



Four-Year Undergraduate Programme

**Bachelor of Technology
in
Biotechnology**

**Faculty of Engineering & Technology
Parul University, Vadodara Gujarat, India**

Faculty of Engineering & Technology
Bachelor of Technology in Biotechnology

1. Vision of the department

To inculcate academic excellence in the field of biotechnology by creating skilled biotechnology professionals who can revolutionize, discover, design & formulate valuable biological products & solutions for the welfare of the society & environment.

2. Mission of the department:

- To develop young enthusiastic biotechnologists who can work in the bio-industry or multidisciplinary areas & contribute to the progress of the nation through research and development.
- To build ethically strong biotechnologists who have moral responsibilities towards the growth of the nation.
- To impart the knowledge among students at par the need of the biotechnology industries and undertake collaborative research challenges which provides long term relation between academia & industry.

3. PROGRAMME EDUCATIONAL OBJECTIVES

The statements below indicate the career and professional achievements that the B.Tech. Biotechnology curriculum enables graduates to attain.

PEO 1	To inculcate successful biotechnology engineers with technical and professional skills to sustain a career in the biotechnology industry.
PEO 2	To endorse biotechnology engineers with strong fundamental and professional knowledge for the lifelong learning in terms of higher education and research.
PEO 3	To train biotechnology engineering professionals with good leadership quality and interpersonal skills to design, analyze and solve the technical problems for bio-industry.

4. PROGRAMME LEARNING OUTCOMES

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	Engineering knowledge:	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PLO 2	Problem analysis:	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.
PLO 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 public health and safety, and cultural, societal, and environmental considerations.
PLO 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.
PLO 5	Modern tool usage:	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PLO 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.
PLO 7	Environment and sustainability:	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PLO 8	Ethics:	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PLO 9	Individual and team work:	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PLO 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.
PLO 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.
PLO 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

5. Credit Framework

Semester wise credit distribution of the programme	
Semester-1	21
Semester- 2	24
Semester 3	21
Semester -4	20
Semester -5	23
Semester -6	22
Semester -7	24
Semester-8	12
Total Credits	167

Category wise Credit distribution of the programme	
Major Core	83
Minor Stream	30
Multidisciplinary	16
Ability Enhancement Course	7
Skill Enhancement Courses	7
Value added Courses	4
Summer Internship	4
Research Project/Dissertation	12
Total Credit	167

6. Program Curriculum

Semester - 1						
S.No	Code	Subject	Credit	Lect	Lab	Tut
1	303105102	Programming for Problem Solving	4	3	2	0
2	303107153	Electronic Workshop	1	0	2	0
3	303109102	Elements of Mechanical Engineering	4	3	2	0
4	303144102	Remedial Biology	3	3	0	0
5	303144101	Basics of Biotechnology	3	3	0	0
6	303191101	Mathematics-I	4	4	-	-
7	303193103	Communication Skills	2	-	-	2
		Total	21	16	6	2
Semester – 2						
S.No	Code	Subject	Credit	Lect	Lab	Tut
8	303104105	Environmental Science	Audit	1	0	0
9	303109101	Engineering Graphics	4	2	4	0
10	303120101	Chemistry	4	3	2	0
11	303144153	Fundamentals of Electrical and Electronics Engineering	4	3	2	0
12	303144155	Cell Biology	2	2	0	0
13	303191151	Mathematics-II	4	4	-	-
14	303192102	Engineering Physics-II	4	3	2	0
15	303193152	Advanced Communication & Technical Writing	2	-	-	2
		Total	24	18	10	2
Semester-3						
S.No	Code	Subject	Credit	Lect	Lab	Tut
16	303144201	Genetics and Molecular Biology	3	3	0	0
17	303144202	Genetics and Molecular Biology Lab	1	0	2	0
18	303144203	Basics of Microbiology	3	3	0	0
19	303144204	Basics of Microbiology Lab	1	0	2	0
20	303144205	Biochemistry	3	3	0	0
21	303144206	Biochemistry Lab	1	0	2	0
22	303144208	Biological Reaction Engineering	3	3	0	0
23	303144209	Introduction to Python Programming	2	2	0	0
24	303144210	Introduction to Python Programming Lab	1	0	2	0

25	303144212	Product Realization	1	0	2	0
26	303193203	Professional Communication Skills	2	-	-	2
		Total	21	14	10	2
Semester-4						
S.No	Code	Subject	Credit	Lec	Lab	Tut
27	303144251	Immunology and Immunotechnology	3	3	0	0
28	303144252	Immunology and Immunotechnology Lab	1	0	2	0
29	303144253	Techniques in Biotechnology	3	3	0	0
30	303144254	Techniques in Biotechnology Lab	1	0	2	0
31	303144255	Enzymology and Enzyme Technology	3	3	0	0
32	303144256	Enzymology and Enzyme Technology Lab	1	0	2	0
33	303144258	Transport Phenomena	3	3	0	0
34	303144259	Biostatistics	4	4	0	0
35	303193252	Professional Grooming and Personality Development	1	-	-	1
		Total	20	16	6	1
Semester- 5						
S.No	Code	Subject	Credit	Lec	Lab	Tut
36	303144301	Bioinformatics and Computational Biology	3	3	0	0
37	303144302	Bioinformatics and Computational Biology Lab	1	0	2	0
38	303144303	Metabolic Engineering	2	2	0	0
39	303144304	Animal Biotechnology	2	2	0	0
40	303144305	Genetic Engineering	3	3	0	0
41	303144306	Genetic Engineering Lab	1	0	2	0
42	303144307	Industrial Biotechnology	2	2	0	0
43	303144308	Industrial Biotechnology Lab	1	0	2	0
44	303144309	Summer Internship - I	2	0	0	0
45	303193304	Professionalism & Corporate Ethics	1	-	-	1
		Open Elective 01 (Compulsory Subjects :1)	2	2	0	0
		PEC 01 (Compulsory Subjects :1)	3	3	0	0
		Total	23	17	6	1
Open Elective - 1						
S.No	Code	Subject	Credit	Lec	Lab	Tut
1	303101331	Basic Aircraft Science	2	2	-	-

2	303104311	Disaster Preparedness and Planning	2	2	0	0
3	303105304	Cyber Security	2	2	0	0
4	303105305	Internet of Things	2	2	0	0
5	303107346	Fundamentals of Communication Engineering	2	2	0	0
6	303109346	Renewable Energy Sources	2	2	0	0
Programme Elective -1						
S.No	Code	Subject	Credit	Lec	Lab	Tut
1	303144331	Pharmaceutical Biotechnology	3	3	0	0
2	303144332	Nano Biotechnology	3	3	0	0
3	303144333	Biofuels and Alcohol Technology	3	3	0	0
Semester - 6						
S.No	Code	Subject	Credit	Lec	Lab	Tut
46	303144351	Plant Biotechnology	4	4	0	0
47	303144352	Plant Biotechnology Lab	1	0	2	0
48	303144353	Bioprocess Engineering	4	4	0	0
49	303144354	Bioprocess Engineering Lab	1	0	2	0
50	303144355	Food Biotechnology	4	4	0	0
51	303144356	Food Biotechnology Lab	1	0	2	0
52	303144357	Mini Project	1	0	2	0
53	303193353	Employability Skills	1	-	-	1
		Open Elective 02 (Compulsory Subjects :1)	2	2	0	0
		PEC 02 (Compulsory Subjects :1)	3	3	0	0
		Total	22	17	8	1
Open Elective - 2						
S.No	Code	Subject	Credit	Lec	Lab	Tut
1	303100351	Programme Management and Entrepreneurship	2	2	0	0
2	303100352	Life Sciences	2	2	0	0
3	303100353	Fundamentals of Management	2	2	0	0
4	303100354	Constitution of India	2	2	0	0
Programme Elective - 2						
S.No	Code	Subject	Credit	Lec	Lab	Tut
1	303144381	3-D Printing	3	3	0	0
2	303144382	Virology	3	3	0	0
3	303144383	Cancer Biology	3	3	0	0

Semester -7						
S.No	Code	Subject	Credit	Lec	Lab	Tut
54	303144401	Environmental Biotechnology	4	4	0	0
55	303144402	Environmental Biotechnology Lab	1	0	2	0
56	303144403	Bioseparation and Downstream Processing	4	4	0	0
57	303144404	Bioseparation and Downstream Processing Lab	1	0	2	0
58	303144405	Biosafety, Bioethics, IPR & Patents	3	3	0	0
59	303144406	Project-I	6	0	12	0
60	303144407	Summer Internship - II	2	0	0	0
		PEC 03 (Compulsory Subjects :1)	3	3	0	0
		Total	24	14	16	0
Programme Elective - 03						
1	303144431	Tissue Engineering	3	3	0	0
2	303144433	Genomics and Proteomics	3	3	0	0
3	303144435	Quality Control and Regulatory Affairs	3	3	0	0
Semester - 8						
61	303144451	Protein Engineering	3	3	0	0
62	303144454	Project-II	6	0	12	0
63		PEC 04 (Compulsory Subjects :1)	3	3	0	0
		Total	12	6	12	0
PEC -04						
1	303144481	Stem Cell Technology	3	3	0	0
2	303144483	Agriculture Biotechnology	3	3	0	0
3	303144485	Biomaterials	3	3	0	0

7. Detailed Syllabus:

Semester – 1

a. Course Name: Programming for Problem Solving

b. Course Code: 303105102

c. Prerequisite: Requires Basic Knowledge of Computer

d. Rationale: This course is design to provide basic ideas of computer programming. This course also makes help to understand programming language. It will help to develop their logical abilities.

e. Course Learning Objective:

CLOBJ 1	Recognize and recall fundamental principles and organizations of computers, demonstrating a foundational understanding of computer architecture and design.
CLOBJ 2	Comprehend the concepts of computer programming languages, illustrating a grasp of syntax, semantics, and the essential components of programming languages
CLOBJ 3	Develop algorithms for solving basic engineering problems, demonstrating the ability to apply theoretical knowledge to practical problem-solving scenarios.
CLOBJ 4	Demonstrate proficiency in the practical application of C programming by writing, compiling, and debugging programs, showcasing the ability to implement and troubleshoot code effectively
CLOBJ 5	Evaluate and analyse complex computational programs written in C, demonstrating the capacity to assess and understand intricate solutions to computational challenges
CLOBJ 6	Develop simple projects using the C programming language, showcasing creativity and application of learned principles to produce functional and practical software solutions

f. Course Learning Outcomes

CLO 1	Recognize the computer's basic principles and organizations
CLO 2	Understand Concepts of Computer Programming Language
CLO 3	Develop the algorithm for solving basic Engineering Problems
CLO 4	Write, Compile and debug program with C Programming
CLO 5	Analyse the Solved, Complex Computational Program written in C.
CLO 6	Develop simple projects using C Language.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	Number System Introduction and type of Number system, Conversion between number system, Arithmetic operations on number system, Signed and unsigned number system Software, Computer Languages and Computer Program	2	1
2	Introduction to 'C' Programming Features of C language, structure of C Program, Flow Charts and Algorithms Types of errors, debugging, tracing/stepwise execution of program, watching variables values in memory.	3	1
3	Constants, Variables and data Types: Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, assigning values to variables, typedef, and defining symbolic constants	5	2
4	Operators and Expression: Introduction to Operators and its types, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Operator precedence and associativity.	10	5
5	Management Input and Output Operators: Introduction, reading a character, writing a character, formatted input, formatted output.	5	2
6	Control structure in C: Decision Making & branching: Decision making with If & Else statements, If.. Else statements (Nested ... Ladder), The Switch & goto statements, The ternary (?:) Operator Looping: The while statement, The break statement & The Do.. While loop, The FOR loop, Jump within loops – Programs	15	7
7	Array: Introduction, One-dimensional arrays, Two-dimensional arrays, arrays, Concept of Multidimensional arrays	10	4
8	String: string, string storage, Built-in-string functions	10	4
9	User-Defined Functions: Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing	10	5

10	Structure and Unions: Introduction, Structure definition, declaring and initializing Structure variables, Accessing Structure members, Copying & Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions	10	5
11	Pointers: Basics of pointers, pointer to pointer, pointer and array, Pointer to array, array of pointers, functions returning a pointer	10	5
12	Dynamic memory allocation: Introduction to Dynamic memory allocation, malloc (), calloc (), free (), realloc ()	5	2
13	File Management in C: Introduction to file management and its functions	5	2
	Total	100	45

i. Text Book and Reference Book:

1. "Programming in ANSI C", (Textbook), By E. Balaguruswamy, Tata McGraw- Hill
2. "C Programming: Test Your Skills", By Ashok Kamthane
3. "Computer Fundamentals", By P.K. Sinha and Priti Sinha, BPB Publications, 4th Edition

j. List of Practical

1	Practical Set 1 (Basics)
	Write a program to print HELLO FRIENDS!
	Write a program that reads two nos. from key board and gives their addition, subtraction, multiplication, division and modulo
	Write a program to calculate area of circle, use Ω as symbolic constants.
	Write a program to convert days into months and days.
	Write a program which calculates the summation of three digits from the given 3 digit number.
	Write a program to demonstrate enumerates data type
	Write a program to compute Fahrenheit from centigrade.
	Write a program to calculate simple interest.
	Read the price of item in decimal form e.g. 12.50 and separate Rs and Paise from the given value e.g. 12 rupees and 50 paise.
2	Practical Set 2 (Control Structures)
	Write a program to find the largest of the three nos. using Nested-If-Else statement.
	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
	Write a program to read marks from keyboard and your program should display equivalent grade according to following table Marks Grade 100-80 Dist 60-79 First Class 35-59 Second Class 0-34 Fail
	Write a program to read marks of a student from keyboard whether the student id pass (if).
3	Practical Set 3 (Array & Strings)
	Write a program which sorts 10 numbers into ascending order.
	Write a program to find maximum element from 1-D array.
	Write a program to find number of odd and even elements from the 1-D array

	Write a program add two 2x2 matrices.
	Write a function for the following operations on string:
4	Practical Set 4 (Functions)
	Write a program to find factorial of a number using recursion.
	Write a program that used user defined function Swap () and interchange the value of two variable
	Write a function to return 1 if the number is prime otherwise return 0.
5	Practical Set 5 (Structures)
	Define a structure type, personal that would contain person name, date of joining and salary
	Define a structure called cricket that will describe the following information: Player name Team name Batting average
6	Practical Set 6 (Pointers)
	Write a program to add two numbers using pointers.
	Write a program to swap two numbers using pointer
7	Practical Set 7 (File Management)
	Write a program to illustrate reading files contents
	Write a program to illustrate the use of fgets()

Semester - 1

- a. **Course Name:** Elements of Mechanical Engineering
- b. **Course Code:** 303109102
- c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
- d. **Rationale:** Elements of Mechanical Engineering Course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.
- e. **Course Learning Objective:**

CLOBJ 1	Identify and basic mechanical components such as gears, bearings, Pumps, Compressor, boiler, I.C Engines.
CLOBJ 2	Understand various laws and behaviour of fluid at different conditions
CLOBJ 3	Illustrate the operational mechanisms through diagrams, models, or practical demonstrations.
CLOBJ 4	Demonstrate construction and working principles of diverse mechanical devices, such as engines, pumps, and compressors.
CLOBJ 5	Evaluate basic problems related to I.C engine, pumps, compressors and fluids.
CLOBJ 6	Analyse and discuss the interactions and relationships between various mechanical elements within a system

f. Course Learning Outcomes

CLO 1	Identify basic mechanical components and their functions
CLO 2	Understand basic Properties and behaviour of various fluids
CLO 3	Understand Construction and working of various mechanical devices
CLO 4	Apply fundamental principles to solve basic mechanical engineering problems

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	Basics of Thermodynamics Prime Movers - Meaning and Classification; Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Internal Energy, Enthalpy, Specific Volume; Thermodynamics – Definition: Change of State, Path, Process, Cycle, Thermodynamic systems, Statement of Zeroth Law, First Law and Second Law of Thermodynamics and its Applications.	10	5
2	Properties of Gases Gas Laws, Boyle's law, Charles law, Combined gas law; Gas Constant, Relation between Cp and Cv Constant Volume Process; Constant Pressure Process; Isothermal Process; Adiabatic Process; Poly-tropic Process. Examples based on above topics.	15	7
3	Properties of Steam Types of Steam and Steam formation; Specific Enthalpy; Specific Volume; Dryness Fraction of Steam; Measurement of Dryness Fraction; Steam Table. Examples based on above topics.	15	7
4	Heat Engines Definition of Heat Engine; Classification of Heat Engine; Carnot Cycle, Rankine Cycle, Otto Cycle and Diesel Cycle. Internal Combustion Engines: Two Stroke Petrol and Diesel Engine; Four Stroke Petrol and Diesel Engine; Measurement of Indicated Power and Brake Power: Numerical on calculation of Mechanical, Thermal and Volumetric Efficiency. Examples based on above topics.	20	9
5	Energy Conversion Devices Steam Generators: Definition and Classification; Cochran, Lancashire, Locomotive, Babcock and Wilcox Boiler: Construction and Working; Boiler Mounting and Accessories. Refrigeration and Air Conditioning: Meaning of Refrigeration; Vapor Compression Refrigeration Cycle; Vapor Absorption Refrigeration Cycle; Air conditioning; Window Air Conditioning and Split Air Conditioning.	20	9
6	Pumps And Air Compressors Pumps Definition, Classification and Application of Pumps; Types and Operation of Rotary pump, Reciprocating Pump, Centrifugal Pump. Air Compressors Definition, Classification and Application of Compressors; Types and Operation of Rotary and Reciprocating Air Compressor.	10	5
7	Motion And Power Transmission Devices Shaft and Axle; Belt Drive; Chain Drive; Friction Drive; Gear Drive; Clutch, Coupling and Brake.	5	2
8	Conventional And Non-Conventional Energy Sources Introduction and Classification of Energy Sources; Conventional Energy Sources E.g. Solid, Liquid, Gaseous and Nuclear fuels; Calorific Value of Fuels; Non-Conventional Energy Sources E.g. Solar Energy, Wind Energy, Hydro Power, Biomass and Biomass Energy; Comparison of Conventional & Non-Conventional Energy Sources.	5	2
	Total	100	60

i. Text Book and Reference Book:

1. "Elements of Mechanical Engineering", By S.B. Mathur, S. Domkundwar, Dhanpat Rai & Sons Publications.
2. "Thermal Engineering, By R.K Rajput", Laxmi Publications.
3. "Thermal Science and Engineering", By Dr. D. S. Kumar, S. K. Kataria andsons Publishers.
4. "Basic Mechanical Engineering", By T. S. Rajan, Wiley Eastern Ltd
5. "Fundamental of Mechanical Engineering", By G. S. Sawhney, PHIPublication New Delhi.

j. List of Practical's

S.No	List of Practical's
1	Demonstration and study of construction and working of Petrol Engine Model.
2	Demonstration and study of construction and working of Diesel Engine Model.
3	Determination of brake thermal efficiency of an I. C. Engine.
4	Demonstration and study of construction and working of various types of boiler Models.
5	Study of construction and working of different boiler mountings and accessories.
6	Demonstration on construction and working of different types of pumps.
7	Demonstration on construction and working of different types of air compressors.
8	Demonstration on vapor compression refrigeration cycle and vapor absorption refrigeration cycle.
9	Demonstration on construction, working and applications of different types of coupling, clutch and brake.
10	Demonstration on construction, working and applications of motion and power transmission devices.

Semester - 1

a. Course Name: Basics of Biotechnology

b. Course Code: 303144101

c. Prerequisite: Knowledge of basic Biology up to 12th class

d. Rationale: To provide a foundation in biology with engineering of living systems and to apply various tools of traditional engineering fields such as mechanical, material, electrical and chemical to understand and solve biomedical and biological problems and harness potential of living systems for the benefit of mankind.

e. Course Learning Objective

CLOBJ 1	Outline the basic concept of biotechnology and applications associated to it.
CLOBJ 2	Relate the biological systems and the living world.
CLOBJ 3	Build the concepts associated with development of biotechnology products
CLOBJ 4	Discuss the ethical issues associated with biotechnology industry and the society

f. Course Learning Outcome:

CLO1	Summarize biotechnology and list some basic applications.
CLO2	Illustrate the applications of system engineering across the wide domain of biological sciences.
CLO3	Apply process for a particular technique in development of biotechnology product.
CLO4	Develop an idea associated with the ethical concepts in relation with biotechnology industry.

g. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	The nature of biotechnology Introduction, What is biotechnology? Biotechnology: an interdisciplinary pursuit, Biotechnology: a three component central core, Product safety, Public perception of biotechnology, Biotechnology and the developing world	15	7
2.	Biomass: a biotechnology substrate	10	5

	A biomass strategy, Natural raw materials, Availability of by-products, Raw materials and the future of biotechnology		
3.	Biological fuel generation Global warming and the significance of fossil fuels, Photosynthesis: the ultimate energy source, Biofuels from biomass, Bioethanol from biomass, Biodiesel, Methane, Hydrogen, The way ahead for biofuels, Contrasting views on climate change	30	12
4.	Biotechnology and medicine Introduction, Pharmaceuticals and biopharmaceuticals, Antibiotics, Vaccines and monoclonal antibodies, Biopharmaceuticals/therapeutic proteins, Pharmacogenetics, Molecular biology and human disease, Diagnostics in developing countries, Gene therapy, Systems biology and medicine	30	12
5.	Safety in biotechnology Introduction, Concepts of hazard and risk, Problems of organism pathogenicity, Problems of biologically active biotechnology products, Biowarfare and bioterrorism	15	9
	Total	100	45

i. Reference Books

1. Biotechnology

By John E. Smith | Cambridge University Press | 5th Edition

2. Biotechnology: Expanding Horizons

By B.D Singh | KALYANI PUBLISHER

3. Molecular Biology

By Robert Weaver | McGraw-Hill | 5th Edition

Semester - 1

a. Course Name: Remedial Biology

b. Course Code: 303144102

c. Prerequisite: Basic knowledge about general biology.

d. Rationale: This course explains the basic fundamentals of biology.

e. Course Learning Objective

CLOBJ 1	Outline the basic concept of biology and applications associated to it.
CLOBJ 2	Relate the biological systems and the living world.
CLOBJ 3	Build the concepts associated with structure and function of cell
CLOBJ 4	Discuss the concepts of alleles, genes and plant biology

f. Course Learning Outcome:

CLO1	Understand the basics of living systems.
CLO2	Understand key common features of living organisms & its function.
CLO3	Know the anatomy and functions of cells.
CLO4	Know the concepts of alleles and genes.
CLO5	Understand the plant physiology.

g. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Introduction to Cell The cell concept, structure of prokaryotic, eukaryotic cells, plant cells and animal cells, Structure and function of cell membrane, cell organelles and their function. Structure and use of compound microscope, Macro and micro molecules, Basic chemical constituents of living body.	15	7
2.	Tissues Tissues in animal and plants, Morphology, anatomy and functions of different parts of plants: Root, stem, leaf, inflorescence, flower, fruit and seed, Concepts of botanical garden, herbaria, zoological park and museums.	25	8

3.	Classification of Animals and Plants Classification of living organisms (Five kingdom classification, major groups and principles of classification in each kingdom), Systematic and binomial system of nomenclature, Concept of animal and plant classification.	20	8
4.	Concept of Genetics Concepts of alleles and genes, Mendelian Experiments, Cell cycle (Elementary Idea), mitosis and meiosis, techniques to study mitosis and meiosis.	15	10
5.	Plant Physiology Plant Physiology: Concepts of diffusion, osmosis, imbibitions, Movement of water, food, nutrients and gases, Photosynthesis, plant growth and development.	25	12
	Total	100	45

i. Reference Books

1. Biology (TextBook)

| Textbook for class XI, NCERT

2. Biology

By Peter H Raven, George b Johnson, Kenneth A., Mason, Jonathan Losos, Susan Singer | McGraw Hill Publication

3. Biology-Textbook of Class

NCERT Publication

Semester - 1

- a. **Course Name:** Mathematics-I
- b. **Course Code:** 303191101
- c. **Prerequisite:** Knowledge of Mathematics up to 12th science level
- d. **Rationale:** The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and matrix algebra, preparing students for engineering challenges with optimized problem-solving skills.
- e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of definite and improper integrals, including the application of integration techniques to find areas and volumes in both Cartesian and Polar coordinates.
CLOBJ 2	Utilize differential equations to model and solve practical scenarios, demonstrating proficiency in various solution techniques.
CLOBJ 3	Solve the convergence and divergence of sequences and series, employing tests such as the Alternating Series Test and Ratio Test
CLOBJ 4	Analyse matrix operations and determinants, exploring their properties and applications in solving systems of linear equations.
CLOBJ 5	Apply Fourier series for representing periodic functions, verifying Dirichlet's conditions.
CLOBJ 6	Explain optimization problems using multivariable calculus concepts, such as Lagrange's multiplier.

f. Course Learning Outcomes:

CLO 1	Develop understanding of fundamental mathematical concepts
CLO 2	Apply and solve mathematical models for real-world engineering problems,
CLO 3	Build knowledge of different mathematical topics to analyze and solve complex engineering problems
CLO 4	Critically analyze mathematical results, interpret their engineering significance, and make informed decisions based on mathematical outcomes, fostering a deeper understanding of the subject.
CLO 5	Discuss mathematical ideas, solutions, and reasoning, both in written and oral formats, demonstrating effective communication skills.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	UNIT 1 Improper Integral & Application of Definite Integral Evaluation of definite and improper integrals, Beta and Gamma functions and their properties Area bounded by curves in Cartesian and Polar form, Area of a region bounded by function, Area of a region bounded by curves in Parametric form, Volume by slicing, Volume of solid by revolution.	8	5
2	UNIT 2 First order Ordinary Differential equation: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications	15	9
3	UNIT 3 Matrices: Matrices & Determinants with Properties, Linear Independence, Rank of Matrix, System of Linear Equations, Consistency of System, Solution of system of Linear Equations by Gauss Jordan and Gauss-Elimination Method, Eigen values, Eigenvectors, Symmetric, Skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization, Cayley Hamilton Theorem and its Applications, Diagonalization, Orthogonal Transformation, Quadratic form.	25	15
4	UNIT 4 Sequences and Series: Basic of Sequences, Bounded and Monotonic Sequences, Series, Convergence of sequence and series, Geometric series, P- series, Cauchy's Integral Test, Comparison Test, Alternating Series, Absolute and Conditional convergence, Ratio test, Cauchy's Root Test, Power series, Taylor's and Maclaurin's series.	17	10
5	UNIT 5 Fourier Series: Fourier Series of 2 periodic functions, Dirichlet's conditions for representation by a Fourier series, Fourier Series of a function of period 2, Fourier Series of even and odd functions, Half range series.	10	6
6	UNIT 6 Multivariable Calculus (Differentiation): Functions of Several Variables, Limit, Continuity, Partial Derivatives, Homogeneous function, Euler's Theorem for homogeneous function, Modified Euler's Theorem, Chain Rule, Implicit function, Jacobian, Tangent plane and Normal line, Maximum and Minimum Values, Lagrange's Multiplier, Taylor's and Maclaurin's Series for functions of two variables.	25	15
	Total	100	60

i. Text Book and Reference Book:

1. **Calculus and Analytic Geometry (TextBook)**
By G.B. Thomas and R.L. Finney | Addison Wesley
2. **Calculus with early transcendental functions**
By James Stewart | Cengage Learning
3. **Higher Engineering Mathematics**
By B. S. Grewal | Khanna Publications
4. **Elementary Linear Algebra (TextBook)**
By Howard Anton, Chris Rorres | Willy India Edition | 9th Edition
5. **Advanced Engineering Mathematics (TextBook)**
By Erwin Kreyszig | Willey India Education
6. **A textbook of Engineering Mathematics**
By N.P. Bali and Manish Goyal | Laxmi Publication

Semester - 1**b. Course Name:** Communication Skill**c. Course Code:** 303193103**d. Prerequisite:** Knowledge of English Language studied till 12th standard**e. Rationale:** : Basic Communication Skills are essential for all Engineers.**f. Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to communicate ideas clearly and effectively
CLOBJ 2	Develop strategies for building positive interpersonal relationships, fostering effective collaboration and teamwork.
CLOBJ 3	Develop active listening skills, including the ability to comprehend, interpret, and respond appropriately to spoken messages.
CLOBJ 4	Exhibit proficiency in written communication, crafting clear, concise, and well-organized messages across various formats (emails, reports, memos, etc.).
CLOBJ 5	Deliver professional presentations, incorporating effective visual aids, engaging content, and confident delivery.
CLOBJ 6	Understand and analyse the common grammatical errors.

g. Course Learning Outcomes:

CLO 1	Understand the importance of creative and critical thinking.
CLO 2	Expand vocabulary with proper pronunciation.
CLO 3	Comprehend the basics of English grammar.
CLO 4	Read & write effectively for a variety of contexts.
CLO 5	Develop confidence in speaking skills.

h. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	2	0	2	-	100	-	-	-	100

i. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	Crazy Scientist: The students will be taught the importance of invention and innovation using some examples that changed the world the way it worked.	5	2
2	Phonetics: • IPA Introduction (listening tracks) • Phonic Sounds • Pronunciation Practice including transcription	10	4

3	Vocabulary Building & Word Formation Process: • Compounding, clipping, blending, derivation, creative respelling, coining and borrowing • Prefixes & suffixes, synonyms & antonyms, standard abbreviations (related activities will be provided)	10	2
4	Speaking Activity : Role play on Critical Thinking (Life boat) • This activity topic gears towards making students do role play based on various scenarios. • It involves giving them a scenario and asking them to further develop the idea in a very interesting manner, then going on to enact it. • It aims to improve students' convincing skills.	10	4
5	Picture Description & Picture Connector • Enable students to use vocabulary and useful expression to describe the picture. • In this class the students will be trained to form logical connections between a set of pictures which will be shared with them. • This geared towards building creativity and presentation skills.	15	2
6	Mine Activity: Usage of Preposition: • Students will learn to use proper prepositions by active participation in the activity.	8	2
7	Worksheets on Identifying Common Errors in Writing: • Sentence structure • Punctuations • Subject-Verb Agreement • Noun-Pronoun Agreement	12	2
8	Reading Skills: • The art of effective reading and its various strategies to be taught to the learners and practice exercises be given on reading comprehension.	10	2
9	Speech and spoken Exchanges; Extempore: • Students will learn the correct usage of spoken language as different from the written form. It will help the students in extempore speech. • This will be done by making the students give variety of impromptu speeches in front of the class: 1 minute talk on simple topics. • To change the average speakers in the class to some of the best Orator.	10	4
10	Book Review: • The learners will identify the central idea of the book, author's style and approach towards the book. • This will enable the learners to express their point of view and hone their creativity and writing skills.	10	4
11.	Activity Session This will enhance the creative thinking among students. To develop their interpersonal communication skills.	0	2
	Total	100	30

i. Reference Books:

- a. Understanding and Using English Grammar Betty Azar & Stacy Hagen; Pearson Education
- b. Business Correspondence and Report Writing SHARMA, R. AND MOHAN, K.
- c. Communication Skills Kumar S and Lata P; New Delhi Oxford University Press
- d. Technical Communication : Principles And Practice Sangeetha Sharma, Meenakshi Raman; Oxford University Press
- e. Practical English Usage MICHAEL SWAN
- f. A Remedial English Grammar for Foreign Student F.T. WOOD
- g. On Writing Well William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
- h. Oxford Practice Grammar, John Eastwood; Oxford University Press

Semester - 2

a. Course Name: Cell Biology

b. Course Code: 303144155

c. Prerequisite: Knowledge of basic Biology up to 12th class

d. Rationale: The course is aimed to make the student understand the basic concept of cell structure, membrane, cellular functions of different types of cells, modes of cellular signalling and signal amplification.

e. Course Learning Objective

CLOBJ 1	Outline the basic concepts of cells.
CLOBJ 2	Demonstrate the different cellular components.
CLOBJ 3	Discuss the different cellular process.
CLOBJ 4	Elaborate cell signalling process

f. Course Learning Outcome:

CLO1	Outline the structure and functions of prokaryotic and eukaryotic cells and cellular components
CLO2	Summarize the different cellular components.
CLO3	Explain the cellular components and processes underlying cell cycle, cell division and apoptosis
CLO4	Elaborate cell signalling process

g. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	0	0	2	20	20	0	60	0	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	An Overview of Cells and Cell Research Origin and evolution of cells, cells as experimental models, tools of cell biology-chemistry of cells-molecular composition of cells,central role of enzymes, metabolic energy, biosynthesis of cell constituents, cell membrane.	10	3
2.	Cell Structure and Function Cell Structure and Function-- Part I: Nucleus, Endoplasmic reticulum, Golgi apparatus and Lysosomes, Bioenergetics and Metabolism – Mitochondria,chloroplasts, Peroxisomes. Cell Structure and Function-- Part II : The cytoskeleton and cell movement, cell surface - transport of small molecules, Endocytosis, cell - cell interactions Adhesionjunctions-Tight junctions-Gap junctions- Plasmodesmata.	20	6
3.	Transport Across Cell Membrane Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na^+ / K^+ / Ca^{+2} T pumps uniport, symport antiporter system. Ligand gated/voltage gated channels, Agonists andAntagonists.	10	3
4.	Advanced Cell Biology Cell division: Mitosis and meiosis, cell growth and proliferation,Cell cycle and regulation. Cancer and its characteristics	20	6
5.	Cell Signaling Modes & Types of Cellular Signals, Receptors: GPCRs, RTKs,Cytokine Receptors & NRTKs, Enzyme linked receptors, Intracellular Signal Transduction Pathways, Cell Signalling andCytoskeleton, Signalling Networks.	20	6
6	Techniques Used to Study Cells Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells - Immunostaining.	20	6
	Total	100	30

i. Reference Books:

1. Cell Biology By CB Powar
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology By P.S.Verma and V. K. Agarwal | Chand (S.) & Co Ltd, India | 1st
3. The Cell: a Molecular Approach By Cooper, G. M., & Hausman, R. E. | Washington: ASM; Sunderland, Pub. Year 2009
4. Molecular Cell Biology By Lodish

Semester -2

- a. **Course Name:** Engineering Graphics
- b. **Course Code:** 303109101
- c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
- d. **Rationale:** “Engineering Graphics” course provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.
- e. **Course Learning Objective:**

CLOBJ 1	Identify and name common drafting tools and their uses.
CLOBJ 2	Interpret engineering drawings and symbols.
CLOBJ 3	Demonstrate the ability to create accurate engineering drawings using industry-standard software.
CLOBJ 4	Solve engineering design problems by applying geometric and spatial concepts.
CLOBJ 5	Generate accurate and professional engineering drawings independently.
CLOBJ 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

f. Course Learning Outcomes:

CLO 1	Identify and recall common drafting tools and their uses.
CLO 2	Interpret and explain engineering drawings and symbols.
CLO 3	Demonstrate the application of industry-standard software to create accurate engineering drawings.
CLO 4	Solve engineering design problems by applying geometric and spatial concepts.
CLO 5	Generate accurate and professional engineering drawings independently.
CLO 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
2	-	2	4	20	20	20	60	30	150

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	INTRODUCTION TO ENGINEERING GRAPHICS Scope of Engineering Drawing in all Branches of Engineering, Uses of Drawing Instruments and Accessories, Introduction to Drawing Standards BIS-SP-46, Representative Fraction, Types of Scales (Plain and Diagonal Scale), Dimensioning Terms and Notations, Types of Arrowheads, Lines, Lettering, Numbering and Dimensioning	5	2
2	ENGINEERING CURVES: Classification of Engineering Curves, Application of Engineering Curves, Constructions of Engineering Curves - Conics, Spirals, Involute and Cycloids with Tangents and Normal	10	3
3	PRINCIPLES OF PROJECTIONS: Types of Projections - Oblique, Perspective, Orthographic and Isometric Projections; Introduction to Principal Planes of Projections, Projections of Points located in all four Quadrants; Projections of lines inclined to one of the Reference Plane and inclined to two Reference Planes.	10	3
4	PROJECTIONS OF PLANES: Projections of various planes – Polygonal, Circular and Elliptical shape inclined to one of the Reference Plane and inclined to two Reference Planes; Concept of Auxiliary Plane of Projections.	10	3
5	PROJECTIONS OF SOLIDS AND SECTIONS OF SOLIDS: Classifications of basic Solids, Projections of Solids - Right Regular Prism, Pyramid, Cone, Cylinder, Tetrahedron and Cube inclined to one of the Reference Plane and inclined to two Reference Planes; Frustum of Prism, Pyramid and Cone inclined to one of the Reference Plane; Types of Cutting Planes - Auxiliary Inclined Plane, Auxiliary Vertical Plane, Horizontal Cutting Plane, Profile Cutting Plane; Sections of Solids resting on H.P/V.P and Inclined to only one of the Reference Planes; Sectional Views, True Shape of the Sections	20	6
6	DEVELOPMENT OF SURFACES: Methods of Development of Lateral Surfaces of Right Regular Solids, Parallel Line Development and Radial Line Development, Applications of Development of Surfaces.	10	3
7	ORTHOGRAPHIC PROJECTIONS: Projections on Principal Planes from Front, Top and Sides of the Pictorial view of an Object, First Angle Projection and Third Angle Projection method; Full Sectional Orthographic Views – Side and Front, Offset Cutting views	15	4
8	ISOMETRIC VIEW/DRAWING AND ISOMETRIC PROJECTIONS: Conversion of Orthographic Views into Isometric Projection, View or Drawing; Isometric Scale.	15	4
9	OVERVIEW OF COMPUTER AIDED DRAFTING TOOL: Introduction to Computer Aided Drafting Software; Preparation of Orthographic Projections and Isometric Views Using Drafting Software	5	2
Total		100	30

i. Text Book and Reference Book:

- a. Engineering Drawing N.D. Bhatt & V.M. Panchal; Charotar Publishing House
- b. ENGINEERING GRAPHICS P. J. Shah; S. Chand & Co., New Delhi Publications.
- c. Graphic Science and Design French, T.E. Vierck, C.J & Foster; Tata McGraw Hill Publications.
- d. Fundamentals of Engineering Drawing Luzadder; W. J & Duff Prentice Hall Publications.
- e. Engineering Drawing and Graphics Venugopal k; New Age International Private Limited Publishers.

j. List of Practical

S.No	List of Practical's
1	Demonstration and study of construction and working of Petrol Engine Model.
2	Demonstration and study of construction and working of Diesel Engine Model.
3	Determination of brake thermal efficiency of an I. C. Engine.
4	Demonstration and study of construction and working of various types of boiler Models.
5	Study of construction and working of different boiler mountings and accessories.
6	Demonstration on construction and working of different types of pumps.
7	Demonstration on construction and working of different types of air compressors.
8	Demonstration on vapor compression refrigeration cycle and vapor absorption refrigeration cycle.
9	Demonstration on construction, working and applications of different types of coupling, clutch and brake.
10	Demonstration on construction, working and applications of motion and power transmission devices.

Semester – 2

- a. **Course Name:** Mathematics-II
- b. **Course Code:** 303191151
- c. **Prerequisite:** Knowledge of Mathematics up to 12th science level
- d. **Rationale:** The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and vector calculus, preparing students for engineering challenges with optimized problem-solving skills.
- e. **Course Learning Objective:**

CLOBJ 1	Define and identify ordinary differential equations of higher order. Classify ODEs based on homogeneity and linearity. Solve homogeneous linear ODEs of higher order with constant coefficients, and variable coefficients.
CLOBJ 2	Solve homogeneous linear ODEs of higher order with constant coefficients, variable coefficients
CLOBJ 3	Apply the Method of Undetermined Coefficients to solve nonhomogeneous ODEs. Utilize the Solution by Variation of Parameters for solving nonhomogeneous ODEs. Explore applications of ODEs in real-world scenarios.
CLOBJ 4	Understand power series solutions for ordinary points and regular singular points. Explore properties and applications of Legendre polynomials and Bessel functions.
CLOBJ 5	Define Laplace transform and its inverse. Understand the linearity property of Laplace transforms. Solve ordinary differential equations using Laplace transforms.
CLOBJ 6	Define Fourier Integral and its applications. Explore Fourier Cosine and Sine Integrals.

- f. **Course Learning Outcomes:**

CLO 1	Demonstrate the ability to translate physical or engineering problems into mathematical equations and solve them.
CLO 2	Develop analytical and critical thinking skills through the process of solving complex mathematical problems.
CLO 3	Understand and interpret mathematical solutions in the context of the given problems.
CLO 4	Communicate mathematical concepts and solutions clearly and effectively, both in written and verbal forms.
CLO 5	Present mathematical arguments and solutions in a logical and organized manner.
CLO 6	Lay a solid foundation for more advanced courses in mathematics and related disciplines.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	UNIT 1 Higher order ordinary differential equations: Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler– Cauchy equations, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters, Applications	8	5
2	UNIT 2 Power Series: Power series solutions at ordinary point and regular singular point; Legendre polynomials, Bessel functions of the first kind and their property	15	9
3	UNIT 3 Laplace Transform: Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, UNIT Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms, Solution of ordinary differential equation by Laplace transform	25	15
4	UNIT 4 Fourier Integral: Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral	17	10
5	UNIT 5 Vector Calculus: Gradient of scalar field, Directional Derivative, Divergence and curl of Vector field, Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.	10	6
6	UNIT 6 Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Triple integrals (Cartesian)	25	15
	Total	100	60

i. Text Book and Reference Book:

1. **Calculus and Analytic Geometry (TextBook)**
By G.B. Thomas and R.L. Finney | Addison Wesley
2. **Calculus with early transcendental functions**
By James Stewart | Cengage Learning
3. **Higher Engineering Mathematics**
By B. S. Grewal | Khanna Publications
4. **Elementary Linear Algebra (TextBook)**
By Howard Anton, Chris Rorres | Willy India Edition | 9th Edition
5. **Advanced Engineering Mathematics (TextBook)**
By Erwin Kreyszig | Willey India Education
6. **A text book of Engineering Mathematics**
By N.P. Bali and Manish Goyal | Laxmi Publications

Semester - 2

a. Course Name: Engineering Physics-I

b. Course Code: 303192101

c. Prerequisite: Knowledge of Physics and some basic concepts in Mathematics like differentiation, integration, limit, differential equation, vector calculus up to 12th science level.

d. Rationale: Knowledge of physics is essential for all Engineering branch because physics is the foundation subject of all the branches of engineering and it develops scientific temperament and analytical capability of engineering students. Comprehension of basic physics concepts enables the students to solve engineering problem logically and develop scientific approach.

e. Course Learning Objective:

CLOBJ 1	Understand and explain the elastic properties of materials. Analyze the tensile stress-strain curve and its implications for material behavior. Evaluate shear strength in both perfect and real crystals.
CLOBJ 2	Investigate thermo-electric effects and their applications. Examine the Wiedemann-Franz law and its significance. Explore phonons and their role in heat transfer. Analyze different modes of heat transfer and specific heat of solids. Compare and contrast the Einstein and Debye models for solids.
CLOBJ 3	Gain a qualitative understanding of statistical mechanics. Differentiate between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.
CLOBJ 4	Analyze transverse waves on a string and harmonic waves. Investigate reflection, transmission, standing waves, and eigenfrequencies.
CLOBJ 5	Explore Einstein's theory of matter-radiation interaction. Understand absorption, spontaneous, and stimulated emission of radiation. Identify characteristics and components of lasers. Classify types of lasers, including Nd:YAG Laser, CO ₂ Laser, and Semiconductor Diode Laser. Examine applications of lasers in various fields.
CLOBJ 6	Understand fluid flow, viscosity, and apply the continuity equation. Analyze Euler and Bernoulli's equations in fluid mechanics

f. Course Learning Outcomes:

CLO 1	Acquire a deep understanding of fundamental principles and concepts in classical mechanics, electromagnetism, thermodynamics, and modern physics.
CLO 2	Develop proficiency in applying mathematical techniques to solve physics problems
CLO 3	Gain familiarity with experimental methods, laboratory equipment, and techniques for conducting physics experiments.
CLO 4	Apply theoretical knowledge to solve a variety of physics problems

CLO 5	Integrate knowledge from different branches of physics to understand interdisciplinary phenomena and real-world applications.
CLO 6	Evaluate the appropriateness of theoretical models in explaining physical phenomena and predict outcomes.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	30	60	20	150

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1	UNIT-I: Modern Physics Introduction about quantum Mechanics, Schrodinger's equations, Time dependent and Time Independent Wave Equation, Physical Significance of the wave Function, Application of Schrodinger equation in particle in One Dimensional Potential Box and Tunneling effects.	20	9
2	UNIT-II: Band theory & Semiconductors Energy bands in solids, Classification of Materials into Conductors, Semiconductors & Insulators, Density of state, E-k diagram, Kronig-Penny model(to introduce origin of band gap), Effective mass. Direct and indirect band gap. Carrier Concentration in semiconductors, Fermi Level in Intrinsic and Extrinsic Semiconductors, P-N junction diode, Ohmic and Schottky Junction.	20	9
3	UNIT-III: Materials Classification of materials: Magnetic materials, Nanomaterials based on semiconductors and metal oxides, Basic characteristic properties of nanomaterials, Novel Materials. Physical, Thermal, Electrical, Optical and Magnetic properties of materials	20	9
4	UNIT-IV: Laser and Fiber Optics Lasers: Interaction of radiation with Matter, Absorption, Spontaneous and Stimulated emission, Characteristics of Lasers, Types of Lasers: Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers. Fiber Optics: Principle and Structure of Optical Fiber, Numerical Aperture of fiber, Types of Optical Fibers, Attenuation in Optical Fibers, Applications of Optical Fibers	20	9
5	UNIT-V: Devices Optoelectronic Devices: Photoconductive cell, photovoltaic cell, Photodiode, Phototransistor, LED, IR emitters, Opto coupler, X-ray diffractometer, Quantum devices and their applications.	20	9
	Total	100	45

i Reference Books:

1. **Semiconductor Optoelectronics** J. Singh; McGraw-Hill Inc, 1995
2. **Fundamentals of Photonics** B. E. A. Saleh and M. C. Teich; John Wiley & Sons, 2007
3. **Semiconductor Devices: Physics and Technology** S. M. Sze; Wiley, 2008
4. **Semiconductor Optoelectronic Devices** P. Bhattacharya; Prentice Hall of India, 1997
5. **Fundamentals of Physics** D. Halliday, R Resnick and J. Walker; Asian Books Pvt. Ltd

j List of Practicals

S.No	List of Experiments
1	I-V characteristics of light emitting diode in forward bias.
2	I-V characteristics of Zener diode in reverse bias.
3	Determination of Velocity of ultrasonic waves in water.
4	Determination of Dielectric constants of Dielectric samples
5	Measurement of Band gap of semiconductor material
6	Measurement of Hall coefficient R_H and carrier concentration in a semiconductor
7	Measurement of Planck's constant using LED
8	Measurement of wavelength of laser light using diffraction grating.
9	Measurement of Numerical aperture of an optical Fiber.
10	Moment of Inertia of a flywheel.
11	Measurement of power loss in an optical fibre
12	B-H Curve tracing.
13	Determination of Young's modulus.
14	Determination of thermal conductivity. (Searle's method or Lee's method)
15	To Determine acceleration due to gravity using compound pendulum.

Semester – 2

a. Course Name: Environmental Science

b. Course Code: 303104105

c. Prerequisite: Knowledge of Physics, Chemistry and Mathematics up to 12th science level and Biology up to 10th science level

d. Rationale: Basic knowledge of the environment is essential for all human beings for a good life and sustainable existence

e. Course Learning Objective:

CLOBJ 1	Understand the interrelation and interdependency of organisms and their interactions with the environment.
CLOBJ 2	Identify eco-friendly measures in engineering projects
CLOBJ 3	Understand preventive steps for environmental protection
CLOBJ 4	Act as a responsible individual who is aware of efficient usage of resources and securing sustainable development

f. Course Learning Outcomes:

CLO 1	Analyse the interrelation and interdependency of organisms and their interactions with the environment.
CLO 2	Recognize eco-friendly measures in engineering projects
CLO 3	Understand preventive steps for environmental protection
CLO 4	Act as a responsible individual who is aware of efficient usage of resources and securing sustainable development.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
1	0	0	Audit	50	50	0	0	0	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1	ENVIRONMENTAL HEALTH, ECOLOGY AND QUALITY OF LIFE Environmental education: Objective and scope, Impact of technology on the environment, Environmental disasters: Case studies, Global environmental awareness to mitigate stress on the environment, Structure and function of an ecosystem, Ecological pyramids, Pyramid of number, Pyramid of energy and pyramid of biomass.	25	7
2	POLLUTION PREVENTION Air & Noise pollution - Sources & their Effects, Case studies of Major Catastrophes, Structure and composition of the atmosphere, Water, Soil, Marine, Thermal & Marine Pollution: The story of fluoride contamination, Eutrophication of lakes, control measures, Measuring water quality: Water quality index, Waste water treatment (general) primary, secondary and tertiary stages, Municipal Solid waste management: Sources and effects of municipal waste, Biomedical waste, Hazardous waste	20	9
3	POPULATION GROWTH, GLOBAL ENVIRONMENTAL CHALLENGES & LATEST DEVELOPMENTS Population Explosion - Causes, Effects and Control, an International initiative in population-related issues, Urbanization, Growth of the world's large cities, Water resources: Sources of water, Stress on water resources, Climate Change, Global Warming and Green House Effect, Acid Rain, Depletion of Ozone layer, Variation in concentrations of GHG gases in ambient air during last millennium, Role of Environmental Information System (ENVIS) in India and similar programs run by EPA(USA), Role of soft tools like Quantum GIS, Autodesk Building Information Modeling (BIM) and City Finance Approach to Climate-Stabilizing Targets (C-FACT), Life Cycle Assessment, Bioinformatics and Optimization tools for sustainable development.	25	7
4	SMART CITIES Introduction to smart cities - about smart cities, what is a smart city, world urbanization, case studies of Songdo, Rio De Janeiro, what makes cities smart. City as a system of systems – Introduction, systems thinking, Milton Keynes Future Challenges, Rich picture as city challenges, Wicked problems, Development of smart city approach – core elements, open data, sustainability, privacy and ethics, development processes. Smart Citizens – their role, engaging citizens, IES Cities, Energy systems, Approaches for Citizen Engagement, cocreating smart cities, cities unlocked, living labs, city problems, crowdsourcing ideas, redesigning cities for citizens, all age-friendly cities, mobility on demand, motion maps, Infrastructure, Technology and Data – urban infrastructure and its technology, future of lighting, IoT, connected objects, sensing the city, NOx eating paints and air quality sensors, safest, smart citizen kit, sensing your city, Sensored City, Cyber security for data power, open, shared and closed data, satellite data, open data revolution, Smart City Project Data Innovation – smart innovations, smart city ecosystem, data-driven innovations for smart cities	30	10

Standards and Capacity Building – the role of Standard, BSI smart city Standards, HyperCat, ITU Smart Sustainable cities, Smart City Readiness, Lessons Learnt from Amsterdam Smart Measurements - metrics and indicators, city indicators, WCCD data portal, value proposition, integrated reporting, smart city learning and education, urban data school.		
Total	100	30

i. Reference Books

1. **Textbook of Environmental Studies For Undergraduate Courses (Text Book)** By Dr Erach Bharucha | Orient BlackSwan | Second Edition, Pub. Year 2013
2. **Basics of Environmental Studies** By U K Khare | Tata McGraw Hill
3. **Environmental Studies** By Anindita Basak | Drling Kindersley(India)Pvt. Ltd Pearson
4. **Environmental Sciences** By Daniel B Botkin & Edward A Keller | John Wiley & Sons
5. **Air Pollution** By M N Rao , H .V N Rao | McGraw Hill Publishing Company Limited, New Delhi
6. **Environmental Engineering** By Howard S. Peavy, Donald R. Rowe, George Tchobanoglous | McGraw-Hill

Semester 3

a. Course Name: Genetics & Molecular Biology

b. Course Code: 303144201

c. Prerequisite: Knowledge of cell biology

d. Rationale: This course introduces the fundamentals of genetics and molecular biology. It discusses the pattern of inheritance, chromosome structure, sex linked genes and inherited disorders, construction of linkage maps and population analysis. Demonstration of different genetics and molecular biology techniques to understand the mutation and analysis of genes

e. Course Learning Objective:

CLOBJ 1	Define the fundamental principles of molecular biology.
CLOBJ 2	Illustrate the genome organisation in prokaryotes & eukaryotes.
CLOBJ 3	Discuss the process of DNA replication.
CLOBJ 4	Explain the process of transcription & translation.
CLOBJ 5	Discuss recombinant DNA technology enzymes used in the process.

f. Course Learning Outcome:

CLO1	Define the basic laws governing the pattern of inheritance.
CLO2	Explain the basic organization and DNA content variations between prokaryotic and eukaryotic genome
CLO3	Explain the gene structure and central dogma of molecular biology
CLO4	Elaborate the different types of mutation and their detection techniques to treat the genetic disorders
CLO5	Develop the basic concepts of population genetics and gene cloning techniques

h. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	0	60	0	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-**Continuous Evaluation, **ESE-** End Semester Examination

h.) Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Fundamental Principles of Genetics Mendel's experiments, Mendel's laws, Gene interaction- Allelic and non-allelic – epistasis, Multiple allelism – ABO and Rh factor inheritance, linkage, recombination and linkage mapping, pedigree analysis, sex determination, sex linked, sex limited and sex influenced inheritance, extra-chromosomal inheritance.	20	9
2.	Genome Organization Genome organization in prokaryotes and eukaryotes - special features of eukaryotic gene structure and organization, genome organization in mitochondria and chloroplast, DNA content and C-value paradox. Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites)	20	9
3.	Gene Structure and Central Dogma of Molecular Biology Structure of a gene, DNA & RNA as a genetic material, packaging of DNA as chromosome, central dogma of molecular biology, DNA replication process in prokaryotes & Eukaryotes, DNA repair, Transcription in prokaryotes and eukaryotes, Reverse transcription, mechanism and regulation of transcription in prokaryotes and eukaryotes. Translation in prokaryotes and eukaryotes, genetic code, properties of genetic code, wobble hypothesis.	30	14
4.	Genetic Mutation Induced and spontaneous mutation, mutation Types, causes and techniques to detect mutation, mutant types, micro-deletion, Genetic syndrome, Molecular basis of genetic diseases, Genetic advances in agriculture and medicine, eugenics	15	7
5.	Population Genetics and Basics of Gene Cloning Hardy-Weinberg equilibrium, changes of gene frequency, QTL mapping, Basic principles of gene cloning and r-DNA Technology	15	6
	Total	100	45

i. Reference Books

1. Introduction to Genetic Analysis

By Anthony J. F. Griffiths, Jeffrey H. Miller, David T. Suzuki, Richard C. Lewontin, and William M. Gel | W.H. Freeman & Co

2. Concepts of Genetics, 7th edition, (Low Price edition) (TextBook)

By M.R. Cummings, W.S. Klug | Pearson Education, Cengage Learning India (P) Limited | 7th, Pub. Year 2002

3. Genetics (Text Book) By M.W. Strickberger | Pearson

4. **Principles of Genetics**, By D. Peter Snustad, Arthur J. Simmons. | John Wiley & Sons | 5th

5. **Genetics: a Conceptual Approach**, By Peter J. Russell. | WH Freeman & Co. | 3rd

6. **Microbial Genetics** By Stanley R. Maloy, John E. Cronan, David Freifelder. | Jones and Bartlett Publisher Inc. |

7. **Genetics: Principles and Analysis** By D.L. Hartl, D.W. Jones. | Jones and Barlett Publishers |

Semester - 3

- a. Course Name:** Genetics & Molecular Biology Lab
b. Course Code: 303144202
c. Prerequisite: Knowledge of cell biology
d. Rationale: Introducing the fundamentals of genetics and molecular biology laboratory practices to understand the basic techniques involved in the qualitative and quantitative analysis of DNA, isolation of plasmid and genomic DNA, calculation of genetic and allelic frequencies and demonstration of PCR amplification of DNA.
e. Teaching & Examination Scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-**Continuous Evaluation, **ESE-** End Semester Examination

f. List of Practical

1. How to calculate genetics and allelic frequencies (numerical problem analysis).
2. Isolation of Bacterial Plasmid DNA.
3. Isolation of genomic DNA from whole blood.
4. Isolation of bacterial genomic DNA.
5. Isolation of Plant DNA.
6. Estimation of DNA content in the given sample by spectrophotometer.
7. Purification of DNA through Electrophoresis & visualization under UV transilluminator.
8. Determination of melting temperature (T_m) of DNA.
9. Polyacrylamide gel electrophoresis of DNA.
10. PCR amplification of DNA.

Semester - 3

- a. **Course Name:** Basics of Microbiology
- b. **Course Code:** 303144203
- c. **Prerequisite:** Knowledge of basic Biology up to 12th class
- d. **Rationale:** Introducing the fundamentals of microbiology through the study of the characteristics of microorganisms, multiplication, growth in different media and various metabolic pathways. Knowledge of these principles will enable students to understand how they react under different conditions and how they cause different diseases and their control
- e. **Course Learning Objective**

CLOBJ 1	Define fundamentals of microbiology.
CLOBJ 2	Illustrate about the nutrition & growth kinetics of bacteria.
CLOBJ 3	Explain different cell capacities – transformation, transduction, conjugation
CLOBJ 4	Discuss explicitly the microbial and biochemical genetics of different microbes

- f. **Course Learning Outcome:**

CLO1	Define the roles and characteristics of microorganisms as well as identify their structural differences through microscopy.
CLO2	Summarize the basic nutritional requirements of microorganisms and different types of microbial culture media for their growth.
CLO3	Explain microbial metabolism and their fermented products.
CLO4	Elaborate explicitly the microbial and biochemical genetics of different microbes.

- g. **Teaching & Examination scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-**Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Introduction to Microbiology Basic of microbial existence: History of Microbiology, classification, and nomenclature of microorganisms. Microscopy: Light, Bright & Dark Field microscopy, Electron microscopy, Phase contrast microscopy, Atomic force microscopy, Microscopic examination of microorganisms-morphology and fine structure of bacteria.	25	10
2.	Microbial Nutrition and Growth Nutritional requirements of bacteria: Growth curve, influence of environmental factors-pH, temperature, oxygen, Heavy metals and Other compounds. Cultivation of bacteria– Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture).	15	8
3.	Microbial Metabolism Bacterial metabolism-Aerobic and anaerobic respiration (definition, examples), fermentation (alcoholic, mixed acid, acetic acid, lactic acid), bacterial photosynthesis (green and purple bacteria), biochemical nitrogen fixation – nonsymbiotic, symbiotic (definition and examples), basic concept of nif –genes. Mod genes, nitrogenase complex, leghemoglobin.	20	8
4.	Microbial Genetics Biochemical genetics. Bacterial Genetics: plasmids, transposon; Genetransfer: transformation, transduction, conjugation; recombination and complementation analysis; genemapping. Viral genetics: genetics of animal virus: polio, HIV and adenovirus, Bacteriophage: genetics of lambda, M13, T4 and T7.	20	9
5.	Applied Microbiology Microbial metabolites: Microbial applications in agricultural, biotechnological, pharmaceutical, and environmental applications. Control of microbes- Sterilisation, disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical compounds, anionic and cationic detergents.	20	10
	Total	100	45

i. Reference Books

1. **A Text Book of Microbiology (Text Book)** R.C Dubey and D. K Maheshwari; S. Chand and Company.; 3rd
2. **General Microbiology** Stanier R.; Macmilan Press ltd.; 5th
3. **Microbiology** M. Pelczar, E.Chan, N.Kreig.; MGH; 5th
4. **Text book of microbiology (Text Book)** Black; Freeman Publishers, 2016

Semester - 3

- a. **Course Name:** Basics of Microbiology Lab
- b. **Course Code:** 303144204
- c. **Prerequisite:** Knowledge of basic Biology up to 12th class
- d. **Rationale:** Introducing the fundamentals of microbiology laboratory practices to understand the characteristics of microorganisms, multiplication and growth on different culture medium. Demonstration of the practical skills by using various microbiology tools to inhibit and control the microorganisms
- e. **Teaching & Examination Scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

f. List of Practical

List of Practical

1. Preparation and sterilization of media and glassware.
2. Preparation and inoculation of agar slants, agar plate and nutrient broth.
3. Culture of microorganisms using various techniques. (Shakers i.e. Cooling and Open shaker).
4. Microscopy (components, principle and working mechanism of microscope).
5. Simple and Differential staining - Gram's staining, Endospore staining, Negative staining, flageller staining.
6. Bacterial colony counting.
7. Isolation of microbes from soil samples and determination of the number of colony forming units.
8. Streak plate technique and single spore isolation.
9. Bacterial growth curve analysis.
10. Antibiotic profiling of microorganisms

Semester - 3

a. Course Name: Biochemistry

b. Course Code: 303144205

c. Prerequisite: Knowledge of basic biology and chemistry

d. Rationale: To provide an understanding of the structure and functions of various bio molecules and their metabolism

e. Course Learning Objective

CLOBJ 1	Define the basic concepts about buffers and other reaction system.
CLOBJ 2	Outline the structure & metabolism of carbohydrates.
CLOBJ 3	Discuss the metabolism of lipids & fatty acids.
CLOBJ 4	Discuss the metabolism of amino acids.
CLOBJ 5	Discuss the metabolism of purine & pyrimidine

f. Course Learning Outcome:

CLO1	Define the different buffers and their buffering capacities in biological system
CLO2	Summarize the classification, structural and functional properties of carbohydrate metabolism and related disorders
CLO3	Explain the classification and functional properties of fat/lipid metabolism and related disorders
CLO4	Explain the structural and functional properties of amino acids and proteins metabolism and related disorders
CLO5	Explain the structural and functional properties of purines and pyrimidines metabolism and related disorders

g. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Introduction to Water and Buffers Water - Structure, Ionization of Water, properties, non-covalent interactions, role in biological processes. pH scale, Weak Acids, and Weak Bases. Buffers and buffering mechanism, Henderson Hasselbalch equation. Buffers used in Biological Systems: Phosphate buffer, Bicarbonate buffer, Protein buffer, Amino acid Buffer & Hemoglobin Buffer System	25	10
2.	Carbohydrate and its Metabolism Carbohydrates – classification, structure and functions of monosaccharides, disaccharides and polysaccharides. Ring structure and mutarotation, stereo isomers and structural isomers. Metabolism – Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, Oxidative, phosphorylation, Disorder/diseases of carbohydrate metabolism	25	10
3.	Fats or Lipids and its Metabolism Fats or lipids – Classification and function: Simple, Compound & Derived lipids, Essential fatty acids. Biosynthesis of fatty acids. Oxidation of saturated & unsaturated fatty acids, β-oxidation. Formation and utilization of ketone bodies. Disorder/diseases of lipid metabolism.	15	7
4.	Amino acids, Proteins and its Metabolism: Structure & Classification of amino acids. Essential and non-essential amino acids. Peptide bond formation, primary, secondary, tertiary & quaternary structure of proteins. Biosynthesis of amino acids. Biodegradation of amino acids: Deamination, transamination. Urea Cycle, Glucose-Alanine cycle. Disorder/diseases of amino acids metabolism	20	10
5.	Purines, pyrimidines and its Metabolism Structure and properties. Metabolism of Nucleotides: Purines & Pyrimidines synthesis: de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Disorder of purines and pyrimidines metabolism.	15	8
	Total	100	45

i. Reference Books

1. Lehninger's Principles of Biochemistry (TextBook) Nelson & Cox
2. Biochemistry Satyanarayana, U.; Elsevier Health Sciences, 2013
3. Molecular Biology of the Cell Bruce Alberts; Garland Science Publishers; 4th
4. Biochemistry Lubert Stryer; Freeman & Co, N
5. Fundamentals of Biochemistry Voet & Voet; John Willey & Sons
6. Harper's Illustrated Biochemistry R.K. Murray et al.; McGraw Hill
7. Outline of Biochemistry Conn & Stump; John Willey & Sons

Semester – 3

- a. **Course Name:** Biochemistry Lab
- b. **Course Code:** 303144206
- c. **Prerequisite:** Knowledge of basic Biology up to 12th class
- d. **Rationale:** Introducing the fundamentals of biochemistry laboratory practices to understand the buffer solutions characteristics of different sugars, quantitative estimation of carbohydrates, nucleic acids and proteins. Moreover, different chromatography is used to separate and distinguish between the sugars, amino acids and fatty acids.
- e. **Teaching & Examination Scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

f. List of Practical

1. Laboratory practices in biochemistry and preparation of different solutions/reagents (calculations): i) percentage solutions, ii) molar solutions iii) normal solutions.
2. Spectroscopy: determination of absorption maxima (λ_{max}) of a given solution.
3. Titration of Strong acid-weak base.
4. Quantitative estimation of carbohydrates.
5. Distinguish reducing and non-reducing sugars.
6. Quantitative estimation of proteins.
7. Quantitative estimation of nucleic acids.
8. Separation of sugars, fatty acids and amino acids by paper chromatography.
9. Separation of amino acids by thin layer chromatography (TLC).
10. Extraction of lipids from plant material.

Semester - 4

- a. **Course Name:** Techniques in Biotechnology
b. **Course Code:** 303144153
c. **Prerequisite:** Knowledge of Molecular biology, biochemistry and biophysics.
d. **Rationale:** Introducing the fundamentals of various analytical instruments and methodology applicable in identification and characterization of various biological macromolecules
e. **Course Learning Objective**

CLOBJ 1	Demonstrate the different types of microscopes and its applications in Biotechnology.
CLOBJ 2	Apply the principle of chromatographic techniques for qualitative and quantitative analysis of biomolecules.
CLOBJ 3	Discuss various spectroscopic techniques for qualitative and quantitative analysis of biomolecules.
CLOBJ 4	Develop knowledge on 3D printing, flow cytometry and biosensors

f. **Course Learning Outcome:**

CLO1	Demonstrate the different types of microscopes and its applications in Biotechnology.
CLO2	Apply the principle of chromatographic techniques for qualitative and quantitative analysis of biomolecules.
CLO3	Discuss the applications of spectroscopy and spectrometry techniques to identify and characterize different types of biomolecules.
CLO4	Explain the electrophoresis and centrifugation techniques for qualitative and quantitative analysis of different biological samples like proteins, nucleic acids
CLO5	Design the application of 3D-bioprinting and biosensors to create and analyse tissue like structures (biomaterials).

g. **Teaching & Examination scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE-Continuous Evaluation, ESE- End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Analytical Lab Components GLPs – Standard Operating Procedures - Documentation - record maintenance. Laboratory and Notebooks - Specifications and Report Sheets. Analytical Methods and Validations- Calibration, Maintenance Logs. Sources of error in experimental results, precision and accuracy.	15	6
2.	Chromatography Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Filtration Chromatography, Affinity Chromatography.	20	9
3.	Spectrophotometry Electromagnetic radiation and spectrum, Atomic absorption and Atomic emission spectroscopy, Principle, working and applications of UV-VIS, NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Circular Dichroism (CD) principles, Principle and applications of Positron Emission Tomography (PET), Basics of X-Ray diffraction analysis and their application in biotechnology.	25	10
4.	Electrophoresis and Centrifugation Principle of Electrophoresis, Factors affecting the Gel electrophoresis, SDS-PAGE, Agarose Gel Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein, Pulse field Gel Electrophoresis. Principle of centrifugation and sedimentation. Types of centrifuges, Preparative and analytical centrifugation; Density gradient centrifugation. Application of centrifugation for preparative and analytical purposes.	20	10
5.	3D Bioprinting and Biosensors Principles of 3D printing, 3D Bioprinting of tissues, organs and microbes. Ideal material properties for bioprinting, Biosensors: Principles and characteristics of Ideal biosensors, Biochemical components of biosensors: Enzyme based and biocatalyst sensors, Bioaffinity systems, Immunosensors. Principle and working of Flow Cytometry and cell sorter.	20	10
Total		100	45

i. Reference Books

- 1. Principles and Practice of Analytical Chemistry** By Fifeild F.W. | Blackwell Scientific, Pub. Year 2016
- 2. Principles and Techniques of Biochemistry and Molecular Biology (Text Book)** By Keith Wilson and John Walker | 6th, Pub. Year 2015
- 3. Bioanalytical Techniques (Text Book)**
By A. Shourie and S S Chapadgaonkar | TERI Press, Pub. Year 2015
- 4. Analytical Biotechnology**

By Philopose P.M. | Domihant Publishers & distributors, New Delhi, Pub. Year 2016

5. Fundamentals of Bioanalytical Techniques and Instrumentation

By Sabari Ghosal & Anupama Sharma Awasthi | PHI learning | 2nd, Pub. Year 2018

6. 3D Bioprinting in Regenerative Engineering: Principles and Applications By Ali Khademhosseini & Gulden Camci-Unal, | CRC Press

Semester - 4

a. Course Name: Techniques in Biotechnology Lab

b. Course Code: 303144254

c. Prerequisite: Knowledge of basic Biology up to 12th class

d. Rationale: Introducing the fundamentals of techniques in biotechnology laboratory practices to understand, identify and characterize different types of biological macromolecules. Illustrating the standard laboratory practices to standardize the various tools and techniques

e. Teaching & Examination Scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

f. List of practical

1. To demonstrate the precision and accuracy using suitable experimental data.
2. To study the plant pigments using paper chromatography.
3. To demonstrate and analyze the data of High-Performance Liquid Chromatography.
4. To separate the amino acids with the help of thin layer chromatography.
5. To separate the polar and non polar compounds through column chromatography.
6. To study and analyze the migration of DNA sample by agarose gel electrophoresis.
7. To study and analyze the given protein sample by SDS- PAGE.
8. To separate the compounds with the help of liquid-liquid extraction.
9. To separate the biological compounds with membrane based separation.
10. Demonstration and study of 3D printing techniques

Semester - 4

- a. **Course Name:** Enzymology and Enzyme Technology
- b. **Course Code:** 303144255
- c. **Prerequisite:** Knowledge of biochemistry, microbiology and biochemical kinetics
- d. **Rationale:** To provide an understanding of the mode of action, structure and functions of various enzymes for industrial purposes
- e. **Course Learning Objective**

CLOBJ 1	Understand the concepts of enzyme & their kinetics
CLOBJ 2	Understand the factors affecting enzymatic reactions and role of inhibitors.
CLOBJ 3	Understand the concept of enzyme immobilization & its applications.
CLOBJ 4	Apply knowledge of developing biosensors & bioreactors.
CLOBJ 5	Perform the extraction, purification & characterization of enzyme from different sources.

- f. **Course Learning Outcome:**

CLO1	Understand the basic concept of enzymology and enzyme kinetics
CLO2	Understand the crucial factors affecting the enzyme catalyzed reactions.
CLO3	Analyse the basic concept and application of enzyme immobilization
CLO4	Explain the basic design of immobilized enzyme bioreactors and its applications
CLO 5	Elaborate the uses of enzyme technology applications in a diverse range of industries

- g. **Teaching & Examination scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Introduction to enzymology Basics of enzymology: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate, lock and key model, induced fit model. Features of active site, enzyme specificity and types. IUB system of classification and nomenclature of enzymes. Enzyme kinetics: Michaelis-Menten kinetics, turnover number; determination of K_m and V_{max} (LB plot, ED plot), Importance of K_m & V_{max} .	20	10
2.	Factors affecting enzyme catalysed reactions Factors affecting the rate of enzyme catalysed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators. Enzyme inhibition: irreversible; reversible (competitive, uncompetitive and non-competitive inhibition); Substrate and Product inhibition, Allosteric regulation of enzymes, Deactivation Kinetics.	20	10
3.	Immobilization of enzymes Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, Covalent binding. Applications of enzyme immobilization. Structure, stability and kinetic properties of immobilized enzymes- partition effect, diffusion effect.	15	7
4.	Designing of immobilized enzyme bioreactors Design of Immobilized Enzyme Bioreactors- Stirred tank reactors (STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed-bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane Reactors	20	8
5.	Industrial applications of enzymes: Brewing and baking industry Processes involved in beer and wine production, use of Enzymes in industrial dough making process. Dairy industry: Enzymes in cheese manufacturing, ripening, flavor and quality. Fruit, Vegetable and meat processing industry: Enzymes used in fruit juices production (citrus and non-citrus), enzymes used in the meat processing industry. Paper, textile and leather Industry: Enzymes used in paper and pulp, enzymes used in tanning, curing, shoaking, dehairing, dewooling	25	10
	Total	100	45

i. Reference Books

- 1. Industrial Enzymology** By Ed Godfrey and West, | Macmillan Press Ltd | 2nd, Pub. Year 1996
- 2. Enzymes Biotechnology (Text Book)** By N Gray, M Calvin, SC Bhatia | CBS Publishers and Distributors Pvt Limited, Pub. Year 2010
- 3. Fundamentals of enzymology (Text Book)** By Nicolas C. price and Lewis stevens | Oxford University Press.
- 4. Fundamentals of Enzymology** By Lewis Stevens, Nicholas C. Price, | Oxford University Press | 3rd, Pub. Year 1999
- 5. Enzymes** By Trevor palmer | East west Press.
- 6. Enzyme technology** By Chaplin and Bucke | Cambridge Univerity Press.
- 7. Biochemical engineering fundamentals** By James E Bailey, David F., Ollis, | McGraw Hill Intl. Edition. | 2nd

Semester 4

- a. **Course Name:** Enzymology and Enzyme Technology Lab
- b. **Course Code:** 303144256
- c. **Prerequisite:** Knowledge of biochemistry, microbiology and biochemical kinetics
- d. **Rationale:** To provide an understanding of the mode of action, structure and functions of various enzymes for industrial purposes.
- e. **Teaching & Examination Scheme**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

f. List of Practical

1. To produce commercially important enzymes from microbial sources.
2. Isolation of alpha amylase from plant source.
3. Determination of enzyme activity and specific activity.
4. Partial purification of isolated enzymes.
5. Method of checking the purity of the enzyme - SDS-PAGE.
6. Determine the enzyme activity on- effect of pH, temperature and inhibitors.
7. Identification of Enzyme by different assays.
8. Immobilization of enzymes by adsorption, entrapment, encapsulation and crosslinking.
9. Purification of enzymes by different methods.
10. Enzyme inhibition.

Semester -4

a. Course Name: Immunology & Immunotechnology

b. Course Code: 303144251

c. Prerequisite: Knowledge of life sciences and cell biology

d. Rationale: This course explains the basics of the immune system in humans and cellular mechanisms involved. It also demonstrates the different immune systems in determining infection and immunological disorders including tumor. It provides the concepts in better diagnosis of diseases and their probable treatment

e. Course Learning Objective

CLOBJ 1	Understand the basic functions of the immune system.
CLOBJ 2	Distinguish the major cells, tissue parts of the immune system.
CLOBJ 3	List the fundamental immunological processes and MHC.
CLOBJ 4	Apply concepts of immunology in disease diagnosis.

f. Course Learning Outcome:

CLO1	Understand various immunological components in body's defence mechanism
CLO2	Classify the major cells, tissue parts of the immune system.
CLO3	Analyse the antigen processing and its presentation in the cell.
CLO4	Explain the different immune mechanisms responsible for infections and immunological disorders.

g. Teaching & Examination scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	0	0	3	20	20	-	60	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-**Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No	Topics	Weightage (%)	Teaching hours
1.	Immune System and Immunity Types An overview & significance of immunology. Hematopoiesis: Origin and differentiation of Lymphocytes and phagocytic cells- receptors and signals that control lymphocyte lineage commitment. Cytokines. Cells and tissues of the immune system-Lymphoid organs. Innate and acquired immunity. Elements of Immunity – B lymphocytes and thymus derived (T) Lymphocytes. Immunogens and antigens, complement system.	20	10
2.	Humoral and Cellular Immunity Immunoglobulins - Classes and subclasses, organization and expression of immunoglobulin genes. Immunoglobulin gene rearrangement – antibody diversity – B-cell development & activation. TCR, TCR diversity, T cell receptor gene rearrangement. T-cell development & activation	15	7
3.	Antigen Processing and its Presentation Classes of MHC – MHC/HLA genetic loci. Molecular structure and assembly of MHC molecules, Antigen presenting cells- antigen processing and presentation	15	7
4.	Immunity to Infection, Hypersensitivity Reactions, Autoimmunity and Immunology of Tumors An overview of immune response to infections, Hypersensitivity reactions, Autoimmunity: an overview of the immunopathogenic mechanisms of autoimmunity. Tumors: Immune response to tumors-types of tumor antigens. Transplantation: Types, immunological mechanisms of graft rejection- immunological strategies to prevent graft rejection-role of immunosuppressive drugs	25	10
5.	Immunotechnology Hybridoma technology - Production and purification of monoclonal antibodies; polyclonal antibodies, Antibody engineering. Immuno techniques: ELISA, RIA, ELISpot, Immunofluorescence, Flow Cytometry, immune histochemistry Immuno diagnostics & immune therapeutics: Current trends & applications.	25	11
	Total	100	45

i. Reference Books:

- 1. Immunology (TextBook)** By Goldsby. R.A, Kindt.T.J, Kuby J and Osborne BA | W.H. Freeman Pubn. New York | 7th, Pub. Year 2014
- 2. Immunology** By Roitt I.M., Brostoff. J, Male. D.K. | B. K. & Co. Ltd., Garland Pub Ltd. | 7th, Pub. Year 2014
- 3. Immunobiology** By C. A. Janeway Jr, P. Travers. | Lecture spring Pub | 8th, Pub. Year 2014
- 4. Cellular and Molecular Immunology (TextBook)**
By Abbas K A, Litchman A. H. | W. B. Saunders Co. | 8th, Pub. Year 2015

Semester – 4

a. Course Name: Immunology & Immunotechnology Lab

b. Course Code: 303144252

c. Prerequisite: Knowledge of life sciences and cell biology

d. Rationale: This course explains the basics of the immune system in humans and cellular mechanisms involved. It also demonstrates the different immune systems in determining infection and immunological disorders including tumor. It provides the concepts in better diagnosis of diseases and their probable treatment.

e. Teaching & Examination Scheme

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	0	2	1	-	-	20	-	30	50

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

f. List of Practical

1. To determine the blood group and Rh of a given blood sample.
2. To perform serum and plasma preparation.
3. To perform isolation of peripheral blood mononuclear cells (PBMCs).
4. To perform single radial immunodiffusion and double immunodiffusion.
5. To perform rocket immune electrophoresis.
6. To perform counter current immune electrophoresis.
7. To perform Dot ELISA.
8. To perform sandwich ELISA.
9. To perform SDS-PAGE to visualize the Antigen and Antibody.
10. To perform Western Blotting.

Semester -4

- a. **Course Name** Professional Grooming & Personality Development
- b. **Course Code:** 303193252
- c. **Prerequisite:** Knowledge of communication theories and basic management skills are essential.
- d. **Rationale:** Acquiring soft skills, life skills and aptitude skills are crucial for organisational communication as well as employability respectively.
- e. **Course Learning Objective:**

CLOBJ 1	Students will develop clear and articulate verbal communication skills.
CLOBJ 2	Students will enhance non-verbal communication, including body language and facial expressions.
CLOBJ 3	Students will be able to understand the importance of personal grooming and hygiene in a professional setting.
CLOBJ 4	Students will be able to understand and apply proper business etiquette in various professional settings.
CLOBJ 5	Students will be able to develop emotional intelligence to understand and manage one's own emotions and those of others.
CLOBJ 6	Students will be able to cultivate leadership qualities and skills to inspire and influence others positively.
CLOBJ 7	Students will be able to understand and practice professional etiquette in various business settings.

f. **Course Learning Outcomes:**

CLO 1	Identify and develop soft skills required for personal and professional growth.
CLO 2	Develop professional etiquette & desired behaviour at the workplace.
CLO 3	Speak and participate effectively in oral organizational communication.
CLO 4	Improve comprehensive skills for reading.
CLO 5	Know how to be assertive in professional environment.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
0	1	0	1	-	100	-	-	-	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching hours
1	Self-Development and Assessment: Various self-assessments for personal and professional development skills that are relevant to career development: Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Guess, Think, Communicate, Relate, and Dream	25	4
2	Corporate Etiquette: Tips and guide to develop personality and gain various etiquettes manners, case studies and activities. - Telephone etiquette - Etiquette for foreign business trips - Etiquette for small talks - Respecting privacy - Learning to say 'No'	25	4
3	Public Speaking: It's process of communicating information to an audience and is helpful in career advancement. Effective Public speaking skills includes: - Choosing appropriate pattern - Selecting appropriate method - Art of persuasion - Making speeches effective - Delivering different types of speeches	20	4

4	Reading Skills Activity & Reading Comprehension: Aims to improve students' Comprehensive Skills in English Language by getting them involved in reading activity and providing practice for reading comprehension.	15	2
5	Listening Skills- Inquiry Based Listening Questions: Aims to improve students' listening skills in English Language providing them practice of various types of inquiry based listening tracks. Students will listen and will be able to find out details from the conversations.	15	1
	Total	100	15

i. Reference Books:

1. Business Correspondence and Report Writing SHARMA, R. AND MOHAN, K.
2. Communication Skills Kumar S and Lata P; New Delhi Oxford University Press
3. Practical English Usage MICHAEL SWAN
4. A Remedial English Grammar for Foreign Student F.T. WOOD
5. On Writing Well William Zinsser; Harper Paperbacks, 2006; 30th anniversary edition
6. Oxford Practice Grammar, John Eastwood; Oxford University Press

