify the target gene from the library.

CO4: illustrate the PCR based techniques involved in genetic manipulation including mutagenesis and demonstrate various sequencing techniques

CO5:comprehend the applications of rDNA technology and describe the role of knock out and RNAinterferencetechnology in gene expression studies.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

BASICS OF RECOMBINANT DNA TECHNOLOGY

Nucleases: Exonucleases and Endonucleases, Restriction Enzymes, RNases, Methylases, Polymerases: DNA Pol I, Klenow Fragments, Reverse Transcriptase, Taq Polymerases. Ligases: T4 DNA Ligase, *E.coli* DNA Ligase, T4 RNA Ligase, Topoisomerases, End Modifying Enzymes: Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases [9]

CREATION OF RECOMBINANT MOLECULES

Restriction mapping, design of linkers and adaptors. Characteristics of plasmid and phage vectors, cosmids, prokaryotic and eukaryotic

Total Hours: 45 hours

Text books:

1. Smita Rastogi and Neelam Pathak, “Genetic Engineering”, Oxford Publication, 2010
2. Ragagopal K., “Recombinant DNA Technology and Genetic Engineering”, Tata McGraw Hill Education Private Ltd., 2012.

Reference(s):	
1	Primrose S.B. &Twyman R.M., “Principles of Gene Manipulation and Genomics”, 7th Edition, Blackwell Publishing. 2006.
2	Richard J. Reece., “Analysis of Genes and Genomes”, John Wiley and Sons Ltd., Singapore, 2004.
3	Gyana Ranjan Rout, K,V, Peter, “ Genetic Engineering of Horticultural crops” Academic Press An imprint of Elsevier, 2018.
4	Desmond S.T. Nicholl, “An Introduction to Genetic Engineering”, Third Edition Cambridge University Press NewYork, 2008.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT L06- Animal Studies in Food Research								
Common to all								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	3	0	0	45	3	40	60	100

Objective(s)	• Tounderstand the functional food concept as related to ingredient efficacy and its nutraceutical properties. • To widen the knowledge on role of food in disease management. • To provide basic concepts on clinical trials. • To Familiarize the principles of pharmacological research. • To extent scientific knowledge on the regulations for animal research
Course Outcomes	**At the end of the course, the students will be able to** CO1: describe the components of functional foods and nutraceuticals. CO2: assess the functions of food in preventing and managing diseases. CO3: interpret the understandings on toxicology and different animals used in preclinical testing. CO4: analyze the pharmacological parameters and management of laboratory animals. CO5: Provide understanding on regulations for the usage of animals in research.:

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Functional food and Nutraceutical

Introduction, classification and executive models for nutraceuticals; plant sources- Plant secondary metabolites; Alkaloids, phenols, Terpenoids. Animal source- Milk and products, meat, fish. Microbial source- prebiotics and probiotics, examples of bacteria used as probiotics, Synbiotics for maintaining good health. Algal source- omega - 3 PUFA. Relation of functional foods & Nutraceutical (FFN) to foods & drugs. [9]

Food in management of health and diseases

Food as a source of drug- nutraceuticals, Role of nutraceuticals in diabetes mellitus, circulatory problems, obesity and stress, nephrological disorders, liver disorders, cancer, osteoporosis, arthritis, psoriasis and ulcers. Examples of nutraceuticals as antioxidants in preventing diseases. [9]

Preclinical testing and clinical trials:

Basic Toxicology, Acute Toxicity studies, Multiple exposure studies, Basic Pharmacology & pharmaceutical chemistry, use of animal model and pre-clinical and clinical trials. New drugs- Investigation (IND) application, NDA requirements. Toxicology – oral toxicity, sub-acute, acute toxicity and chronic toxicity. Toxic dose, LD50, dose-response relationships. [9]

Pharmacological Research

Introduction, laboratory animals- physiological parameters and response, Handling and care of different animals; routes of administration oral, intraperitonial, intramuscular and intravenous; advantages and disadvantages of animal experimentation, anaesthesia and chemica euthanasia used in laboratory. [9]

Regulations for animal research

Animal ethics, regulations for conducting animal experimentation, 3 R's concept, alternatives to animal experimentations, Regulatory agencies, Pharmacovigilance, GCP Guidelines and GLP Guidelines, Research ethics and publication ethics. [9]

Total Hours: 45 hours

Text books:

1. Shayne C. Gad, Shayne C. Gad. "Animal models in Toxicology", 3rd edition, CRC Press. Taylor & Francis group,2016.
2. Robert , H., Weichbrod, Gail A., (Heidbrink) Thompson., John N. Norton," Management of Animal Care and UsePrograms in Research, Education, and Testing" 2nd ed, CRC Press. Taylor & Francis group, 2017.

Reference(s):	
1	Israel Goldberg (Ed.) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA,1999
2	Gupta., S.K., "Drug discovery and clinical Research,"Jaypee Brothers Medical Publishers,2011
3	Raj K. Keservani., Anil K. Sharma., Rajesh K. Kesharwani,"Nutraceuticals and Dietary Supplements Applications in Health Improvement and Disease Management", CRC Press. Taylor & Francis group,2021.
4	Young, J. (1996) Functional Foods: Strategies for successful product development. FT Management Report Pearson Professional Publishers, London.

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT L07 - Basics of Bioinformatics								
Common to all								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	3	0	0	45	3	40	60	100

Objective(s)	• To develop inter disciplinary skills in the application of computers in biotechnology and learn aboutthe biological data. • To learn about the bioinformatics databases, databanks, data format of Biological databases. • To understand the concept of data processing and data retrieval from the online sources. • To Analyze the optimal alignment using methods of sequence analysis • To acquire the applications and scope of in-silico biology.
Course Outcomes	**At the end of the course, the students will be able to** CO1: get acquainted with biological data acquisition methods and file formats CO2: recite various biological primary databases, secondary databases and different sequence file formats. CO3: characterize the optimal alignment of sequences either by local or global algorithm. CO4: describe the methods involved in pairwise and Multiple sequence alignment and analysis the conserved regions CO5: know the major applications of Bioinformatics and scope.

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

BIOLOGICAL DATA ACQUISITION

The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information, Scope of Bioinformatics, Data file formats, Data life Cycle and Database Management System models. [9]

DATABASES

Biological Database and its Types Introduction to data types and Source. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum). [9]

DATA PROCESSING

Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Local versus global. Distance metrics. Similarity and homology. Scoring matrices. [9]

METHODS OF ANALYSIS

Dynamic programming algorithms, Needleman-Wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment. [9]

APPLICATIONS

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis: Comparative genomics, orthologs, paralogs. Genome analysis – Genome annotation. [9]

Total Hours: 45 hours

Text books:

1. Arthur K. Lesk, "Introduction to Bioinformatics" Oxford University Press. ,4th edition 2014
2. Durbin R., Eddy S.,Krogh A., Mitchison G.,"Biological Sequence Analysis Probabilistic Models of proteins andnucleic acids" Cambridge University Press. 2013

Reference(s):

1. David W. Mount., "Bioinformatics Sequence and Genome Analysis", 2nd Edition, Cold Spring Harbor LaboratoryPress, New York, US, 2004.
2. Rastogi, S.C., "Bioinformatics – Concepts, skills and applications", CBS Publishers and Distributors, New Delhi, India, 2003.
3. EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss and Garry Wong,"RNA-Seq Data Analysis: A Practical Approach",CRC Press, 2014
4. Xinkun Wang,"Next Generation Sequencing Data Analysis" CRC Press, 2016

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018

50 BT L08 - Production Technology of Agriculture and Food Processing Machinery

Common to ALL

Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	3	0	0	45	3	40	60	100

Objective(s)

- To improve the level of understanding of agriculture and food processing machinery
- To help the agriculture farmers for selecting the appropriate machinery based on crops
- To know the various bakery products and its importance in machinery planning
- To enhance the knowledge of modern machinery in fruits and vegetable set up
- To apply the modern packing solution for various industry needs

Course Outcomes

At the end of the course, the students will be able to

CO1: employ the different production tools involved in the agriculture and food processing machinery
CO2: Analyse the different machinery involved in post harvest processing set up
CO3: interpret the strategy of planning of different machinery for bakery products
CO4: Enhance the knowledge of machinery involved in fruits and vegetable processing
CO5: recall the modern technology involved in food packing machinery

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Production Technology of farming machinery

Welding and its types, CNC machine, lathe machine, Drilling equipment, Laser cutting machinery and its types, Simulation software, Earth moving Equipment – their construction & working principles viz Buldozer, trencher, Excavators etc., Sowing, planting and transplanting equipment. [9]

Post harvesting machinery

Agriculture crop processing machinery – winnowers, graders, aspirators, destoner, Dehuller, Sheller, Separators, Elevators, Colour sortex machine, Rice polisher machine. [9]

Food Bakery machinery

Bakery machinery and equipment: Mixing- blenders, Horizontal and vertical planetary, Make up equipment, Divider, Rounder, Proofer, moulder. Baking equipment – Different types of oven, slicer. Cookies making machinery, cakes, buns and bread. [9]

Modern Fruits and Vegetable Processing machinery

Fruits sorter, Construction of Solar based cold storage and refrigerated vans, Freezer design and usage ; Plate contact freezer, air blast freezer, cryogenic freezer, Irradiation technology and machinery, Design of various dryer; PHTC, RPEX,LSU and Drum dryer. Solar dryer. [9]

Product packaging machinery

Benefit of Vacuum, gas and shrink packaging. Band sealing machine, Single head and multi head granules packaging machine, Wrapping machine, Thermal sealing machine, Liquid filling and pouch packing machinery. Powder packing machine and its variants. [9]

Total Hours: 45 hours

Text books:	
1	Zeki Berk, “Food Process Engineering and Technology”, Academic Press, 2018
2	Bosoi, E. S., “Theory, construction and calculation of Agriculture machines” (Vol 1 and 2), Oconion Press pvt.Ltd., New Delhi, 1990
Reference(s):	
1	Mukhopadhyay S.N., “Food Engineering: Process And Technology”, CRC Press, 2017
2.	Tadeusz Kudra, Arun S. Mujumdar, “Advanced Drying Technologies”, 2nd Edition, CRC Press, 2009
3.	Jagdishwar Sahay. “Elements of Agricultural Engineering”, Standard Publishers Distributors, Delhi, 2006.
4.	Harry L. Field, John M. Long, “ Introduction to Agricultural Engineering Technology: A Problem Solving Approach”,4th Edition, Springer International Publishing AG, Switzerland, 2018

Mapping of COs with POs and PSOs

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

K.S.Rangasamy College of Technology – Autonomous R2018								
50 BT L09 -Pollution and its management								
Common to All Department								
Semester	Hours / Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
V/VI/VII	**3**	**0**	**0**	**45**	**3**	**40**	**60**	**100**
Objective(s)	• To learn the fundamental concepts in the field of pollution. • To study the depth of different pollution and its control. • To impart knowledge on hazardous waste management. • To develop methods for removal of pollutants. • To understand all the regulations and act proposed by the law.							
Course Outcomes	**At the end of the course, the students will be able to** CO1: recall the basics about causes of pollution and its impact on environment CO2: clarify the difference among different types of pollution and its controls CO3: explain hazardous waste and biomedical waste management CO4: gain knowledge on removal mechanism of pollutants CO5: role of regulatory bodies in protecting the natural resources and prevention of pollution							

Note: The hours given against each topic are of indicative. The faculty have the freedom to decide the hours required for each topic based on importance and depth of coverage required. The marks allotted for questions in the examinations shall not depend on the numbers hours indicated.

Introduction to Pollution

Concept of pollution, causes of environmental pollution, Environmental problems due to pollution, concept of Development, Major conflicts of Development and Environment, Mining and Environment. [9]

Air, Water, Soil Pollution and its control

Air Pollution: Definition, major air pollutants, Classification of air pollutants, their sources and impacts, acid rain, oil pollution, photochemical smog, effects on organisms and on materials. Methods of air pollution control. Noise Pollution and its methods of control. Water Pollution: Concept, classification, major sources and impacts, oil pollution, thermal pollution, oceanic pollution, eutrophication and water treatment processes. Soil Pollution: Soil pollution, causes of soil pollution, soil salinity, sources of soil pollutants, major impacts and remedial measures [9]

Hazardous waste and Biomedical waste management

Hazardous waste, characterization and site assessment waste minimization and resource recovery, chemical physical and biological, treatment; hazards of improper treatment and disposal method; accidental exposure of dangerous waste and emergency measures. Biomedical waste classification and its management methods. [9]

Removal of pollutants

Methods for removal of pollutants from gaseous effluents; particulate matter, waste water treatment Activated sludge process. Removalof Nitrogenous pollution, Removal of nitrogen; physico-chemical processes; biological method of pollution control. Analytical methods of small amount of the metal pollutants; removal and recovery techniques of heavy metals. [9]

Regulatory Aspects and legislation

Industrial Emissions Liquids and gasses; pollution caused by various chemical industries and its overall effect on quality of human life and the environment, water quality management in India. MINAS for sugar industries, distilleries, pesticides industry and mercury from caustic soda industry, Good analytical practices for proper assessment of pollutants, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, National and International conventions and agreements on environment [9]

Total Hours: 45 hours

Text books:

1. Krishnan Khannan, “Fundamentals of Environmental Pollution” S. Chand and Company Ltd., 1994
2. Rao C.S. “Environmental Pollution Control” Wiley Eastern Ltd.,1993

Reference(s):	
1	Metcalf and Eddy, “Wastewater engineering, Treatment and Reuse”, Tata Mc Graw Hill Publications, 2008.
2	Yung- Tse Hung, Lawrence K Wang, Nazih K Shammas, “Hand Book of Environment and Waste Management: Air and Water Pollution Control”, World Scientific Publishing Co. Pvt. Ltd., Singapore, 2012.
3	Martina Zelenakova, “Water Management and the Environment: Case Studies”, Springer International Publishing, Switzerland, 2018.
4	De Nevers, “Air Pollution Control and Engineering” Mc Graw Hills, 1993

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					2		3					3	2	3
CO2		3		3	3	3	3				3	3	2	3
CO3		3		3	3	3	3				3	3	3	2
CO4		3	3	3	3	3	3	3			3	3	3	2
CO5		3	2	2			3	3				3	2	3