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), Madurai District.

B.TECH. BIOTECHNOLOGY

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABI

(III & IV)

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”.

PROGRAM EDUCAITON OBJECTIVES:

Educational objectives of the course Bachelor of Biotechnology programme can be divided into

PEO1:

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

PEO2:

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.

PEO3:

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

PEO4:

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

	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):

1. **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.
2. **Socially Aware graduates:** The student will be able to apply biotechnological know-how to address environmental, ethical, intellectual property rights and societal issues.
3. **Industry ready graduates:** The student will be able to apply the acquired knowledge to provide cost-effective and sustainable solutions in Biotechnology.

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SEMESTER III

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA1373	Transforms and Partial Differential Equations	BS	3	1	0	4	4
2	BT1301	Cell Biology	PC	3	0	0	3	3
3	BT1302	Microbiology	PC	3	0	0	3	3
4	BT1303	Stoichiometry	PC	3	1	0	4	4
5	BT1306	Thermodynamics for Biotechnologist	ES	3	0	0	3	3
PRACTICAL								
6	BT1311	Cell Biology Laboratory	PC	0	0	4	4	2
7	BT1312	Microbiology Laboratory	PC	0	0	4	4	2
8	HS1321	Interpersonal Skills - Listening and Speaking	EE	0	0	2	2	1
			TOTAL	**15**	**2**	**10**	**27**	**22**

SEMESTER IV

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA1473	Probability and Statistics	BS	3	1	0	4	4
2	BT1401	Analytical Methods and Instrumentation	PC	3	0	0	3	3
3	BT1402	Basic Industrial Biotechnology	PC	3	0	0	3	3
4	BT1403	Enzyme Technology and Biotransformations	PC	3	0	0	3	3
5	BT1404	Molecular Biology	PC	3	0	0	3	3
6	BT1406	Fluid Mechanics and Heat Transfer Operations	ES	3	0	0	3	3
PRACTICALS								
7	BT1411	Chemical Engineering Laboratory for Biotechnologist	PC	0	0	4	4	2
8	BT1412	Instrumentation and Methods of Analysis Laboratory	PC	0	0	4	4	2
9	HS1421	An Introduction to Advanced Reading and Writing	EE	0	0	2	2	1
			TOTAL	**18**	**1**	**10**	**29**	**24**

SEMESTER III

MA1373 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

OBJECTIVES

This course enables the students to

- To introduce the basic concepts of PDE used in solving partial differential Equations.
- To introduce Fourier series which plays a vital role in solving boundary value problems.
- To acquaint the students with Fourier transform and Z-transform techniques

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange's Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 12

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two- dimensional heat equation – Fourier series solutions in cartesian coordinates.

UNIT IV FOURIER TRANSFORM 12

Fourier integral theorem – Fourier transform pair - Sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 12

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z - transform.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Form the partial differential equations and solve them using various techniques

CO2 Find the Fourier constants and frame the Fourier series of periodic functions

CO3 Classify and solve the initial and boundary value problems such as wave and heat flow equation

CO4 Compute the Fourier transforms of standard functions and learn the properties

CO5 Apply the techniques of Z- transform to get the solutions of differential equations

TEXTBOOKS:

1 Erwin kreyszig, 2015, *Advanced Engineering Mathematics*, John Wiley & Sons, 10th Edition, New Delhi.

2 Grewal B,S, 2017*, Higher Engineering Mathematics*, Khanna Publishers, 44th Edition, New Delhi.

REFERENCES:

1 Bali, N, Goyal, M, & Watkins C, 2009*, Advanced Engineering Mathematics,* Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi.

2 Narayanan, S, Manicavachagom Pillay T, K & Ramanaiah, G , 1998, *Advanced Mathematics for Engineering Students*, Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai.

3 Glyn James, 2011, *Advanced Modern Engineering Mathematics*, Pearson Education, 4 th Edition, New Delhi.

4 Peter V, O'Neil, 2012, *Advanced Engineering Mathematics*, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi.

5 Ramana, 2010, B,V*, Higher Engineering Mathematics*, Tata McGraw Hill, 11th Reprint, New Delhi.

BT1301 CELL BIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Acquire the basic knowledge of the structural and functional properties of cells
- Understand the fundamental of cell signalling and membrane transport mechanism
- Understand the key analytical techniques in cell biology

UNIT I CELL ORGANELLES & CYTOSKELETON 9

Cell – Fundamental unit of life; Structural organization of prokaryotic and eukaryotic cell; Structure and functions of cell organelles: Nucleus and cytoplasm. Mitochondria and Chloroplast, Endoplasmic reticulum and its types, Golgi complex, Lysosomes, Vacuoles and peroxisomes. Organelle biomarkers; Cytoskeleton: Structure, Composition, Assembly and functions of microtubules, microfilaments and intermediate filaments, Microfilaments: mechanism of myosin-ATPase activity, contraction; Microtubules, microfilaments activity in Organelle movement.

UNIT II CELL DIVISION AND CONNECTION 9

Cell cycle – Mitosis, Meiosis ; Molecules controlling cell cycle – Cyclins, CDK, Regulation of cell cycle ; Cell cycle - Check points ; Extra cellular matrix – Basal lamina, Connective tissue ; Cell-Cell and Cell-ECM Junctions and their Adhesion Molecules - Gap junctions, Tight junctions, Desmosomes, Hemidesmosomes.

UNIT III MEMBRANE TRANSPORT 9

Basics of membrane transport: Size, solubility and electrochemical gradient of solutes across membrane. Transport proteins: Uniporters, Symporters, Antiporters, Aquaporins, ATP driven pumps and its types, Ion-channels – voltage and ligand gated. Role of ion-channels and ATP pumps in nerve conduction. Principles of Patch-Clamp experiment to study ion-channels activity.

UNIT IV CELL SIGNALLING 9

Cell signaling models: autocrine, endocrine and paracrine; Steps in signal transduction, Signal amplification, Modes of intercellular signaling ; Intracellular receptor pathways - Nitric oxide pathway; Signaling at the cell surface: GPCRs and Second messengers ; Receptors with intrinsic or associated enzymatic activity: Receptor tyrosine kinases – Ras MAP Kinase pathway, cytokine receptor – JAK/STAT pathway, receptors that are ion channels – Ca2+signaling, receptors activating pathways involving proteolysis - Wnt pathway.

UNIT V TECHNIQUES IN CELL BIOLOGY 9

Cell fractionation: Extraction, Homogenization and Centrifugation techniques. Microscopy and cell architecture; Cell isolation: Fluorescence Activated Cell Sorter (FACS) and Magnetic-

activated cell sorting (MACS); Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture ; Types of cell cultures – Monolayer, Suspension, Clone culture, Mass culture-microcarrier culture ; Cell viability studies: Using tetrazolium salts, LDH release and Tryphan blue exclusion.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Demonstrate the fundamental composition, structure and characteristics of prokaryotic and eukaryotic cell membrane
CO2	Illustrate the fundamental composition, structure and characteristics of prokaryotic and eukaryotic cell organelles
CO3	summarize the action of membrane transport proteins in transport of ions and small molecules across the membrane
CO4	Analyze the basic mechanism behind membrane trafficking and intracellular protein transport
CO5	Utilize a microscope and other bioinstrumentation required in cellular or molecular biology investigations

TEXT BOOKS

1 Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., 2015. *Analyzing cells, molecules, and systems*. *Molecular Biology of the Cell* (6th Edition). Richter LM (Ed.). Garland Science, NY and Abingdon, UK, pp.439-528.

2 Lodish, H., Berk, A., Kaiser, C.A., Kaiser, C., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P., 2008. *Molecular cell biology*. Macmillan.

3 Karp, G., 2009. *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.

REFERENCES

1 Cooper, G.M. and Hausman, R.E., 2004. *The cell: a molecular approach*.

2 Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P., 2006. *The world of the cell*. San Francisco, CA: Pearson/Benjamin Cummings.

3 Simon, E.J., Dickey, J.L., Hogan, K.A. and Reece, J.B., 2016. *Essential Biology*. United States of America, Pearson Education, Inc.

BT1302 MICROBIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Know Different types of microorganisms and Structural organization,
- Define Multiplication, growth, control and their applications.

UNIT I INTRODUCTION 9

History and Scope of microbiology; Classification and Nomenclature of microorganisms; Stains and Staining techniques- Simple staining, Differential staining (Gram & Acid fast); Special staining-(Capsular, Flagellar & Endospore).

UNIT II MICROBES- STRUCTURE AND MULTIPLICATION 9

Structural organization and multiplication of bacteria, viruses, Bacteriophages; General characteristics and reproduction of Fungi (Mould& Yeast), Algae, Actinomycetes and Mycoplasma.

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 9

Nutritional classification of microorganisms based on carbon, Energy and electron sources; Definition of growth, Different media used for bacterial culture; Cultural characteristics; Growth curve and Different methods to quantify bacterial growth; Aerobic and naerobic bioenergetics.

UNIT IV CONTROL OF MICROORGANISMS 9

Physical and chemical control of microorganisms; Antibiotics - anti-bacterial, antifungal and anti-viral agents; Mode of action and Resistance to antibiotics; Host-microbe interactions; clinically important microorganisms.

UNIT V APPLICATIONS OF MICROBIOLOGY 9

Primary metabolites; secondary metabolites and their applications; Production of biogas; Bioremediation; Biofertilizers and Biopesticides; Food preservation; Microbial leaching; Biosensors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Define the categories of microorganisms, their classification, diversity and microscopy

CO2 Demonstrate structural differences among diversified microbes

CO3 Explain method to cultivate microorganisms and microbial metabolic pathways

CO4 Demonstrate methods and parameters to control microbes and evaluation of microbial control.

CO5 Apply various microbial systems in biotechnological industries for commercial products

TEXT BOOKS

1 Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., 2001. *Microbiology*. Tata McGraw Hill Edition, New Delhi, India

2 Brock, T.D., Madigan, M.T., Martinko, J.M. and Parker, J., 2014. *Brock biology of microorganisms*. Upper Saddle River (NJ): Prentice-Hall.

3 Gerard J. Tortora, Berdell R. Funke & Christine L. Case. 2018 *Microbiology: An Introduction*. Pearson, 13th Ed.

REFERENCE BOOKS

1 Willey, J.M., Sherwood, L. and Woolverton, C.J., 2011. *Prescott's microbiology* (Vol. 7). New York: McGraw-Hill.

2 Louise Hawley, Don Dunn, "*Microbiology and Immunology*" 2002 Kaplan, Inc.

3 Cruger.Wulf and Anneliese Crueger, 2017 "*Biotechnology: A Textbook of. Industrial. Microbiology"*, 3nd Edition, Panima Publishers.

BT1303 STOICHIOMETRY

L	T	P	C
3	1	0	4

OBJECTIVES:

This course enables the students to

- Learn about the various units and dimensions of physical quantities.
- Develop skills of the students in the area of Chemical Engineering with emphasis in material and energy balance calculations without chemical reactions.

- Develop skills of the students in the area of Chemical Engineering with emphasis in material and energy balance calculations with chemical reactions.

UNIT I BASIC CHEMICAL CALCULATIONS (9 + 3)

Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other; Composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density; Chemical Reaction - limiting reactant, excess reactant, fractional conversion, percent conversion, yield, selectivity, extent of reaction.

UNIT II IDEAL AND ACTUAL GAS EQUATIONS (9 + 3)

Ideal and actual gas equations – Vander Walls, compressibility factor equations; Application to pure gas & gas mixtures – partial pressures, partial volumes; Air-water vapour systems – Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume, Humidity chart, Wet and Dry bulb temperatures, Dew point; pH of solutions; Vapour pressure.

UNIT III MATERIAL BALANCE (9 + 3)

Material balance concept – overall & component; material balance applications – Evaporator, Gas absorber, Distillation (Binary system), Liquid extraction, Solid-liquid extraction, Drying, Crystallization, Humidification, Mixing, Recycle and Bypass illustration.

UNIT IV ENERGY BALANCE (9 + 3)

Thermo physics - general energy balance equation for open systems, closed systems; sensible heat calculation; heat required for phase change; Thermo chemistry – heat of formation, heat of reaction, heat of combustion; Application of steam tables - saturated and superheated steam.

UNIT V CHEMICAL REACTION (9 + 3)

Combustion reactions – solid, liquid and gaseous fuels; applications - oxidation of sulphur compounds and related processes, carbon dioxide from limestone, phosphorous compounds, nitrogen, ammonia, nitric acid, metallurgical applications; processes in biological systems – yield and yield coefficient, elemental balance, respiratory quotient, degree of reduction, oxygen requirement.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Solve the various unit conversion problems and problems related to basic chemical calculations in chemical engineering and biotechnology practice.

CO2 Solve the problems related to ideal, actual gas, air-water vapour system and humidity.

CO3 Apply the concept of material balance without chemical reaction and analysis of data for steady and unsteady state operations in chemical and biochemical engineering.

CO4 Apply the concept of energy balance for open and closed systems and the concept of thermochemistry in chemical engineering and biotechnology application.

CO5 Apply the concepts of material and energy balance with chemical reactions.

TEXT BOOKS:

1. Bhatt, B.I. and Thakore, S.B., 2010. *Stoichiometry*. Tata McGraw-Hill Education.
2. Narayanan, K.V. and Lakshmikutty, B., 2016. *Stoichiometry and process calculations*. PHI Learning Pvt. Ltd.
3. Himmelblau, D.M. and Riggs, J.B., 2012*. Basic principles and calculations in chemical engineering*. FT press.

REFERENCE BOOKS:

1. McCabe, W.L., Smith, J.C. and Harriott, P., 1993. *Unit operations of chemical engineering*. New York: McGraw-hill.
2. Sikdar, D.C., 2013. *Chemical Process Calculations*. PHI Learning Pvt. Ltd.
3. Hicks, T.G. and Chopey, N.P., 2012. *Handbook of chemical engineering calculations*. McGraw-Hill Education.

BT1306 THERMODYNAMICS FOR BIOTECHNOLOGISTS

L	T	P	C
3	0	0	3

OBJECTIVES

This course will enable the students to

- Understand the basic principles of work and energy and thermodynamics laws.
- Learn the principles of entropy and entropy driven processes in biochemical systems along with free energy and phase equilibria.
- Have a comprehensive understanding of PVT behavior of fluids and chemical reaction equilibria.

- To have a complete knowledge on principles of chemical reaction equilibria as applied to biological systems

UNIT I THERMODYNAMIC LAWS AND PROPERTIES OF FLUIDS 9

Concept of heat, work and energy; Forms – work and energy; First Law of thermodynamics- a generalized balance equation and conserved quantities; internal energy and enthalpy changes; Second law of thermodynamics - volumetric properties of fluids exhibiting non-ideal behaviour; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property changes; Maxwell's relations and applications.

UNIT II SOLUTION THERMODYNAMICS 9

Partial molar properties; concept of chemical potential and fugacity; ideal and non-ideal solutions; concept and application of excess properties of mixtures; activity coefficient; composition models; Gibbs-Duhem equation; Thermodynamic properties of ions in solutions; Entropy – Calculations of entropy changes, Clausius inequality, Irreversibility.

UNIT III PHASE EQUILIBRIA 9

Criteria for phase equilibria; Phase equilibrium in single and multi-component system; Phase rule for non-reacting systems; Duhem's theorem; Vapour-Liquid Equilibria (VLE) calculations for binary and multi-component systems; Azeotropes; Consistency Test for VLE Data; Liquid-Liquid equilibria.

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; other factors affecting the equilibrium conversion; calculation of equilibrium conversion and yields for single and multiple reactions.

UNIT V THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION 9

Thermodynamics of microbial growth stoichiometry; thermodynamics of maintenance; calculation of the operational stoichiometry - at different growth rates, Herbert-Pirt relation for electron donor; thermodynamics and stoichiometry of product formation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Outline the concepts of equilibrium conditions, internal energy, enthalpy, free energy, chemical potential and thermodynamic laws.

CO2 Summarize the basic concepts in solution thermodynamics and relative energies of different liquid and solid solution

CO3 Illustrate the basic concepts of different phases (multiple) and its equilibria

CO4 Identify and apply appropriate thermodynamic relations in chemical reaction system

CO5 Analyze the biochemical reaction to the knowledge of basic thermodynamics of chemical reactions in biological systems

TEXT BOOKS

1. Smith, J.M., Van Ness, H.C. and Abbott, M.M., 2009. *Introduction to Chemical Engineering Thermodynamics,* ', Mc Grawhill Book Company. International Edition.
2. Narayanan, K.V., 2004. *A textbook of chemical engineering thermodynamics*. PHI Learning Pvt. Ltd..
3. Smolke, C. ed., 2009. *The metabolic pathway engineering handbook: fundamentals (Vol. 1).* CRC press.
4. Von Stockar, U., 2013. *Biothermodynamics: The role of thermodynamics in biochemical engineering*. PPUR Presses polytechniques.

REFERENCE BOOKS

1. Sandler, S.I., 2017. *Chemical, biochemical, and engineering thermodynamics.* John Wiley & Sons..
2. Atkins, P.W. and De Paula, J., 2013. *Physical chemistry*. John Wiley & Sons.
3. Haynie, D.T., 2013. *Biological thermodynamics*. Cambridge University Press.
4. Peter Atkins, P. and De Paula, J., 2014. *Atkins' Physical Chemistry*. OUP Oxford.

BT1311 CELL BIOLOGY LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

This course enables the students to

- Learn about the principles of microscopy and sterilisation techniques
- Get trained with different cell staining and viability methods

LIST OF EXPERIMENTS

1. Identification of plant cells – root, stem and leaf.
2. Identification of animal cells – blood cells, squamous epithelial cells.
3. Plant -sub-cellular staining
4. Hemocytometer – enumeration of Red Blood Cells and White Blood Cells.
5. Bacterial cell viability studies - Tryphan blue dye exclusion, Tetrazolium salts
6. Cell/tissue lysis - Homogenization
7. Cell fractionation - Differential fractionation
8. Cell division - mitosis in onion root
9. Cell division - meiosis (pre-stained slides)
10. Histopathology - Hematoxylin and Eosin staining (pre-prepared paraffin sections fixed on slide)
11. Membrane transport – Osmosis, Dialysis, Diffusion
12. Tonicity -(hyper, hypo and iso) osmolality condition

TOTAL: 60 PERIODS

EQUIPMENT REQUIRED (FOR 30 STUDENTS)

1. Refrigerated centrifuge – 2 Nos.
2. Temperature controlled Incubator shaker – 2 Nos.
3. Temperature controlled water bath – 2 Nos.
4. Ice flake machine – 1 Nos.
5. Tissue homogenizer – 2 Nos
6. Microplate reader – 1 No.
7. Laminar air flow – 3 nos.

Glass wares/Plastic wares/Chemicals/Media as required

COURSE OUTCOMES

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

CO1 Demonstrate the working principles of Microscopy.

CO2 Develop the ability to examine the sub cellular structures.

CO3 Carry out differential staining in order to understand the internal components / complexities of a cell.

CO4 Evaluate the integrity and lysis of cells in culture for downstream experiments

CO5 Identify the viability of cells

REFERENCES

1. Rickwood, D. and J.R. Harris 1996, *Cell Biology : Essential Techniques*, John Wiley,
2. Davis, J.M. 1994, *Basic Cell Culture : A Practical Approach*, IRL,.

BT1312 MICROBIOLOGY LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

This course enables the students to

- Know Laboratory biosafety, sterilization techniques.
- Learn Media preparation, isolation of microorganisms and staining techniques.
- Familiarize the growth of microbes, environmental factors effect on growth and Control of microbes.

LIST OF EXPERIMENTS

1. Laboratory Safety, Use of Equipment; Sterilization Techniques
2. Culture Media- Preparation of Nutrient medium (Broth and agar – Slant, Deep)
3. Pure Culture Techniques, Streak plate, Pour plates, Spread plate, Slants, Stabs
4. Microscopy – Working and principles, Microscopic identification of Yeast/Mould
5. Staining
   - Simple staining
   - Differential - Gram's Staining
   - Endospore staining
   - Capsular staining
   - Lacto-phenol Cotton blue staining – Fungi
6. Motility test – Hanging drop method
7. Enumeration of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
8. Growth Curve in Bacteria
9. Effect of pH, Temperature, UV radiation on Growth Bacteria
10. Biochemical analysis: Indole, Methyl red, Vogus proskaur test, Citrate utilization, TSI – type study – *E.coli*
11. Antibiotic Sensitivity Assay

12. Effect of Disinfectants- Phenol Coefficient

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Prepare different types of media and demonstrate culture techniques

CO2 Demonstrate the different types of staining for microbe identification.

CO3 Perform different methods of enumeration of microorganisms in different samples and microbial growth.

CO4 Evaluate the effect of various physical factors on growth and microbial biochemical efficacy.

CO5 Carry out antibiotic sensitivity and effect of disinfectant on growth of microorganisms.

TEXT BOOK

1. Cappuccino, J.G. and N. Sherman 2013 —*Microbiology: A Laboratory Manual*ll*,* 10th Edition, Addison-Wesley.

REFERENCES

1. Brown, A. and Smith, H., 2014. *Benson's Microbiological Applications, Laboratory Manual in General Microbiology*

HS1321	**INTERPERSONAL SKILLS - LISTENING AND SPEAKING**	**L**	**T**	**P**	**C**
OBJECTIVES:		**0**	**0**	**2**	**1**

The course will enable learners to:

- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- Improve general and academic listening skills
- Make effective presentations.

UNIT I LISTENING AS A KEY SKILL **6**

Listening as a key skill- its importance- speaking – give personal information – ask for personal information – express ability – enquire about ability – ask for clarification - Improving pronunciation– pronunciation basics –– stressing syllables and speaking clearly – intonation patterns – conversation starters: small talk.

UNIT II LISTEN TO A PROCESS INFORMATION **6**

Listen to a process information- give information, as part of a simple explanation –– taking lecture notes – preparing to listen to a lecture – articulate a complete idea as opposed to producing fragmented utterances - compare and contrast information and ideas from multiple sources- converse with reasonable accuracy over a wide range of everyday topics.

UNIT III LEXICAL CHUNKING **6**

Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minute informal talk – greet – respond to greetings – describe health and symptoms – invite and offer –accept – decline – take leave – listen for and follow the gist- listen for detail

UNIT IV GROUP DISCUSSION **6**

Being an active listener: giving verbal and non-verbal feedback – participating in a group discussion – summarizing academic readings and lectures conversational speech listening to and participating in conversations – persuade- negotiate disagreement in group work**.**

UNIT V GROUP & PAIR PRESENTATIONS **6**

Formal and informal talk – listen to follow and respond to explanations, directions and instructions in academic and business contexts – strategies for presentations and interactive communication – group/pair presentations

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 Develop their communicative competence in English with specific reference to listening

CO2 Prepare conversation with reasonable accuracy

CO3 Apply lexical Chunking for accuracy in speaking

CO4 Demonstrate their ability to communicate effectively in GDs

CO5 Explain directions and instructions in academic and business contexts

TEXT BOOKS:

1. Brooks, Margret, 2011, *Skills for Success. Listening and Speaking. Level 4,* Oxford University Press, Oxford.
   Richards, C, Jack& David Bholke, 2010, *Speak Now Level 3,* Oxford University Press, Oxford.

REFERENCE BOOKS:

1. Bhatnagar, Nitin & Mamta Bhatnagar, 2010, *Communicative English for Engineers and Professionals,* Pearson, New Delhi.
2. Hughes, Glyn & Josephine Moate, 2014, *Practical English Classroom,* Oxford University Press, Oxford.
3. Vargo, Mari, 2013, *Speak Now Level 4*, Oxford University Press, Oxford.
4. Richards, C, Jack, 2006, *Person to Person (Starter)*, Oxford University Press, Oxford.
5. Ladousse, Gillian Porter, 2014, *Role Play*. Oxford University Press, Oxford.

WEB RESOURCES:

1. https://www.cambridge.org/elt/blog/wp-content/uploads/2019/10/Learning-Language-in-Chunks.pdf

2. https://english.eagetutor.com/english/628-how-to-greet-your-boss-people-in-office.html

3. https://www.groupdiscussionideas.com/group-discussion-topics-with-answers/

4.https://www.bbc.co.uk/worldservice/learningenglish/business/talkingbusiness/unit3presentations/1opening.shtml

SEMESTER IV

MA1473 PROBABILITY AND STATISTICS

L	T	P	C
3	1	0	4

OBJECTIVES:

The Course will enable students to

- Understand the basics of random variables and some standard distributions that can describe real life phenomenon.
- Establish the basic concepts of two-dimensional random variables.
- Impart the knowledge of testing of hypothesis for small and large samples.
- Describe the basic principles in the design of simple experiments for comparing pairs of treatments.
- Introduce the basic concepts of statistical quality control that plays a vital role in the field of Engineering and Technology.

UNIT I RANDOM VARIABLES 12

Basics of Probability - Discrete and continuous random variables – moments – moment generating functions – binomial, Poisson, geometric, uniform, exponential, gamma and normal distributions – functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 12

Joint distributions — marginal and conditional distributions — covariance — correlation – Karl Pearson's correlation coefficient – Rank correlation – Spearman's rank correlation coefficient – Kendall's rank correlation coefficient - linear regression.

UNIT III TESTS OF SIGNIFICANCE 12

Type I and Type II errors — tests for single mean, difference of means (large and small samples) — tests for single variance and equality of variances — chi-square test for goodness of fit — independence of attributes.

UNIT IV DESIGN OF EXPERIMENTS 12

Basic Principles of experimental design - Completely randomized design – randomized block design – Latin square design –2 level factorial design.

UNIT V STATISTICAL QUALITY CONTROL 12

Control charts for measurements ($\overline{X}$ and R charts for continuous data) — control charts for attributes (p, c, np and u charts for discrete data) - tolerance limits.

TOTAL: 60 PERIODS

COURSE OUTCOMES

After completing this course, students will be able to:

CO1 Solve various problems using random variables and distributions

CO2 Compute the correlation between two variables and linear regression equation for a set of data

CO3 Apply the concept of testing of hypothesis for small and large samples in real life problems

CO4 Interpret the data using ANOVA and basic experimental design

CO5 Apply the techniques of Statistical quality control in industrial Engineering problems

TEXT BOOKS:

1. Devore, J L 2017, *Probability and Statistics for Engineering and the Sciences*, Cengage Learning, 9th Edition, Boston.
2. Johnson, R A, & Gupta, C B 2017, *Miller and Freund's Probability and Statistics for Engineers*, Pearson India Education, Asia, 9th Edition, New Delhi.

REFERENCES:

1. Milton, J S & Arnold, J C 2008, *Introduction to Probability and Statistics*, Tata McGraw Hill, 4th Edition, New Delhi.
2. Ross, S M 2014, *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, 5th Edition, New Delhi.
3. Spiegel, M R, Schiller, J, Srinivasan, R A & Goswami, D 2017, *Schaum's Outline of Theory and Problems for Probability and Statistics*, McGraw Hill Education, 3rd Edition, New Delhi.

BT1401 ANALYTICAL METHODS OF INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- learn the fundamentals about the light spectrum, Absoprtion, Emission, Fluorescence, NMR and Mass spectroscopy
- understand instrumentation and working principle of optical instruments
- acquire knowledge on the different chromotographic methods for separation of biological products.

UNIT I INTRODUCTION TO ELECTROMAGNETIC SPECTRUM 9

Properties of electromagnetic radiation- wave properties; components of optical instruments – Sources of radiation, wavelength selectors, sample containers, radiation transducers, signal process and read outs; signal to noise ratio - sources of noise , Enhancement of signal to noise; types of optical instruments ; Principle of Fourier Transform optical Measurements.

UNIT II SPECTROSCOPY AND ITS APPLICATIONS 9

Theory, instrumentation, types and applications of Molecular absorption spectrometry, Emission spectroscopy (Fluorescence and Phosphorescence, Infrared absorption spectrometry Raman spectroscopy. Theory, instrumentation and applications of XRD; Other techniques- Turbidometry, nephelometry

UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9

Theory of NMR; environmental effects on NMR spectra – chemical shift; NMR-spectrometers; applications of 1H and 13C NMR; Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass; Electron paramagnetic resonance- g values; instrumentation.

UNIT IV SEPARATION METHODS 9

General description of chromatography – Band broadening and optimization of column performance; Liquid chromatography ; Partition chromatography ; Adsorption chromatography, expanded bed adsorption chromatography ; Ion exchange chromatography ; size exclusion chromatography; Affinity chromatography; HPLC; principles of GC, super critical fluid chromatography, displacement chromatography-horizontal and vertical electrophoresis;

Capillary electrophoresis – Applications.

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells; Electrode potential cell potentials – potentiometry, reference electrode , ion selective and molecular selective electrodes ; Instrument for potentiometric studies; Voltametry – Cyclic and pulse voltametry, Applications of voltametry ; Study of surfaces – Scanning probe microscopes – AFM and STM

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Illustrate the instrumentation and working principle of optical instruments

CO2 Restate the principle, illustrate the instrumentation of spectroscopic methods and utilize them for applications in biotechnology.

CO3 Restate the principles, illustrate the instrumentation of NMR and Mass spectroscopy and utilize them for applications in biotechnology

CO4 Restate the principles, illustrate the instrumentation of various separation methods and utilize them for applications in biotechnology.

CO5 Restate the principles, illustrate the instrumentation of electrochemical analysis and advanced surface microscopic techniques and utilize them for applications in biotechnology

TEXT BOOKS:

1. Skoog, D.A., Holler, F.J. and Crouch, S.R., 2017. *Principles of Instrumental Analysis*. Cengage learning.
2. Willard, H.H., Merritt Jr, L.L., Dean, J.A. and Settle Jr, F.A., 1988. *Instrumental methods of analysis*.7thEdition, CBS.
3. Braun, R.D., 1987. *Introduction to instrumental analysis*. Mcgraw-Hill College. Pharma Book Syndicate, 1987.

REFERENCES:

1. Ewing,G.W. 1985 *Instrumental Methods of Chemical* Analysis, 5th Edition, McGraw-Hill.
2. Sharma, B.K., 1981. *Instrumental methods of chemical analysis*. Krishna Prakashan Media.
3. Haven, M.C., Tetrault, G.A. and Schenken, J.R. eds., 1994. *Laboratory instrumentation*. John Wiley & Sons.

BT1402 BASIC INDUSTRIAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

This course enables the students to

- Develop an understanding on overall industrial bioprocess
- Help them to manipulate the process to the requirement of the industrial needs.
- Understand various strategies for the bulk production of commercially important modern bio products, industrial enzymes, products of plant and animal cell cultures.

UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 9

Biochemistry of fermentation; Concepts of upstream and downstream processing in Bioprocess, Process flow sheet – block diagrams, pictorial representation. Fermentation - Bacterial, Fungal and Yeast; Strategies for strain improvement; Bioprocess strategies in Plant Cell and Animal Cell culture; monitoring and control of contamination.

UNIT II PRODUCTION OF PRIMARY METABOLITES 9

Biosynthetic pathways and production of commercially important primary metabolites: Organic Acids – Citric acid, Lactic acid, Acetic acid, Gluconic acid; Amino Acids – L-Glutamic acid, L-Lysine, L-Tryptophan; Alcohols – Ethanol, Butanol; Enzymes.

UNIT III PRODUCTION OF SECONDARY METABOLITES 9

Biosynthetic pathways and production processes for various classes of secondary metabolites: Antibiotics – Penicillin, Cephalosporin, Tetracycline; Vitamins – Vitamin B12, Riboflavin, β-Carotene; Steroid Precursors - sapogenins.

UNIT IV PRODUCTION OF BIOFUELS, AGRI AND FOOD PRODUCTS 9

Production of Biodiesel, Biogas, Biopesticides, Biofertilizers, Biopolymers, Cheese, Beer, Single Cell Proteins – Bacterial, Yeast, Algal & Mushroom culture.

UNIT V PRODUCTION OF RECOMBINANT BIOPRODUCTS 9

Production of recombinant proteins having therapeutic and diagnostic applications, Monoclonal antibodies, Vaccines, Human Growth Factor, Insulin, Tumor Suppressor Proteins, Future Aspects.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Illustrate the steps involved in industrial bioprocess
CO2	Explain the basic biotechnological principles, methods and models in the production of primary metabolites.
CO3	Outline the various metabolic engineering approaches in the production of secondary metabolites.
CO4	Apply various bioprocess principles in the production of industrial bioproducts
CO5	The students will be able to restate the principles, illustrate the instrumentation of electrochemical analysis and advanced surface microscopic techniques and utilize them for applications in biotechnology

TEXT BOOKS:

1. Casida, L.E., 1968. *Industrial microbiology.*
2. Crueger, W., Crueger, A., Brock, T.D. and Brock, T.D., 1990. *Biotechnology: a textbook of industrial microbiology*.
3. Stanbury, P.F., Whitaker, A. and Hall, S.J., 2013. *Principles of fermentation technology*. Elsevier.
4. Watson, J.D., Myers, R.M., Caudy, A.A. and Witkowski, J.A., 2007. *Recombinant DNA: genes and genomes: a short course*. Macmillan.

REFERENCES:

1. Prescott, S.C. and Dunn, C.G., 1949. *Industrial microbiology.*
2. Moo-Young, M., 2019. *Comprehensive biotechnology*. Elsevier.
3. El-Mansi, M., Bryce, C.F.A., Demain, A.L. and Allman, A.R*., Fermentation microbiology and biotechnology*. 2007.

BT1403 ENZYME TECHNOLOGY AND BIOTRANSFORMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Familiarize the basic concepts of mechanism of enzyme action.
- Apply the kinetics aspects of reaction with single substrate, multi substrate, inhibitor and immobilized enzyme in various biotechnological applications
- Explore skills in production, purification of enzyme and its applications in biotransformation reactions.

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes; Mechanisms of enzyme action; Concept of active site and energetics of enzyme substrate complex formation; Specificity of enzyme action; Principles of catalysis - collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions; Estimation of Michaelis-Menten parameters; Types of inhibition & models; Multi substrate enzyme kinetics; Allosteric regulation of enzymes; Monod-Changeux-Wyman models; Effect of pH and temperature on enzyme action.

UNIT III ENZYME IMMOBILIZATION 9

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples, advantages and disadvantages; Kinetics of immobilized enzyme - Factors affecting the kinetics of bound enzymes, Effect of internal and external diffusional limitations, Diffusional effects and determination of kinetic parameters.

UNIT IV ENZYME PRODUCTION AND PURIFICATION 9

Production and purification of crude enzyme from microbial, plant and animal sources; Development of enzymatic assays; methods of characterization of enzymes – structural and functional properties.

UNIT V APPLICATIONS OF ENZYMES 9

Hydrolytic reactions - Ester, Amide, Epoxides, Nitriles; Reduction reactions - aldehydes, Ketones; Oxidation reactions - Alkanes, Aromatic, Baeyer-Villiger; Enzymes in organic synthesis - esters, amide, peptide; Modified and Artificial Enzymes; Catalytic antibodies; Introduction to Biosensors - design of enzyme electrodes and their application as biosensors in industry, healthcare and environment; Immobilized enzymes in biofuel research.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Explain the complexities of enzyme action for biotechnological applications

CO2 Outline the kinetics of enzyme action.

CO3 Apply the knowledge of immobilized enzyme and its kinetics

CO4 Design strategies for the production and purification of enzymes.

CO5 Comprehend the uses of enzymes catalyst in various biotransformation reactions

TEXT BOOKS:

1. Trevor Palmer and Philip Bonner., 2008. *ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry*. 2nd Edn, East West Publishers.
2. Harvey W. Blanch, Douglas S. Clark., 2007. *Biochemical Engineering*, Taylor & Francis.
3. Harvey W. Blanch and Douglas S. Clark., 2021. *Applied Biocatalysis*. 1st Edn. CRC Press.

REFERENCES:

1. Nelson DL, Cox MM., 2021. *Lehninger Principles of Biochemistry*. 8th Edn. W.H.Freeman & Co Ltd.
2. Alka Dwevedi, 2018. *Enzyme Immobilization: Advances in Industry, Agriculture, Medicine, and the Environment*. Springer.
3. Ajit Sadana, Neeti Sadana., 2010. *Handbook of Biosensors and Biosensor Kinetics*. 1st Edn. Elsevier Science.

BT1404 MOLECULAR BIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Familiarize the basic principles of molecular biology and explore skills in molecular biology to aware the complexity and harmony of the cells.

UNIT I INTRODUCTION TO NUCLEIC ACIDS 9

Structure and physicochemical properties of elements in DNA and RNA; Primary and secondary structure of DNA - Chargaff's rule, Watson & Crick model; Conformational variants of double helical DNA - Hoogsteen base pairing, Triple helix, Quadruple helix; Tertiary structure of DNA – DNA supercoiling, Forces stabilizes DNA structure, Reversible denaturation and hyperchromic effect, Organization of prokaryotic chromosomes – lampbrush chromosome, Polytene chromosomes; Organization of eukaryotic chromosomes – Histone proteins.

UNIT II DNA REPLICATION & REPAIR 9

Central dogma, Meselson & Stahl experiment; DNA replication - bi–directional DNA replication, Okazaki fragments, D-loop, rolling circle and theta mode of replication, Differences in prokaryotic and eukaryotic DNA replication, Proteins involved in DNA replication, Fidelity of DNA replication – DNA mutations and repair mechanisms; Inhibitors of DNA replication; Telomere replication in eukaryotes.

UNIT III TRANSCRIPTION 9

Structure and function of mRNA, rRNA and tRNA; Characteristics of promoter and enhancer sequences; RNA synthesis - Initiation, elongation and termination of RNA synthesis, Proteins involved in RNA synthesis, Fidelity of RNA synthesis; Inhibitors of transcription; Differences in prokaryotic and eukaryotic transcription; Post transcriptional modification - RNA processing, 5'-Capping, Poly 'A' tail addition and base modification, Splicing, Alternative splicing.

UNIT IV TRANSLATION 9

Introduction to Genetic code - Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and Eukaryotic ribosomes; Translation - Initiation, Elongation and termination of protein synthesis; Differences in prokaryotic and eukaryotic translation mechanism; Inhibitors of protein synthesis; Post-translational modifications.

UNIT V REGULATION OF GENE EXPRESSION 9

Hierarchical levels of gene regulation; Introduction to operon concept; Prokaryotic gene regulation –lac and trp operon; Regulation of gene expression with reference to λ phage life cycle; Eukaryotic gene regulation – at replication, transcriptional and translational levels; Recombination and crossing over as mechanism of gene regulation – Holliday model, Jumping genes.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Familiarize the concepts of physical and chemical characteristics of nucleic acid
CO2	Comprehend the DNA replication mechanism in prokaryotic and eukaryotic cells.
CO3	Demonstrate the transcription and post transcriptional events to find out the check points in drug discovery
CO4	Demonstrate the translation and post translation modification events to find out the check points in drug discovery
CO5	Articulate the concepts of gene regulation in molecular biotechnology applications

TEXT BOOKS:

1. Malacinski G.M., 2015, *Freifelder's Essentials Of Molecular Biology*, 4th Edn, Narosa Publication.
2. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P., 2016. *Molecular Biology of the cell*, 8th Edn. Garland Science Publishers.
3. Krebs JE, Goldstein ES, Kilpatrick ST., 2017. *Lewin's Essential GENES XII*, 12th Edn. Jones and Bartlett Publishers.

REFERENCES:

1. Cooper GM, Hausman RE., 2015. *The Cell: A Molecular approach*. 7th Edn. Sinauer Associates Inc.,U.S.
2. Nelson DL, Cox MM., 2021. *Lehninger Principles of Biochemistry*. 8th Edn. W.H.Freeman & Co Ltd.
3. Tropp, Burton E.,2012. *Molecular Biology : Genes to Proteins*. 4th Edn. Laxmi Publications.

BT1406 FLUID MECHANICS AND HEAT TRANSFER OPERATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn about the fluid statics, fluid dynamics, fluid moving machinery.
- Understand the fundamental laws that governs heat transfer process.
- Expose the applications of conduction, convection and radiation heat transfer.

UNIT I FLUID PROPERTIES & FLUID MECHANICS 9

Fluid definition; compressible, incompressible fluids; coefficient of isothermal compressibility; Fluid properties - Density Specific gravity, Specific weight, Surface tension, Vapour pressure, Viscosity; Newtonian and Non-Newtonian fluids; Fluid statics – Barometric equation – application for incompressible and compressible fluids; Pressure changes in atmospheric air – Gauge and absolute pressure – pressure measurement with Bourdon gauge & manometers. Centre of pressure concept. Fluid Dynamics – equation of continuity – Bernoulli's equation – press loss in straight pipes – in fittings – expansion and contraction losses (applied to Newtonian Fluids only); Fluid flow measurement - Orifice, Venturi & Rotameter for Newtonian fluids.

UNIT II FLOW OF FLUID THROUGH PACKINGS 9

Fluidization, Fluid transport Industrial application of fluid flow through packing- characteristics of packed bed-Bed surface area-void fraction-Laminar flow through packed bed and turbulent flow pressure drop experienced by the fluid-equations and application problems. Fluidization phenomena-Industrial application - minimum fluidization velocities. Fluid moving machinery-pumps centrifugal, Reciprocating-gear, Peristaltic pumps, Introduction togas moving machinery-Fans, blowers, compressors.

UNIT III CONDUCTION HEAT TRANSFER 9

Heat transfer phenomena-thermodynamics & heat transfer. Heat conduction – Fourier's equation – steady-state conduction in plexor and radial systems – Resistance concept – series and resistance in conduction –and parallel resistance in conduction – unsteady state conduction – lumped capacity model – extended surfaces (Fins) –combined conduction & convection – two

dimensional conduction.

UNIT IV CONVECTION HEAT TRANSFER 9

Forced and natural convection – Dimensional analysis, Dimensional numbers, Convection heat transfer coefficient, Correlations for flow over plate, through tubes, over spheres and cylinders, Agitated systems, Packed columns, condensation phenomena, Film and dropwise condensation over tubes. Boiling and Condensation phenomena.

UNIT V RADIATION HEAT TRANSFER AND HEAT TRANSFER EQUIPMENT 9

Electromagnetic waves, energy of radiation, Planck's equation-Blackbody, Radiation exchange. Kirchhoff's law, Stefen Boltzmann equation of radiant energy – Wien's law, Radiation exchange between surfaces – black, grey bodies, view factors-sample problems. Concept of overall heat transfer coefficient, Heat exchangers, types, boilers, Kettles, Heat exchanger Design concept. NTU concept.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Solve the problems related to fluid statics and dynamics in momentum transfer.
CO2	Outline the concepts of fluid moving machinery, flow through packed column as well as fluidized column.
CO3	Differentiate among different modes of heat transfer, various laws and terms used for design purpose.
CO4	Solve problems related to convection, boiling and condensation phenomena,
CO5	Illustrate the principles of radiation mode of heat transfer and their applications

TEXTBOOK

1. Geankoplis, C.J. 2015, *Transport Processes and Unit Operations,* IV edition, Prentice Hall of India.
2. Nag, P.K. 2003, *Heat & Mass Transfer*, 3rd edition, Tata McGraw Hill.
3. McCabe, W.L, Sonith, J. C and Harriot, P, 2001, *Unit operations of chemical Engineering,* 6th edition, McGraw Hill.

REFERENCE BOOKS

1. Frank Kreith, Raj, M. Manglik and Mark S. Bohn, 2011, *Principles of Heat Transfer,* 7th

edition, Cenage Learning Inc.

2. Coulson, J.M., 1999, *Coulson and Richardson's Chemical Engineering Volume 1-Fluid Flow, Heat Transfer and Mass Transfer,* 6th Edition, Elsevier.

BT1411 CHEMICAL ENGINEERING LABORATORY FOR BIOTECHNOLOGISTS

L	T	P	C
0	0	4	2

OBJECTIVES:

This course enables the students to

- Understand the basics of fluid flow characteristics.
- Apply the principles of mechanical separations in chemical and biotechnology field.
- Understand the basics of principles of heat and mass transfer.

LIST OF EXPERIMENTS

1. Flow measurement – Variable Head Meters (Venturimeter and Orificemeter)
2. Flow measurement – Variable Area Meter (Rotameter)
3. Pressure drop in flow through pipes
4. Pressure drop in flow through packed column
5. Pressure drop in flow through fluidized bed
6. Characteristics of centrifugal pump
7. Characteristics of reciprocating pump
8. Solid-Liquid Separation - Filtration
9. Settling and Sedimentation
10. Heat transfer characteristics in heat exchanger
11. Simple distillation
12. Liquid-Liquid extraction
13. Drying characteristics in a pan dryer
14. Adsorption

TOTAL: 60 Periods

Equipment Needed for 30 students

Colorimeter	2
Filter leaf	1
Orifice meter	1
Venturimeter	1

Rotameter	1
Hot air oven	1
Fluidized Bed	1
Packed Bed	1
Plate and Frame Filter Press	1
Heat Exchanger	1

Glassware, Chemicals, Media as required

COURSE OUTCOMES

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

CO1 Calibrate the flow measuring devices and measure the flow rate.

CO2 Investigate the pressure drop in various conduits.

CO3 Analyse the operating characteristics of pumps.

CO4 Separate solid-liquid slurries using filtration equipment.

CO5 Find the heat and mass transfer terminologies using heat exchanger, distillation, extraction, adsorption and drying equipment.

REFERENCES

1. McCabe, W.L., Smith, J.C. and Harriott, P., 2001. *Unit operations of chemical engineering* 6th edition, New York: McGraw-Hill.
2. Kreith, F. and Bohn, M.S., 1997. *Principles of heat transfer* 7th edition. Cenage Learning Inc.
3. Geankoplis, C.J., 2006. *Transport processes and separation process principles* 4th edition. Prentice Hall Professional Technical Reference.

BT1412 INSTRUMENTATION AND METHODS OF ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

This course enables the students to

- Have a practical hands on experience on Absorption Spectroscopic methods
- Understand and perform nephlometric and fluorimertic experiments
- Acquire experience in the purification by performing chromatography

LIST OF EXPERIMENTS

1. Precision and validity checking of instrument using KMnO4 solution
2. Verification of Beer Lambert's law using standard sugar solution and protein solution
3. UV spectra of nucleic acids and proteins
4. Limits of detection using aluminium alizarin complex
5. Finding the molar absorbtivity and stoichiometry of the Fe (1,10phenanthroline)3 using absorption spectrometry.
6. Finding the pKa of 4-nitrophenol using absorption spectroscopy.
7. Chemical actinometry using potassium ferrioxolate.
8. Estimation of SO^{4-} by nephelometry.
9. Estimation of Al^{3+} by Flourimetry.
10. Estimation of thiamine by Fluorimetry
11. Chromatography analysis of amino acids using TLC
12. Chromatography analysis of plant pigments using column chromatography.

TOTAL: 60 PERIODS

EQUIPMENT NEEDED FOR 30 STUDENTS

- UV visible spectrophotometer 2
- Spectrofluorometer
- Nephlometer / turbidometer
- Actinometer
- TLC plates 12
- Adsorbent column 12
- Glassware, Chemicals- as required

COURSE OUTCOMES

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

CO1 Determine the precision and validity of experiments

CO2 Identify biomolecules by spectrum analysis

CO3 Perform experiments using nephlometry and fluorimetry

CO4 Perform experiments using absorption spectroscopy

CO5 Perform experiments using thin layer and column chromatography techniques

REFERENCES

1. Skoog, D.A., Holler, F.J. and Crouch, S.R., 2017. *Principles of Instrumental Analysis*. Cengage learning.
2. Willard, H.H., Merritt Jr, L.L., Dean, J.A. and Settle Jr, F.A., 1988. *Instrumental methods of analysis*. 7th Edition, CBS.
3. Braun, R.D., 1987. *Introduction to instrumental analysis*. Mcgraw-Hill College. Pharma Book Syndicate, 1987.
4. Ewing,G.W. 1985 *Instrumental Methods of Chemical Analysis*, 5th Edition, McGraw-Hill,

HS1421 AN INTRODUCTION TO ADVANCED READING AND WRITING

L	T	P	C
0	0	2	1

OBJECTIVES:

The course will enable learners to

- To strengthen the reading skills of students of engineering.
- To enhance their writing skills with specific reference to technical writing
- To develop their critical thinking skills.
- To provide more opportunities to develop their project and proposal writing skills

UNIT I EFFECTIVE READING 6

Reading – Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title. Reading-Read for details-Use of graphic organizers to review and aid comprehension.

UNIT II CRITICAL READING 6

Reading– Understanding pronoun reference and use of connectors in a passage- speed reading techniques. Reading– Genre and Organization of Ideas- Reading– Critical reading and thinking- understanding how the text positions the reader.

UNIT III PARAGRAPH WRITING 6

Writing-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence.-Write a descriptive paragraph Writing-State reasons and examples to

support ideas in writing– Write a paragraph with reasons and examples- Write an opinion paragraph

UNIT IV ESSAY WRITING **6**

Writing– Elements of a good essay - Types of essays- descriptive-narrative- issue-based-argumentative-analytical.

UNIT V EFFECTIVE WRITING **6**

Writing– Email writing- visumes – Job application- Report Writing - Project writing-Writing convincing proposals

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 Understand how the text positions the reader

CO2 Develop critical thinking while reading a text

CO3 Develop a descriptive paragraph

CO4 Make use of sentence structures effectively when creating an essay

CO5 Demonstrate proper usage of grammar in writing E-Mails, Job application and project proposals

TEXT BOOKS:

1.Gramer, F, Margot & Colin, S, Ward, 2011, *Reading and Writing (Level 3)* Oxford University Press, Oxford.

2. Debra Daise, CharlNorloff, and Paul Carne, 2011, *Reading and Writing (Level 4)* Oxford University Press: Oxford.

REFERENCE BOOKS:

1. Davis, Jason & Rhonda LIss. 2006 *Effective Academic Writing (Level 3)* Oxford University Press: Oxford.

2. E. Suresh Kumar and et al. 2012, *Enriching Speaking and Writing Skills,* Second Edition, Orient Black swan: Hyderabad.

3. Withrow, Jeans and et al. 2004 *Inspired to Write. Readings and Tasks to develop writing skills*, Cambridge University Press: Cambridge.

4. Goatly, Andrew, 2000 *Critical Reading and Writing*, Routledge: United States of America.

5. Petelin, Roslyn & Marsh Durham, 2004 *The Professional Writing Guide: Knowing Well and Knowing Why*, Business & Professional Publishing: Australia.

WEB RESOURCES:

http://learnenglishteens.britishcouncil.org/skills/reading

https://learnenglish.britishcouncil.org/skills/reading

https://www.readingrockets.org/article/25-activities-reading-and-writing-fun

https://linguapress.com/advanced.htm