RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Go, change the world

SCHEME & SYLLABUS
SECOND YEAR B.E. PROGRAMS

CHEMICAL ENGINEERING

BACHELOR OF ENGINEERING (B.E.)
2022 SCHEME

ACADEMIC YEAR 2023-24

CHEMICAL ENGINEERING

DEPARTMENT VISION

Imparting quality technical education in Chemical Engineering to promote leadership in research, innovation and sustainable technology through teamwork.

DEPARTMENT MISSION

- Impart quality education in basic and applied areas of Chemical Engineering.
- Enable students and faculty to achieve proficiency in the areas of Chemical Processes, Energy, Unit Operations and Computational Chemical Engineering using state-of-art laboratories and modern infrastructure.
- Encourage faculty and students to make career in research and contribute towards innovative processes and products.
- Develop inclusive technologies with a focus on new materials and sustainability.
- Collaborate with industries and research Institutes for academics and research.
- Inculcate leadership qualities, entrepreneurial skills, societal and ethical values in students and faculty.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Exhibit knowledge of basic sciences, concepts and principles of Chemical Engineering.

PEO 2: Comprehend, analyze, design and implement engineering systems with a focus on research,innovation and sustainability.

PEO 3: Work in multidisciplinary team and cater to the needs of process industries with appropriate safety, health and environmental regulations.

PEO 4: Demonstrate effective communication skills, leadership qualities and develop into successfulentrepreneurs.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Gain knowledge of Chemical Engineering fundamentals and demonstrate problem formulation capabilities
PSO2	Analyze and solve engineering problems with a focus on environment and sustainability
PSO3	Contribute to multidisciplinary research using relevant Chemical Engineering tools

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.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	AEC	Ability Enhancement Courses

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Bachelor of Engineering in CHEMICAL ENGINEERING

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	MAT231BT	Statistics, Laplace Transform and Numerical Methods	3	1	0	**4**	MAT	Theory	100	****	**3**	100	****
2	XX232AT	Basket Courses - Group A	3	0	0	**3**	BT/CV/ME	Theory	100	****	**3**	100	****
3	CH233AI	Momentum Transfer	3	0	1	**4**	CH	Theory+Lab	100	50	**3**	100	50
4	CH234AI	Particulate Technology	3	0	1	**4**	CH	Theory+Lab	100	50	**3**	100	50
5	CH235AT	Chemical Process Calculations	3	1	0	**4**	CH	Theory	100	****	**3**	100	****
6	HS237XL	Ability Enhancement Courses - Group C	0	0	2	**2**	HS	Lab	****	50	**2**	****	50
7	CS139DT*	Bridge Course: C Programming	2(A)	0	0	**AUDIT**	CS	Theory	50	****	****	****	****
		Total				**21**							
Note:													
*	Bridge course is for Diploma students. Only CIE and no SEE.												

MATHEMATICS COURSES			
Sl.No	**Course Code**	**Course Title**	**Common to the Programs**
1	MAT231AT	Linear algebra, fourier transforms and statistics	EC, EE, EI, ET
2	MAT231BT	Statistics, laplace transform and numerical methods	AS, BT, CH, IM, ME
3	MAT231CT	Linear algebra and probability theory	CD, CS, CY, IS
4	MAT231DT	Applied mathematics for civil engineering	CV
5	MAT231ET	Mathematics for artificial intelligence & machine learning	AI & ML
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)			
Sl.No	**Course code**	**Course Title**	**BoS**
1	CV232AT	Environment & Sustainability	CV
2	ME232AT	Material Science for Engineers	ME
3	BT232AT	Bio Safety Standards and Ethics	BT
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.	**Course Code**	**Course Title**	**BoS**
1	HS247AL	National Service Scheme	HS
2	HS247BL	National Cadet Corps	HS
3	HS247CL	Physical Education: Sports & Athletics	HS
4	HS247DL	Music	HS
5	HS247EL	Dance	HS
6	HS247FL	Theater (Light Camera & Action)	HS
7	HS247GL	Art Work & Painting	HS
8	HS247HL	Photography & Film Making	HS

Bachelor of Engineering in CHEMICAL ENGINEERING

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	MAT241T	Probability Theory and Linear Programming (AS, CH, CV, EE, EI, ET & ME)	3	0	0	**100**	MAT	Theory	**100**	****	**3**	**100**	****
2	XX232AT	Basket Courses - Group A	3	0	0	**100**	BT/CV/ME	Theory	**100**	****	**3**	**100**	****
3	CH343AI	Process Heat Transfer	3	0	1	**100**	CH	Theory + Lab	**100**	**50**	**3**	100	50
4	CH344AI	Chemical Reaction Engineering	3	0	1	**100**	CH	Theory + Lab	**100**	**50**	**3**	100	50
5	CH345AT	Chemical Engineering Thermodynamics	3	0	0	**100**	CH	Theory	**100**	****	**3**	100	****
6	CH246XT	Professional Elective Courses - Group B	2	0	0	**50**	HSS	NPTEL	**50**	****	**3**	**50**	****
7	CH247DL	Design Thinking Lab	0	0	2	****	CH	LAB	****	**50**	**2**	****	50
8	HS248AT	Universal Human Values	2	0	0	**2**	HSS	Theory	**50**	****	**2**	50	****
9	MAT149DT*	Bridge Course: Mathematics	2 (A)	0	0	**AUDIT**	MAT	Theory	**50**	****	**2**	****	****
		Total				**23**							

*Bridge course is for Diploma students. Only CIE and no SEE.

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)			
Sl.No	**Course code**	**Course Title**	**BoS**
1	CV232AT	Environment & Sustainability	CV
2	ME232AT	Material Science for Engineers	ME
3	BT232AT	Bio Safety Standards and Ethics	BT

Group B: NPTEL COURSES (Professional Elective Courses) (NPTEL courses are subject to change based on the availability of the course on the NPTEL Platform)		
Sl. No.	**Course Code**	**Course Title**
1.	CH246AT	Technologies For Clean and Renewable Energy Production
2.	CH246BT	Colloids and Surfaces
3.	CH246CT	Natural Gas Engineering
4.	CH246DT	Application of Spectroscopic Methods in Molecular Structure Determination
5.	CH246ET	Introduction to Polymer Science

Semester: III						
STATISTICS, LAPLACE TRANSFORM AND NUMERICAL METHODS (Theory) (AS, BT, CH, IM, ME)						
Course Code	:	MAT231BT		**CIE**	:	**100 Marks**
Credits: L: T: P	:	3:1:0		**SEE**	:	**100 Marks**
Total Hours	:	45L+30T		**SEE Duration**	:	**3 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). **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						
ENVIRONMENT & SUSTAINABILITY **Category: Professional Core** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	**CV232AT / CV242AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	42L		**SEE Duration**	**:**	**3.0 Hours**

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 Pollution. Solid, Hazardous and E-Waste management. Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.	
Unit – II	**09Hrs**
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	**09 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 **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.	
Unit –IV	**09 Hrs**
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. 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 –V	**08 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:	
CO1	Understand the basic elements of Environment and its Biodiversity.
CO2	Explain the various types of pollution and requirement for sustainable strategy for present scenario.
CO3	Evaluate the different concepts of sustainability and its significance for welfare of all life forms.
CO4	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**
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**
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**
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						
MATERIALS SCIENCE FOR ENGINEERS **Category: Professional Core** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	ME232AT/ ME242AT		**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 behaviour 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: fibre-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. Characterisation 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	Analyse 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 **Category: Professional Core** **(Common to all Programs)** **(Theory)**						
Course Code	**:**	**BT232AT/BT242AT**		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**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 on 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 Licenses 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: III						
MOMENTUM TRANSFER **Category: Professional Core** **(Theory and Practice)**						
Course Code	**:**	**CH233AI**		**CIE Marks**	**:**	**100 +50**
Credits: L:T:P	**:**	**3:0:1**		**SEE Marks**	**:**	**100 +50**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Fluid Statics and Applications Variation of pressure with height –hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers. Continuous gravity decanter **Fluid Flow Phenomena** Types of fluids –Newtonian and non – Newtonian fluids, Types of flow – laminar and turbulent flow. Reynolds number, Boundary layer separation and wake formation	
Unit – II	**09 Hrs**
Basic Equations of Fluid Flow Continuity equation, Bernoulli equations, Modified equations for real fluids with correction factors. **Flow of Incompressible Fluids in Conduits** Laminar flow through circular pipes, Darcy's law, Hagen Poiseuille equation. Friction factor charts, Calculation Pump work using Bernoulli equation	
Unit –III	**09Hrs**
Flow of Fluids Past Immersed Bodies Pressure drop studies in packed bed –Ergun, Kozeny-Carman and Blake-Plummer Equations, Fluidization, Types of fluidization, Minimum fluidization velocity, Applications of fluidization.	
Unit –IV	**09 Hrs**
Transportation and Metering of Fluids Measurement of flow rates by Pitot tube, Orifice meter, Venturi meter and Rota meter. Flow through open channels–weirs and notches. Performance characteristics of pumps–positive displacement and centrifugal pumps	
Unit –V	**09 Hrs**
Dimensional Analysis Dimensional homogeneity, Rayleigh's and Buckingham π– methods. Significance of dimensionless numbers. **Flow of Compressible Fluids** Concept of Mach number, Basic equations of Compressible flow, Velocity of Sound for isothermal process and adiabatic process, Area-velocity relationship, Flow of Compressible fluid through orifices and nozzles	

LABORATORY EXPERIMENTS
1. Flow through circular pipes
2. Flow through helical coils
3. Flow measurement using Venturi meter
4. Flow measurement using Orifice meter
5. Flow over notches
6. Determination of Hydraulic coefficients
7. Flow through Packed bed
8. Flow through Fluidized bed
9. Performance study of centrifugal pump
10. Flow through pipe fittings
11. Flow through non circular pipes

Course Outcomes: After completing the course, the students will be able to	
CO1	Recall the concepts of fluid statics and dynamics.
CO2	Explain the fundamental equations of fluid flow.
CO3	Analyze the flow behavior in various geometries and packed columns
CO4	Apply fluid flow principles in flow measurement, transportation and energy losses.

Reference Books	
1	"Unit Operations of Chemical Engineering", McCabe and Smith W.L., 7th Edition, 2007, McGraw Hill, New York. ISBN 13: 9789339213237
2	"Chemical Engineering", Coulson J.M. and Richardson J.F., Vol.2, 5th Edition, 2003, Asian Books (P) Ltd., New Delhi. ISBN 10: 0080379575
3	"A Textbook of Fluid Mechanics and Hydraulic Machines", R K Bansal, Laxmi publication , New Delhi, ISBN:9788131808153
4	"Engineering Fluid Mechanics", Kumar K.I., 3rd Edition, 2009, Eurasia Publishing House (P) Ltd., New Delhi. ISBN 8121901006

RUBRICFOR 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. 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL CIE 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 of questions covering entire syllabus	20
	PART B (Maximum of THREE 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						
PARTICULATE TECHNOLOGY **Category: Professional Core** **(Theory and Practice)**						
Course Code	**:**	**CH234AI**		**CIE Marks**	**:**	**100 +50**
Credits: L:T:P	**:**	**3:0:1**		**SEE Marks**	**:**	**100 +50**
Total Hours	**:**	**45L + 30P**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Particle Technology: Particle shape and size, shape factor and sphericity. Standard screens, wire screens, screen efficiency, screen analysis and its types, Number of particles and specific surface of mixture of particles, Ideal and actual screens, Effectiveness of screen, Types of Screening equipment, Grizzlies, Trommels, Shaking Screens, Gyrating Screens, Vibrating Screens. Subsieve Analysis: ICI Sedimentation, Air Elutriation, Air permeability, Beaker decantation.	
Unit – II	**09 Hrs**
Size Reduction: Forces and criteria for communition, Laws of size reduction, Work Index. Methods of operating crushers – Free crushing, Choke feeding, Open circuit grinding, Closed circuit grinding, Wet and dry grinding. **Equipment for size reduction** – Blake jaw crusher, Gyratory crusher, Smooth roll crusher, angle of nip, Impactor, Attrition mill, Ball mill- Critical speed of ball mill	
Unit –III	**09 Hrs**
Motion of Particles through Fluids: Mechanics of particle motion, equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field. Terminal velocity, drag coefficient, Motion of spherical particles in Stoke's region, Newton's region and Intermediate region, Criterion for settling regime, Modification of equation for hindered settling, Batch Sedimentation, Dorr thickener.	
Unit –IV	**09 Hrs**
Filtration: Factors affecting rate of filtration, Classification of filtration, Constant rate, constant pressure, specific cake resistance, filter medium resistance, empirical equations for cake resistance, characteristics of filter media **Industrial filters:** Plate and Frame filter press, leaf filter, Rotary drum filter. Filter aids, Principles of cake filtration, Modification of Kozeny – Carman Equation for filtration.	
Unit –V	**09 Hrs**
Agitation and mixing: Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation. **Miscellaneous Separation:** Jigging, Froth floatation process, Additives used during flotation, Floatation cells, Typical floatation circuits. Size enlargement (only working principle of equipment) – Flocculation, Briquetting, Pelletization, Granulation	

Laboratory Component

1	Sieve analysis and Screen effectiveness studies
2	Particle Size Analysis using Air Elutriator
3	Particle Size Analysis using ICI sedimentation
4	Particle Size Analysis using Beaker decantation
5	Determination of Specific surface area using Air permeability set up
6	Verification of Laws of size reduction using Ball mill
7	Verification of Laws of size reduction using Jaw crusher
8	Verification of Laws of size reduction using Drop weight crusher
9	Design of Thickener
10	Separation of solids using Cyclone Separator

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the principles of size analysis, size reduction, particle motion, filtration, mixing and size enlargement.
CO2:	Choose appropriate methods and equipment for size reduction, particle size determination, conveying, separation and mixing of solids
CO3:	Evaluate particle size and performance of size reduction, conveying, separation and methods of handling of solids and settling velocity
CO4:	Develop equations for motion of particles through fluids and fluid flow past the particles.

Reference Books	
1	Warren McCabe, Julian Smith, Peter Harriott. Unit Operations of Chemical Engineering, 7th Edition, 2004, McGraw Hill Education, *ISBN*-13: 978-0072848236
2	Martin Rhodes, Introduction to particulate Technology, 2nd Edition, 2008, Wiley, ISBN- 13: 978-0470014271
3	Coulson and Richardson's Chemical Engineering Vol. 2, Richardson J.F, J. H. Harker with J. R. Buckhurst, 5th Edition, 2002, Butterworth-Heinemann, ISBN-978-0750644457
4	K. A Ghavane,Unit Operations I, Nirali Prakashan Publishers & Distributors, *ISBN* 13: 978-8123910994

RUBRICFOR 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. 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. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL CIE 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 of questions covering entire syllabus	20
	PART B (Maximum of THREE 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						
CHEMICAL PROCESS CALCULATIONS **Category: Professional Core** **(Theory)**						
Course Code	**:**	**CH235AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:1:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45 L+30T**		**SEE Duration**	**:**	**3Hours**

Unit-I	**08 Hrs**
Basic Chemical Calculations: Conversion of equations, composition of mixtures of solids, liquids and gases, percentage by weight, mole and volume. Normality, Molarity, Molality and ppm. Concentration scales based on specific gravity-Baume, Twaddle, Brix and API gravity scales	
Unit – II	**09 Hrs**
Vapor Pressure: Definition of vapor pressure, partial pressure, relative saturation, percentage saturation, humidity, molal humidity, relative humidity, percentage humidity Problems involving evaporation and condensation processes **Material balance without reaction:** Introduction to material balances, problems on mixing, distillation	
Unit –III	**10 Hrs**
Material balance without reaction (continued): Extraction, crystallization, evaporation, absorption and leaching. Material balances without reactions involving bypass, recycle and purging	
Unit –IV	**9 Hrs**
Mathematics of Material balance with Chemical reactions: Limiting and excess reactants, fractional and percentage conversion, yield and selectivity, numerical problems **Combustion and energy generation calculations**: Ultimate and proximate analyses of fuels, Orsat analysis, combustion problems	
Unit –V	**9 Hrs**
Calculations involving Energy Balance: General energy balance equation for steady state, heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Standard heat of formation, standard heat of reaction, standard heat of combustion. Calculation of ΔHR at elevated temperatures, adiabatic reaction temperature and adiabatic flame temperature	

Course Outcomes: After completing the course, the students will be able to	
CO 1	Understand the basic principles of unit operation and processes
CO 2	Apply the conservation principles to unit operations and processes to carry out material Balance
CO 3	Analyze the unit operations and processes to carry out energy balance
CO 4	Develop systematic problem formulation and problem-solving skills

Reference Books	
1.	Stoichiometry and Process Calculations, Narayanan K.V., and Lakshmikutty F., 2nd Edition, 2017, Prentice Hall India Pvt Ltd, New Delhi, ISBN- 9788120352896
2.	Elementary principles of Chemical Processes, Richard M.F, Ronald W. R, Lisa G. B 4th Edition, 2016, Wiley Publishers, ISBN- 9781118431221
3.	Stoichiometry, Bhatt B. I., Shuchen B Thakore., 5th Edition,2010, Tata McGraw Hill Publishing Ltd., New Delhi, ISBN 9780070681149 0070681147
4.	Basic Principles and Calculations in Chemical Engineering, Himmelblau D.M and Riggs J B.,8th Edition, 2012, Prentice Hall of India, New Delhi, ISBN-0-13-234660-5

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). **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						
NATIONAL SERVICE SCHEME (NSS) (Practical)						
Course Code	**:**	**HS237AL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**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 propertime 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	**30 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 belowmentioned activity)

1. Helping local schools to achieve good result and enhance their enrolment in Higher/technical/ vocationaleducation.
2. Preparing an actionable business proposal for enhancing the village/ farmer income and approach forimplementation.
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, SwachhBharat, 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 the same.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.

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	:	**HS237BL**		**CIE**	:	**50 Marks**
Credits: L:T:P	:	**0:0:1**		**SEE**	:	**50 Marks**
Total Hours	:	**30P**		**SEE Duration**	:	**02 Hrs**

Unit-I	**14 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	**06 Hrs**
Weapon Training (WT): Introduction & Characteristics of 7.62 Self Loading rifle, Identification of rifle parts	
Unit –III	**06 Hrs**
Adventure activities: Trekking and obstacle course	
Unit –IV	**04 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 ofaccidents 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 socialservice 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 withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**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	**:**	**HS237CL**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**00:00:01**		**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 and Sports 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%**	**0%**
	CIE	**SEE**
Presentation 1- Selection of topic- (phase 1) Justification for Importance, need of the hour withsurveyed data.	**10**	*****
EXPERIENTIAL LEARNING Presentation 2 (phase 2) Content development, strategies for implementationmethodologies.	**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: III						
MUSIC (Practical)						
Course Code	**:**	**HS237DL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hrs**
Content						**30 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 GlorySt 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**	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						
DANCE (Practical)						
Course Code	**:**	**HS237EL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**30 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	**:**	**HS237FL**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hrs**

Contents **30 Hrs**

1. Break the ICE
2. Introduction to freedom Talk to each and every single person for a period of 5 complete minutes. This is 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 informedchoices 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	**:**	**HS237GL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**30 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 ofperspective
4. Students will be introduced to the significance of color in art, as well as the principles of color theory andapplication.
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 anddye.
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 compulsorily take 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 effectivelyin drawing and painting on paper.
CO3	Develop the ability to properly use drawing and painting materials (surfaces, tools and equipment, and soon).
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 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						
PHOTOGRAPHY & FILM MAKING (Practical)						
Course Code	**:**	**HS237HL**		**CIE**	**:**	**50 Marks**
Credits: L: T: P	**:**	**0:0:1**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hrs**
Contents						**30 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: III						
BRIDGE COURSE: C PROGRAMMING (Common to all Programs)						
Course Code	**:**	**CS139DT**		**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.

CONTINUOUS INTERNAL EVALUATION		
ASSESSMENT AND EVALUATION PATTERN Theory & quizzes questions are to be framed using Bloom's Taxonomy Levels - Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating		
WEIGHTAGE	**CIE (50%)**	**SEE (50%)**
QUIZZES: Each quiz is evaluated for 10 marks		
Quiz-I for 10 Marks	Each quiz is evaluated for 10 marks adding up to 1**0 MARKS.**	*****
Quiz-I for 10 Marks		
TESTS: Each test will be conducted for 50 Marks adding upto 100 marks. Final test marks will be reduced to 40		
Test – I for 50 Marks	Each test will be conducted for 50 Marks adding upto 100 marks. Final test marks will be reduced to **30 MARKS**	*****
Test – II for 50 Marks		
EXPERIENTIAL LEARNING:	**10**	*****
MAXIMUM MARKS FOR THE THRORY (A+B+C)	**50**	*****
TOTAL MARKS FOR THE COURSE	**50**	*****

Semester: IV						
PROBABILITY THEORY AND LINEAR PROGRAMMING (AS, CH, CV, EE, EI, ET, ME) (Theory)						
Course Code	**:**	MAT241T		**CIE**	**:**	**100 Marks**
Credits: L: T:P	**:**	2:1:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	30L+26T		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**06 Hrs**
Random Variables: Random variables-discrete and continuous, probability mass function, probability density function, cumulative distribution function, mean and variance. Two or more random variables - Joint probability mass function, joint probability density function, conditional distribution and independence, Covariance and Correlation. Implementation using MATLAB.	
Unit – II	**06 Hrs**
Probability Distributions: Discrete distributions - Binomial, Poisson and Geometric. Continuous distributions – Exponential, Uniform, Normal and Weibull. Implementation using MATLAB.	
Unit –III	**06 Hrs**
Sampling Distributions and Estimation: Population and sample, Sampling distributions - Simple random sampling (with replacement and without replacement). Standard error, Sampling distributions of means (σ known), Sampling distributions of proportions, Sampling distribution of differences and sums. Estimation-point estimation, interval estimation. Implementation using MATLAB.	
Unit –IV	**06 Hrs**
Inferential Statistics: Principles of Statistical Inference, Test of hypothesis - Null and alternative hypothesis, Procedure for statistical testing, Type I and Type II errors, level of significance, Tests involving the normal distribution, one – tailed and two – tailed tests, P – value, Special tests for large and small samples (F, Chi – square, Z, t – test). Implementation using MATLAB.	
Unit –V	**06 Hrs**
Linear Programming: Mathematical formulation of linear programming problem. Solving linear programming problem using Graphical, Simplex and Big M methods. Implementation using MATLAB.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Illustrate the fundamental concepts of random variables, distributions, sampling, inferential statistics and optimization.
CO2:	Compute the solution by applying the acquired knowledge of random variables, distributions, sampling, inferential statistics and optimization to the problems of engineering applications.
CO3:	Evaluate the solution of the problems using appropriate probability and optimization techniques to the real-world problems arising in many practical situations.
CO4:	Interpret the overall knowledge of random variables, probability distributions, sampling theory, inferential statistics and optimization gained to engage in life – long learning.

Reference Books	
1	Probability & Statistics for Engineers & Scientists, Ronald E. Walpole & Raymond H. Myers, 9th Edition, 2016, Pearson Education, ISBN-13: 978-0134115856.
2	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, 2014, John Wiley & Sons, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3	Introduction to Probability and Statistics for Engineers and Scientists, Sheldon Ross, 5th Edition, 2014, Academic Press, ISBN: 13-978-0123948113.
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). **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: IV						
PROCESS HEAT TRANSFER **Category: Professional Core** **(Theory and Practice)**						
Course Code	**:**	**CH343AI**		**CIE Marks**	**:**	**100 + 50**
Credits: L:T:P	**:**	**3:0:1**		**SEE Marks**	**:**	**100 + 50**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
Introduction: Various modes of heat Transfer. Conduction, Convection and Radiation **Conduction:** Fourier's law, Steady state unidirectional heat flow through single and multiple layer slabs, cylinders & spheres **Insulation:** Properties of insulation materials. Critical and optimum thickness of insulation	
Unit – II	**09 Hrs**
Extended Surfaces: Fins- Types of fins-Derivation of fin efficiency for longitudinal fins **Convection:** Individual and Overall heat transfer coefficients- LMTD, LMTD correction factor. Dimensional analysis. Empirical correlations for forced and natural convection.	
Unit –III	**09 Hrs**
Heat Transfer with Phase Change: Boiling phenomenon, nucleate boiling and film boiling, Condensation-Film and drop wise condensation. Nusselt's equation application. **Heat Transfer Equipment:** Double pipe heat exchanger. Shell and tube heat exchangers, Condensers, Construction details.	
Unit –IV	**09 Hrs**
Evaporators: Classification of evaporators, Capacity, Economy, heat transfer area of evaporator, Methods of feeding, Vapor recompression evaporators	
Unit –V	**09 Hrs**
Radiation: Properties and definitions-Absorptivity-Reflectivity-Emissivity-Emissive power and intensity of radiation - Stefan-Boltzmann law, Weins displacement law, Kirchoff's law, Radiation between surfaces.	

LABORATORY EXPERIMENTS
1.Natural Convection in Bare Tube 2. Natural Convection in Tubes with Fins 3. Vertical Condenser 4. Horizontal Condenser. 5. Shell and Tube Condenser 6. Emissivity Determination 7. Packed Bed Heat Transfer 8. Double Pipe Heat Exchanger. 9. Heat Transfer in Jacketed Vessel 10. Transient Heat Conduction 11. Insulation Thickness 12. Heat Transfer in Fluidized Bed 13. Evaporator 14. Heat Transfer in jacketed vessel

Course Outcomes: After completing the course, the students will be able to	
CO1	Define and describe various modes of heat transfer
CO2	Evaluate the heat flux, thermal resistances and temperatures at various locations
CO3	Predict and estimate properties, heat transfer co-efficient of Heat Exchangers,
CO4	Design heat transfer equipment and components for various applications

Reference Books	
1	Unit Operations of Chemical Engineering, McCabe and Smith W.L., 7th Edition, 2007,McGraw Hill, New York, ISBN: 0072848235
2	Unit Operations of Chemical Engineering, Coulson J.M and Richardson J.F., Vol.1, 6th Edition, 2006, New Delhi, India, ISBN: 9780080131856
3	Process Heat Transfer, Kern D.Q., 7th Edition 2004, McGraw Hill, New York, ISBN: 0070341907
4	Heat Transfer, Rao Y.V.C., 1st Edition, 2010, Universities Press (India) Ltd., New Delhi, ISBN:9780072848236

RUBRICFOR 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. 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. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL CIE 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 of questions covering entire syllabus	20
	PART B (Maximum of THREE 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						
CHEMICAL REACTION ENGINEERING **Category: Professional Core** **(Theory and Practice)**						
Course Code	**:**	**CH344AI**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3 Hours**
Unit-I						**09 Hrs**
Introduction: classification of reactions, rate, order, molecularity. Single reactions: Integral method, differential method of analysis, constant volume, variable volume reactions, half-life, total pressure method. Temperature dependent term and kinetic modelling.						
Unit – II						**09 Hrs**
Reactor Design: Type of reactors, design of batch, plug flow and mixed flow ideal reactors both constant volume and variable volume reactions, space time, mean residence time.						
Unit –III						**09 Hrs**
Multiple reactor systems: Size comparison of reactors, analysis of different types of ideal reactors in series and parallel combination, design of combination of reactors, optimum combination of reactors.						
Unit –IV						**09 Hrs**
Multiple reactions: Kinetics of series, parallel, series-parallel combination and reversible reactions, design of ideal batch, plug flow and mixed flow reactors for series and parallel reactions.						
Unit –V						**09 Hrs**
Residence Time Distribution: Non-ideality and its causes, Residence Time Distribution studies, E and F curves, mean residence time, segregated model, tanks in series model, axial dispersion model.						

Laboratory Component

1	Batch Reactor-Equimolar
2	Plug Flow Reactor.
3	Mixed Flow Reactor
4	Residence Time Distribution in Packed Bed Reactor
5	Residence Time Distribution in Tubular vessel
6	Residence Time Distribution in Constantly Stirred Tank Reactor.
7	Semi Batch Reactor
8	Batch Reactor-Non-equimolar
9	Temperature effect on kinetics
10	Reactors in series
11	Fluidised Bed Reactor
12	Adiabatic Reactor

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals, terminology, and basic principles in reaction engineering
CO2:	Analyze batch, plug flow, and mixed flow reactors
CO3:	Interpret reactor data for kinetics and for reactor design
CO4:	Design ideal reactors for single and multiple reactions

Reference Books	
1	Chemical Reaction Engineering, Octave Levenspiel, 3rd Edition, 2004, ISBN 9780471254
2	Elements of Chemical Reaction Engineering, H.Scott Fogler, 5th Edition, 2016, ISBN 9780133887822
3	Chemical Engineering Kinetics, J M Smith, 3rd Edition, 1981, ISBN 9780070587106

RUBRICFOR 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. 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. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL CIE 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 of questions covering entire syllabus	20
	.PART B (Maximum of THREE 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						
CHEMICAL ENGINEERING THERMODYNAMICS **Category: Professional Core** **(Theory)**						
Course Code	**:**	**CH345AT**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**45L**		**SEE Duration**	**:**	**3Hours**

Unit-I	**09 Hrs**
First Law: Review of definitions, Cyclic process, Steady flow process. **Equations of State:** Ideal gas law, van der Waals equation of state. Work done in various processes. **The Second Law of Thermodynamics:** Statement, heat engines, heat pumps, mathematical statement for second law, Carnot cycle, Calculation of ideal work and lost work.	
Unit – II	**09 Hrs**
Fundamental Property relations: Maxwell's Relations, Relations for Internal energy, Enthalpy, Entropy and heart capacities, Gibb's free energy and generating function, Residual properties, Enthalpy and Entropy from Residual Properties. Two phase systems.	
Unit –III	**09 Hrs**
Framework of Solution Thermodynamics: Chemical Potential and equilibrium, Partial Properties, Gibbs-Duhem Equation, Ideal gas state mixture model, Gibbs theorem, fugacity and fugacity co- efficient of pure specie and species in solution, Determination of fugacity (pure species) and partial molar properties.	
Unit –IV	**09 Hrs**
Binary systems: Ideal solution model, Lewis-Randal Rule, Excess properties **Phase Equilibrium**: Qualitative behavior, Phase rule, Pxy and Txy diagrams, Raoult's law, positive and negative deviations, azeotropes. **Thermodynamic formulations of Vapor Liquid Equilibria:** Excess Gibbs Energy and activity coefficients, Modified Raoult's law, Bubble point and dew point calculations, van Laar and Margules Equations.	
Unit –V	**09 Hrs**
Chemical Reaction Equilibria: Phase rule for reacting systems, reaction coordinate, Application of equilibrium criteria to chemical reactions, 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	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Correlate thermodynamic properties.
CO2	Apply principles of thermodynamics to simple chemical engineering systems
CO3	Analyse thermodynamic systems
CO4	Predict thermodynamic properties for design

Reference Books	
1.	Introduction to Chemical Engineering Thermodynamics J Smith. M. and Vanness H.C., 8th Edition 2018, McGraw Hill (India), ISBN13: 9780070145870
2.	Chemical Engineering Thermodynamics, Rao Y.V.C., 2nd Edition, 2013, New Age International Publications, ISBN: 978873710483
3.	Textbook of Chemical Engineering Thermodynamics, Narayanan K.V., 2nd Edition, 2013, Prentice Hall of India Private Limited, New Delhi, ISBN 978-8120347472
4.	Engineering Thermodynamics, Nag P.K., 6th Edition, 2017, Tata McGraw Hill Book Co., New Delhi, ISBN: 978-9352606429
5	Introduction to Chemical Engineering Thermodynamics J Smith. M. and Vanness H.C., 8th Edition, 2018, McGraw Hill (India), ISBN13: 9780070145870

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 IV						
TECHNOLOGIES FOR CLEAN AND RENEWABLE ENERGY PRODUCTION **Category: Professional Core Elective B** **(Theory)**						
Course Code	:	**CH246AT**		**CIE Marks**	:	**50**
Credits: L:T:P	:	**2:0:0**		**SEE Marks**	:	**50**
Total Hours	:	**30 L**		**SEE Duration**	:	

Unit - I	**08 Hrs**
Introduction, characterization of coal and conventional routes for energy production from coal. Cleaner routes for energy production form coal	
Unit - II	**11 Hrs**
Characterization of crude oil and conventional routes for crude oil utilization. Cleaner routes for energy production form petroleum crude. Cleaner energy production from gaseous fuels	
Unit - III	**11 Hrs**
Solar and wind energy production. Production of hydro and geothermal energy. Energy production from biomass and wastes and energy conservation	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals of clean and renewable energy
CO2:	Explain the characterization of fuels.
CO3:	Compare energy production using various methods

Reference Books	
1	Miller Bruce G., Coal Energy Systems, Elsevier Academic Press, Paris 2005
2	Twidel, J. and Tony W., Renewable Energy Resources, Second Edition, Taylor & Francis 2006
3	Kreith F., Goswami D.Y., Energy Management and Conservation, CRC Press 2008
4	Sukhatme S., J Nayak J., Solar Energy: Principles of thermal Collection and Storage, 3rd Edition Tata McGrow-Hill Pulishing Company Ltd. 2008
5	Mondal P and Dalai A., Sustainable utilization of natural resources, CRC Press 2017.

Semester IV						
COLLOIDS AND SURFACES **Category: Professional Core Elective B** **(Theory)**						
Course Code	:	**CH246BT**		**CIE Marks**	:	**50**
Credits: L:T:P	:	**2:0:0**		**SEE Marks**	:	**50**
Total Hours	:	**30 L**		**SEE Duration**	:	

Unit - I	**08 Hrs**
Introduction to Colloids. Characterization of Colloids	
Unit - II	**11 Hrs**
van der Waals Interactions. Colloid-Polymer Interactions	
Unit - III	**11 Hrs**
Electrical Double Layer Interactions. Electrokinetics and Particles at Interfaces	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals of colloids and surfaces
CO2:	Explain the surface phenomena in all the colloids
CO3:	Analyse the interactions between particles

References	
	https://nptel.ac.in/courses/105106204

Semester IV						
NATURAL GAS ENGINEERING **Category: Professional Core Elective B** **(Theory)**						
Course Code	:	**CH246CT**		**CIE Marks**	:	**50**
Credits: L:T:P	:	**2:0:0**		**SEE Marks**	:	**50**
Total Hours	:	**30 L**		**SEE Duration**	:	

Unit - I	**08 Hrs**
Introduction, Gas Production: Upstream, Reservoir- Well Completion. Properties of Natural Gas: Phase Behavior: Well inflow performance relationship (IPR), Skin factor, Productivity Index, Gas well testing.	
Unit - II	**11 Hrs**
Wellbore Performance: TPR Curve, Single Phase & amp; Multi Phase flow, Choke Performance: CPR Curve, Sonic and Subsonic Flow, Well Deliverability: Nodal Analysis. Natural Gas Production: Downstream, Surface Facilities, Principle of Separator, Design of Separator: Vertical, Horizontal; Two Phase Separation, Three Phase Separation Natural Gas Processing: Dehydration of Natural Gas, Design of Dehydration, Sweeting	
Unit - III	**11 Hrs**
Transportation and Measurement, Pipeline Design Flow through pipeline, issues and solutions, Unconventional Production of Natural Gas: Shale Gas, Gas Hydrates, Coal bed Methane, Oil Shale, Pyrolysis of Carbonaceous Materials etc.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals of Natural gas engineering
CO2:	Explain the processes and technologies involved in gas processing
CO3:	Design the unit operations involved in gas processing.

Reference Books	
1	B. Guo and A. Ghalambor, Natural Gas Engineering Handbook, Gulf Publishing Company, 2005.
2	D.L. Katz and R.L. Lee, Natural Gas Engineering, McGraw_Hill, 1990.
3	B. Guo, W.C. Lyons and A. Ghalambor, Petroleum Production Engineering: A Computer AssistedApproach, Elseveir, 2007.
4	T. Ahmed and P. D. McKinney, Advanced Reservoir Engineering, Elseveir, 2005.

Semester IV						
APPLICATION OF SPECTROSCOPIC METHODS IN MOLECULAR STRUCTURE DETERMINATION **Category: Professional Core Elective B** **(Theory)**						
Course Code	:	**CH246DT**		**CIE Marks**	:	**50**
Credits: L:T:P	:	**2:0:0**		**SEE Marks**	:	**50**
Total Hours	:	**30 L**		**SEE Duration**	:	

Unit - I	**08 Hrs**
Introduction to spectroscopic methods – Nuclear magnetic resonance spectroscopy (NMR), spin ½ nuclei, 1H and 13C-NMR spectroscopy, FT-NMR method. Chemical shifts, spin spin coupling, spin-spin splitting pattern recognition for structure elucidation, coupling constants. 1H NMR spectroscopy, Second order effects in NMR spectrum, AB and AA'BB', ABC spin systems. Solving simple structure elucidation problems with 1H and 13C NMR spectroscopy	
Unit - II	**11 Hrs**
Stereochemistry determination using NMR techniques. Study of dynamic processes by NMR spectroscopy – examples from organic and organometallic chemistry Mass Spectrometry – various ionization methods – EI, CI, ESI and MALDI methods, fragmentation patterns of simple organic molecules, Use of HRMS. Mass spectrometry – fragmentation patterns of simple organic molecules (continued), solving structure elucidation problems using mass spectrometry.	
Unit - III	**11 Hrs**
UV-Vis spectroscopy, electronic transitions in organic molecules, selection rules, application of Beer Lambert law, qualitative and quantitative analysis by UV-Vis spectroscopy. Solving structure elucidation problems using multiple spectroscopic data (NMR, MS, IR and UV-Vis).	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the principles of spectroscopic methods
CO2:	Explain the various spectroscopic methods
CO3:	Apply spectroscopic methods in the determination of organic molecules.

References	
	https://onlinecourses.nptel.ac.in/noc22_cy45/preview

Semester IV						
INTRODUCTION TO POLYMER SCIENCE **Category: Professional Core Elective B** **(Theory)**						
Course Code	:	**CH246ET**		**CIE Marks**	:	**50**
Credits: L:T:P	:	**2:0:0**		**SEE Marks**	:	**50**
Total Hours	:	**30 L**		**SEE Duration**	:	

Unit - I	**08 Hrs**
Introduction: Background, Nomenclature, Classifications, Molecular Weight, Examples of Applications, Principles of Polymerization. Synthesis of Polymers: Step-Growth Polymerization, Radical Chain Polymerization, Synthesis of Polymers: Radical Chain Polymerization (cont.), Controlled Radical Polymerization, Emulsion Polymerization.	
Unit - II	**11 Hrs**
Synthesis of Polymers: Ionic Chain Polymerization, Coordination Polymerization, Ring-Opening Polymerization, Copolymerization. Characterization of Polymers: Polymers in Solution, Chain Dimension, Determination of Molecular Weight. Determination of Molecular Weight (cont.), Frictional Properties of Polymers in Solution, Hydrodynamic Size, Chemical Composition, Polymer Processing.	
Unit - III	**11 Hrs**
Phase Structure and Morphology of Bulk Polymers: Amorphous and Crystalline States, Viscoelasticity, Multicomponent Polymer Systems, Properties of Bulk Polymers. Properties of Bulk Polymers (Cont.): Mechanical, Optical, Electrical, Surface and Other Industrially Relevant Properties, Polymer Degradation and Stability, Polymer Additives, Few Contemporary Topics, Challenges and Opportunities in Polymer Science.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall the fundamentals of polymer science
CO2:	Explain the synthesis and characterization of polymers
CO3:	Analyse the various properties of polymers

Reference Book	
1	Introduction to Polymers, Third Edition by Robert J. Young, Peter A. Lovell, CRC Press

Semester: IV						
DESIGN THINKING LAB						
Course Code	**:**	**CH247DL**		**CIE Marks**	**:**	**50**
Credits: L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours	**:**	**30P**		**SEE Duration**	**:**	**02 Hours**

Course Learning Objectives: To enable the students to:

1	***Knowledge Application:*** Acquire the ability to make links across different areas ofknowledge and to generate, develop and evaluate ideas and information to apply these skills to provide solutions of societal concern
2	***Communication:*** Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both the written and oral forms.
3	***Collaboration:*** Acquire collaborative skills through working in a team to achievecommon goals.
4	***Independent Learning:*** Learn on their own, reflect on their learning and take appropriate action to improve it.

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 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 ofany modifications suggested by the evaluation committee.

The Design Thinking lab tasks would involve:

1. Carry out the detailed questionnaire to arrive at the problem of the selected theme.The empathyreport shall be prepared based on the response of the stake holders.
2. For the problem identified, the team needs to give solution through thinking out of the box innovatively to complete the ideation stage of DTL
3. Once the idea of the solution is ready, detailed design must be formulated in theDesign stageconsidering the practical feasibility.
4. If the Design of the problem is approved, the team should implement the design andcome out withprototype of the system.
5. Conduct thorough testing of all the modules in the prototype developed and carry outintegrated 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 projectreport alsoshould 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 asthe report.

The students are required to submit the Poster and the report in the prescribed format provided by the department.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Interpreting and implementing the empathy, ideate and design should be implemented by applying the concepts learnt.
CO 2:	The course will facilitate effective participation by the student in team work and development of communication and presentation skills essential for being part of any ofthe domains in his / her future career.
CO 3:	Applying project life cycle effectively to develop an efficient prototype.
CO 4:	Produce students who would be equipped to pursue higher studies in a specialized area or carry out research work in an industrial environment.

Scheme of Evaluation for CIE Marks: Evaluation will be carried out in three phases:

Phase	Activity	Weightage
I	Empathy, Ideate evaluation	10M
II	Design evaluation	15M
III	Prototype evaluation, Digital Poster presentation and report submission	25M
	Total	**50M**

Scheme of Evaluation for SEE Marks:

Sl. No.	Evaluation Component	Marks
1.	Written presentation of synopsis: Write up	5M
2.	Presentation/Demonstration of the project	15M
3.	Demonstration of the project	20M
4.	Viva	05M
5.	Report	05M
	Total	**50M**

Semester: IV						
UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS (Theory)						
Course Code	**:**	**HS248AT**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Total Hours	**:**	**28L**		**SEE Duration**	**:**	**2.00 Hours**

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 Human Relationship: Understanding values in human-human relationship; meaning of Justice and program for its fulfilment to ensure mutual happiness; Trust and 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 completion of the course the students will be able to	
CO1	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	Understand human relationships and human nature in mind so that they will have better critical ability.
CO3	Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
CO4	Apply what they have learnt to their own self in different day-to-day settings in real life.

Reference Books	
1	Human Values and Professional Ethics, R. R. Gaur, R Sangal, G P Bagaria, 1st Edition, 2010, Excel Books, New Delhi, ISBN: 9788174467812.
2	Human Values, A.N. Tripathi, 3rd Edition, 2019, New Age Intl. Publishers, New Delhi, ISBN: 9788122425895.
3	India Wins Freedom, Maulana Abdul Kalam Azad, 1st Edition, 1988, Orient Blackswan, ISBN: 97881250051481.
4	The Story of My Experiments with Truth, Mohandas Karamchand Gandhi, 1st Edition, 2011, Create Space Publishing platform, ISBN: 9781463694876.
5	Small is Beautiful, E. F Schumacher, 1st Edition, 2011, (PBD)VINTAGE, ISBN: 9780099225614.

ASSESSMENT AND EVALUATION PATTERN
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation. Example: Assessment by faculty mentor: 10 marks Self-assessment: 10 marks Assessment by peers: 10 marks Socially relevant project/Group Activities/Assignments: 20 marks Semester End Examination: 50 marks. The overall pass percentage is 40%. In case the student fails, he/she must repeat the course

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q. NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type questions covering entire syllabus	10
	PART B (Maximum of TWO Sub-divisions only)	
2	Unit 1 : (Compulsory)	14
3 & 4	Unit 2 : Question 3 or 4	13
5 & 6	Unit 3 : Question 5 or 6	13
	TOTAL	**50**

Semester: IV						
Bridge Course: MATHEMATICS (Mandatory Audit Course)						
Course Code	:	MAT149DT		**CIE**	:	50 Marks
Credits: L: T: P	:	2:0:0		**SEE**	:	**NO SEE** (AUDIT COURSE)
Total Hours	:	30L				

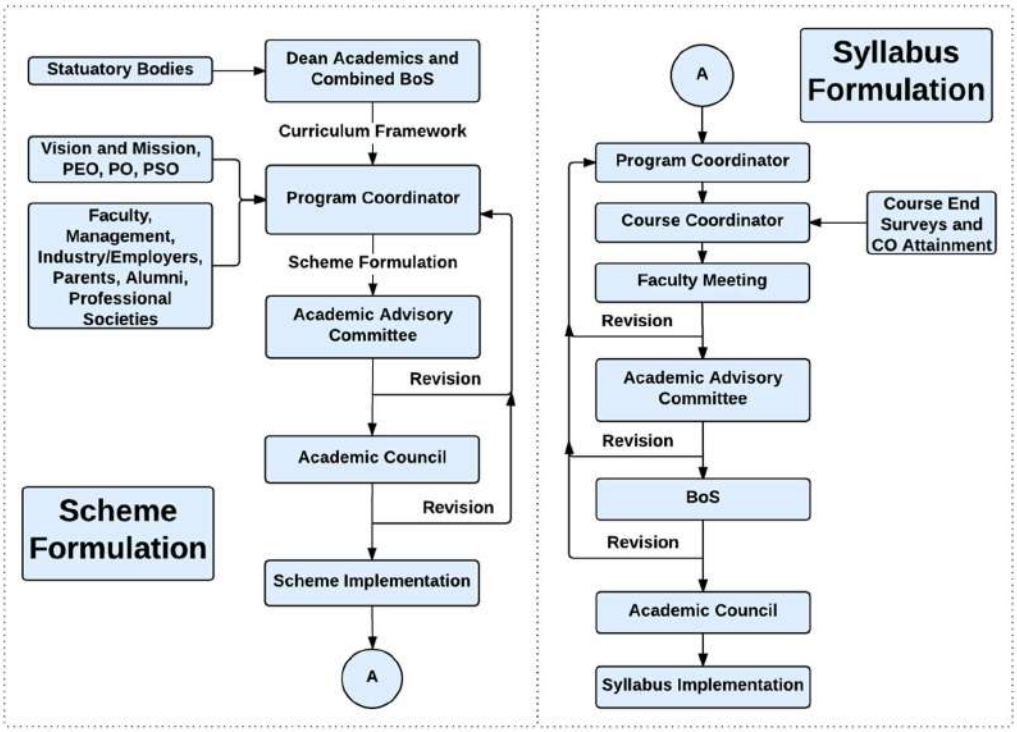
Unit-I	**10 Hrs**
Multivariable Calculus: **Partial Differentiation:** Introduction, simple problems. Total derivative, composite functions. Jacobians – simple problems. **Vector Differentiation:** Introduction, velocity and acceleration, gradient, divergence – solenoidal vector function, curl – irrotational 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.

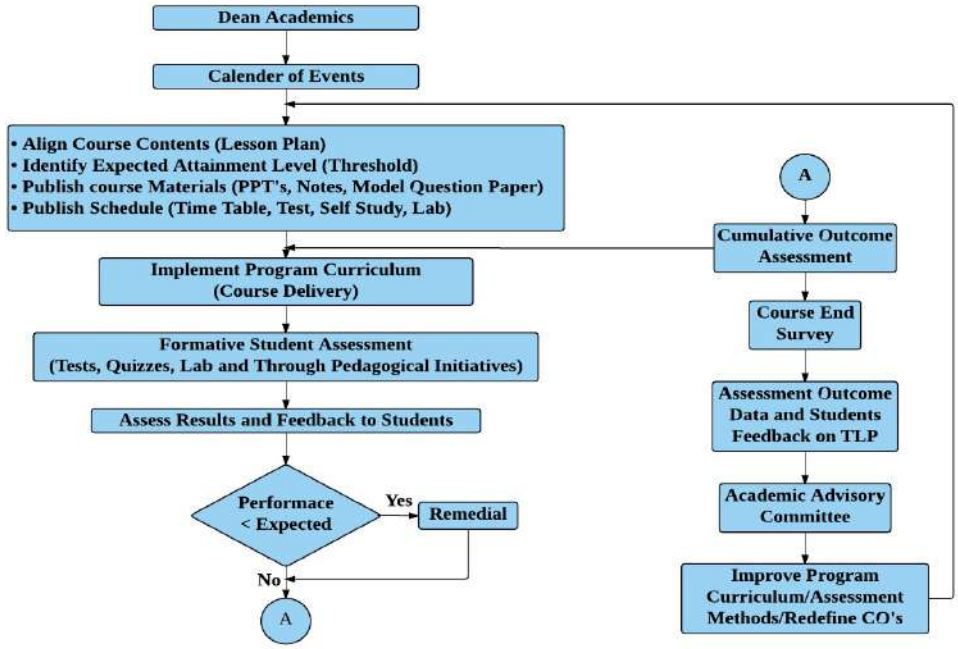
Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44^{th} Edition, 2015, Khanna Publishers, ISBN: 978-81-933284-9-1.
2	Higher Engineering Mathematics, B.V. Ramana, 11^{th} Edition, 2010, Tata McGraw-Hill, ISBN: 978-0-07-063419-0.
3	A Textbook of Engineering Mathematics, N.P. Bali & Manish 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**

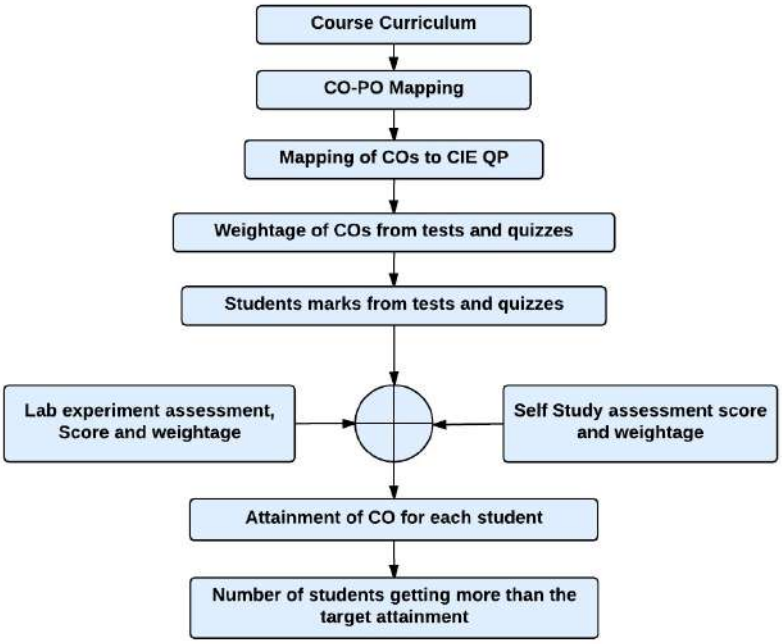
Curriculum Design Process



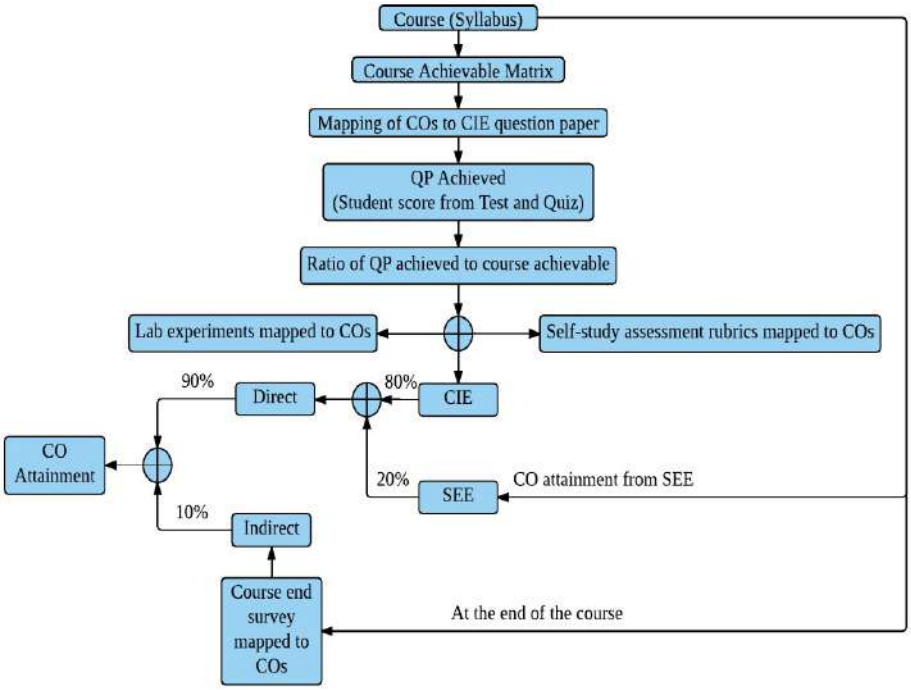
Academic Planning and Implementation



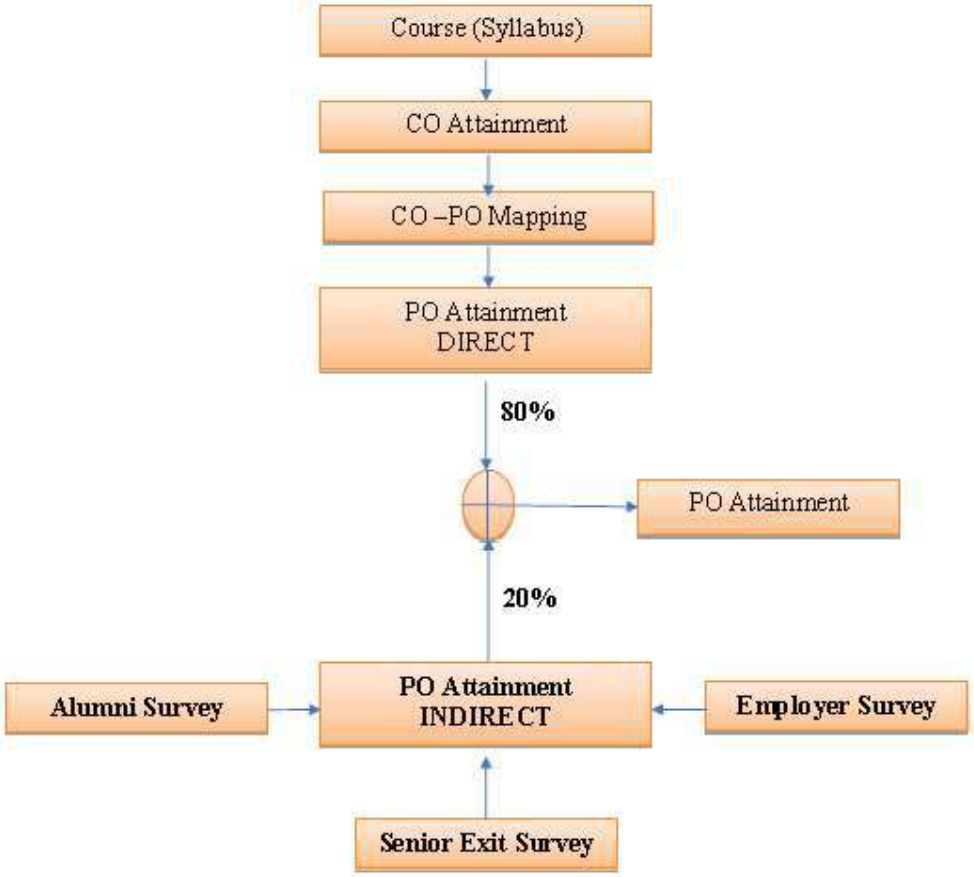
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

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

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

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

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

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

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

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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

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

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

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