RV College of Engineering®

Biotechnology

Bachelor of Engineering (B.E)

Scheme And Syllabus Of III & IV Semester
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, EI, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2024

99TH
NIRF RANKING IN ENGINEERING (2024)

TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023
1501+
TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023 (ASIA)
501-600

EDUFUTURE EXCELLENCE AWARD
BEST PRIVATE ENGINEERING UNIVERSITY (SOUTH)
BY ZEE DIGITAL

1001+
SUBJECT RANKING (ENGINEERING)

801+
SUBJECT RANKING (COMPUTER SCIENCE)

IIRF 2023
ENGINEERING RANKING INDIA
NATIONAL RANK-10
STATE RANK - 2
ZONE RANK - 5

QS-IGUAGE DIAMOND UNIVERSITY RATING (2021-2024)

CURRICULUM STRUCTURE

61 CREDITS PROFESSIONAL CORES (PC)

23 CREDITS BASIC SCIENCE

22 CREDITS ENGINEERING SCIENCE

18 CREDITS PROJECT WORK / INTERNSHIP

12 CREDITS* OTHER ELECTIVES & AEC

12 CREDITS PROFESSIONAL ELECTIVES

12 CREDITS HUMANITIES & SOCIAL SCIENCE

160 CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

17
Centers of Excellence

11
Centers of Competence

212
Publications On Web Of Science

669
Publications Scopus (2023 - 24)

1093
Citations

70
Patents Filed

39
Patents Granted

61
Published Patents

11
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INSDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

EXECUTED MORE THAN RS.40 CRORES WORTH SPONSORED RESEARCH PROJECTS & CONSULTANCY WORKS SINCE 3 YEARS

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2024

DEPARTMENT VISION

A Premier Department in Biotechnology Education, Research and Innovation with a Focus on Sustainable Technologies for the Benefit of Society and Environment.

DEPARTMENT MISSION

- Create state-of-the-art infrastructure for research and training in Biotechnology.
- Develop graduates who are ethical and socially concerned.
- Promoting collaboration with academia, industries and research organizations at national and international level.
- Contribute to socioeconomic development through sustainable and inclusive technologies

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Have a strong foundation in scientific and engineering fundamentals that prepare them for a successful career in Biotechnology and allied fields

PEO2: Function at a technically competent level in formulating and solving problems in Biotechnology

PEO3: Organize and utilize the knowledge to develop Biological processes and gene manipulation techniques

PEO4: Exhibit professionalism, ethical attitude, oral and written communication skills, team work and develop an outlook for lifelong learning

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Gain knowledge in Basic sciences, Mathematics and Biology to understand the Engineering problems related to Biotechnology and Bioinformatics.
PSO2	Develop the skills in the area of Biotechnology, Chemical Engineering and Informatics to solve complex Biological problems.
PSO3	Acquire technical knowledge to design, analyse, optimize and scale up Bio processes to develop value added products.
PSO4	Develop intellectual, personal and professional abilities through experiential learning and interdisciplinary projects

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	PY	Physics
9.	CY	Chemistry
10.	MA	Mathematics
11.	AS	Aerospace Engineering
12.	AI & ML	Artificial Intelligence & Machine Learning
13.	BT	Biotechnology
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	CV	Civil Engineering
17.	EC	Electronics & Communication Engineering
18.	EE	Electrical & Electronics Engineering
19.	EI	Electronics & Instrumentation Engineering
20.	ET	Electronics & Telecommunication Engineering
21.	IM	Industrial Engineering & Management
22.	IS	Information Science & Engineering
23.	ME	Mechanical Engineering

INDEX

III Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1	MAT231TB*	Statistics, Laplace Transform and Numerical Methods	1-2
2	CV232TA/ME232TB/BT232TC	Environment & Sustainability / Material Science for Engineers / Bio Safety Standards and Ethics	3-8
3	BT233AI	Cell and Molecular Biology	9-11
4	BT234AI	Unit Operations	12-14
5	BT235AI	Thermodynamics and Bioanalytical Techniques	15-17
6	BT237DL	Design Thinking Lab	18-19
7	CS139AT**	Bridge Course: C Programming	20-22

IV Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1	BT241AT	Biostatistics	23-24
2	CV242TA/ME242TB/ BT242TC	Environment & Sustainability / Material Science for Engineers/ Bio Safety Standards and Ethics	25-30
3	BT343AI	Programming for Computational Biology	31-33
4	BT344AI	Biochemistry	34-36
5	BT345AT	Bioprocess Calculations	37-38
6	BT246TX	Professional Core Electives – Group A	39
7	HS247LX ***/	**ABILITY ENHANCEMENT COURSE**	39-53
8	HS248XT	Universal Human Values	54-55
9	MAT149AT***	Bridge Course: Mathematics	56-57

Bachelor of Engineering in BIOTECHNOLOGY

III Semester

Sl. No.	Course Code	Course Title	Credit Allocation				BoS	Category	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	MAT231TB*	Statistics, Laplace Transform and Numerical Methods	3	1	0	4	MA	Theory	100	***	3	100	***
2	XX232TX	Basket Courses - **Group A**	3	0	0	3	BT/ CV/ ME	Theory	100	***	3	100	***
3	BT233AI	Cell and Molecular Biology	3	0	1	4	BT	Theory + Lab	100	50	3	100	50
4	BT234AI	Unit Operations	3	0	1	4	BT	Theory + Lab	100	50	3	100	50
5	BT235AI	Thermodynamics and Bioanalytical Techniques	3	0	1	4	BT	Theory + Lab	100	50	3	100	50
6	BT237DL	Design Thinking Lab	0	0	2	2	BT	Lab	***	50	2	***	50
7	CS139AT**	Bridge Course: C Programming	2(A)	0	0	AUDIT	CS	Theory	50	***	***	***	***
		Total				21							

Group A: Basket Courses (Students can select any ONE COURSE out of THREE COURSES in ODD Sem & ONE COURSE out of remaining courses in EVEN Sem)								
2	CV	CV232TA	Environment & Sustainability	3	0	0	3	Theory
	ME	ME232TB	Material Science for Engineers	3	0	0	3	Theory
	BT	BT232TC	Bio Safety Standards and Ethics	3	0	0	3	Theory

IV Semester

Sl. No	Course Code	Course Title	Credit Allocation				BoS	Category	Max Marks CIE		SEE Duration (H)	Max Marks SEE	
			L	T	P	Total			Theory	Lab		Theory	Lab
1	BT241AT	Biostatistics	3	0	0	**3**	BT	Theory	**100**	***	**3**	**100**	***
2	XX242TX	Basket Courses - **Group A**	3	0	0	**3**	BT/CV/ME	Theory	**100**	***	**3**	**100**	***
3	BT343AI	Programming for Computational Biology	3	0	1	**4**	BT	Theory + Lab	**100**	**50**	**3**	**100**	**50**
4	BT344AI	Biochemistry	3	0	1	**4**	BT	Theory + Lab	**100**	**50**	**3**	**100**	**50**
5	BT345AT	Bioprocess Calculations	3	0	0	**3**	BT	Theory	**100**	***	**3**	**100**	***
6	BT246TX	Professional Core Electives **Group B**	2	0	0	**2**	BT	NPTEL	**50**	***	***	**50**	***
7	HS247LX	Ability Enhancement Course- **Group C**	0	0	2	**2**	HSS	Lab	***	**50**	**2**	***	**50**
8	HS248AT	Universal Human Values	2	0	0	**2**	HSS	Theory	**50**	***	**2**	**50**	***
9	MAT149AT	Bridge Course: Mathematics	2 (A)	1	0	**AUDIT**	MA	Theory	**50**	***	***	***	***
		Total				**23**							

Group A: Basket Courses (Students can select any ONE COURSE out of THREE COURSES in ODD Sem & ONE COURSE out of remaining courses in EVEN Sem)								
2	CV	CV232TA/CV242TA	Environment & Sustainability	3	0	0	3	Theory
	ME	ME232TB/ ME242TB	Material Science for Engineers	3	0	0	3	Theory
	BT	BT242TC/ BT242TC	Bio Safety Standards and Ethics	3	0	0	3	Theory

GROUP B: PROFESSIONAL CORE ELECTIVES (NPTEL COURSES)- Courses are subject to change based on the availability of courses in NPTEL platform			
Sl. No.	**Course Code**	**Course Title**	**Duration**
1	BT246TA	Computational neuroscience	8 Weeks
2	BT246TB	Environmental biotechnology	8 Weeks
3	BT246TC	Experimental biotechnology	8 Weeks
4	BT246TD	Introduction to developmental biology	8 Weeks
5	BT246TE	Introduction to dynamical models in biology	8 Weeks
6	BT246TF	Introduction to Cell Biology	8 Weeks
7	BT246TG	Cell Culture Technologies	8 Weeks
8	BT246TH	Computer Aided Drug Design	8 Weeks
9	BT246TI	Introduction to Mechanobiology	8 Weeks
10	BT246TJ	Introduction to Biostatistics	8 Weeks
11	BT246TK	Bioengineering: An Interface with Biology and Medicine	8 Weeks
12	BT246TL	Biostatistics and Design of experiments	8 Weeks
13	BT246TM	Data Analysis for Biologists	8 Weeks
14	BT246TN	Medical Biomaterials	8 Weeks
15	BT246TO	Nanotechnology in Agriculture	8 Weeks

Group C: Ability Enhancement Courses During III Sem: AS, CH, CV, EC, EE, EI, ET, IM & ME. During IV Sem: AI, BT, CD, CS, CY & IS.					
Sl. No.	**BoS**	**Course Code**	**Course Title**	**Category**	**Credits**
7	HS	HS247LA	National Service Scheme	LAB	2
	HS	HS247LB	National Cadet Corps	LAB	2
	HS	HS247LC	Physical Education : Sports & Athletics	LAB	2
	HS	HS247LD	Music	LAB	2
	HS	HS247LE	Dance	LAB	2
	HS	HS247LF	Theater (Light Camera & Action)	LAB	2
	HS	HS247LG	Art Work & Painting	LAB	2
	HS	HS247LH	Photography & Film Making	LAB	2

Semester: III						
STATISTICS, LAPLACE TRANSFORM AND NUMERICAL METHODS (Theory) (AS, BT, CH, IM, ME)						
Course Code	**:**	MA231TB		**CIE**	**:**	**100 Marks**
Credits: L: T: P	**:**	3:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	45L+30T		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**09 Hrs**

Statistics:
Central moments, mean, variance, coefficients of skewness and kurtosis in terms of moments. Correlation analysis, rank correlation, curve fitting, linear and multivariate regression analysis. Implementation using MATLAB.

Unit – II	**09 Hrs**

Complex Analysis:
Complex function, analytic function, Cauchy-Riemann equations, harmonic functions. Construction of analytic function– Milne -Thomson method. Taylor, Maclaurin, Laurent series. Zeros and poles, Residue theorem. Implementation using MATLAB.

Unit –III	**09 Hrs**

Laplace Transform:
Existence and uniqueness of Laplace transform, transform of elementary functions, region of convergence. Properties - linearity, scaling, s - domain shift, differentiation in the s - domain, division by t, differentiation and integration in the time domain. Laplace transform of time domain periodic functions, Heaviside unit step function, unit impulse function, t - shift property. Implementation using MATLAB.

Unit –IV	**09 Hrs**

Inverse Laplace Transform:
Definition, properties, evaluation using different methods. Convolution theorem. Application to solve ordinary linear differential equations. Implementation using MATLAB.

Unit –V	**09 Hrs**

Numerical Methods for Partial Differential Equations:
Numerical solutions to partial differential equations – Finite difference approximation to derivatives, solution of Laplace equation in two-dimension, heat and wave equations in one dimension (explicit methods). Implementation using MATLAB.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of statistics, complex analysis, Laplace & inverse Laplace transform and numerical methods.
CO2:	Apply the acquired knowledge of statistics, complex analysis, Laplace transform and numerical methods for partial differential equations to solve the problems of engineering applications.
CO3:	Analyze the solution of the problems obtained from appropriate techniques of statistics, complex analysis, Laplace transform and numerical methods to the real - world problems.
CO4:	Interpret the overall knowledge of statistics, complex analysis, Laplace transform and numerical methods to solve partial differential equations arising in many practical situations.

Reference Books	
1	Advanced Engineering Mathematics, Dennis G. Zill, Warren S. Wright, 7th Edition, 2020, Jones and Bartlett publishers, ISBN: 13-978-1284105902.
2	Numerical Methods for Scientific and Engineering Computation, M.K. Jain, S.R.K. Iyenger and R.K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Higher Engineering Mathematics, B.S. Grewal, 44th Edition, 2015, Khanna Publishers, ISBN: 81-7409-195-5.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted **(**Two regular tests & One optional Improvement test**).** Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (05), Program specific requirements (05), Video based seminar/presentation/demonstration (10), MATLAB (20). **ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	1	-	2
CO2	3	2	2	1	1	-	-	-	1	1	-	2
CO3	3	3	2	2	1	-	-	-	1	2	-	2
CO4	3	3	3	2	-	-	-	-	1	1	-	3

High-3: Medium-2: Low-1

Semester: III/IV						
ENVIRONMENT & SUSTAINABILITY **Category: Basket Courses - Group A** **Stream: (Common to all Programs)** **(Theory)**						
Course Code	**:**	**CV232TA/ CV242TA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**10 Hrs**
ENVIRONMENT AND BIODIVERSITY Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity. **ENVIRONMENTAL POLLUTION** Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.	
Unit – II	**8 Hrs**
RENEWABLE SOURCES OF ENERGY Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Energy Cycles, carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change. Applications of - Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	
Unit –III	**8 Hrs**
SUSTAINABILITY AND MANAGEMENT Introduction to Environmental Economics, Environmental Audit, Development, GDP, Sustainability - concept, needs and challenges-economic, social and aspects of sustainability - from unsustainability to sustainability-millennium development goals and protocols. Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.	
Unit –IV	**8 Hrs**
Sustainable Development Goals - targets, indicators and intervention areas Climate change - Global, Regional and local environmental issues and possible solutions. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry. **SUSTAINABILITY PRACTICES** Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment. Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports.	
Unit –V	**8 Hrs**
Corporate Social Responsibility (CSR) - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management. Relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India. Sustainability Reporting: Flavor of GRI, Dow Jones Sustainability Index, CEPI. Investor interest in Sustainability.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Understand the basic elements of Environment and its Biodiversity.
CO 2	Explain the various types of pollution and requirement for sustainable strategy for present scenario.
CO 3	Evaluate the different concepts of sustainability and its significance for welfare of all life forms.
CO 4	Recognize the role of Corporate social responsibility in conserving the Environment.

Reference Books	
1.	'Environmental Science and Engineering', Benny Joseph, Tata McGraw-Hill, New Delhi, 2016. ISBN-13 - 978-9387432352
2.	'Introduction to Environmental Engineering and Science', Gilbert M.Masters, Wendell P Ela, 3rd edition, Pearson Education, 2006. ISBN-13 - 978-0132339346.
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
4.	A Handbook of Corporate Governance and Social Responsibility (Corporate Social Responsibility), David Crowther and Guler Aras, Gower Publishing Ltd, ISBN - 13 - 978-0566088179.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

SEMENSTERSemester: III / IV						
MATERIALS SCIENCE FOR ENGINEERS **Category: Professional Core** **(Theory)**						
Course Code	**:**	ME232TB / 242TB		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**3 Hours**

Unit-I	**06 Hrs**
The Fundamentals of Materials The electronic structure of atoms, types of atomic and molecular bonds: ionic bond, covalent bond, metallic bond, secondary bonds, mixed bonding, hybridization. Energy bands in metals, insulators, and semiconductors. Basic crystallography. Defects and dislocations. Types of materials: polymers, metals and alloys, ceramics, semiconductors, composites.	
Unit – II	**10 Hrs**
Material behavior: Thermal properties: thermal conductivity, thermoelectric effects, heat capacity, thermal expansion coefficient, thermal shock, thermocouple. Electrical Properties: dielectric behaviours and temperature dependence of the dielectric constant, insulating materials, ferroelectricity, piezoelectricity, super conductor. Optical properties: luminescence, optical fibers, Mechanical Properties: Stress-strain diagram, elastic deformation, plastic deformation, hardness, viscoelastic deformation, impact energy, fracture toughness, fatigue.	
Unit –III	**10 Hrs**
Materials and their Applications: Semiconductors, dielectrics, optoelectronics, structural materials, ferrous alloys, nonferrous alloys, cement, concrete, ceramic, and glasses. Polymers: thermosets and thermoplastics, composites: fiber-reinforced, aggregated composites, electronic packaging materials, biomaterials, processing of structural materials.	
Unit –IV	**07 Hrs**
Heat Treatment: Post processing heat treatment of electronic devices: thermal oxidation, diffusion, rapid thermal processing. Heat treatment of ferrous materials: annealing, spheroidizing, normalizing, hardening, tempering. formation of austenite, construction of Time Temperature Transformation (TTT) curves. Special heat treatment processes: carburizing, nitriding, cyaniding, flame, and induction hardening. Defects in heat treatment.	
Unit-V	**07 Hrs**
Nanomaterials: Synthesis of nanomaterials: ball milling, sol-gel, vapour deposition growth, pulse laser, magnetron sputtering, lithography. Nano porous materials: zeolites, mesoporous materials, carbon nanotubes, graphene, nano FRPs, nano fabrics, bioresorbable and bio-erodable materials, nano ceramic, nano glasses, nano biomaterials, nano implant associated materials. Characterization of nano structures, spectroscopic techniques, automatic force microscopy.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the classification of materials, their atomic structure, and properties.
CO2	Investigate the properties and applications of different materials.
CO3	Analyze the effect of different heat treatment processes.
CO4	Recognize different types of nanomaterials, synthesis methods and characterisation techniques.

Reference Books	
1.	Material Science and Engineering, William D Callister, 6th Edition, 1997, John Wiley and Sons, ISBN: 9812-53-052-5
2.	Introduction to Physical Metallurgy, Sydney H Avner, 1994, Mc. Graw Hill Book Company, ISBN: 0-07-Y85018-6
3.	Material Science and Engineering, William F Smith, 4th Edition, 2008, Mc. Graw Hill Book Company, ISBN: 0-07-066717-9
4.	A.S. Edelstein and R.C. Cammarata, Nanomaterials: Synthesis, Properties and Applications, CRC Press 1996, ISBN:978-0849322749

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III/IV						
BIO SAFETY STANDARDS AND ETHICS						
Course Code	**:**	**BT232TC/BT242TC**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Biohazards, Bio safety levels and cabinets: Introduction to Biohazards, Biological Safety levels, Bio safety Cabinets, Study of various types of Bio safety cabinets. Various parameters for design of Biosafety cabinets (Materials used for fabrication, sensors, filters, pumps, compressors)	
Unit – II	**08 Hrs**
Biosafety Guidelines: Biosafety guidelines of Government of India, GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM (Review committee o Genetic manipulation), GEAC (Genetic Engg Approval Committee) for GMO applications in food and agriculture. Overview of National Regulations and relevant International Agreements including Cartagena Protocol.	
Unit –III	**10 Hrs**
Food safety standards: FSSAI (Food Safety and Standards Authority of India), Functions, License, types of FSSAI Licences and compliance rules. **Food Hygiene:** General principles of food microbiology and overview of foodborne pathogens, sources of microorganisms in the food chain (raw materials, water, air, equipment, etc.) Quality of foods, Microbial food spoilage and Foodborne diseases, Overview of beneficial microorganisms and their role in food processing and human nutrition, Food Analysis and Testing, General principles of food safety management systems, Hazard Analysis Critical Control Point (HACCP).	
Unit –IV	**09 Hrs**
Food Preservations, processing, and packaging Food Processing Operations, Principles, Good Manufacturing Practices HACCP, Good production, and processing practices (GMP, GAP, GHP, GLP, BAP, etc) Overview of food preservation methods and their underlying principles including novel and emerging methods/principles.Overview of food packaging methods and principles including novel packaging materials.	
Unit-V	**09 Hrs**
Food safety and Ethics: Food Hazards, Food Additives, Food Allergens Drugs, Hormones, and Antibiotics in Animals. Factors That Contribute to Foodborne Illness, Consumer Lifestyles and Demand, Food Production and Economics, History of Food Safety, The Role of Food Preservation in Food Safety. Ethics: Clinical ethics, Health Policy, Research ethics, ethics on Animals. Biosafety and Bioethics.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Have a comprehensive knowledge of Biohazards and bio safety levels
CO2	Understand the biosafety guidelines and their importance to the society
CO3	Acquire knowledge with respect to the Food standards, Hygiene, food processing and packing
CO4	Appreciate the food safety, Ethics, biosafety and bio ethics

Reference Books	
1.	Deepa Goel, Shomini Parashar, IPR, Biosafety and Bioethics 1st Edition, 2013, ISBN: 978-8131774700.
2.	Cynthia A Roberts, The Food Safety, Oryx Press, first edition, 2001, ISBN: 1–57356–305–6.
3.	Hal King, Food Safety Management Systems, Springer Cham, 2020, ISBN: 978-3-030-44734-2.
4.	Alastair V. Campbell, Bioethics: The Basics, Routledge; 2nd edition, 2017, ISBN: 978-0415790314.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: III

CELL AND MOLECULAR BIOLOGY Category :PROFESSIONAL CORE COURSE (Theory and Practice)

Course Code	**:**	**BT233AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3 hrs**

Unit-I — **08 Hrs**

Cell: Structure of Prokaryotic and Eukaryotic cell. DNA as the Genetic material: Griffith, Hershey-Chase experiments. Cell cycle and its regulation, Mitosis and meiosis, Cell signaling: Reception, transduction and response. Programmed cell death. Structure and functions of Chloroplast and Mitochondria.

Unit – II — **10 Hrs**

Central Dogma of Molecular Biology: Replication of DNA in Prokaryotic cell and Eukaryotic cell. Mechanism of action of telomerase, DNA damage, and repair: Base excision repair, mismatch excision repair, photo-reactivation, nucleotide excision, and SoS repair. Homologous & non-homologous recombination, Transposons: DNA Transposons and retrotransposons. Transcription in the prokaryotic and eukaryotic cell: Initiation, elongation, and termination. Processing of mRNA. Translation in the prokaryotic and eukaryotic cell: Initiation, elongation, and termination. Post- translational modification of proteins. Secretory and nonsecretory (Chloroplast and Mitochondria) protein-sorting pathways in eukaryotic cells.

Unit –III — **09 Hrs**

Gene Regulation: Regulation of gene expression in prokaryotes (lac-operon and trp-operon). Positive and negative gene regulation in prokaryotes, mechanism of riboswitches. Regulation of gene expression in eukaryotes: Transcriptional, RNA processing, Translational, and Post-translational level. Regulation of gene expression by Hormones (steroid hormone, auxin, and gibberellic acid) in eukaryotes. Gene silencing: antisense technique, RNA interference (miRNA and si RNA) and Ribozymes. Genome editing systems (CRISPR/Cas9, Zinc finger nucleases and TALENs).

Unit –IV — **09 Hrs**

Microbiology: Structure of Bacteria (*Escherichia coli*), Blue green algae (*Spirulina*), Fungi (*Saccharomyces cerevisiae*), Protozoa, (Amoeba), and Viruses (Bacteriophage, Coronavirus). Horizontal gene transfer in bacteria: Conjugation, Transformation and Transduction. Culture of microorganisms: Nutrient media preparation, Sterilization of media, Isolation of microorganisms from soil sample, Growth and Measurement of bacteria, replica-plating technique. Simple and Differential (Gram) staining techniques. Beneficial microflora for Humans, agriculture, environment, and industry. Human diseases caused by fungi, protozoa, bacteria and viruses.

Unit –V — **09 Hrs**

Immunology: Immune system, Innate and adaptive immune response, Human antibody: Structure, types, and functions. Vaccines: Inactivated, attenuated, viral vector, protein subunit, DNA, and RNA vaccines. Cancer: Causes and Genetics, Oncogenes, tumour suppressor genes, signalling pathways in tumorigenesis. Immunological Techniques: Immunofluorescence, rocket immunoelectrophoresis (RIEP), Radio-immuno-assay, and ELISA.

LABORATORY EXPERIMENTS

Isolation of microorganisms from soil sample by serial dilution technique: spread plate, streak plate, and pour plate technique.
Culture of microorganisms: study of bacterial growth curve
Staining of microorganisms: Simple (Fungi) and Differential (Gram) staining. Isolation of cellulase/pectinase/amylase producing microorganisms from soil sample. Antibiotic sensitivity testing of bacteria.
Isolation of genomic DNA from bacteria. Isolation of chloroplast from plant cells.
Study of divisional stages of mitosis and meiosis in plants (Onion) Rocket immunoelectrophoresis (RIEP)
Enzyme linked Immunosorbent Assay (ELISA)

Experiential learning

Innovative Projects:
Isolation of industrially important microbes.
Production of useful compounds from microbes.
Plant-microbe interaction.
Formulation of bio pesticides.
Formulation of biofertilizers.
Detection of microbial contamination in water and food.
Isolation of genomic DNA from bacteria/plant/animal cells.
Extraction of total proteins from plant seeds.
Early detection of diseases in plants/humans.
Students can pick up any one project as part of experiential learning

Course Outcomes: After completing the course, the students will be able to	
CO1	Acquire knowledge on various molecular mechanisms/processes of the cell.
CO2	Compare and contrast various cellular and molecular mechanisms of the cell.
CO3	Apply various techniques required for isolation, culture and manipulation of cells, and detection of proteins/DNA/enzymes/antigens/antibodies in the sample.
CO4	Analyse and articulating the biological information, designing experiment and interpret the results.

Reference Books	
1.	Molecular Cell Biology, Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Martin KC, Yaffe M, Amon A, 9th Edn, 2021, MacMillan, ISBN-978-1319426736, ISBN-978-1319365042.
2.	Karp's Cell and Molecular Biology, 9th Edn, 2020, John Wiley & Sons Inc, ISBN-10:1119598249, ISBN-13: 978-1119598244
3.	Kuby Immunology Punt J, Stranford S, Jones P, Owen JA, 8th Edn, 2018, W.H. Freeman Publication, ISBN-10: 1319114709, ISBN-13: 978-1319114701.
4.	Prescots Microbioogy, 10th Edn, 2017, McGraw Hill, ISBN: 9813151269, ISBN-13: 978-9813151260

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY AND PRACTICE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: III						
UNIT OPERATIONS **Category :PROFESSIONAL CORE COURSE** **(Theory and Practice)**						
Course Code	**:**	**BT234AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**03 Hours**

Unit-I	**09 Hrs**
Introduction to Fluid Mechanics: Fluid Statics- Hydrostatic equilibrium, Barometric equation, Pressure measurements- Manometers-U tube, Differential U tube. Fluid dynamics - Shear stress, Shear strain, Newton's law of viscosity, Newtonian and Non Newtonian fluids. Fluid flow: Continuity equation, Bernoulli's equation, Hagen-Poiseulle'sequation, simple numerical.	
Unit – II	**09 Hrs**
Flow metering and measurement: Construction and working of Centrifugal pump, reciprocating pump, cavitation, NPSH. Applications of Bernoulli's equation- Venturimeter, Orifice meter, Pitot tube, Rotameter. Heat Transfer: Modes of heat transfer. Steady state conductions through single-layer, composite- layer, slabs, cylinders, spheres with constant thermal conductivity. Natural and forced convection. Film co- efficient, overall Heat transfer co-efficient. Log mean temperature difference (LMTD), simple problems	
Unit –III	**09 Hrs**
Heat Exchange Equipment: Construction and elementary design of double pipe heat exchanger, shell and tube heat exchanger. Simple numerical to calculate heat transfer area in heat exchangers. Evaporation: Single effect and multiple effect evaporators, Capacity and economy, types of feeding arrangements in multiple effect evaporators	
Unit –IV	**09 Hrs**
Particle Size Analysis: Size reduction- Laws of Size reduction, Work Index, Equipment for size reduction- Ball mill, drop weight crusher. Settling: Drag, drag coefficient. Types of settling, Terminal settling velocity for one dimensional motion of spherical particle through gravitation force and external force. Motion of particles in Stoke's, Newton's and intermediate, Filtration: Classification of filtration, Characteristics of filter media and filter aids, Industrial filters- rotary drum filter, leaf filter	
Unit –V	**09 Hrs**
Distillation: Types of distillation: simple, flash, steam distillation. Distillation with and without reflux, types of feed line, reflux ratio, minimum reflux ratio, McCabe Thiele Method to find number of plates. Liquid – liquid Extraction: Single stage and multistage extraction and number of theoretical stages for continuous counter current, multistage extraction operation when liquids are insoluble. Numericals	

LAB EXPERIMENTS

1. Determination of percentage of extraction of biological compounds.
2. Determination of Frendulich and Langmiur isotherms for adsorption of biological compounds.
3. Determination of specific cake resistance 'α 'and filter medium resistance 'Rm' using a leaf filter for filtration of biological compounds
4. Verification of Rayleigh's equation for simple distillation of biological compounds.
5. Determine the discharge co-efficient (Cd) of Orifice meter.
6. Determine the discharge co-efficient (Cd) of Venturimeter.
7. Determination of the friction factor for the flow of water through a packed bed using Ergun's equation.
8. Determine the friction factor for the flow of water in the pipes
9. Determine the heat transfer coefficient in shell and tube heat exchanger
10. Determine the heat transfer coefficient in double pipe heat exchanger
11. Determine the emissivity of a cylinder and sphere 12. Steam distillation for biological sample.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basic fluid flow principles and solve the problems with the application of conservation laws.
CO2	Design and analyze the performance of heat exchangers and Single stage evaporator
CO3	Apply the knowledge of solid-solid and fluid -solid separation techniques for various applications including environmental pollution control
CO4	Apply the mass transfer concepts in the design of an extraction and distillation column

Reference Books	
1.	W. L. McCabe, J. C. Smith and P. Harriott, Unit Operations in Chemical Engineering, McGraw-Hill, New York, 7thEdition, 2005,ISBN2005978-0071247108.
2.	R.K.Bansal, Fluid Mechanics and Hydraulics of Machines,Laxmi Publications, New Delhi, 9thEdition. 2010. ISBN: 978-81-318-0815-3.
3.	J.M.Coulsonand J.F.Richardson:ChemicalEngineeringVoI1.Fluidflow, Heat Transferrin MassTransfer. Butterworth Heinemann, animprint of Elservier,6thEdition,Indian Reprint,2006.IS BN: 13:978-0387-25116-5.
4.	C. J. Geankoplis, Transport processes and Unit Operations, Prentice Hall India, 3rd Edition, 2007, ISBN-0205059392, 9780205059393.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY AND PRACTICE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS.	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: III

THERMODYNAMICS & BIOANALYTICAL TECHNIQUES Category: PROFESSIONAL CORE COURSE (Theory and Practice)

Course Code	**:**	**BT235AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **09 Hrs**

Introduction: The Scope of Thermodynamics, Dimensions and Units, Measures of amount size, force, temperature, pressure, work, energy and heat.

The First Law and other Basic Concepts: Internal energy, The first law of thermodynamics for open and close systems, Thermodynamic state and state functions, Equilibrium, the phase rule, Enthalpy, Heat capacity.

Unit – II — **09 Hrs**

The Second Law of Thermodynamics: Statement, heat engines, heat pumps, Entropy, entropy changes for ideal gas (constant volume, pressure, temperature and adiabatic processes), Carnot cycle.

Vapor/Liquid Equilibrium: Introduction, criteria for phase equilibrium, T-x,y, P-x,y, and x-y diagrams and numerical for Ideal system.

Unit –III — **09 Hrs**

Solution Thermodynamics: Fugacity and fugacity coefficient. Partial molar properties, Chemical potential, and Gibbs Duhem equation. Numerical

Chemical Reaction Equilibria: The reaction coordinate, application of equilibrium criteria to chemical reactions, The standard Gibbs-Energy Change and the Equilibrium constant, Effect of temperature on the equilibrium constant, evaluation of equilibrium constants, Relation of equilibrium constants to composition, equilibrium conversions for single reactions.

Unit –IV — **09 Hrs**

Electrophoresis and Chromatography - Principle, types and applications of agarose gel electrophoresis, native gel electrophoresis, sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS PAGE) and 2D gel electrophoresis. **Chromatographic techniques:** Affinity chromatography, ion exchange chromatography, gel filtration chromatography, Thin layer chromatography, High performance Liquid chromatography, Fast Protein Liquid chromatography, Gas chromatography

Unit –V — **09 Hrs**

Centrifugation and Spectroscopic Analytical Techniques: Centrifugation – Principle, types and applications of Preparative, analytical and ultracentrifugation. Centrifugation standards.

Spectroscopic Analytical Techniques: Basic concepts and principles of spectroscopy, UV-Visible, infrared and atomic absorption spectroscopy, Mass Spectrometry, Fluorescence spectroscopy, Raman spectroscopy, Nephelometry and Turbidometry.

LAB EXPERIMENTS

1. Determination of protein concentration
2. Determination of nucleic acid concentration
3. Determination of absorbance maxima of biologically important samples: Pigments / DNA/Protein.
4. Ion Exchange chromatography
5. Thin layer chromatography
6. Gel filtration chromatography
7. Analysis of DNA using Agarose gel electrophoresis
8. Flash and pour Point calculation.

Open ended experiment

1. Analysis of Proteins using SDS PAGE
2. Separation of Molecules using Centrifugation technique
3. Estimation of sulphate in a given sample using Turbidometer.
4. Determine the partial molar volume of a component in a binary mixture at ambient condition (given temperature and pressure)
5. Study the characteristics response of the different types of temperature devises.

All students should do 8 lab experiments and any 2 open ended experiments.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the laws of thermodynamics on closed and open systems.
CO2	Evaluate the thermodynamic properties of ideal and real gases.
CO3	Use different bioanalytical techniques to solve biological problems and to analyze biological systems/samples.
CO4	Design simple experiments to isolate and characterize biomolecules.

Reference Books	
1.	A text book of chemical Engineering thermodynamics, Narayan K V, Second Edition, 2013, Prentice Hall Publication, ISBN9788120347472
2.	Physical chemistry for life sciences, Atkins P and D Paula, WH Freeman and company, New York 2nd, 2011, Prentice Hall of India, New Delhi, ISBN-81-203-1145-0
3.	Introduction to Chemical Engineering Thermodynamics, J M Smith and D C Vanes, Eighth Edition, 2018, Mcgraw Hill, ISBN-1259696529
4.	Principles and Techniques of Instrumentation, Keith M. Wilson, John M. Walker., 8th Edition, 2017, Cambridge University Press. ISBN-13: 978-1316614761 ISBN-10: 131661476X

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY AND PRACTICE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16

7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: IV						
DESIGN THINKING LAB **Category: PROFESSIONAL CORE COURSE** **(Lab)**						
Course Code	**:**	**BT237DL**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**00:00:02**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30 P**		**SEE Duration**	**:**	**3Hours**

Guidelines

STAGE–I

Empathy: The Empathy phases of the process are focused on understanding the experiences, emotions and motivations of others. Designers use specific empathy methods to learn more about the needs of the users for whom they are designing. Empathy is the centerpiece of a human-centered design process. The Empathize mode is the work you do to understand people, within the context of your design challenge. Methods: Interviewing Probes, survey and Observations.

STAGE–II

Define: The Define phase of the process is focused on developing a point of view about the need of your user. During this stage of process, designers narrow from lots of information to a statement that is inspiring and specific. Methods: Empathy Mapping, Point of View.

STAGE–III

Ideate: The Ideate phase of the process is focused on generating as many solutions to a problem as possible. Once many solutions have been generated, students will select one to move forward to prototyping. Methods: Brainstorming and Selection

STAGE–IV

Prototype: The Prototype phase is where designers construct representation of their solutions. These representations are intended to elicit feedback and answer specific questions about a concept. Methods: Improve, Rapid and Experiential Prototyping

STAGE–V

Test: The Test phase of the process is focused on getting specific feedback about how ideas can improve. It is important to remember during this phase that prototypes are imperfect, but feedback is gift. Methods: Testing **Guidelines for Design Thinking Lab:**

1. The Design Thinking Lab (DTL) is to be carried out by a team of two-three students.
2. Each student in a team must contribute equally in the tasks mentioned below.
3. Each group has to select a theme that will provide solutions to the challenges of societal concern. Normally three to four themes would be identified by the department
4. Each group should follow the stages of Empathy, Design, Ideate, Prototype and Test for completion of DTL.
5. After every stage of DTL, the committee constituted by the department along with the coordinators would evaluate for CIE. The committee shall consist of respective coordinator & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The team should prepare a Digital Poster and a report should be submitted after incorporation of any modifications suggested by the evaluation committee.

Design Thinking Lab Tasks

1. Carry out the detailed questionnaire to arrive at the problem of the selected theme.
2. The empathy report shall be prepared based on the response of the stake holders.
3. For the problem identified, the team needs to give solution through thinking out of the box innovatively to complete the ideation stage of DTL
4. Once the idea of the solution is ready, detailed design has to be formulated in the Design stage considering the practical feasibility.
5. If the Design of the problem is approved, the team should implement the design and come out with prototype of the system.

Conduct thorough testing of all the modules in the prototype developed and carry out integrated testing

6. Demonstrate the functioning of the prototype along with presentations of the same.
7. Prepare a Digital poster indicating all the stages of DTL separately. A Detailed project report also should be submitted covering the difficulties and challenges faced in each stage of DTL.
8. Methods of testing and validation should be clearly defined both in the Digital poster as well as the report.

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Apply the knowledge of engineering and technology to empathize with the stake holder requirements and draw insights through effective communication
CO2	Formulate, analyze and ideate sustainable solutions considering societal and environmental needs, aligning with SDGs.
CO3	Validate the knowledge effectively and pursue through intra-disciplinary or interdisciplinary teams to develop prototypes/ pretotypes
CO4	Apply 21st century skills and Education 4.0 to enhance the solutions and engage in lifelong learning

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION		
Phase	**Activity**	**Marks**
1.	Empathy and Define Phase	**20**
2.	Ideate Phase	**20**
3.	Prototype & Testing Phase	**10**
	MAXIMUM MARKS FOR THE CIE	**50**
RUBRIC FOR SEMESTER END EXAMINATION		
Q.NO.	**CONTENTS**	**MARKS**
1.	Write Up	**10**
2.	Presentation and Demonstration	**30**
3.	Viva	**10**
	TOTAL	**50**

Semester: III						
BRIDGE COURSE: C PROGRAMMING (Mandatory Audit Course) (Common to all Programs)						
Course Code	**:**	**CS139AT**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0(Audit)**		**SEE**	**:**	**--**
Total Hours	**:**	**30L**		**SEE Duration**	**:**	**--**

Unit-I	**6 Hrs**
Introduction to Programming Definition of a computer. Components of computer system, Programming Languages. Design and implementation of efficient programs. Program Design Tools: Algorithms, Flowcharts and Pseudo codes. Types of Errors.	
Unit – II	**6 Hrs**
Introduction to C Introduction, structure of a C program, Writing the first program, Files used in a C program. Compiling and executing C Programs using comments, C Tokens, Character set in C, Keywords, Identifiers, Basic Data Types in C, Variables, Constants, I/O statements in C. Operators in C, Type conversion and type casting, scope of variables.	
Unit –III	**6 Hrs**
Decision Control and Looping Statements Introduction to decision control, conditional branching statements, iterative statements, Nested loops, Break and continue statements, goto statements **Arrays** Introduction, Declaration of Arrays, Accessing elements of an array, Storing values in arrays, Operations on Arrays- Traversing, Inserting and Deletion of element in an array. Two dimensional arrays- Operations on two dimensional arrays.	
Unit –IV	**6 Hrs**
Strings Introduction, Operations on strings- finding length of a string, converting characters of a string into uppercase and lowercase, Concatenating two strings, appending a string to another string, comparing two string, reversing a string. String and character Built in functions. **Functions** Introduction, Using functions, Function declaration/function prototype, Function definition, Function call, Return statement.	
Unit-V	**6 Hrs**
Functions Passing parameters to a function, Built-in functions. Passing arrays to functions. Recursion. **Structures and Pointers** Introduction: Structure Declaration, Typedef declaration, initialization of structures, accessing members of a structures, Introduction to pointers, declaring pointer variables.	

Course Outcomes: After completing the course, the students will be able to:-	
CO 1	Analyse problems and design solution using program design tools.
CO 2	Evaluate the appropriate method/data structure required in C programming to develop solutions by investigating the problem.
CO 3	Design a sustainable solution using C programming with societal and environmental concern by engaging in lifelong learning for emerging technology
CO 4	Demonstrate programming skills to solve inter-disciplinary problems using modern tools effectively by exhibiting team work through oral presentation and written reports.

Reference Books	
1.	Programming in C, Reema Thareja, 2018, Oxford University Press. ISBN: 9780199492282.
2.	The C Programming Language, Kernighan B.W and Dennis M. Ritchie, 2015, 2nd Edition, Prentice Hall, ISBN (13): 9780131103627.

3.	Turbo C: The Complete Reference, H. Schildt, 2000, 4th Edition, Mcgraw Hill Education, ISBN-13: 9780070411838.
4.	Algorithmic Problem Solving, Roland Backhouse, 2011, Wiley, ISBN: 978-0-470-68453-5

PRACTICE PROGRAMS

Implement the following programs using cc/gcc compiler

1. Familiarization with programming environment: Concept of creating, naming and saving the program file in gedit/vi editor, Concept of compilation and execution, Concept of debugging in GDB environment.
2. Implementation and execution of simple programs to understand working of
   - Formatted input and output functions- printf() and scanf().
   - Escape sequences in C.
   - Using formula in a C program for specific computation: For example: computing area of circle, converting Celsius to Fahrenheit, area of a triangle, converting distance in centimeters to inches, etc.
   - Preprocessor directives (#include, #define).
3. Execution of erroneous C programs to understand debugging and correcting the errors like:
   - Syntax / compiler errors.
   - Run-time errors.
   - Linker errors.
   - Logical errors.
   - Semantical errors.
4. Implementation and execution of simple programs to understand working of operators like:
   - Unary.
   - Arithmetic.
   - Logical.
   - Relational.
   - Conditional.
   - Bitwise.
5. Develop a C program to compute the roots of the equation ax2 + bx + c = 0.
6. Develop a C program that reads N integer numbers and arrange them in ascending or descending order using selection sort and bubble sort technique.
7. Develop a C program for Matrix multiplication.
8. Develop a C program to search an element using Binary search and linear search techniques.
9. Using functions develop a C program to perform the following tasks by parameter passing to read a string from the user and print appropriate message for palindrome or not palindrome.
10. Develop a C program to compute average marks of 'n' students (Name, Roll_No, Test Marks) and search a particular record based on 'Roll_No'.
11. Develop a C program using pointers to function to find given two strings are equal or not.
12. Develop a C program using recursion, to determine GCD , LCM of two numbers and to perform binary to decimal conversion.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 05 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	10
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO** tests will be conducted. Each test will be evaluated for 25 Marks, adding upto 50 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 20 MARKS.**	20
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (10) & Phase II (10) ADDING UPTO 20 MARKS.**	20
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

Semester: IV						
BIOSTATISTICS **Category: PROFESSIONAL CORE COURSE** **(Theory)**						
Course Code	**:**	**BT241AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**9 Hrs**
Introduction and Data presentation: Basic concepts, definitions, formulae, common terms in statistics. Tools and application of Biostatistics. Types of numerical data - Nominal data, Ordinal data, Ranked data, Discrete data and Continuous data. Tables - Frequency distribution and Relative frequency, Graphical representation, Sampling Theory – Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling.	
Unit – II	**9 Hrs**
Measures of central tendency and dispersion: Central Limit Theorem, Graphical representation of data in central tendency, Mean, Median and Mode. Frequency data. Measures of variation- Dispersion, Range, Mean deviation and Standard deviation.	
Unit –III	**9 Hrs**
Probability and distributions: Theorems of probability, Bayes' theorem. Probability distributions- Discrete distribution (Binomial distribution, Poisson distribution) testing of hypothesis (Chi square test, t test and z test).	
Unit –IV	**9 Hrs**
Correlation and Regression: Introduction, Types of correlation, Correlation coefficient - Pearson's correlation coefficient, Spearman's Rank correlation coefficient and their applications. Regression concepts, Types of regression - Simple Linear Regression, Multiple Regression, Logistic regression, regression validation, Goodness of fit.	
Unit –V	**9 Hrs**
Mathematical modelling in Biotechnology & Experimental Design: Lotka-Volterra Model of Predation, Mutation, Selection, Matrix Model of Base Substitution, mathematical model for Inheritance such as Genetic Inbreeding Model and Mendalian Model of Genetics. Growth equations of microbial populations. Experimental Design: Introduction of an experimental design, basic Concepts, principles and designing of an experiment. Randomized Block Design (RBD), completely Randomized Design (CRD), Factorial Design and Split Plot Design.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand and explain the fundamental concepts of statistics in Biostatistics
CO2	Organize Data, communicate essential features of data both numerically and graphically
CO3	Provide interpretations/conclusions of statistical problems as mathematical modelling.
CO4	Identify research questions and experimental design questions that may be answered using statistical methods and to translate the questions into the appropriate analysis procedure.

Reference Books	
1.	Dr. K S. Chandrashekar, Engineering Mathematics-IV, Sudha publications, 2017, ISBN: 8193001087
2.	Pranab Kumar Banerjee, Introduction to Biostatistics, S. Chand & Co. Ltd, 2011, ISBN:9788121923293
3.	Khan and Khanum, Fundamentals of Biostatistics, Ukaaz publications, 2020, ISBN: 9788190044103.
4.	Marcello Pagano and Kimberlee Gauvreau, Principle of Biostatistics, Thomson Asia Pvt., Ltd., 2nd ed. 2018, ISBN: 9781138593145

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III/IV						
ENVIRONMENT & SUSTAINABILITY **Category: Basket Courses - Group A** **Stream: (Common to all Programs)** **(Theory)**						
Course Code	**:**	**CV232TA/ CV242TA**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**42L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**10 Hrs**
ENVIRONMENT AND BIODIVERSITY Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity. **ENVIRONMENTAL POLLUTION** Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.	
Unit – II	**8 Hrs**
RENEWABLE SOURCES OF ENERGY Energy management and conservation, New Energy Sources: Need of new sources. Different types of new energy sources. Energy Cycles, carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change. Applications of - Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	
Unit –III	**8 Hrs**
SUSTAINABILITY AND MANAGEMENT Introduction to Environmental Economics, Environmental Audit, Development, GDP, Sustainability - concept, needs and challenges-economic, social and aspects of sustainability - from unsustainability to sustainability-millennium development goals and protocols. Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.	
Unit –IV	**8 Hrs**
Sustainable Development Goals - targets, indicators and intervention areas Climate change - Global, Regional and local environmental issues and possible solutions. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry. **SUSTAINABILITY PRACTICES** Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment. Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports.	
Unit –V	**8 Hrs**
Corporate Social Responsibility (CSR) - Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management. Relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India. Sustainability Reporting: Flavor of GRI, Dow Jones Sustainability Index, CEPI. Investor interest in Sustainability.	

Course Outcomes: After completing the course, the students will be able to: -	
CO 1	Understand the basic elements of Environment and its Biodiversity.
CO 2	Explain the various types of pollution and requirement for sustainable strategy for present scenario.
CO 3	Evaluate the different concepts of sustainability and its significance for welfare of all life forms.
CO 4	Recognize the role of Corporate social responsibility in conserving the Environment.

Reference Books	
2.	'Environmental Science and Engineering', Benny Joseph, Tata McGraw-Hill, New Delhi, 2016. ISBN-13 - 978-9387432352
2.	'Introduction to Environmental Engineering and Science', Gilbert M.Masters, Wendell P Ela, 3rd edition, Pearson Education, 2006. ISBN-13 - 978-0132339346.
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
4.	A Handbook of Corporate Governance and Social Responsibility (Corporate Social Responsibility), David Crowther and Guler Aras, Gower Publishing Ltd, ISBN - 13 - 978-0566088179.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

SEMENSTERSemester: III / IV						
MATERIALS SCIENCE FOR ENGINEERS **Category: Professional Core** **(Theory)**						
Course Code	**:**	ME232TB / 242TB		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**3 Hours**

Unit-I	**06 Hrs**
The Fundamentals of Materials The electronic structure of atoms, types of atomic and molecular bonds: ionic bond, covalent bond, metallic bond, secondary bonds, mixed bonding, hybridization. Energy bands in metals, insulators, and semiconductors. Basic crystallography. Defects and dislocations. Types of materials: polymers, metals and alloys, ceramics, semiconductors, composites.	
Unit – II	**10 Hrs**
Material behavior: Thermal properties: thermal conductivity, thermoelectric effects, heat capacity, thermal expansion coefficient, thermal shock, thermocouple. Electrical Properties: dielectric behaviours and temperature dependence of the dielectric constant, insulating materials, ferroelectricity, piezoelectricity, super conductor. Optical properties: luminescence, optical fibers, Mechanical Properties: Stress-strain diagram, elastic deformation, plastic deformation, hardness, viscoelastic deformation, impact energy, fracture toughness, fatigue.	
Unit –III	**10 Hrs**
Materials and their Applications: Semiconductors, dielectrics, optoelectronics, structural materials, ferrous alloys, nonferrous alloys, cement, concrete, ceramic, and glasses. Polymers: thermosets and thermoplastics, composites: fiber-reinforced, aggregated composites, electronic packaging materials, biomaterials, processing of structural materials.	
Unit –IV	**07 Hrs**
Heat Treatment: Post processing heat treatment of electronic devices: thermal oxidation, diffusion, rapid thermal processing. Heat treatment of ferrous materials: annealing, spheroidizing, normalizing, hardening, tempering. formation of austenite, construction of Time Temperature Transformation (TTT) curves. Special heat treatment processes: carburizing, nitriding, cyaniding, flame, and induction hardening. Defects in heat treatment.	
Unit-V	**07 Hrs**
Nanomaterials: Synthesis of nanomaterials: ball milling, sol-gel, vapour deposition growth, pulse laser, magnetron sputtering, lithography. Nano porous materials: zeolites, mesoporous materials, carbon nanotubes, graphene, nano FRPs, nano fabrics, bioresorbable and bio-erodable materials, nano ceramic, nano glasses, nano biomaterials, nano implant associated materials. Characterization of nano structures, spectroscopic techniques, automatic force microscopy.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Understand the classification of materials, their atomic structure, and properties.
CO2	Investigate the properties and applications of different materials.
CO3	Analyze the effect of different heat treatment processes.
CO4	Recognize different types of nanomaterials, synthesis methods and characterisation techniques.

Reference Books	
1.	Material Science and Engineering, William D Callister, 6th Edition, 1997, John Wiley and Sons, ISBN: 9812-53-052-5
2.	Introduction to Physical Metallurgy, Sydney H Avner, 1994, Mc. Graw Hill Book Company, ISBN: 0-07-Y85018-6
3.	Material Science and Engineering, William F Smith, 4th Edition, 2008, Mc. Graw Hill Book Company, ISBN: 0-07-066717-9
4.	A.S. Edelstein and R.C. Cammarata, Nanomaterials: Synthesis, Properties and Applications, CRC Press 1996, ISBN:978-0849322749

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: III/IV						
BIO SAFETY STANDARDS AND ETHICS						
Course Code	**:**	**BT232TC/BT242TC**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L**		**SEE Duration**	**:**	**3 Hours**

Unit-I	**09 Hrs**
Biohazards, Bio safety levels and cabinets: Introduction to Biohazards, Biological Safety levels, Bio safety Cabinets, Study of various types of Bio safety cabinets. Various parameters for design of Biosafety cabinets (Materials used for fabrication, sensors, filters, pumps, compressors)	
Unit – II	**08 Hrs**
Biosafety Guidelines: Biosafety guidelines of Government of India, GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM (Review committee o Genetic manipulation), GEAC (Genetic Engg Approval Committee) for GMO applications in food and agriculture. Overview of National Regulations and relevant International Agreements including Cartagena Protocol.	
Unit –III	**10 Hrs**
Food safety standards: FSSAI (Food Safety and Standards Authority of India), Functions, License, types of FSSAI Licences and compliance rules. **Food Hygiene:** General principles of food microbiology and overview of foodborne pathogens, sources of microorganisms in the food chain (raw materials, water, air, equipment, etc.) Quality of foods, Microbial food spoilage and Foodborne diseases, Overview of beneficial microorganisms and their role in food processing and human nutrition, Food Analysis and Testing, General principles of food safety management systems, Hazard Analysis Critical Control Point (HACCP).	
Unit –IV	**09 Hrs**
Food Preservations, processing, and packaging Food Processing Operations, Principles, Good Manufacturing Practices HACCP, Good production, and processing practices (GMP, GAP, GHP, GLP, BAP, etc) Overview of food preservation methods and their underlying principles including novel and emerging methods/principles.Overview of food packaging methods and principles including novel packaging materials.	
Unit-V	**09 Hrs**
Food safety and Ethics: Food Hazards, Food Additives, Food Allergens Drugs, Hormones, and Antibiotics in Animals. Factors That Contribute to Foodborne Illness, Consumer Lifestyles and Demand, Food Production and Economics, History of Food Safety, The Role of Food Preservation in Food Safety. Ethics: Clinical ethics, Health Policy, Research ethics, ethics on Animals. Biosafety and Bioethics.	

Course Outcomes: After completing the course, the students will be able to:	
CO1	Have a comprehensive knowledge of Biohazards and bio safety levels
CO2	Understand the biosafety guidelines and their importance to the society
CO3	Acquire knowledge with respect to the Food standards, Hygiene, food processing and packing
CO4	Appreciate the food safety, Ethics, biosafety and bio ethics

Reference Books	
2.	Deepa Goel, Shomini Parashar, IPR, Biosafety and Bioethics 1st Edition, 2013, ISBN: 978-8131774700.
2.	Cynthia A Roberts, The Food Safety, Oryx Press, first edition, 2001, ISBN: 1–57356–305–6.
3.	Hal King, Food Safety Management Systems, Springer Cham, 2020, ISBN: 978-3-030-44734-2.
4.	Alastair V. Campbell, Bioethics: The Basics, Routledge; 2nd edition, 2017, ISBN: 978-0415790314.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: (Internal Choice)	16
5 & 6	Unit 3: (Internal Choice)	16
7 & 8	Unit 4: (Internal Choice)	16
9 & 10	Unit 5: (Internal Choice)	16
	TOTAL	**100**

Semester: IV

PROGRAMMING FOR COMPUTATIONAL BIOLOGY
Category: PROFESSIONAL CORE COURSE
(Theory and Practice)

Course Code	**:**	**BT343AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**

Introduction to Genome and Proteomic databases – types and examples, databases of Proteomic, Genomic data, Metabolic pathway and Molecular structures. (Suffix trie and suffix tree, Parallel Generalized Suffix Tree Construction for Genomic Data)

Unit – II	**09 Hrs**

Dynamic Programming:
Introduction to dynamic Programming. Dynamic Programming methods (Top down and Bottom up). Dyanmic Programming Problem. Steps to solve Dynamic Programming Problem. Dynamic Programming Algorithms - Fibonacci series, Tree traversal with minimum cost, global alignment and local alignment of sequences, exon chaining, zukar algorithm, Double dynamic algorithm and gene finding.

Unit –III	**09 Hrs**

Machine learning algorithms I:
Introduction to Machine Learning. Types of Machine Learning, classification, regression and clustering. Classification algorithms – Decision Tree, Bayesian Network, SVM, Random forests, HMM and ANN. Case studies Prediction of protein functional sites, Biological activity of molecules, and classification of cancer.

Unit –IV	**09 Hrs**

Machine learning algorithms II:
ESTs using K-Means clustering, brain tumor segmentation and genes using P-DBSCAN, Self- Organizing Maps in Sequence analysis, UPGMA and NJ, Clustering algorithm for Protein–Protein Interaction (PPI) networks identification and Identification of Metabolic Pathways.

Unit –V	**09 Hrs**

Hadoop and Big Data analytics:
Introduction to Hadoop and Cloud Computing. Hadoop Architecture. Hadoop based Algorithms for Genomics and Proteomics – CloudAligner, Contrail, Myrna, MAPREDUCE, GPU-BLAST and YunBee. Case studies.

LABORATORY EXPERIMENTS

1. Design, Develop and Execute Python program for Fibonacci series and Tree traversal with minimum cost.
2. Design, Develop and Execute Python program based on Needleman and Wunch algorithm for Global Sequence Alignment.
3. Design, Develop and Execute Python program based on Smith and Waterman for Local Sequence Alignment.
4. Design, Develop and Execute Python program to implement random classifier for Image classification.
5. Design, Develop and Execute Python program to construct Phylogenetic Tree based on UPGMA algorithm.
6. Design, Develop and Execute Python program to identify diseased genes based on Needleman and Wunch algorithm.
7. Develop and Execute Python program to implement bowtie algorithm for Genome Maping.
8. Develop and deploy Python program Workflow for Network Analysis.
9. Perform differential gene expression assay for large RNA-seq datasets using Myrna.
10. Perform Parallel Genome Assembly using Contrail.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand Dynamic programming based and Machine Learning based algorithms for Big Data Analytics in Computational Biology.
CO2	Explore Applications Computational algorithms in Data Mining, Computational Genomics and Proteomics and Medical Imaging.
CO3	Apply the Algorithmic applications to solve the problems related to process modelling, simulation and process engineering in Life Sciences.
CO4	Use Python Programming skills to implement Dynamic programming based and Machine Learning based algorithms for Big Data Analytics in Computational Biology.

Reference Books	
1.	Pradipta Maji, Sushmita Paul, Scalable Pattern Recognition Algorithms, Springer International Publishing 2014, ISBN: 9783319056302.
2.	Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning - From Theory to Algorithms, Cambridge University Press 2014, ISBN: 9781107057135.
3.	Loveleen Gaur, Samuel Fosso Wamba, Arun Solanki, Advanced AI Techniques and Applications in Bioinformatics, CRC Press 2021, ISBN: 9781000462982.
4.	Tim J. Stevens, Wayne Boucher, Python Programming for Biology - Bioinformatics and Beyond, Cambridge University Press 201, ISBN: 9780521895835.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY AND PRACTICE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: IV

BIOCHEMISTRY

Category: PROFESSIONAL CORE COURSE

(Theory and Practice)

Course Code	**:**	**BT344AI**		**CIE**	**:**	**100 + 50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3Hrs**

Unit-I — **09 Hrs**

Foundations of Biochemistry

Influence of hydrogen Bonds and other weak interactions in biomolecules, behavior of hydrophilic and hydrophobic substances in water, thermodynamics of transferring a nonpolar molecule from an aqueous solution to a nonpolar solvent, types of solutions (hypertonic, isotonic and hypotonic), osmosis and diffusion.

Ionization of water, pH, Henderson hasselbagh equation and its significance, influence of acids and bases in altering the pH, types of buffers and preparation of buffers. The blood buffering system.

Unit – II — **09 Hrs**

Carbohydrates and Nucleic acids

Carbohydrates: Structure and properties of monosaccharide, disaccharide and polysaccharide (structural polysaccharides and storage polysaccharides). Carbohydrate metabolism: Aerobic and anaerobic glycolysis, tricarboxylic acid cycle and gluconeogenesis.

Nucleic acids- Nucleotides, bases, sugars, structure, types, properties and functions of DNA and RNA. Limited Flexibility of DNA. Forces stabilizing nucleic acid structures - Principles of base-stacking, base pairing and Ribose puckering. DNA melting Curve-DNA denaturation and renaturation.

Unit –III — **09 Hrs**

Nucleic acids and Lipids

Amino Acids: Classification, structure and properties of amino acids. Proteins: Primary, secondary (planar peptide group and its effect on limited polypeptide conformation, alpha helix, beta sheets), Ramachandran plot, Tertiary and quaternary structures. Globular and fibrous proteins. Biodegradation of amino acids- deamination, transamination and urea cycle.

Lipid metabolism: Biosynthesis and biodegradation of fatty acids. Biochemical functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids.

Unit –IV — **09 Hrs**

Enzymes

Enzyme classification. Enzyme catalyzed reactions, factors affecting enzyme activity, co-factors and co-enzymes. Extraction, purification and characterization of enzymes. Determination of molecular mass of enzymes. Enzyme assays. Enzyme kinetics- Michaelis–Menten Equation. Enzyme Inhibition: Competitive, uncompetitive and non-competitive. Determination of inhibition constants.

Unit –V — **09 Hrs**

Hormones and vitamins

The major endocrine systems and their target tissues, Hormonal Regulation of Metabolism. Common endocrine disorders: Diabetes Mellitus, Hypothyroidism, hyper thyroidism, Graves disease, Hashimoto's disease. Vitamins: Types and associated deficiency diseases, case studies. Role of Nutraceuticals in health

Laboratory Component

1. Qualitative tests for amino acids
2. Qualitative tests for carbohydrates
3. Estimation of the concentration of reducing sugars
4. Estimation of the concentration of total sugars.
5. Estimation of the concentration of total proteins
6. Estimation of the concentration of nucleic acids

Open ended experiments:

1. Enzyme extraction and determination of enzyme activity.
2. SDS- PAGE
3. Estimation of ascorbic acid
4. Calculation of Km &Vmax for an enzyme catalyzed reaction
5. Effect of temperature on enzyme activity
6. Effect of pH on enzyme activity

Experiments 1-6 is performed by all students. Students should pick any 3 open ended experiments from the above list of open ended experiments and perform during the semester.

PART B

Innovative Experiments (IE)

1. Extraction and Purification of enzymes
2. Purification of industrially important compounds
3. Characterization of bioactive compounds
4. Extraction and purification of valuable compounds from waste.

Students can pick up any one project as part of experiential learning

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend biochemical principles and fundamentals of biochemistry and apply them to a given scenario
CO2	Analyze complex biochemical pathways within living cells to solve a given problem
CO3	Review research literature, analyze biochemical problems and present the data following professional ethics
CO4	Conduct basic biochemical experiments, analyze, interpret and present the data

Reference Books	
1.	Principles of Biochemistry, Donald Voet, Judith G. Voet, Charlotte W. Pratt, 4th Edition, 2012, John Wiley & Sons, ISBN-10: 1 9781464126116, ISBN-13: 978-1464126116
2.	Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 67h Edition, 2017, W.H. Freeman, ISBN-10: 9781464126116, ISBN-13: 978-1464126116
3.	Biochemistry, U Satyanarayana, 5th Edition, 2017, Books & Allied Ltd, ASIN: B073Y7XGH4
4.	Biochemistry, Denise Ferrier, Lippincott, 2017, Williams & Wilkins, ISBN: 149636354X, 9781496363541

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY AND PRACTICE)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY AND PRACTICE)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	30
3	Viva	10
	TOTAL	**50**

Semester: IV

BIOPROCESS CALCULATIONS
Category: PROFESSIONAL CORE COURSE
(Theory)

Course Code	**:**	**BT345AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **09 Hrs**

Basic Concepts of Units and Conversion

Introduction: Dimensions and System of Units, Fundamental and derived units, Mole Concept, Concept of mole. Expressions for composition of mixtures of solids, liquids and gases, percentage by weight, mole and volume. Composition of mixtures and solutions.

Unit – II — **09 Hrs**

Material balance for various Separation Processes

Material balance without reaction: Distillation, Extraction, crystallization, evaporation, drying. Continuous filtration, batch mixing, Continuous fermentation. Simple numerical examples.

Unit –III — **09 Hrs**

Material balance for various Bioprocesses

Material balance Involving Chemical reactions: Principles of Stoichiometry, Concept of limiting and excess reactants; fractional conversion, percentage of conversion, percentage yield. Material balance involving reactions with reference to ethanol production.

Unit –IV — **09 Hrs**

Material balance for Recycle, Bypass and Purging Operation

Recycle by-pass and Purge: Material balances with and without reactions involving recycle; by-pass; and purge streams, Uses of recycle and purge streams, Problems involving recycle and purge streams. Simple numerical examples.

Unit –V — **09 Hrs**

Stoichiometry for Microbial Process

Microbial stoichiometry – Stoichiometry of microbial growth and product formation, Growth Stoichiometry and electron balances, Biomass yield, Product stoichiometry, Theoretical Oxygen demand, Oxygen consumption in aerobic microbial cultures, Maximum possible yield in bioprocess.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the concept of dimension and unit conversion to check dimensional consistency of balanced equation and understand the specific terms used in process calculation.
CO2	Perform material balance problems without chemical reactions.
CO3	Develop material balance equations for biochemical processes with reactions.
CO4	Formulate growth medium based on stoichiometry and elemental balances.

Reference Books

1.	Bioprocess Engineering principles, Pauline M Doran., Second Edition, 2013, Academic press, Elsevier, UK, ISBN: 9780122208515
2.	Basic Principles and Calculations in Chemical Engineering, Himmelblau D.M., Sixth Edition, 2007, Prentice Hall of India, New Delhi, ISBN-81-203-1145-0
3.	Bioprocess Engineering Basic Concepts, Shuler M.L., and Kargi F., Second Edition, 2002, Prentice Hall of India, New Delhi, ISBN-0130819085
4.	Stoichiometry, Bhatt B. I., Vora S. M., Fourth Edition,2004, Tata McGraw Hill Publishing Ltd., New Delhi , ISBN 0-07-462039-8

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20)ADDING UPTO 40 MARKS**.	**40**
	MAXIMUM MARKS FOR THE CIE THEORY	**100**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	20
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1: (Compulsory)	16
3 & 4	Unit 2: Question 3 or 4	16
5 & 6	Unit 3: Question 5 or 6	16
7 & 8	Unit 4: Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

Semester: IV						
NATIONAL SERVICE SCHEME(NSS) **(Practical)**						
Course Code	**:**	**HS247LA**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**

Prerequisites:

1. Students should have service-oriented mindset and social concern.
2. Students should have dedication to work at any remote place, any time with available resources and proper time management for the other works.
3. Students should be ready to sacrifice some of the timely will and wishes to achieve service-oriented targets on time.

Content	**13 Hrs**

Students must take up any one activity on below mentioned topics and must prepare contents for awareness and technical contents for implementation of the projects and has to present strategies for implementation of the same. Compulsorily must attend one camp.

CIE will be evaluated based on their presentation, approach, and implementation strategies. (Any one of the below mentioned activity)

1. Helping local schools to achieve good result and enhance their enrolment in Higher/technical/ vocational education.
2. Preparing an actionable business proposal for enhancing the village/ farmer income and approach for implementation.
3. Developing Sustainable Water management system for rural/ urban areas and implementation approaches.
4. Setting of the information imparting club for women leading to contribution in social and economic issues.
5. Spreading public awareness/ government schemes under rural outreach program. (Minimum 5 programs)
6. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc...
7. Social connect and responsibilities
8. Plantation and adoption of plants. Know your plants
9. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing
10. Waste management – Public, Private and Govt organization, 5 R's
11. Water conservation techniques – Role of different stakeholders - Implementation
12. Govt. School Rejuvenation and assistance to achieve good infrastructure.
13. Organize National integration and social harmony events/ workshops / seminars. (Minimum 2 programs) and ONE NSS-CAMP.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the importance of his/her responsibilities towards society.
CO2	Analyze the environmental and societal problems/ issues and will be able to design solutions for thesame.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainabledevelopment.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
NATIONAL CADET CORPS(NCC) (Practical)						
Course Code	**:**	**HS247LB**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**15P**		**SEE Duration**	**:**	**02 Hrs**

Unit-I	**07 Hrs**
Drill: Foot Drill- Drill ki Aam Hidayaten, Word ki Command, Savdhan, Vishram, Aram Se, Murdna, KadvarSizing, Teen Line Banana, Khuli Line, Nikat Line, Khade Khade Salute Karna	
Unit – II	**03 Hrs**
Weapon Training (WT): Introduction & Characteristics of 7.62 Self Loading rifle, Identification of rifle parts	
Unit –III	**03 Hrs**
Adventure activities: Trekking and obstacle course	
Unit –IV	**02 Hrs**
Social Service and Community Development (SSCD): Students will participate in various activities throughoutthe semester e.g., Blood donation Camp, Swachhata Abhiyan, Constitution Day, All National Festival	

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand that drill as the foundation for discipline and to command a group for common goal.
CO2	Understand the importance of a weapon its detailed safety precautions necessary for prevention of accidents and identifying the parts of weapon.
CO3	Understand that trekking will connect human with nature and cross the obstacles to experience army way of life.
CO4	Understand the various social issues and their impact on social life, Develop the sense of self-less social service for better social & community life.

Reference Books	
1.	NCC Cadet Hand Book by R K Gupta, Ramesh Publishing House, New Delhi, Book code:R- 1991, ISBN: 978-93-87918-57-3, HSN Code: 49011010
2.	nccindia.ac.in

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
PHYSICAL EDUCATION (SPORTS & ATHLETICS) (Practical)						
Course Code	**:**	**HS247LC**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**2.5 Hrs**
Content						**30 Hrs**

Topics for Viva:

1. On rules and regulations pertaining to the games / sports
2. On dimensions of the court, size / weight of the ball and standards pertaining to that sports / game
3. Popular players and legends at state level / National level/ International level
4. Recent events happened and winner / runners in that sport / game
5. General awareness about sport / game, sports happenings in the college campus

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the basic principles and practices of Physical Education and Sports.
CO2	Instruct the Physical Activities and Sports practices for Healthy Living.
CO3	To develop professionalism among students to conduct, organize & Officiate Physical Education andSports events at schools and community level.

Reference Books	
1.	Health, Exercise and Fitness, Muller, J. P. (2000), Delhi: Sports.
2.	Play Field Manual, Anaika ,2005, Friends Publication New Delhi.
3.	IAAF Manual.
4.	Track and Field Marking and Athletics Officiating Manual, M.J Vishwanath,2002, Silver Star Publication, Shimoga.
5.	Steve Oldenburg (2015) Complete Conditioning for Volleyball, Human Kinestics.
Note: Skills of Sports and Games (Game Specific books) may be referred	

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
MUSIC (Practical)						
Course Code	**:**	**HS247LD**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**
Content						**13 Hrs**

1. Introduction to different genres of music
2. Evolution of genres in India: Inspiration from the world
3. Ragas, time and their moods in Indian Classical Music
4. Identification of ragas and application into contemporary songs
5. Adding your touch to a composition
6. Maths and Music: A demonstration
7. Harmonies in music
8. Chords: Basics and application into any song
9. Music Production-I
10. Music Production-II

Students have to form groups of 2-4 and present a musical performance/ a musical task which shall be given by the experts. The experts shall judge the groups and award marks for the same.

CIE will be evaluated based on their presentation, approach, and implementation strategies. Students need to submit their certificates of any event they participated or bagged prizes in. This shall also be considered for CIE evaluation.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand basics of Music and improve their skills.
CO2	Appreciate the impacts on health and well-being.
CO3	Perform and present music in a presentable manner.
CO4	Develop skills like team building and collaboration.

Reference Books	
1.	Music Cognition: The Basics by Henkjan Honing.
2.	Basic Rudiments Answer Book - Ultimate Music Theory: Basic Music Theory Answer Book by Glory St Germain.
3.	Elements Of Hindustani Classical Music by Shruti Jauhari.
4.	Music in North India: Experiencing Music, Expressing Culture (Global Music Series) by George E. Ruckert.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	

Sector wise study & consolidation	**10**	Implementation strategies of the project with report
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
DANCE (Practical)						
Course Code	**:**	**HS247LE**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**13 Hrs**

1. Introduction to Dance
2. Preparing the body for dancing by learning different ways to warm up.
3. Basics of different dance forms i.e., classical, eastern, and western.
4. Assessing the interest of students and dividing them into different styles based on interaction.
5. Advancing more into the styles of interest.
6. Understanding of music i.e., beats, rhythm, and other components.
7. Expert sessions in the respective dance forms.
8. Activities such as cypher, showcase to gauge learning.
9. Components of performance through demonstration.
10. Introduction to choreographies and routines.
11. Learning to choreograph.
12. Choreograph and perform either solo or in groups.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand the fundamentals of dancing.
CO2	Adapt to impromptu dancing.
CO3	Ability to pick choreography and understand musicality.
CO4	To be able to do choreographies and perform in front of a live audience.

Reference Books	
1.	Dance Composition: A practical guide to creative success in dance making, Jacqueline M. Smith

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
THEATER (LIGHT CAMERA & ACTION) **(Practical)**						
Course Code	**:**	**HS247LF**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**13 Hrs**

1. Break the ICE
2. Introduction to freedom Talk to each and every single person for a period of 5 complete minutes. Thisis aimed at to make everyone in the room comfortable with each other. This helps everyone get over socialanxiety, Shyness and Nervousness.
3. Ura
4. Rhythm Voice Projection, Voice Modulation, Weeping & Coughing Voice projection is the strength of speaking or singing whereby the voice is used powerfully and clearly. It is a technique employed to command respect and attention, as when a teacher talks to a class, or simply to be heard clearly, as used by an actor in a theatre.
5. It's Leviosa, Not Leviosaaa!
6. Speech work: Diction, Intonation, Emphasis, Pauses, Pitch and Volume Tempo Dialogues delivery. The art of dialogue delivery plays a vital role in in ensuring the efficacy of communication especially from thedramatic aspect of it, this unit discusses some tips to help the young actors improve their dialogue deliveryskills:
7. Elementary, My dear Watson.
8. Responsibilities of an actor tools of an actor character analysis Observations aspects, Stage presence, concentration, conviction, confidence, energy and directionality.
9. Show time
10. Pick a genre: COMEDY, THRILLER, HORROR, and TRAGEDY: Showcase a performance. Stylized acting with reference to historical and mythological plays. Mime: conventional, occupational and pantomime Mono acting: different types of characters

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Develop a range of Theatrical Skills and apply them to create a performance.
CO2	Work collaboratively to generate, develop, and communicate ideas.
CO3	Develop as creative, effective, independent, and reflective students who are able to make informed choices in process and performance.
CO4	Develop an awareness and understanding of the roles and processes undertaken in contemporary professional theatre practice.

Reference Books	
1.	The Empty Space by Peter Brook.
2.	The Viewpoints Book: A Practical Guide to Viewpoints and Composition by Anne Bogart and Tina Landau.

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****

Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: III						
ART WORK & PAINTING (Practical)						
Course Code	**:**	**HS247LG**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**

Contents — **13 Hrs**

1. Use points, line and curves to create various shapes and forms
2. Use of shapes and forms to create various objects and structures
3. Recognizing distinctions in objects when viewed from various perspectives and grasping basic notions of perspective
4. Students will be introduced to the significance of color in art, as well as the principles of color theory and application.
5. Applied the concepts of unity, harmony, balance, rhythm, emphasis and proportion, abstraction and stylizationto create a composition.
6. Learn how to use which materials and for what types of art and textures.
7. Use of the above concepts to create art through the medium of collage, mosaic, painting, mural, batik, tie and dye.
8. Real world application of the above concepts in the form of book cover design and illustration, cartoon, poster, advertisements, magazine, computer graphics and animation
9. Familiarization with the many art forms and techniques of expression found throughout India.

AND

ONE EDUCATIONAL VISIT TO AN ART MUSEUM / INSTITUTE / GALLERY

Students must turn in assignments for each of the above said topics on a weekly basis and have to compulsorilytake part in the museum visit. CIE will be evaluated based on a still life piece, a composition using any one of the media of composition and a presentation on Indian art styles and creation of a piece pertaining to the presentedart style.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Use lines, shapes, and colors to depict the various sentiments and moods of life and nature.
CO2	Use one's creativity to develop forms and color schemes, as well as the ability to portray them effectively in drawing and painting on paper.
CO3	Develop the ability to properly use drawing and painting materials (surfaces, tools and equipment, and so on).
CO4	Improve their observation abilities by studying everyday items as well as numerous geometrical and non-geometrical (i.e., organic) shapes found in life and nature and to hone their drawing and painting talents in response to these insights.

Reference Books	
1.	Catching the Big Fish: Meditation, Consciousness, and Creativity, David Lynch
2.	Art & Fear: Observations on the Perils (and Rewards) of Artmaking, David Bayles & Ted Orland

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****

EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the projectwith report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

Semester: IV						
PHOTOGRAPHY & FILM MAKING (Practical)						
Course Code	**:**	**HS247LH**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**13P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**13 Hrs**

1. Introduction to photography.
2. Understanding the terminologies of DSLR.
3. Elements of photography.
4. Introduction to script writing, storyboarding.
5. Understanding the visualization and designing a set.
6. Basics of film acting
7. Video editing using software
8. Introduction to cinematography.
9. Understanding about lighting and camera angles.
10. Shooting a short film.

Students must form groups of 2-4 and present a short film which shall be given by the experts. The experts shall judge the groups and award marks for the same.

CIE will be evaluated based on their presentation, approach and implementation strategies. Students need tosubmit their certificates of any event they participated or bagged prizes in. This shall also be considered for CIE evaluation.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	Understand basics of photography and videography and improve their skills.
CO2	Appreciate the skills acquired from photography.
CO3	Perform and present photos and films in a presentable manner.
CO4	Develop skills like team building and collaboration.

Reference Books	
1.	Read This If You Want to Take Great Photographs – Henry Carroll
2.	The Digital Photography Book: Part 1 – Scott Kelby

ASSESSMENT AND EVALUATION PATTERN		
WEIGHTAGE	**50%**	**50%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour with surveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementation methodologies.	**10**	*****
Case Study-based Teaching-Learning	**10**	Implementation strategies of the project with report
Sector wise study & consolidation	**10**	
Video based seminar (4-5 minutes per student)	**10**	
TOTAL MARKS FOR THE COURSE	**50 MARKS**	**50 MARKS**

SEMESTER: IV

UNIVERSAL HUMAN VALUES
Category: Common to all Programs
Stream: Theory

Course Code	**:**	**HS248AT**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**28L**		**SEE Duration**	**:**	**02 Hrs**

Unit-I — **10 Hrs**

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:
Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration 'Natural Acceptance' and Experiential Validation Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facility, Understanding Happiness and Prosperity correctly.
Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility.

Understanding Harmony in the Human Being - Harmony in Myself!:
Understanding human being as a co- existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' Understanding the Body as an instrument of Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health;

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Unit – II — **10 Hrs**

Understanding Harmony in the Family and Society- Harmony in Human Relationship:
Understanding valuesin human-human relationship; meaning of Justice and program for its fulfilment to ensure mutual happiness; Trustand Respect as the foundational values of relationship, Understanding the meaning of Trust.
Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.
Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Unit –III — **08 Hrs**

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence:
Understanding the harmony in the Nature, Interconnectedness, and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all pervasive space, Holistic perception of harmony at all levels of existence.
Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Course Outcomes: After completing the course, the students will be able to: -	
CO1	By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions,
CO2	While keeping human relationships and human nature in mind. They would have better critical ability.
CO3	They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO4	It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Reference Books	
1.	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004
3.	The Story of Stuff (Book).
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher.
6.	Slow is Beautiful - Cecile Andrews.

RUBRICS FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 5 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**10**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 25 Marks, adding up to 50 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 20 MARKS.**	**20**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (10) & Phase II (10) ADDING UPTO 20 MARKS**.	**20**
MAXIMUM MARKS FOR THE CIE THEORY		**50**

RUBRICS FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	**10**
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1: (Compulsory)	**12**
3 & 4	Unit 2: Question 3 or 4	**14**
5 & 6	Unit 3: Question 5 or 6	**14**
	TOTAL	**50**

Semester: IV						
Bridge Course: MATHEMATICS (Mandatory Audit Course) (Common to ALL Branches)						
Course Code	**:**	MA149AT		**CIE**	**:**	50 Marks
Credits: L: T: P	**:**	2:0:0		**SEE**	**:**	**NO SEE** (AUDIT COURSE)
Total Hours	**:**	30L				

Unit-I	**10 Hrs**

Multivariable Calculus:

Partial Differentiation: Introduction, simple problems. Total derivative, composite functions. Jacobians – simple problems.

Vector Differentiation: Introduction, velocity and acceleration, gradient, divergence – solenoidal vector function, curl – irrotational vector function and Laplacian, simple problems.

Unit – II	**10 Hrs**

Differential Equations:

Higher order linear differential equations with constant coefficients, solution of homogeneous equations - Complementary functions. Non-homogeneous equations – Inverse differential operator method of finding particular integral based on input function (force function).

Unit –III	**10 Hrs**

Numerical Methods:

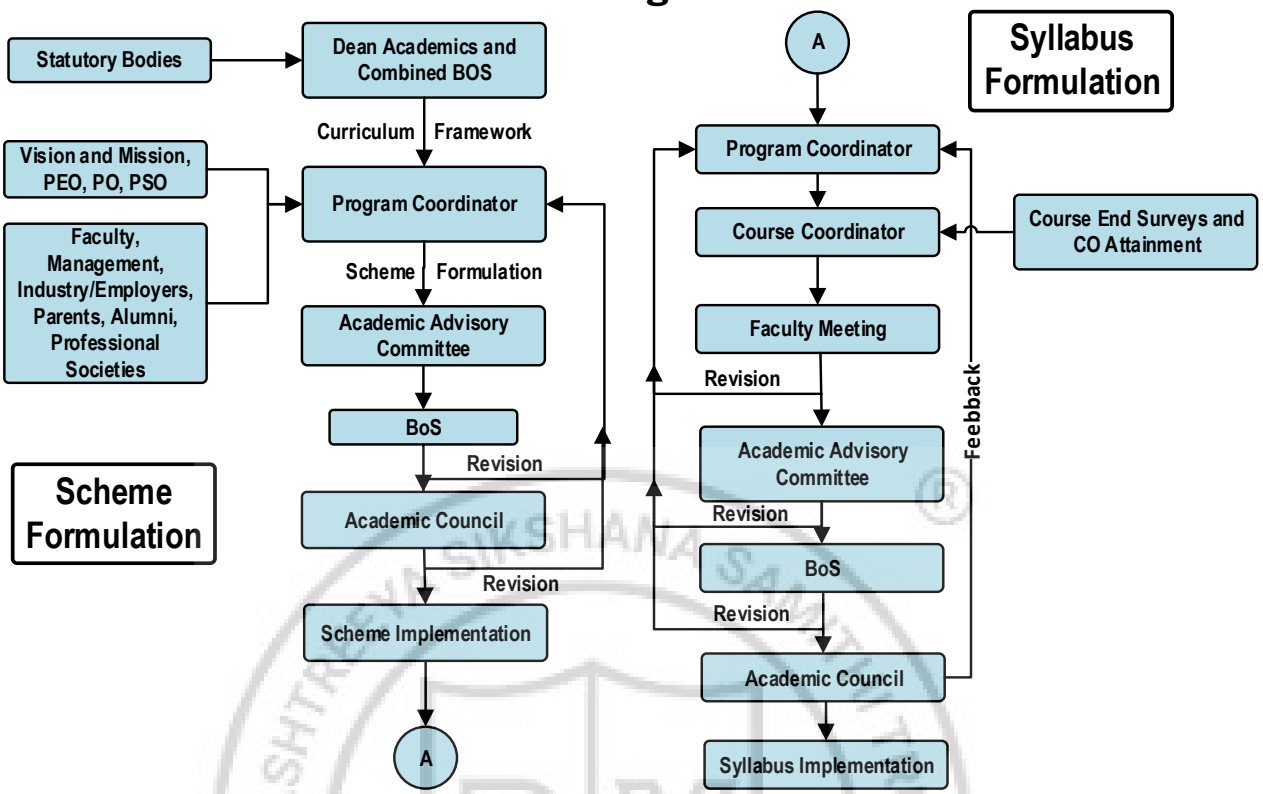
Solution of algebraic and transcendental equations – Intermediate value property, Newton-Raphson method. Solution of first order ordinary differential equations – Taylor series and 4^{th} order Runge-Kutta methods. Numerical integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules. (All methods without proof)**.**

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of partial differentiation, vector differentiation, higher order linear differential equations and numerical methods.
CO2:	Derive the solution by applying the acquired knowledge of differential calculus, differential equations, velocity, and acceleration vectors to the problems of engineering applications.
CO3:	Evaluate the solution of the problems using appropriate techniques of differential calculus, vector differentiation, differential equations, and numerical methods.
CO4:	Compile the overall knowledge of differential calculus, vector differentiation, differential equations and numerical methods gained to engage in life – long learning.

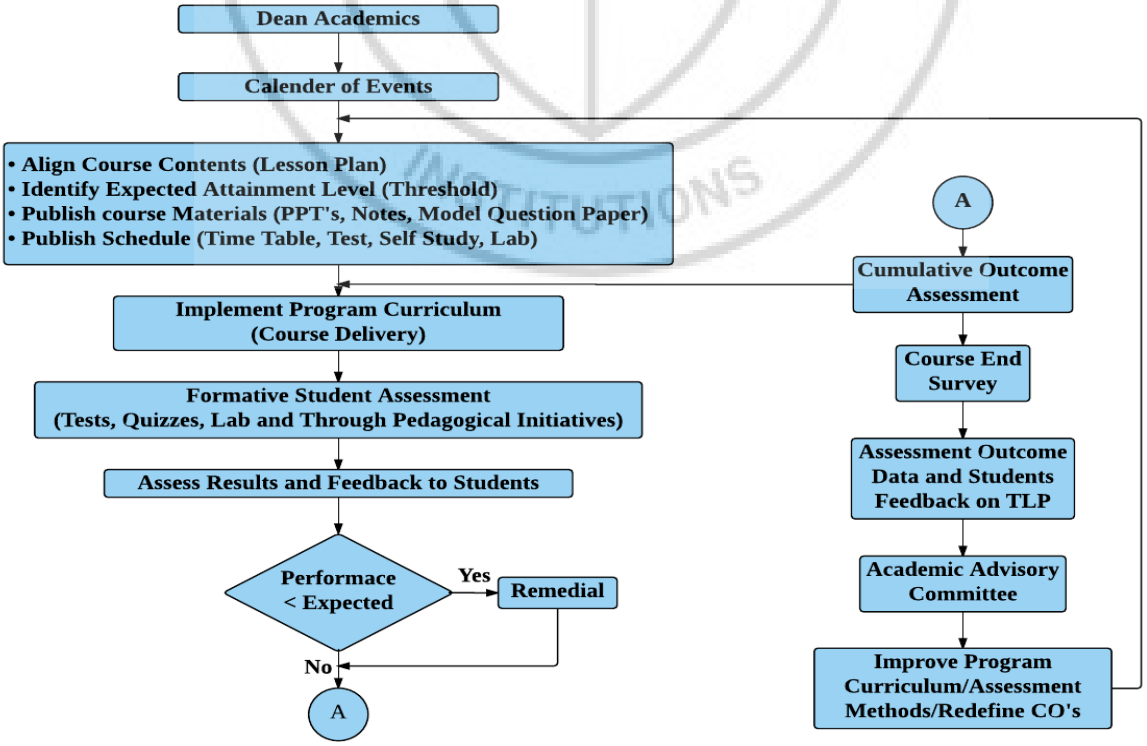
Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44^{th} Edition, 2015, Khanna Publishers, ISBN: 978-81-933284-9-1.
2	Higher Engineering Mathematics, B.V. Ramana, 11^{th} Edition, 2010, Tata McGraw-Hill, ISBN: 978-0-07-063419-0.
3	A Textbook of Engineering Mathematics, N.P. Bali & Manish Goyal, 7^{th} Edition, 2010, Lakshmi Publications, ISBN: 978-81-31808320.
4	Advanced Engineering Mathematics, E. Kreyszig, 10^{th} Edition (Reprint), 2016. John Wiley & Sons, ISBN: 978-0470458365.

RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.**	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO TESTS will be conducted. Each test will be evaluated for 30 Marks, adding upto 60 Marks. **FINAL TEST MARKS WILL BE AVERAGE OF TWO TESTS.**	**30**
	MAXIMUM MARKS FOR THE CIE THEORY	**50**

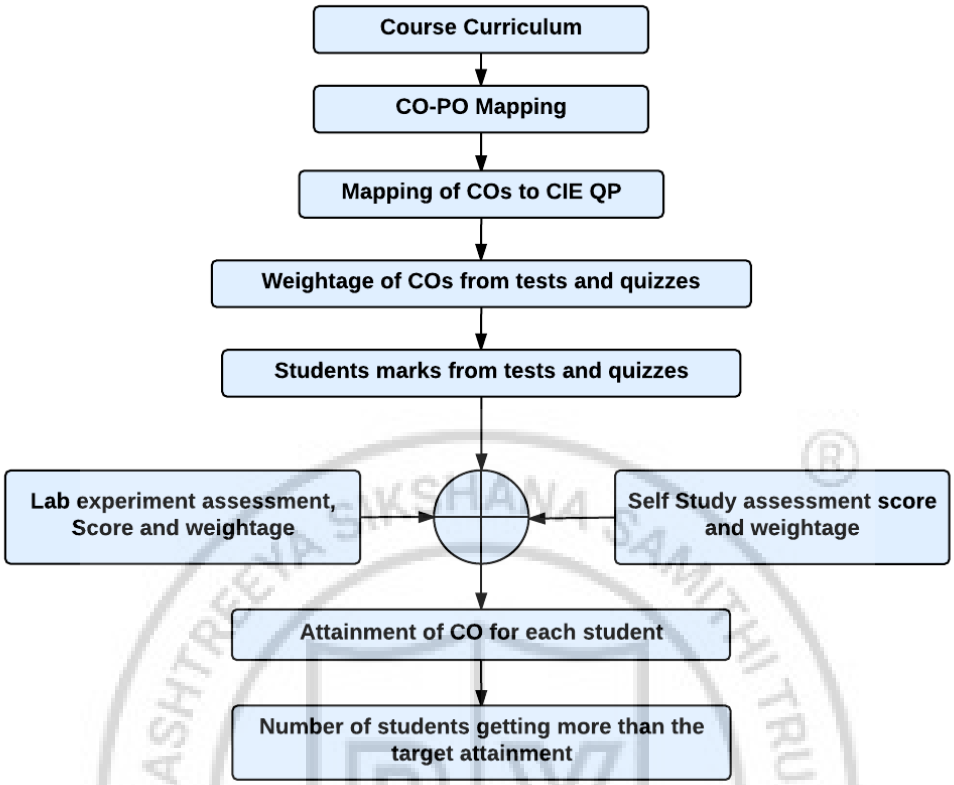
Curriculum Design Process



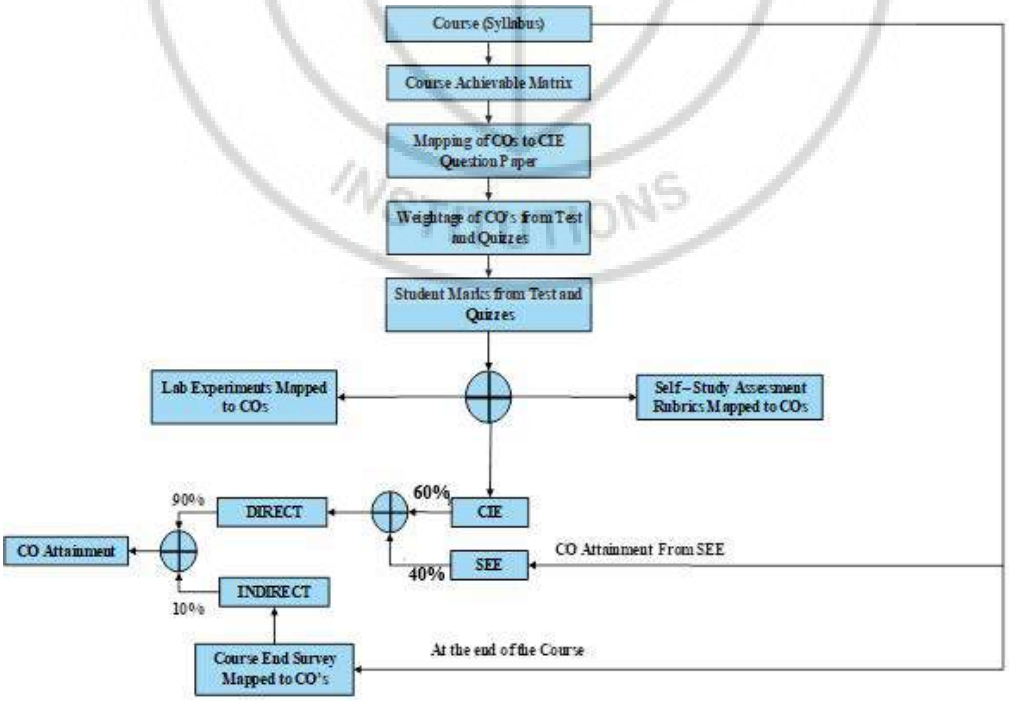
Academic Planning and Implementation



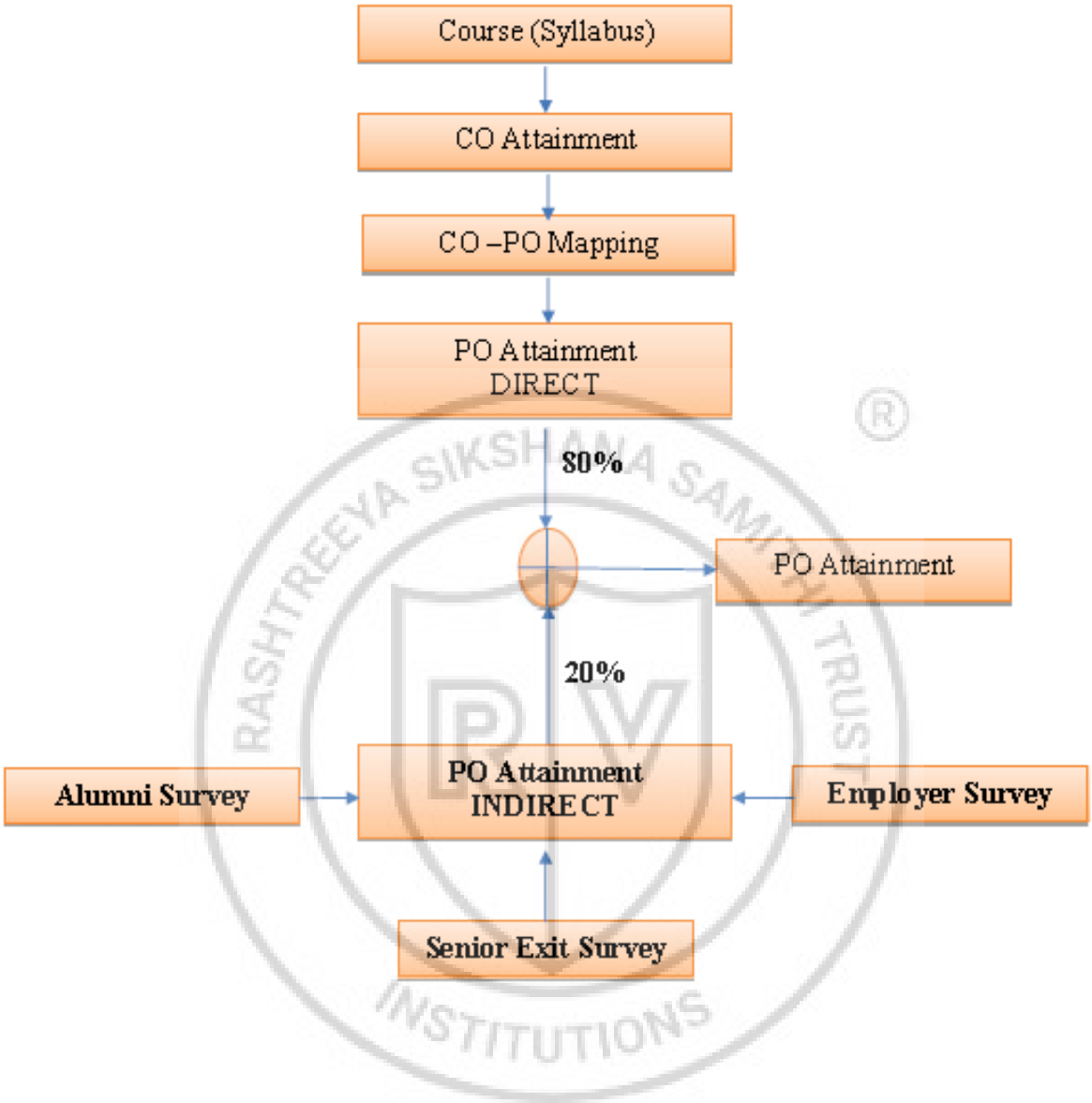
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



KNOWLEDGE & ATTITUDE PROFILE

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

INNOVATIVE TEAMS OF RVCE

Ashwa Mobility Foundation (AMF): Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

Astra Robotics Team: Focuses on designing and building application-specific robots.

Coding Club: Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

Entrepreneurship Development Cell (E-Cell): Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

Frequency Club Team: Works on software and hardware, emphasizing AI and Machine Learning.

Team Garuda: Develops a supermileage urban concept electric car and E-mobility products.

Team Jatayu: Builds low-cost UAVs with autonomous capabilities for various tasks.

Solar Car Team: Aims to create a solar electric vehicle for sustainable transportation.

Team Antariksh: Focuses on space technology and the development of operational rockets.

Team Chimera: Builds a Formula Electric Car through R&D in E-Mobility.

Helios Racing Team: Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

Team Hydra: Develops autonomous underwater vehicles for tasks like water purification.

Team Krushi: Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

Team Vyoma: Designs and tests radio-controlled aircraft and UAVs.

Team Dhruva: Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

Ham Club: Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

- To deliver outcome based Quality education, emphasizing on experientiallearning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation