KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.TECH. BIOTECHNOLOGY
REGULATION – 2021
AUTONOMOUS SYLLABUS
CHOICE BASED CREDIT SYSTEM
VII TO VIII SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Biotechnology, unique of its kind in the field of research and development activities pertaining to the field of biotechnology in this part of the world.

MISSION:

To impart highly innovative and technical knowledge in the field of biotechnology to the urban and rural student folks through "Total Quality Education".

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: **Program Specific Academic Excellence:** The student will be able to pursue higher education in India/Abroad in Biotechnology and its related fields by taking up competitive exams like GATE, CSIR, TANCET, GRE, TOEFL etc

PEO 2: **Professional Attitude:** The student will be able to come up with solutions for any scientific or technical problems related to Biotechnological industries/institutes by engaging in independent and life-long learning.

PEO 3: **Core Competence:** The student will be able to plan and conduct experiments in modern biotechnology and allied field laboratories using modern tools including interpreting the significance of resulting data, reporting results and writing technical reports

PEO 4: **Collaboration:** The students will be able to work in multidisciplinary team with confidence and will be able to venture out with entrepreneurial activities.

PROGRAM OUTCOMES:

After going through the four years of study, the Biotechnology graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	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
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable

		development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	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.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : **Future ready graduates:** The student will be able to identify, choose and perform to their best ability in the next career step: Higher education/Job/Entrepreneurial initiatives.

PSO2 : **Industry ready graduates:** The student will be able to apply the acquired knowledge to provide cost-effective and sustainable solutions in Biotechnology

B.TECH. BIOTECHNOLOGY REGULATIONS - 2021
AUTONOMOUS SYLLABUS
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VII TO VIII SEMESTER CURRICULUM

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	BT2401	Downstream Processing	PC	3	3	0	0	3
2	GE2401	Universal Human Values and Ethics	HS	2	2	0	0	2
3		Management Elective	HS	3	3	0	0	3
4		Open Elective – II*	OE	3	3	0	0	3
5		Open Elective – III*	OE	3	3	0	0	3
6		Open Elective – IV*	OE	3	3	0	0	3
PRACTICALS								
7	BT2402	Computational Biology Laboratory	PC	3	0	0	3	1
8	BT2403	Downstream Processing Laboratory	PC	4	0	0	4	2
9	BT2404	Mini Project Work	EM	3	0	0	3	1
				TOTAL	**17**	**0**	**10**	**21**

*Course from the Curriculum of other UG programmes.

SEMESTER VIII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	BT2451	Project Work	EM	20	0	0	20	10
				TOTAL	**0**	**0**	**20**	**10**

MANANGEMENT ELECTIVE

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	GE2491	Principles of Management	HS	3	3	0	0	3
2	GE2492	Total Quality Management	HS	3	3	0	0	3

OPEN ELECTIVE

SL. NO.	OPEN ELECTIVE	COURSE CODE	COURSE NAME	CATE GORY	CONTACT PERIODS	L	T	P
1	II	OBT701	Introduction to Food Manufacturing	OEC	3	0	0	3
2	III	OBT702	Basics of Nanobiotechnology	OEC	3	0	0	3
3	III	OBT703	Biology for Engineers	OEC	3	0	0	3
4	IV	OBT704	Principles of Food Processing	OEC	3	0	0	3
5	IV	OBT705	Testing of Biological Materials	OEC	3	0	0	3

Course Code	Course Name	L	T	P	C
BT2401	DOWNSTREAM PROCESSING	3	0	0	3

Category: Professional Core

a. Preamble

This course enables the students to

- Develop a comprehensive understanding of downstream processing principles, techniques, and applications in biotechnology.
- Recognize the critical role of downstream processing in biotechnology and its applications in the biotechnology industries.
- Analyse and evaluate downstream processing challenges, strategies, and emerging trends in bioprocessing.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Select cell disruption and pretreatment methods in accordance with the distinctive features of cells and biomolecules.	K3
CO2	Apply the principles of filtration and centrifugation to eliminate insoluble components from the fermentation broth.	K3
CO3	Demonstrate proficiency in selecting separation methods for the effective isolation of biomolecules.	K3
CO4	Determine the suitable chromatographic and electrophoretic methods for the purification of biomolecules.	K4
CO5	Analyse and develop formulation strategies for biomolecules to guarantee the quality of the bioproduct.	K4

c. Course Syllabus **Total: 45 Periods**

INTRODUCTION TO DOWNSTREAM PROCESSING **9**

Introduction to separation of biomolecules and its importance in biotechnology; Characteristics of fermentation broth and biomolecules; Cell disruption for product release - Physical, chemical and enzymatic methods; Pretreatment and stabilisation of bioproducts.

PHYSICAL METHODS OF SEPARATION **9**

Unit operations for Solid Liquid Separation; Filtration: Theory; Compressible and incompressible filter cakes; Darcy's law; Filtration cycle; Equipment for Batch and Continuous filtration; Centrifugation: Relative Centrifugal Force, Settling Velocity; Theory of Tubular-bowl centrifuges and Disk-bowl centrifuges; Centrifugal Filtration; Scale-up of centrifuges - sigma factor.

ISOLATION OF PRODUCTS **9**

Adsorption; Liquid-liquid extraction; Aqueous two-phase extraction; Precipitation of proteins by using salt, organic solvents, high molecular weight polymers; Membrane-based purification: Ultrafiltration, Microfiltration, Reverse osmosis, and Dialysis.

PRODUCT PURIFICATION **9**

Chromatography - principles, instruments and practice; Types - Adsorption, Reverse Phase, HPLC, Ion-exchange, Size exclusion, Bio affinity and Pseudo affinity chromatographic techniques.

FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS **9**

Crystallisation: Basic principles, Nucleation and Crystal growth, Supersaturation theory; Commercial crystallisers; Product drying: Heat and mass transfer in drying; Types of commercial dryers - Vacuum dryers, Freeze dryers, Spray dryers; Case Studies - Downstream processing of Citric Acid, Lactic Acid, Penicillin, Insulin and Monoclonal antibodies.

d. Activities

Through industrial visits, students will understand various downstream processing techniques and equipment used in industries and prepare a report.

e. Learning Resources

Textbooks

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, *Bioseparations - Downstream Processing for Biotechnology*, Wiley Interscience, 1988.
2. Nooralabettu Krishna Prasad., *Downstream Process Technology: A New Horizon in Biotechnology*, Prentice Hall India, 2010.
3. Sivasankar, B. *Bioseparations: Principles and Techniques,* Prentice Hall India, 2006.

Reference Books

1. Raja Ghosh, *Principles of Bioseparations Engineering,* World Scientific, 2006.
2. R. G. Harrison, P. Todd, S. R. Rudger and D. P. Petrides, *Bioseparation Science and Engineering*, Oxford University Press, 2003.

Course Code	Course Name	L	T	P	C
GE2401	UNIVERSAL HUMAN VALUES AND ETHICS	2	0	0	2

Category: Science and Humanities

a. Preamble

This course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the essential complementarily between 'VALUES' and 'SKILLS' for ensuring happiness and prosperity.	K2
CO2	Explore Human being as the Co-existence of the Self and the Body	K3
CO3	Develop holistic perspective towards value-based living in a natural way	K3
CO4	Discuss the interconnectedness of the four orders of Nature and existence.	K2
CO5	Comprehend the ethics of human values, Humanistic education and constitution, strategies of value-based life and profession	K2

c. Course Syllabus **Total: 30 Periods**

INTRODUCTION TO VALUE EDUCATION **6**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity - Current Scenario, Method to Fulfil the Basic Human Aspirations

HARMONY IN THE HUMAN BEING **6**

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

HARMONY IN THE FAMILY AND SOCIETY **6**

Harmony in the Family - the Basic Unit of Human Interaction, 'Trust' - the Foundational Value in Relationship, 'Respect' - as the Right Evaluation, Other Feelings, Justice in Human to- Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

HARMONY IN THE NATURE/EXISTENCE **6**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS **6**

Natural Acceptance of Human Values, Definitiveness of (Ethical) 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-based Life and Profession

d. Activities

Practice Sessions - Introduction to Value Education

1 Sharing about Oneself

2 Exploring Human Consciousness

3 Exploring Natural Acceptance

Practice Sessions– Harmony in the Human Being

4 Exploring the difference of Needs of Self and Body

5 Exploring Sources of Imagination in the Self

6 Exploring Harmony of Self with the Body

Practice Sessions– Harmony in the Family and Society

7 Exploring the Feeling of Trust

8 Exploring the Feeling of Respect

9 Exploring Systems to fulfil Human Goal

Practice Sessions– Harmony in the Nature (Existence)

10 Exploring the Four Orders of Nature

11 Exploring Co-existence in Existence

Practice Sessions– Implications of the Holistic Understanding – a Look at Professional Ethics

12 Exploring Ethical Human Conduct

13 Exploring Humanistic Models in Education

14 Exploring Steps of Transition towards Universal Human OrderThrough industrial visits, students will understand various downstream processing techniques and equipment used in industries and prepare a report.

e. Learning Resources

https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php

https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Textbooks

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

Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
4. Economy of Permanence - J C Kumarappa
5. India Wins Freedom - Maulana Abdul Kalam Azad

Course Code	Course Name	L	T	P	C
BT2402	COMPUTATIONAL BIOLOGY LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

The course enables the students to

- Develop skills in the analysis and interpretation of various in silico techniques such as molecular docking and homology modelling
- Gain the knowledge about the application of sequence and phylogenetic analysis

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Perform basic operations in Linux operating system, retrieve biological data and use bioinformatics tools	K4
CO2	Utilize the fundamental knowledge of Biological databases such as Genbank, Protein databank and Uniprot.	K4
CO3	Perform protein and nucleotide sequence analysis, next generation sequencing data analysis and phylogenetic studies	K4
CO4	Design a project comprising of Homology modeling and structural analysis of proteins and molecular docking	K5
CO5	Execute simple R programs	K5

c. Course Syllabus **Total : 45 Periods**

1. Linux Commands: Directory commands, File Related commands, cut, paste, commands, Sort.
2. Advanced Linux commands : Redirection, Pipes, Grep filter
3. Biological Databases: Data formats and Data retrieval
4. Homology search using BLAST family of programs: BLASTp, PSIBLAST, BLASTn, Standalone BLAST

5. Multiple Sequence Alignment using CLUSTALW
6. Generating Phylogenetic trees and Bootstrapping using MEGA
7. Understanding PDB structures, Ligand databases.
8. Protein Visualization tools: PyMol
9. Homology Modeling and Assessing the quality of models: Swiss Model, Modeller
10. Molecular docking: Docking of macromolecules with ligands: Autodock
11. R-Programming – Data cleaning, Preprocessing
12. Application of R Programming in transcriptomics

d. Learning Resources

Text Books

1. Claverie, J.M. and Notredame, C., *Bioinformatics for dummies*. John Wiley & Sons., 2006.
2. Gibas, C., Jambeck, P. and Fenton, J., *Developing bioinformatics computer skills*. O'Reilly Media, Inc., 2001.

Reference Books

1. Agostino, M., *Practical bioinformatics*. Garland Science, 2012.
2. Pevsner, J., *Bioinformatics and functional genomics*. John Wiley & Sons, 2015.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No	Description of the Equipment	Quantity Required
1.	Hardware Requirements Personal Computers (Intel Core i5, 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	Softwares : Pymol, Pyrx, Modeller, Autodock, MEGA, R Package	30

Course Code	Course Name	L	T	P	C
BT2403	DOWNSTREAM PROCESSING LABORATORY	0	0	4	2

Category: Professional Core

a. Preamble

The course aims to

- Understand the nature of the end product, its concentration, stability and degree of purification required
- Design processes for the recovery and subsequent purification of targeted biological products.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop experimental designs to achieve efficient solid-to-liquid separation.	K3
CO2	Select suitable cell disruption techniques based on the characteristics of the cells.	K3
CO3	Perform the relevant method for concentrating bioproducts.	K3
CO4	Execute various chromatography techniques to purify bioproducts to the desired level of purity.	K4
CO5	Implement distinct product polishing methods based on the physiological properties of bioproducts.	K4

c. Course Syllabus **Total: 60 Periods**

LIST OF EXPERIMENTS

1. Filtration - Calculation of Specific Cake resistance
2. Centrifugation - Estimation of Sigma Factor in Batch Centrifuge
3. Cell Disruption - Ultrasonication and Homogenisation.
4. Aqueous Two-Phase Extraction of biological molecules
5. Precipitation of proteins by ammonium sulphate
6. Membrane separation – Dialysis, Ultrafiltration
7. Adsorption Chromatography

8. Size Exclusion chromatography
9. Ion exchange chromatography
10. High-Performance Liquid Chromatography (HPLC)
11. Product polishing – Spray drying, Rotary Vaccum Evaporation and Freeze Drying.

d. Activities

Students will design a Downstream Process for separating and purifying a specific biomolecule.

e. Learning Resources

Reference Books

1. P. A. Belter, E. L. Cussler and Wei-Shou Hu, *Bioseparations - Downstream Processing for Biotechnology*, Wiley Interscience, 1988.
2. Nooralabettu Krishna Prasad., *Downstream Process Technology: A New Horizon in Biotechnology*, Prentice Hall India, 2010.
3. Jenkins, R.O. (Ed.), *Product Recovery In Bioprocess Technology,* Biotechnology By Open Learning Series, Butterworth-Heinemann. 1992.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No	Description of the Equipment	Quantity Required
1.	UV-Visible Spectrophotometer	1
2.	Laminar Airflow Chamber	1
3.	Incubator	1
4.	Shaker Incubator	1
5.	Homogenizer	1
6.	Ultrasonicator	1
7.	Centrifuge	1
8.	Vacuum Filtration	1
9.	Lyophilizer	1
10.	Spray Dryer	1
11.	Rotary Vaccum Evaporator	1

Course Code	Course Name	L	T	P	C
BT2404	MINI PROJECT	0	0	3	1

Category: Professional Core

a. Preamble

This course enables the students to

- Develop the ability to solve specific problem right from its identification and literature review and identify appropriate solutions for the same
- Prepare and deliver effective scientific solutions for identified problems

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify a potential problem based on literature survey/impending industrial/real time needs.	K3
CO2	Categorize various solution methodologies to solve problem taken for study.	K4
CO3	Carry out design/experimental procedure relevant to the problem.	K4
CO4	Analyze design/experimental results.	K4
CO5	Draw conclusion based on analysis and recommend solution to potential engineering problems.	K5

Total : 45 Periods

The students will be working in single or group of 3 to 4 on a scientific problem approved by the Head of the Department under the guidance of the faculty member and prepare a comprehensive report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation on project topic jointly by external and internal examiners constituted by the Head of the Department

Course Code	Course Name	L	T	P	C
GE2491	PRINCIPLES OF MANAGEMENT	3	0	0	3

Category: Management courses

a. Preamble

This course introduces fundamental principles of management, emphasizing their universal applicability in diverse organizations. It covers core managerial functions, explores organizational structures, and provides insights into effective global leadership qualities and skills.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the trends and challenges of management in global scenario, the different types of organization and its effectiveness.	K2
CO2	Utilize the strategies and policies which are involved in planning, Steps involved in the process of planning and use it for decision.	K2
CO3	Explain the structure, purpose, selection and recruitment process in organizations.	K2
CO4	Explain the various motivational theories and processes of management including its functions.	K2
CO5	Compare and contrast the various control techniques.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management - Nature, Scope and Functions of Management - Evolution of Management - Contributions of FW Taylor (14 principles of Management), Henri Fayol, Elton Mayo, Roethilisberger, H.A.Simon and P.F Drucker- Management theories - Science or Art - Manager Vs Entrepreneur- types of managers managerial roles and skills -

Evolution of Management - Scientific, human relations, system and contingency approaches - Current trends and issues in Management.

PLANNING **9**

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

ORGANISING **9**

Nature and purpose - Formal and informal organization - Organization chart - Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority - Centralization and decentralization - Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

DIRECTING **9**

Directing meaning - importance - principles of directing - Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - 14 types and theories of leadership - Communication - Process of communication, types of communication and its uses - Barrier in communication - Effective Communication - Communication and IT.

CONTROLLING **9**

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of computers and IT in Management control - Productivity problems and management - Inventory Management - PERT, CPM - Application - Control and performance - Direct and preventive control.

d. Activities

Students shall be given exposure to various concepts of delegation of authority, centralization, and decentralization within the college premises.

e. Learning Resources

Text Books

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, Tata McGraw Hill,1998.

2. Stephen P. Robbins and Mary Coulter, *Management*, Prentice Hall (India) Pvt. Ltd,2009.

Reference Books

1. Robert Kreitner and Mamata Mohapatra, *Management*, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, *Fundamentals of Management*, Pearson Education, 7th Edition,2011.
3. Tripathy PC and Reddy PN, *Principles of Management*, Tata McGraw Hill, 1999.

Course Code	Course Name	L	T	P	C
GE2492	TOTAL QUALITY MANAGEMENT	3	0	0	3

Category: Professional Core

a. Preamble

Quality is the mantra for success or even for the survival of any organization in this competitive global market. Total Quality Management (TQM) is an enhancement to the traditional way of doing business. It is a proven technique to guarantee survival in worldclass competition. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach. At the end of the course the students are expected to recognize the quality issues in an organization and analyze the ways to solve those using TQM techniques, and demonstrate skills in using modern TQM tools.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe TQM concepts of selected enterprise.	K2
CO2	Comprehend the TQM principles and how it is implemented in a selected enterprises.	K2
CO3	Discuss the various traditional and new TQM tools.	K2
CO4	Explain the fundamentals of QFD and TPM.	K2
CO5	Apply QMS and EMS in business organization.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Concept of Quality and Quality Management - Determinants of quality of a product & Service - Reliability - Definition of TQM - Basic concepts of TQM - TQM Framework - Barriers to TQM - Benefits of TQM - Gurus of TQM (Brief Introduction) - Quality statements – vision, mission, and policy.

TQM PRINCIPLES **9**

Continuous Improvement Process - Deming Philosophy - Juran Trilogy - PDSA cycle - Kaizen - Concepts of Quality circle - Japanese 5S principles and 8D methodology.

TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability - Bench marking: Reasons for benchmarking , Benchmarking process, Understanding Current Performance, Planning, Pitfalls and Criticisms of Benchmarking - FMEA: Intent, Documentation, Stages: Design FMEA and Process FMEA.

TQM TOOLS & TECHNIQUES II **9**

Quality circles - Quality Function Deployment: QFD Team - Benefits of QFD - Voice of the customers - Organization of Information - House of Quality - QFD Process - Taguchi quality loss function - TPM: Concepts, improvement needs - Performance measures - Cost of Quality.

QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEM **9**

Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards - Sector Specific Standards: AS 9100, TS16949 and TL 9000 - ISO 9001 Requirements - Implementation - Documentation - Internal Audits - Registration - ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction - ISO 14000 Series Standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS.

d. Activities

Students shall be exposed to learn the knowledge and skills necessary to drive organizational excellence through the implementation of effective quality management strategies.

e. Learning Resources

Text Books

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, *Total Quality Management*, Revised 3rd Edition, Pearson Education Asia, 2013.
2. Suganthi L & Anand Samuel, *Total Quality Management*, Prentice Hall Publications, 2004.

Reference Books

1. Kiran.D.R, *Total Quality Management: Key concepts and case studies*, Butterworth – Heinemann Limited, 2016.
2. Shridhara Bhat K, *Total Quality Management: Text and Cases*, Himalaya Publishing House India, 2nd Edition, 2016.

Course Code	Course Name	L	T	P	C
OBT701	INTRODUCTION TO FOOD MANUFACTURING	3	0	0	3

Category: Open Elective

a. Preamble

This course enables the students to

- Learn the basic concepts of various food processing techniques and their working principle.
- Enhance the knowledge on minimal processing and hurdle technology.
- Emphasize the various processing methods involved in converting raw material into quality food products.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Classify the engineering properties of foods.	K2
CO2	Identify the principle and application of thermal processing of food materials	K3
CO3	Make use of the applications of drying process	K3
CO4	Utilize the non-thermal food processing methods	K3
CO5	Apply the knowledge of hurdle technology and minimal processing for certain foods.	K3

c. Course Syllabus **Total : 45 Periods**

PROPERTIES OF FOODS **9**

Engineering properties of foods - Physical, electrical, rheological; Texture of food materials - definition and evaluation methods; Measurement of rheological parameters, Instruments used for various foods - Solids and Fluids.

THERMAL PROCESSING OF FOODS **9**

Classification of thermal processes, principles of thermal processing, blanching, pasteurization, commercial canning operations, irradiation and microwave heating -

principles, mechanism and applications.

DRYING OF FOODS **9**

Normal drying curve, changes in food during drying, drying methods, Types of dryer - tray dryer, continuous belt dryer, fluidized bed dryer, drum dryer, spray dryer, freeze dryer and vacuum dryer.

REFRIGERATION AND FREEZING **9**

Requirements of refrigerated storage, controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, freezing - principle, changes in the food during freezing, freezing methods - direct and indirect, still air sharp freezer, blast freezer and cryogenic freezing.

HURDLE TECHNOLOGY AND MINIMAL PROCESSING **9**

Principles and applications, hurdle effect in fermented foods, shelf stable products, intermediate moisture foods, application of hurdle technology. Minimal processing of foods with thermal methods and non-thermal methods, criteria for minimally processed foods.

d. Activities

Students shall be exposed to activities such as seminar and puzzle on various food processing methods.

e. Learning Resources

Text Books

1. Romeo T.T, Singh R.K, and Kong F., *Fundamentals of Food Process Engineering*, 4th Edition, Springer, 2018.
2. James F. Steffe., *Rheological Methods in Food Process Engineering*, Freeman Press, East Lansing, USA, 1992.

Reference Books

1. Fellows. P., *Food Processing Technology – Principles and Practice*, second edition, CRC Press, Woodland Publishing Limited, Cambridge, England, 2000.
2. Singh, R. Paul., Heldman, R. Dennis., *Introduction to Food Engineering*. 2rd Edition. Academic Press, London, 2005.

Course Code	Course Name	L	T	P	C
OBT702	BASICS OF NANOBIOTECHNOLOGY	3	0	0	3

Category: Foundation Course (Engineering Science)

a. Preamble

This course enables the students to

- Explain the fundamental concepts of Nanotechnology and the applications of nanomaterials in biotechnology.
- Provide a comprehensive overview of various characterization methods and explore the wide array of nanomaterial applications.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Discuss the overview of the core principles of nanotechnology, various categories of nanomaterials, and the progress in their advancement	K2
CO2	Identify the role of nanomaterials in biotechnology	K2
CO3	Execute the different Characterization techniques of Biomaterials	K3
CO4	Demonstrate the various applications of nano-biotechnology	K3
CO5	Interpret the societal impacts of nano-biotechnology in the field of health, food and cosmetics.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO NANOTECHNOLOGY **9**

Introduction to nanoscale- Types of nanomaterials; Classifications of nanostructured materials - nano particles, quantum dots, nanowires, ultra-thin films, multilayered materials; Physical and chemical properties of nanoscale materials; Development of nanobiotechnology- timeline and progress.

NANOMATERIAL IN BIOTECHNOLOGY **9**

Biomimetic nanotechnology; protein-based nanostructures; Nanomotors - bacterial (*E. coli*) and mammalian (Myosin family); DNA nanotechnology - nanostructures in cells study, microarray platforms; Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection; lab-on-a-chip devices (LOC); tissue engineering.

NANOMATERIAL CHARACTERIZATION **9**

Instrumentation and applications - UV - Visible spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR), Surface Plasmon resonance (SPR), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic force microscopy (AFM), Dynamic light scattering (DLS), X- ray Diffraction technique (XRD).

NANO BIOTECHNOLOGY APPLICATIONS **9**

Micro- and Nano electromechanical devices in drug delivery; Nano biosensors - applications of quantum dots in biotechnology; DNA based nanomaterials as biosensors; Nano catalysts; Nano crystalline silver for bacterial inhibition; Nanoparticles for sun barrier products.

SOCIETAL IMPACTS OF NANO-BIOTECHNOLOGY **9**

Engineered nanomaterial of relevance to human health; Foods and Agricultural Industry; cosmetics and consumer goods; Water Treatment and the environment; Toxic and environmental risks of nanomaterials; Bioterrorism.

d. Activities

Students will be engaged in hands-on learning activities to gain a thorough comprehension of fundamental nanobiotechnology concepts and their practical applications.

e. Learning Resources

Text Books

1. Niemeyer, Christof M., and Chad A. Mirkin, eds. Nanobiotechnology: concepts, applications and perspectives. Vol. 1. John Wiley & Sons, 2004.
2. Mirkin, Chad A., and Christof M. Niemeyer, eds. Nanobiotechnology II: more concepts and applications. John Wiley & Sons, 2007.
3. Goodsell, David S. Bionanotechnology: lessons from nature. John Wiley & Sons, 2004.

Reference Books

1. Xie, Y., editor. The Nanobiotechnology Handbook. 1st ed., CRC Press, 2012.
2. Dhawan, Alok, et al., eds. *Nanobiotechnology: Human Health and the Environment*. CRC Press, 2018.
3. Goswami, Arunava, and Samrat Roy Choudhury. *Nanobiotechnology: Basic and Applied Aspects*. Anthem Press, 2017.

Course Code	Course Name	L	T	P	C
OBT703	BIOLOGY FOR ENGINEERS	3	0	0	3

Category: Open Elective

a. Preamble

This course enables the students to

- Understand biological mechanisms from an engineering perspective.
- Think about solving real time problems using biological mechanisms

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the fundamentals of cell structure and cell cycle.	K2
CO2	Summarize the classification and functions of biomolecules.	K2
CO3	Illustrate the basic molecular mechanisms such as replication, transcription and translation.	K3
CO4	Interpret the basic concepts of infection and immunity.	K3
CO5	Analyze the role of biology in various sectors.	K4

c. Course Syllabus **Total: 45 Periods**

INTRODUCTION TO CELLS **9**

Cell: What is a Cell, Cell theory, Cell shapes, Structure of a Cell, Cell cycle, Chromosomes; Prokaryotic and Eukaryotic Cell; Cell Organelles - Nucleus, Mitochondria, Lysosomes, Endoplasmic reticulum and Golgi apparatus, Chloroplasts; Cytoskeleton - Microtubules, Actin filaments and Intermediate filaments.

BIOMOLECULES **9**

Chemical Composition of Living Forms; Carbohydrates, lipids, Proteins, Nucleic acid (DNA and RNA) and their types; Enzymes - Classification, Nomenclature and their Applications in Industry.

CENTRAL DOGMA AND INTRODUCTION TO RECOMBINANT DNA TECHNOLOGY **9**

Gene, Genome and Chromosome; Prokaryotic gene and Eukaryotic gene structure; Central Dogma of Molecular Biology - Replication, Transcription, Translation; Regulation of Gene

Expression (Prokaryotes) - lac operon; Introduction to Recombinant DNA technology and Cloning; Overview of Transgenic plants and animals.

MICROBIOLOGY AND IMMUNOLOGY **9**

Microscopy; Microbes as infectious agents - Bacterial (Tuberculosis), Viral (CoVID) and fungal (Athlete's foot) and yeast (Candidiasis); Immunity - innate and acquired immunity; Organs and Cells of the immune system; Classification of antibodies; Types of T cells; Transplantation; Autoimmunity.

APPLICATION OF BIOLOGY **9**

Healthcare: Antibiotics, Vaccines, Insulin; Beneficial bacteria: Probiotic bacteria, Nitrogen fixing bacteria, Fermented foods and products; Biosensors; Tissue engineering and its application; Bio engineering (production of artificial limbs, joints and organs); Biomimicry; Bioimaging and artificial intelligence for disease diagnosis.

d. Activities

Students will be made aware of basic concepts through activities like Jigsaw activity, Quiz etc.

e. Learning Resources

Text Books

1. Johnson, A.T., *Biology for engineers*. CRC Press, 2018.
2. Thyaga Rajan, S., Selvamurugan, N., Rajesh, M.P., Nazeer, R.A., Thilagaraj, R.W., Barathi, S. and Jaganathan, M. K., *Biology for Engineers.* Tata McGraw-Hill, New Delhi, 2012.
3 De Robertis, E.D.P. and De Robertis, E.M.F., *Cell and Molecular Biology*, Lippincott Williams & Wilkins, Philadelphia, USA, 2010.

Reference Books

1. Vaccari, D. A., Strom, P. F., and Alleman, J. E., *Environmental Biology for Engineers and Scientists.* John Wiley and Sons, 2006.
2. Waite, G. N., *Applied cell and molecular biology for engineers.* McGraw-Hill Education, 2007.
3 Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. W.H. Freeman and Co. Ltd., 2006.
4 Robert F. Weaver, *Molecular Biology.* McGraw-Hill Education, 2012.

Course Code	Course Name	L	T	P	C
OBT704	PRINCIPLES OF FOOD PROCESSING	3	0	0	3

Category: Open Elective

a. Preamble

This course enables the students to

- Learn the basic concepts of food processing methods and detailed study of food preservation.
- Enhance the knowledge of various food commodities and their processing methods.
- Obtain the knowledge of food additives and their importance.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the constituents of food and the chemical reactions in processed foods.	K2
CO2	Relate the processing methods of foods to their effects.	K3
CO3	Make use of the processing methods for various food commodities.	K3
CO4	Illustrate the advanced processing methods with their applications.	K3
CO5	Apply the knowledge of food additives and their importance.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION

Definition of food, Functions of foods, Food groups, Food Science - Definition, objectives and applications. Nutrients - Classification, macro and micro constituents - Carbohydrate, Proteins, Fats and Lipids, Minerals and Vitamins

PROCESSING METHODS **9**

Methods of processing -moist heat, dry heat and combination methods, Nutrient losses during cooking and processing, Sensory evaluation of foods-methods and applications

PROCESSING OF FOOD COMMODITIES **9**

Cereals and pulses, nuts and oil seeds, vegetables, milk, meat, fish, egg and poultry, spices and condiments

ADVANCED METHODS **9**

Gelatinization, denaturation, colloids, emulsion, foam, sol, gel, fermentation, crystallization, enzymatic and non-enzymatic browning of foods, Anti nutritional factors in foods.

FOOD ADDITIVES **9**

Classification and role - preservatives, antioxidants, chelating agents, flour improvers, artificial sweeteners, flavours, colours, stabilizers, emulsifier, firming agent, leavening and releasing agent. Food fortification-enrichment-need-application in foods

d. Activities

Students shall be exposed to activities such as seminar and puzzle on various food processing methods.

e. Learning Resources

Text Books

1. Potter N., *Food Science,* CBS Publishers and Distributors, Delhi, 2005.
2. Sivasankar. B., *Food Processing and Preservation*, PHI Learning Private Limited, 2015.

Reference Books

1. Shafeiur Rahman. M., *Handbook of Food Preservation*, Marcel Dekker, Inc, 1999.
2. Khetarpaul. N., *Food Processing and Preservation*, Dya Publishing House, New Delhi, 2005.

Course Code	Course Name	L	T	P	C
OBT705	TESTING OF BIOLOGICAL MATERIALS	3	0	0	3

Category: Open Elective

a. Preamble

This course enables the students to

- Understand the structural morphology, properties and biological requirements of a general biomaterials used in medicine.
- Gain knowledge on testing and assessment of biomaterials.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the structural morphology, properties and biological requirements of general biomaterials used in medicine.	K2
CO2	Classify the various materials and its application	K2
CO3	Understand the physio-chemical properties of different biomaterials	K2
CO4	Develop a biocompatible materials for biomedical applications	K3
CO5	Analyze the efficacy of biomaterials	K3

c. Course Syllabus **Total: 45 Periods**

FUNDAMENTALS OF BIOMATERIAL SCIENCE 9

Introduction to Materials, General structure and properties. Concept of biocompatibility, Fundamentals of Biocompatibility Tests. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilization of biomaterials.

CLASSIFICATION OF COMMON MATERIALS AND APPLICATIONS 9

Nanocomposites, Bioresorbable and Bioerodable Materials, Natural polymers, Carbon nanotubes, Metal and alloys in Medical application: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys). Ceramics and glasses-bio ceramics, Type of Ceramics and their classification.

PHYSICO-CHEMICAL PROPERTIES OF BIOMATERIALS 9

Mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), Morphology and Texture, Physical (electrical, optical, magnetic, thermical), Chemical and Biological properties.

DESIGN AND MANUFACTURING OF BIOCOMPATIBLE MATERIALS 9

Design of materials for biomedical application: Cardiovascular, Dental Implants, Orthopedic Application, Skin, Ophthalmologic Applications, Wound Healing, Sutures, Biomedical and Biosensors, Concept of biomimetic synthesis, Preparation of fiber and wire, Fabrication of Porous Materials, Direct molding Technique, Different advanced fabrication technique.

METHODS FOR ASSESSMENT OF BIOMATERIALS 9

In Vitro Assessment of Cell and Tissue Compatibility, In Vivo Assessment of Tissue Compatibility, Evaluation of Blood-Materials Interactions, Microscopy for Biomaterials Science, Problems and possible solutions in implant fixation; Failure analysis of medical devices and implants. Toxicokinetics in Biomaterial and Device Safety Evaluation.

d. Activities

Students will be divided into groups and a quiz competition will be conducted after the completion of each unit.

e. Learning Resources

Text Books

1. Buddy D.R, Allan S. H, Frederick J.S, Jack EL., *Biomaterials Science: An Introduction to Materials in Medicine,* Academic Press, USA. 2004.
2. Park J.B. and Bronzino J.D., *Biomaterials: Principles and Applications*. CRC Press, 2002.
3 Gad-McDonald, Samantha, Gad, Shayne C, *Biomaterials, medical devices, and combination products: biocompatibility testing and safety assessment*, CRC Press, 2015.

Reference Books

1. Dee K.C., Puleo D.A and Bizios R. *An Introduction to Tissue-Biomaterial Interactions.* Wiley, 2002.
2. Ambrosio L. *Biomedical composites,* Woodhead Publishing Limited., 2009.

Course Code	Course Name	L	T	P	C
BT2451	**PROJECT WORK**	**0**	**0**	**20**	**10**

Category: Professional Core

a. Preamble

This course enables the students to

- Develop the ability to solve specific problem right from its identification and literature review and identify appropriate solutions for the same
- Prepare and deliver effective scientific solutions for the identified problem

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify a potential problem based on literature survey/impending industrial/real time needs.	K3
CO2	Categorize various solution methodologies to solve problem taken for study.	K4
CO3	Carry out design/experimental procedure relevant to the problem.	K4
CO4	Analyze design/experimental results.	K4
CO5	Draw conclusion based on analysis and recommend solution to potential engineering problems.	K5

Total : 300 Periods

The students will be working in single or group of 3 to 4 on a scientific problem approved by the Head of the Department under the guidance of the faculty member and prepare a comprehensive report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation on project topic jointly by external and internal examiners constituted by the Head of the Department