RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of I to IV Semester

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
CHEMICAL ENGINEERING

DEPARTMENT OF

CHEMICAL ENGINEERING

VISION

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

MISSION

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

QUALITY POLICY

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

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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DEPARTMENT OF
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CHEMICAL ENGINEERING

VISION

Imparting quality education that promotes leadership in Research, Innovation and Sustainable Technologies through teamwork and Entrepreneurship in Chemical Processes, Energy, Unit Operations and Computational Chemical Engineering to meet societal requirements.

MISSION

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

PROGRAMME OUTCOMES (PO)

M.Tech in Chemical Engineering graduates will be able to:

PO1.Scholarship of Knowledge: Acquire in-depth knowledge in Chemical Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

PO2.Critical Thinking: Analyse complex chemical engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3.Problem Solving: Think laterally and originally, conceptualise and solve chemical engineering problems, evaluate a wide range of potential solutions for those problems and

arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4.Research Skill: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering

PO5.Usage of modern tools: Create, select, learn 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.

PO6.Collaborative and Multidisciplinary work: Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7.Project Management and Finance : Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after considerisation of economical and financial factors.

PO8.Communication : Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

PO9.Life-long Learning: Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10.Ethical Practices and Social Responsibility: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11.Independent and Reflective Learning: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback. PO6: Recognize opportunities and contribute synergistically towards solving engineering problems effectively, individually

and in teams, to accomplish a common goal and exhibit professional ethics, competence and to engage in lifelong learning.

Program Specific Criteria for M.Tech in Chemical Engineering

M.Tech in Chemical Engineering graduates will be able to:

1. Gain comprehensive knowledge in Chemical Engineering and demonstrate research capabilities
2. Analyse and solve engineering problems in materials, biotechnology, environment and energy domains
3. Contribute to multidisciplinary research using relevant Chemical Engineering tools

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional 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.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing & Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
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DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech Program in CHEMICAL ENGINEERING

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MAT 11A	Applied Mathematics	Maths	4	0	0	**4**
2	18MCH 12	Modelling and Simulation of Processes	CH	4	0	1	**5**
3	18MCH 13	Process Equipment Design	CH	4	0	1	**5**
4	18HSS 14	Professional Skills Development	HSS	0	0	0	**0**
5	18MCH1AX	Elective Group-A	CH	4	0	0	**4**
6	18MCH 1BX	Elective Group-B	CH	4	0	0	**4**
Total number of Credits				**20**	**0**	**2**	**22**
Total Number of Hours / Week				**20**	**0**	**4**	**24**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MCH 21	Plant Wide Control of Chemical Process	CH	4	0	1	**5**
2	18MCH 22	Heterogeneous Reaction Systems	CH	4	0	0	**4**
3	18IEM 23	Research Methodology	IM	3	0	0	**3**
4	18MCH 24	Minor project	CH	0	0	2	**2**
5	18MCH 2CX	Elective Group-C	CH	4	0	0	4
6	18MCH 2DX	Elective Group-D	CH	4	0	0	4
7	18 XX 2GXX	Global Elective Group-G	R.BoS	3	0	0	3
Total number of Credits				**22**	**0**	**3**	**25**
Total Number of Hours / Week				**22**	**0**	**6**	**28**

SEMESTER : I		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MCH 1A1	Solid Waste Management
2.	18MCH 1A2	Fuel Cell Technology
3.	18MCH 1A3	Piping Engineering
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MCH 1B1	Renewable Energy Resources and Systems
2.	18MCH 1B2	Industrial Waste Water Treatment
3.	18MCH 1B3	Interfacial Phenomena and Surface Engineering
SEMESTER : II		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MCH 2C1	Fluidization Engineering
2.	18MCH 2C2	Oil and Gas Processing
3.	18MCH 2C3	Biochemical Engineering
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MCH 2D1	Advanced Polymer Composites
2.	18MCH 2D2	Chemical Process Integration
3.	18MCH 2D3	Nanotechnology in Chemical Engineering

GROUP E: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	03
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	03
3.	IM	18IM2G03	Modelling using Linear Programming	03
4.	IM	18IM2G04	Project Management	03
5.	CH	18CH2G05	Energy Management	03
6.	ME	18ME2G06	Industry 4.0	03
7.	ME	18ME2G07	Advanced Materials	03
8.	CHY	18CHY2G08	Composite Materials Science and Engineering	03
9.	PHY	18PHY2G09	Physics of Materials	03
10.	MAT	18MAT2G10	Advanced Statistical Methods	03

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

M.Tech Program in COMPUTER SCIENCE AND ENGINEERING

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MCE31	Operating System Design	CS	4	1	0	**5**
2	18MCE32	Internship	CS	0	0	5	**5**
3	18MCE33	Major Project : Phase-I	CS	0	0	5	**5**
4	18MCE3EX	Professional Elective-E	CS	4	0	0	**4**
Total number of Credits				**8**	**1**	**10**	**19**
Total Number of Hours/Week				**8**	**2**	**20**	**30**

SEMESTER : III		
GROUP E: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1	18MCE3E1	Software Defined Systems
2	18MCE3E2	Web Analytics and Development
3	18MCE3E3	Cyber Security

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MCE41	Major Project : Phase-II	CS	0	0	20	**20**
2	18MCE42	Technical Seminar	CS	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

SEMESTER : I						
APPLIED MATHEMATICS (Common to MPD, MMD, MCM, MPE, MBT, MBI, MCH, MST, MHT)						
Course Code	**:**	**18MAT11A**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Statistics:
Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.

Unit – II	**10 Hrs**

Probability distributions:

Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.

Unit – III	**11 Hrs**

System of linear equations and eigen value problems:

System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.

Unit – IV	**11 Hrs**

Numerical solution of differential equations:

Boundary value problems (IVP & BVP)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.

Unit – V	**10 Hrs**

Engineering optimization:

Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.

Course Outcomes
After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.
CO3	Analyse the physical problem to establish statistical/mathematical model and use appropriate method to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.

Reference Books

1	Theory and Problems of Probability, Schaum's Outline Series, Seymour Lipschutz and Marc lars Lipson, 2nd edition, ISBN: 0-07-118356-6.

2	Introductory method of numerical analysis, S. S. Sastry, 4th edition, 2009, Prentice-Hall India Pvt. Ltd. ISBN : 81-203-1266-X.
3	Numerical methods for scientific and engineering computation, M K Jain, S. R. K. Iyengar, R. K. Jain, 6th edition, 2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
4	Engineering Optimization Theory and Practice, Singiresu S. Rao, 3rd Edition, New Age International (P)Ltd., ISBN: 81-224-1149-5.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
MODELLING AND SIMULATION OF PROCESSES (THEORY & PRACTICE)						
Course Code	**:**	**18MCE12**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+0+26P**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction Models and model building. Lumped parameter models (steady-state and unsteady-state). Distribution parameter models (steady-state and unsteady state) Stochastic models- discrete state/continuous state. Parameter estimation	
Unit – II	**11 Hrs**
Modeling of Chemical Engineering Systems Scope and coverage, scope and principle, equation of motion, transport equations, Equations of state, equilibrium and chemical kinetics.	
Unit – III	**11 Hrs**
Models for Chemical Engineering Systems CSTR- Isothermal, constant and variable holdup, two heated tanks, pressurized CSTR, Batch Reactor, Reactor with Mass transfer	
Unit – IV	**10 Hrs**
Multivariable Processes Matrix Properties and state properties, Transpose, inversion, Eigen Values, Canonical Transformation, Singular Values	
Unit – V	**10 Hrs**
Numerical analysis for simulation Introduction to simulation, Role of computers and numerical methods in simulation, Iterative convergence methods, explicit convergence, Wegstein and Muller methods, explicit numerical integration algorithms, implicit methods. Numerical examples.	
Unit – VI (Lab Component)	**2 Hrs/ Week**
1. Cooling Tower 2. Distillation Column 3. Ethanol Plant 4. Atmospheric crude distillation 5. Multistage Crosscurrent Adsorption System 6. Reactors in series 7. Reactors in parallel 8. Combination of reactors	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the principles of modeling and simulation
CO2	Apply mathematical tools to solve model equations
CO3	Analyze chemical engineering systems for model development
CO4	Develop mathematical models for simple chemical engineering systems

Reference Books

1	William L. Luyben, Process Modeling, Simulation, and Control for Chemical Engineers, 2nd Edition, McGraw-Hill1989, ISBN:0070391599
2	Ramirez W.F., Computational Methods for Process Simulation,2nd Edition, Butterworth, 1998,ISBN:9780080529691
3	Franks R.E., Modeling and Simulation in Chemical Engineering, John Wiley, 1972,ISBN:0471275352
4	Gaikwad R.W, and Dhirendra, Process Modelling and Simulation, 2nd Edition, Denetted & Co., 2006,ISBN: 8190322826

Scheme of Continuous Internal Evaluation (CIE): Theory for 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE): Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE): Theory for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks

SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

SEMESTER: I						
PROCESS EQUIPMENT DESIGN						
Course Code	**:**	**18MCH13**		**CIE Marks**	**:**	**75+25**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**
Each design to be taught for 8 hours						**52Hrs**

Detailed Engineering Process & Mechanical Design Aspects and sketching (The sketch shall include sectional front view, full Top/side view) of the following:

1. Shell and Tube Exchanger.
2. Horizontal and Vertical Condensers
3. Evaporator Single Effect
4. Bubble Cap Distillation Column
5. Packed bed Absorption Column
6. Crystalliser

Students will prepare detailed drawing of individually allotted equipment and submit these results as part of the assignment which will be evaluated.

Course Outcomes
After going through this course the student will be able to:

CO1	Understand design procedure of process equipments
CO2	Apply chemical engineering principles to design process equipments
CO3	Estimate physical dimensions of various parts of chemical process equipments and accessories
CO4	Analyze various design options at all design stages

References

1.	R.H.Perry and D.W.Green, Chemical Engineers Handbook, McGraw Hill, 7th Edition, 1998, ISBN 0-07-115982-7
2	J.M.Coulson and J.F.Richardson, Chemical Engineering, Pregman Press, Vol.6, 3rd Edition 1993, ISBN:10-0750641428
3	Brownell and Young: Process Equipment Design - Vessel Design, John Willey, Published 1951, ISBN:0471113190
4	M.V.Joshi, Process Equipment Design,3rd Edition, Macmillan and Co. India, Delhi, Reprint 1998, ISBN 023-063-810-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of tests and assignments. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 75. Five assignments are given for 10 marks each and the sum of the marks scored from five assignments is reduced to 25.
Total CIE is 75+25=100 Marks

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The question paper consists of two questions carrying 100 marks for the design and detailed sketch of equipment. Student is required to answer any one. There shall not be split of equipments among the questions.

SEMESTER : I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit – II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit – III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit – IV	**03 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills	
Unit – V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes

After going through this course the student will be able to:

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Phase	Activity
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

SEMESTER : I						
SOLID WASTE MANAGEMENT (Professional Elective-A1)						
Course Code	**:**	**18MCH1A1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — 10 Hrs

Functional elements, Philosophy and organization, Status of solid waste management, Integrated waste management strategy. Legislation and Government agencies, Planning solid waste management. Transport - collection systems, collection equipment, transfer stations, collection route optimization, Onsite handling, Collection SCS, HCS, and separation processes, source reduction, Storage and processing, Transfer and transport

Unit – II — 10 Hrs

Processing techniques and equipment. Biochemical Conversion: Composting - Aerobic composting. Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Types of biogas plants, Community biogas plants

Thermal conversion techniques Pyrolysis, Gasification, waste to energy Generation Sources of energy generation, Gasification; Types of gasifiers; Industrial applications of gasifiers, Briquetting; Utilization and advantages of briquetting; Refuse derived Fuel.

Unit – III — 10 Hrs

Waste disposal options - Disposal in landfills - Landfill Classification, types and methods - site selection - design and operation of sanitary landfills, secure landfills - leachate and landfill gas management - landfill closure and environmental monitoring - closure of landfills - landfill remediation

Incineration; Furnace type & design; Medical / Pharmaceutical waste incineration; Environmental impacts; Measures of mitigate environmental effects due to incineration

Unit – IV — 11Hrs

Hazardous waste and their management, Process management issues, Planning. Sources and Nature of Hazardous Waste - Impact on Environment - Hazardous Waste -Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation& Closure.

Biomedical (Handling and Management) Rules 2008, sources, treatment and disposal, E Waste Management

Unit – V — 11Hrs

Case studies on major industrial solid waste generation units- Coal fired power plant, Textile industry, Brewery, Distillery, Oil refinery, Radioactive generation units. Oil spills. Recent Developments in Solid Wastes Reuse and Disposal: Power Generation, Blending with construction materials and Best Management Practices (BMP), Role of various organizations in Solid Waste Management – Governmental, Non-Governmental, Citizen Forums.

Unit – VI (Lab Component)

1. Cooling Tower
2. Distillation Column
3. Ethanol Plant
4. Atmospheric crude distillation
5. Multistage Crosscurrent Adsorption System
6. Reactors in series
7. Reactors in parallel

Combination of reactors

Course Outcomes

After going through this course the student will be able to:

CO1	Understand the importance of waste reduction at source.
CO2	Apply the principles of existing and emerging technologies to convert waste to value added products
CO3	Analyze and select appropriate waste management techniques

CO4	Develop solid waste management scheme for an urban area

Reference Books	
1.	George Tchobanoglous, Integrated Solid Waste Management, McGraw-Hill Publishers, 2003,ISBN:0070632375
2.	B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, Waste Management, Springer, 2004, ISBN:9783642082122
3.	Jagbir Singh, and A.L. Ramanathan, Solid Waste Management Present and Future Challenges, I.K. International House Pvt. Ltd., New Delhi, 2010,ISBN:9789380026428
4.	R.E.Landreth and P.A.Rebers, Municipal Solid Wastes – problems and Solutions, Lewis Publishers, 2002, ISBN:9781566702157

Scheme of Continuous Internal Evaluation (CIE): Theory for 100 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE): Theory for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : I						
FUEL CELL TECHNOLOGY (Professional Elective-A2)						
Course Code	**:**	**18MCH1A2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	11Hrs
Hydrogen characteristics and importance, conventional and non-conventional methods of hydrogen production, hydrogen storage, handling and safety	
Unit – II	10Hrs
Introduction, fuel cell definition, historical developments, working principle of fuel cell, components of fuel cell, open circuit voltage, fuel cell reactions, fuels for cells and their properties, balance of plant and Fuel Cell reaction kinetics, activation kinetics and electrode kinetics	
Unit – III	10Hrs
Classification of fuel cells, alkaline fuel cell, direct methanol fuel cell, phosphoric acid fuel cell, fabrication, advantages, disadvantages and applications	
Unit – IV	11Hrs
Solid oxide fuel cell, proton exchange membrane fuel cell, molten carbonate fuel cell, fabrication, advantages, disadvantages and applications	
Unit – V	10Hrs
Fuel Cell Characterization, current – voltage curve, in-situ characterization, current – voltage measurement, current interrupt measurement, cyclic voltammetry, electrochemical impedance spectroscopy and ex-situ characterization techniques	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the concepts of fuel cells and their kinetics.
CO2	Apply thermodynamics and chemical engineering principles to evaluate performance of a fuel cell
CO3	Analyze the performance of various fuel cells based on efficiencies and characteristics
CO4	Develop new components or alternative materials for existing fuel cells

Reference Books

1.	Viswanathan and M Aulice Scibioh; Fuel Cells – Principles and Applications, Universities Press; First Edition, reprinted in 2009, ISBN 9781420060287
2.	James Larminie and Andrew Dicks, Fuel Cell Systems Explained; John Wiley & Sons; Second Edition, 2003, ISBN 9780768012590
3.	O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY, First Edition (2006), ISBN 9780470258439
4.	Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. First Edition (2007), ISBN 9780387688152

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum.
of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks.
Total CIE is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each uni

SEMESTER : I						
PIPING ENGINEERING (Professional Elective-A3)						
Course Code	**:**	**18 MCH1A3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	10Hrs

Fundamentals of Fluid Mechanics: Euler's equation of motion, continuity equation, Bernoulli's equation, gas laws.

Hydraulic Design Considerations: Determination of pipe size, determination of pressure losses, thrusts in pipe lines, design of gas pipe lines, measurement of flow in pipes.

Metallurgy of Piping Materials: Selection of piping materials, physical properties of pipe materials, alloying elements in steel, recommended piping materials.

Unit – II	10Hrs

Pipes and Pipe Fittings: Standards and specifications, steel pipes, steel pipe fittings, cast iron pipes, cast iron fittings, jointing of cast iron pipes, tubes of other materials, design of flanges and flanged pipes.

Valves and Allied Fittings: Valves, functions of valves, valve materials and methods of construction, pressure drop in valves, valve size, types of valves, valve fittings

Unit – III	10Hrs

Pipe Supports: Load on structural supports, supporting structures of pipe lines, pipe supports- design considerations, platforms and ladders, foundation, supporting span of overhead pipelines, stiffening ribs, pipe clamping, flexible hanger supports.

Unit – IV	11Hrs

Piping Fabrication: Codes and standards, piping fabrication, welding joints in pipe lines, welding processes used in piping fabrication, preparation of pipe edges, welding electrodes, heat treatment of weld joints, inspection of weld joints, repair of defective weld joints, acceptance standards.

Corrosion Erosion in Pipelines: Corrosion control in a critical task, corrosion process, corrosion reaction, types of corrosion, anticorrosive protective coatings, cathodic protection of pipelines, abrasion.

Unit – V	11Hrs

Expansion Effects and Compensating Methods: Pipe expansions, methods of compensation, thermal force calculation, methods of compensation, permissible equivalent stresses caused by' additional external loads expansion devices calculation of anchor force using a bellow below material and life, use of hinged compensators. **Thermal Insulation:** Functions of thermal insulators, modes of heat transfer, insulating materials, temperature drop in a pipeline, application of insulation, calculation of condensate, desuperheaters.

Course Outcomes

After going through this course the student will be able to:

CO1	Recall the fundamentals of fluid flow, heat transfer, insulation and corrosion.
CO2	Calculate pressure losses in pipes and describe the different methods for determining the pipe size.
CO3	Apply the concept of fluid flow, heat transfer, insulation and corrosion for design of pipelines.
CO4	Compare and distinguish amongst various alloying elements, materials of construction pipe fittings, supports, expansion devices and materials of insulation.

Reference Books

1	GK. Sahu, "Handbook of Piping Design", 2nd Edition, New Age Publishers, 1998. ISBN-10: 8122424562
2	Mohinder L. Nayyar, "Piping Hand Book", 7th Edition, Mc. Graw Hill Publication, 1996, ISBN-13: 978-0070471061

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : I						
RENEWABLE ENERGY RESOURCES & SYSTEMS (Professional Elective-B1)						
Course Code	**:**	**18MCH1B1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**11Hrs**
Introduction: Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil Shale, Nuclear energy Option	
Unit – II	**11Hrs**
Solar Energy: Solar radiation: measurements and prediction. Solar thermal collectors- flat plate collectors, concentrating collectors. Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems. Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications :battery charger, domestic lighting, street lighting, water pumping, power generation schemes	
Unit – III	**10Hrs**
Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications	
Unit – IV	**10Hrs**
Ocean Energy: Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.	
Unit – V	**10Hrs**
Other Sources: Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the importance of various renewable energy sources
CO2	Apply the principles of existing and emerging technologies to harness renewable energy
CO3	Analyze the performance of renewable energy systems
CO4	Develop power generation schemes using renewable energy systems

Reference Books

1	D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia 2000, ISBN: 9781560327141
2	C. S. Solanki, Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009, ISBN:9788120343863
3	L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990, ISBN:9780139605277
4	David &Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press,1994, ISBN:9780791812051
5	S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage,Tata McGraw-Hill ,1984, ISBN: 1259081966

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored

from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit
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SEMESTER : I						
INDUSTRIAL WASTEWATER TREATMENT (Professional Elective-B2)						
Course Code	**:**	**18MCH1B2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10Hrs**

Characteristics of Industrial Wastewater:
Physical characteristics: color, odor, temperature, turbidity, total solids. Chemical characteristics: inorganic and organic characteristics and their determination. Biological characteristics: Classification of microorganisms, pathogenic organisms, Toxicity, Analysis of solids data. Measurement of organic matter, Modeling of BOD reaction, Estimation of BOD, COD.

Unit – II **10Hrs**

Physico - Chemical Treatment:
Introduction to wastewater treatment methods and steps. Screens, Grit chamber, Comminutors, Flow Equalisation. Selection of treatment process and basic design considerations. Sedimentation: theory, types and design. Principle of Coagulation and Flocculation: types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, design criteria and numerical examples.

Unit – III **11Hrs**

Bio - Chemical Treatment:
Biological process for wastewater treatment. Microbial growth kinetics, Suspended and attached growth processes - Aerobic and Anaerobic. Activated Sludge Process, Extended Aeration, Contact Stabilization, sludge blanket systems, Rotating Biological Contactors. Management of sludge: Thickening, Digestion, Dewatering, Sludge drying and Composting.

Unit – IV **11Hrs**

Advanced Treatment:
Disinfection: different methods, disinfectants, factors affecting disinfection. Chlorination: classification, dechlorination. Water Softening – Ions causing hardness, Membrane Technologies; Microfiltration, Ultra filtration, Nanofiltration and Reverse Osmosis, Solar Evaporation Pans, Ion Exchange process, Nitrogen and phosphorous removal

Unit – V **10Hrs**

Effluent Treatment Plants:
CPCB guidelines and standards for effluent treatment and disposal, Effluent treatment plant of typical chemical industries: Sugar, Dairy, Distillery, Textile, and Pharmaceutical industries.
Operation and Maintenance of ETPs: Factors affecting operation and Maintenance of ETPs, Control and Monitoring of ETPs

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the importance of wastewater management
CO2	Apply the physico-chemical and biological principles to treat industrial wastewater
CO3	Analyze the performance of various wastewater treatment techniques
CO4	Develop scheme for treating typical industrial effluents

Reference Books

1	Patwardhan, A.D., Industrial Waste Water Treatment, 2009,Edition, PHI learning, ISBN: 978-81-203-3350-5
2	Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, 2013 Edition, McGraw-Hill Science/Engineering/Math ISBN:978 0073401188
3	Wesley Eckenfelder, W Industrial water pollution control, 2000 Edition, Tata McGraw-Hill Publishing Company Ltd., ISBN:7302051348

4	NG WunJern, Industrial Wastewater Treatment, 2006 Edition, Imperial College Press, ISBN 1-86094-580-5

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : I						
INTERFACIAL PHENOMENA AND SURFACE ENGINEERING (Professional Elective-B3)						
Course Code	**:**	**18MCH1B3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Introduction: Various applications, concept of surface as surface of excess energy and surface of tension, equivalence of two concepts with examples, pressure tensor.	
Unit – II	**11Hrs**
Excess Pressure: Generalized equation for pressure jump across a curved surface, pressure jump cylindrical surfaces, zero pressure jump surface; vapor pressure a drop, solubility of a drop, ostwald ripening and its prevention, capillary condensation, super saturation, nucleation, superheating	
Unit – III	**11Hrs**
Measurement of Interfacial Tension: Capillary rise method, drop weight method, Wilhelm plate method, Du nuoy ring method. Thermodynamics of interfaces, temperature and pressure effects, work of adhesion, cohesion, spreading co-efficient. Gibbs treatment of highly non-ideal mixtures. Gibbs isotherm, measurement of surface concentration, validation of gibbs isotherm.	
Unit – IV	**10Hrs**
Three Phase Systems: Neumann triangle, engulfing of one phase by the other, solid-liquid-fluid systems, contact angle, advancing and receding contact angles, detergency, intermolecular forces – forces between molecules, three components of vander walls forces, forces between macroscopic bodies, continuum theories, deryaguin's approximation.	
Unit – V	**10Hrs**
Electrical Double Layer: In a charged plate immersed in an electrolyte solution, repulsive pressure due to overlapping of electrical double layer, origin of repulsive force – entopic, total interaction energy profiles for particles/drops between particles, rate of collision between particles with and without a force field between them, stability factor.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the concepts of Surface Engineering
CO2	Measure Interfacial Tension based on Thermodynamic principle
CO3	Analyse inter molecular forces in Three Phase system
CO4	Explain Electrical double theory in electrolyte solutions

Reference Books

1. C.A. Miller & P. Niyogi. 'Interfacial phenomena, Equilibrium and Dynamic Effects', Marshel Deckder, 1985.
2. A.W.Adamson. 'Physical chemistry of surfaces', John Wiley, 5th edition.
3. Milliet.J.L. 'Surface Activity', 2nd edition., Van Nostrad, 1961.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Continuous Internal Evaluation (CIE): Theory for 100 Marks
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two

SEMESTER : II						
PLANT WIDE CONTROL OF CHEMICAL PROCESS (Theory and Practice)						
Course Code	**:**	**18MCH21**		**CIE Marks**	**:**	**100+50**
Credits L: T: P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**

Unit – I	**10Hrs**
Review of Process Dynamics, first order systems, thermometer, level tank, CSTR, second order system – U tube manometer, mass vibrator and response studies	
Unit – II	**11Hrs**
Feed Back Control, **f**eedback controllers, PID controller design and tuning, Zeigler – Nichols controller tuning Stability**:** Concept and Criterion, Routh test, Root locus, frequency response analysis – Bodediagrams, Phase margin and gain margin	
Unit – III	**11Hrs**
Advanced control techniques, **c**ascade, feed-forward and feed-backward, ratio control, selective and adaptive control, smith predictor and internal module controller.	
Unit – IV	**10Hrs**
Multi variable controller, **f**eatures and examples of multi input and multi output processes, design of cross controller, relative gain array, Niderlinski index Control Structures for unit operations, **s**imple distillation column, heat exchanger, evaporator, and reactor	
Unit – V	**10Hrs**
Plant wide control for improved economics, **p**rocess operation for a given throughput and for maximum throughput, concept of bottleneck constraint, application of optimizing controllers for throughput maximization on case study processes	

Course Outcomes
After going through this course the student will be able to:

CO1	Recall the concepts of process dynamics.
CO2	Explain control mechanism in chemical process
CO3	Apply various control techniques for process parameters
CO4	Analyze the stability of chemical process.

Reference Books

1	G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, 1st ed. New Delhi: Prentice-Hall of India, 1984, ISBN 0-81-203-0665-1.
2	Ray Ogunnaike, Babatunde Ayodeji Ogunnaike, Willis Harmon Ray, Process Dynamics, Modeling, and Control, Oxford University Press, 1994, ISBN: 0195091191, 9780195091199
3	C. Branan, Rules of Thumb for Chemical Engineers: A manual of quick, accurate solutions to everyday process engineering problems, 4th ed. Noida: Elsevier, 2008; ISBN 978-0-7506-7856-8
4	W.L. Luyben, M.L. Luyben, Essentials of Process Control, Int. ed. Singapore: McGraw-Hill, 1997.
5	C.A. Smith, A.B. Corripio, Principles and Practice of Automatic Process Control, 1st ed. John Wiley & Sons, USA, 1991, ISBN 0-471-88346-8.

components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE): Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE): Theory for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

SEMESTER : II						
HETEROGENEOUS REACTION SYSTEMS						
Course Code	**:**	**18MCH22**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	10Hrs
Non ideal reactor analysis, mixing concepts, Residence Time Distribution, response measurements, segregated flow model, Dispersion model, series of stirred tanks model, analysis of non-ideal reactors and two parameter model	
Unit – II	10Hrs
Non-catalytic Heterogeneous Reactions, **i**ntroduction, fluid-fluid reactions, fluid-solid reactions & models to determine time of conversion **C**lassification of catalysts, preparation of catalysts, catalyst supports	
Unit – III	10Hrs
Catalyst Characterization, **s**urface area measurements, BET theory, pore size distribution, porosity - chemisorption techniques, crystallography and surface analysis techniques.	
Unit – IV	11Hrs
Catalytic Heterogeneous Reactions, **c**atalytic reactions, rate controlling steps, Langmuir - Hinshelwood model, Eiley - Riedel mechanism Catalyst deactivation, poisons, sintering of catalysts, kinetics of deactivation.	
Unit – V	11Hrs
External diffusion effects in Heterogeneous Reactions, surface kinetics and pore diffusion effects, Effectiveness factor Rreactors for heterogeneous catalytic & non-catalytic reactions	

Course Outcomes
After going through this course the student will be able to:

CO1	Apply principles of transfer operation in kinetics studies of heterogeneous reaction systems
CO2	Analyze complex chemical reaction mechanisms and kinetics
CO3	Develop rate equations for catalytic reaction systems
CO4	Evaluate the performance of reactors for multiphase reaction systems

Reference Books

1.	Smith J.M, Chemical Engineering Kinetics, 3rd Edition, McGraw- Hill, 1984, ISBN:0071247084
2.	Bischoff and Froment, Chemical Reactor Design and Analysis, Addision Wesley, 1982, ISBN:9780471024477
3.	Fogler H.S, Elements of Chemical Reaction Engineering, Prentice Hall, 1986.ISBN: 978-0137146123
4	Octave Levenspiel, Chemical Reaction Engineering 3 rd Edition ,John wiley and sons, ISBN: 9780471254249

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**

Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

Unit – II	**08 Hrs**

Data and data collection

Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Sampling Methods: Probability sampling and Non-probability sampling

Unit – III	**08 Hrs**

Processing and analysis of Data

Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

Unit – IV	**08 Hrs**

Advanced statistical analyses

Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

Unit-V	**07 Hrs**

Essentials of Report writing and Ethical issues

Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism

Case studies: Discussion of case studies specific to the domain area of specialization

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books:

1	Research Methodology Methods and techniques by, Kothari C.R., New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S., 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Continuous Internal Examination
Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

SEMESTER : II						
MINOR PROJECT						
Course Code	**:**	**18MCE24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes: After completing the course, the students will be able to

CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER : II
FLUIDISATION ENGINEERING **(Professional Elective-C1)**

Course Code	**:**	**18MCH2C1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	10Hours
Introduction to fluidization and applications Phenomenon of fluidization, behaviour of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Beds for Industrial applications, coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons	
Unit – II	11Hours
Mapping of fluidization regimes characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distributor, power consumption	
Unit – III	10Hours
Bubbling fluidized beds Davidson model for bubble in a fluidized bed, and its implications, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model	
Unit – IV	10Hours
Solids movement and Gas dispersion Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models.	
Unit-V	10Hours
Fluidized bed reactors Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds. Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size	

Course Outcomes

After going through this course the student will be able to:

CO1	Understand the behavior fluidization in fluidized bed
CO2	Evaluate the characterization of particles in fluidization regimes
CO3	Estimate the power consumption in fluidised bed reactor
CO4	Design fluidized bed reactors in chemical industries

Reference Books

1.	Levenspiel O. and Kunnii D., "Fluidization Engineering", John Wiley, 1972, ISBN: *9780409902334*
2.	Liang-Shih Fan, "Gas-Liquid-Solid Fluidization Engineering", Butterworths, 1989, ISBN-13: 9780409951790

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3)

Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II
OIL AND GAS PROCESSING **(Professional Elective-C2)**

Course Code	**:**	**18MCH2C2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hours**
Lube oil processing, Propane de-asphalting, Solvent Extraction, Dewaxing, Finishing Processes, Lube oil additives, Properties of Bitumen, Methods of Manufacture of Bitumen Product Blending, Hydrogen Production, Sulphur Recovery, Control of air and water pollution, solid waste management	
Unit – II	**11Hours**
Two phase oil and gas separation equipment, types, construction detail, working principle, internal sizing, theory of separation and detail design of separator. Three phase separators, types, construction detail, working principle, vessel internal and control equipment. Theory and sizing of three phase separator. Filters, Vacuum towers.	
Unit – III	**10Hours**
Theory of emulsion and demulsifies, treating system, equipment, sizing and heat calculations. Electronic coalescesers. Skimmer tanks, skimmer sizing equations and produced water treating system. Crude stabilization unit. Environmental problems during separation (ETP) and solutions. Storage of crude oil. Types of tanks, Evaporation loss, safety systems. Safety during processing of oil and gas at onshore & offshore.	
Unit – IV	**10Hours**
Gas liquid separations, dehydration processes, absorption and adsorption by gas permeation. Desulfurization processes, solid bed sweetening process, physical and chemical absorption processes, Acid gas removal. Integrating natural gas processing Introduction, types of compressors, Selection, Thermodynamics of compressors	
Unit-V	**11Hours**
Corrosion mechanism and influencing factors, corrosion preventive methods, chemical inhibitors, Cathodic protection, protective coating s and plastics, removal of corrosion gases and selection of appropriate materials for preventing corrosion.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand working principle for design of separators
CO2	Apply various techniques for the separation of oil-water emulsion.
CO3	Analyze performance of oil pipeline corrosion preventive measures
CO4	Develop methods to process and transport gas

Reference Books

1.	Bhaskararao, B.K, 'Modern Petroleum Refining Processes', Oxford and IBH Publishing Co. Pvt. Ltd., Fifth Edition, 2008, ISBN: 9788120417151, 8120417151.
2.	Gary, J.H and Handework, G.E., 'Petroleum Refining Technology and Economics', Marcel Dekker, Inc., Fifth Edition, 2007, ISBN 9780849370380.
3.	Ram Prasad, 'Petroleum Refining Technology', Khanna Publishers, First Edition, 2015, ISBN-10: 8174090649
4.	BahaduriAlireza, 'Natural Gas Processing: Theory and Engineering Design', Gulf Publishing Company, First Edition , 2014, **ISBN:** 9780080999715.
5.	Fahim, M.A., Alsahhaf, T.A. and Elkilani, A. 'Fundamentals of Petroleum Refining', Elsevier, First Edition , 2010, **ISBN:** 9780444527851.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course

3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II
BIO CHEMICAL ENGINEERING

(Professional Elective-C3)						
Course Code	**:**	**18MCH2C3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hours**
Microbiology: Scope, Classification of microorganisms, Whitaker's 5–Kingdom concept. Prokaryotic cells: structure, Classification and reproduction in bacteria. Eukaryotic cells: structure, Classification and reproduction in Fungi, Yeasts, molds. Biochemistry**:** Cell construction, Amino acids and proteins, Carbohydrates: Mono and polysaccharides, Nucleic acids, RNA and DNA, Lipids, fats, steroids, Cell nutrients	
Unit – II	**10 Hours**
Enzyme Catalyzed Reactions: Introduction, Enzyme kinetics, MM, BH approach, evaluation of kinetic parameters. **Enzyme Inhibitors:** Types of inhibitors, Effects of temperature and pH, Enzyme immobilization, methods of immobilization.	
Unit – III	**10 Hours**
Stoichiometry of Cell Growth and Product Formation: Elemental balances, available electron balances, degrees of reduction; yield coefficients of biomass and product formation, maintenance coefficients. **Growth media:** Medium formulation, Oxygen consumption and heat evolution in aerobic cultures.	
Unit – IV	**11 Hours**
Kinetics of Microbial Growth and Product Formation: Phases of cell growth and kinetics in batch cultures, Monod and Leudeking-Piret equations, unstructured nonsegrated models to predict specific growth rate, substrate limited growth, models with growth inhibitors. Introduction to structured models, Ideal Bioreactors, Batch reactor, Ideal Chemostat. Sterilization techniques	
Unit-V	**11 Hours**
Recovery and purification of products: Removal of microbial cells and other solid matter, foam separation, precipitation, filtration, centrifugation, cell disruption, chemical methods, liquid-liquid extraction, chromatography, membrane separation, drying.	

Course Outcomes

After going through this course the student will be able to:

CO1	Recall the basics of microbiology and enzymes.
CO2	Explain the various product recovery operations
CO3	Analyze the enzyme kinetics and the factors affecting enzyme kinetics
CO4	Predict appropriate sterilization Techniques

Reference Books

1	Shuler and Khargi, BioProcess Engineering, Basic Concepts, 3rd edition, Prentice Hall, 2017, ISBN-13: 978-0137062706
2	Bailey and Ollis, Biochemical Engineering Fundamentals, 2nd edition,1986, McGraw-Hill Chemical Engineering Series ISBN-13: 978-0070032125
3.	Bioprocess Engineering Principles, 2nd edition, Academic Press, 2012, ISBN: 978-0-12-220851-5
4.	James Lee available as e-book jmlee.org/documents/ebiochesample.pdf

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

Reference Books	
1.	Composite Materials- Science and Engineering. Second Edition- Krishnan K Chawla- Springer International edition.ISBN81-8128-490-9
2.	Hand book of Polymer science and Technology V-I. M.H.Ferry/A.V.Becker, CBS Publishers and Distributors. ISBN: 81-239-1132-7
3.	V.R.Gowarikar, N.V.Viswanathan, Jayadev Sreedhar, "Polymer Science", New Age International Pvt.Ltd, 2012: ISBN:0-85226-307-4
4	Fried W.Billmeyer, J.R, "Text Book of Polymer Science, Wiley Inter Science", 3rd Edition: 2005.ISBN:0471-82834-3

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3)

SEMESTER : II						
ADVANCED POLYMER COMPOSITES (Professional Elective-D1)						
Course Code	**:**	**18MCH2D1**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hours**
Introduction to Advanced Polymer Composites (APC): Definition, Polymer matrices, Thermoplastics Matrices, Manufacture and properties of PP-PVC- Aramid-PEEK-PPS-Poly sulfone.Thermosetting Matrices: Manufacture and properties of Isophthalic polyester, Epoxy and Polyimide. Elastomeric matrices: Manufacture and properties of PB-SBR	
Unit – II	**11Hours**
Reinforcement fibres: Manufacture and properties of PE fibre/ Nylon/Glass fibres/ Carbon fibres/CNT/Aramid**.**Interface in PMC: Wettability, Types of bonding at the interface, Glass fibre- polymer, Aramid fibre-polymer, PE fibre-polymer	
Unit – III	**10Hours**
Processing of PMC: Thermoplastic matrix composite (Film stacking, Diaphragm forming, Tape laying, Injection moulding, Sheet Molding compound), Thermoset matrix composite (Hand lay-up and spray technique,Filament winding, Pultrusion, Resin transfer moulding, Prepregs).	
Unit – IV	**10Hours**
Designing with composites: Characteristics of composites, Design procedure, Hybrid composite systems, Carbon fibre composites. Fatigue and Creep behavior of PMC. Expressions for Thermal conductivity of composites	
Unit-V	**11Hours**
Testing of PMC: Flexural tests (Single fibre pull out test, Fragmentation test, Laser spallation test). Health and safety methods for PMC. Recycling and disposal methods. Application of PMC: Aircraft, Automotive, and Construction industries, Military, Space and Medical devices.	

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain structure of polymer matrix composites from interfacial interaction
CO2	Apply design procedure using composition-property correlation
CO3	Analyze mechanical/thermal performance of polymer matrix composites
CO4	Develop advanced application of polymer matrix composites

Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II						
CHEMICAL PROCESS INTEGRATION (Professional Elective-D2)						
Course Code	**:**	**18MCH2D2**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction to Process Integration: Process synthesis, process analysis, targeting minimum waste and strategies for targets.	
Unit – II	**10 Hrs**
Graphical Techniques: Sources, sinks, source – sink mapping, pinch diagram for direct-recycle and multi component mapping diagram	
Unit – III	**10 Hrs**
Synthesis of Mass Exchange Networks: Design of individual mass exchangers, mass exchange networks and mass exchange pinch diagram.	
Unit – IV	**11 Hrs**
Algebraic Approach: Algebraic approach to targeting direct recycles and targeting mass exchange. **Heat Integration:** Thermal pinch diagram and minimum utility targeting by algebraic approach.	
Unit –V	**11 Hrs**
Combined Heat and Power Integration: Heat engines, heat pumps, placement of heat engines and heat pumps in heat exchange networks.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the fundamentals, strategies and approaches of process integration.
CO2	Apply process integration strategies on chemical engineering systems for mass and utility targeting.
CO3	Analyze chemical engineering processes to identify limits on process integration.
CO4	Evaluate purchase/waste/energy minimization in chemical engineering processes.

Reference Books

1.	Process Integration, Mahmoud M El-Halwagi, 1st Edition, 2006, Elsevier Academic Press, ISBN – 13: 978 0 12 370532 7
2.	Chemical Process Design and Integration, Robin Smith, 2nd Edition, 2005, John Wiley & Sons, ISBN – 0 471 48681 7
3.	Pinch Analysis and Process Integration, Ian C. K., 2nd Edition, 2007, Elsevier BH, ISBN – 13: 978 0 75068 260 2
4.	Heat Exchanger Network Synthesis, Shenoy U. V., 1st Edition, 1995, Gulf Professional Publishing, ISBN – 0 884 15391 6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II						
NANOTECHNOLOGY IN CHEMICAL ENGINEERING (Professional Elective-D3)						
Course Code	**:**	**18MCH2D3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I 10Hrs

Introduction to nanotechnology: Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography

Unit – II 11Hrs

Approaches to Synthesis of Nanoscale Materials and characterization

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, spray pyrolysis, ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods. Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging.

Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM,PSD, Zeta potential, DSC and TGA.

Unit – III 10Hrs

Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie'shypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

Unit – IV 10Hrs

Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nano fiber or Nanotube Fillers, Plate-like Nano fillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nano composites. Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nanocomposites.

Unit – V 11Hrs

Applications to Safety, Environment and Others

Chemical and Biosensors- Classification and Main Parameters of Chemical and Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nano biotechnology, Drug Delivery. Nano coatings, Self cleaning Materials, Hydrophobic Nanoparticles, Photocatalysts, Biological nanomaterials, Nano electronics, Nano machines & nano devices, Societal, Health and Environmental Impacts.

Course Outcomes

After going through this course the student will be able to:

CO1	Understand Physical and chemical deposition techniques in Nano Technology
CO2	To Characterise the synthesized nano materials
CO3	To synthesize semiconductor and polymer based nano materials
CO4	Application of Nanotechnology in Chemical , Biotechnology and safety

Reference Books

1	A Textbook of Nanoscience and Nanotechnology pradeep T, 2012, Tata McGraw Hill Education Pvt. Ltd. ISBN:9781259007323
2	Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", Edited byWILEY-VCH Verlag GmbH Co. KGaA, Weinheim ISBN: 3-527-30359-6, 2003

3	Kelsall Robert W., Hamley Ian W., GeogheganMark, "Nanoscale Science and Technology" ,John Wiley & Sons, Ltd, 2006.
4	KalRanganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering",McGraw-Hill Companies, Inc. ISBN: 978-0-07-162609-5, 2010

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks.. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. The marks component for each assignment is 15 marks. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Business analytics

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II **08 Hrs**

Trendiness and Regression Analysis

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit – III **08 Hrs**

Organization Structures of Business analytics

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV **08 Hrs**

Forecasting Techniques

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit –V **07 Hrs**

Decision Analysis

Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st Edition 2014
3	Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE**	**:**	**100 Marks**
Credits L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**7 Hrs**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT – II	**9 Hrs**

Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.

UNIT – III	**9 Hrs**

Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.

UNIT – IV	**7 Hrs**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – V	**7 Hrs**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components,
over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps,
iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.

CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books

1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books	
1	Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg - John 2nd Edition, 2000, Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-81-265-1256-0
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012, Tata McGraw Hill ISBN 13: 978-0-07-133346-7
4	Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER : II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**08 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	
Unit – III	**08 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**08Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**07 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes **After going through this course the student will be able to:**	
CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books	
1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 8th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11th Edition, 2013, John Wiley & Sons Inc., ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4th Edition, 2004, John Wiley & Sons, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for

conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**

Energy conservation:
Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.

Unit-II	**08 Hrs**

Wet Biomass Gasifiers:
Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages

Unit –III	**08 Hrs**

Dry Biomass Gasifiers :
Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.

Unit –IV	**08Hrs**

Solar Photovoltaic:
Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.
Wind Energy:
Classification, Factors influencing wind, WECS & classification.

Unit –V	**07 Hrs**

Alternative liquid fuels:
Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN: 9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the Industrial Internet of Things, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016 ISBN 978-87-93379-81-7

4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	
Unit – II	**08 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber: Properties, processing and applications. Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers: Properties and applications. Composites : Properties and applications.	
Unit – III	**08 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**08 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit –V	**08 Hrs**
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	

Course Outcomes
After going through this course the student will be able to:

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology, Gregory L. Timp, 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I — **08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced
composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II — **08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,
Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III — **08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics
– need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV — **07 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process,
Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V — **08 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.	
Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition- Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PHYSICS OF MATERIALS (Global Elective-09)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Crystal Structure

Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit – II **08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III **08 Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit – IV **07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit –V **08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique- spin coating, Nitinol, CuAlNi alloy and applications.

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes

After going through this course the student will be able to:

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1. Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.

2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-780
3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint 2015.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II

ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Sampling Techniques: Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.	
Unit – II	**08 Hrs**
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).	
Unit – III	**08 Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).	
Unit – IV	**07 Hrs**
Linear Statistical Models: Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).	
Unit –V	**09 Hrs**
Linear Regression: Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.	

Course Outcomes
After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.
CO3	Analyse the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1.	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10th Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.

4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SYLLABUS
FOR
SEMESTER III & IV

SEMESTER : III						
TRANSPORT PHENOMENA (Theory)						
Course Code	**:**	**18MCH31**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**

Velocity profile, Average Velocity, Shear Stress Distribution and Forces in Laminar Flow: Development of models to describe laminar flow over flat inclined plate, flow through a circular tube, flow through annulus, flow between parallel plate and through a slit, flow as wetted wall column, annular flow with inner cylinder

Velocity Distributions in Turbulent Flow: Comparison of laminar and turbulent flows, time-smoothed equations of change, Reynolds rules of averaging, Reynolds stresses, turbulence models moving.

Unit – II	**10 Hrs**

Thermal Conductivity and Mechanism of Energy Transport: Fourier law of heat conduction. Effect of Temperature and pressure on thermal conductivity, heat transfer through composite plane wall, composite cylindrical wall, composite spherical wall, Over-all heat transfer co-efficient.

Temperature Distribution in Solids and Laminar Flow: Heat conduction problems of Chemical Engineering for heat conduction with internal generation by electrical, nuclear, viscous sources, heat transfer in annular flow, conduction through walls of varying thermal conductivity as function of temperature.

Unit – III	**10 Hrs**

Diffusivity and Mechanism of Mass Transport: Fick's law of diffusion, Effect of temperature and pressure on diffusivity of liquids and gases

Concentration Distributions in Solids and in Laminar Flow: Steady state shell mass balance, Diffusion through stagnant gas and liquid film, Equi-molar counter diffusion, Diffusion with homogeneous and heterogeneous reaction, diffusion and reaction inside a porous catalyst..

Unit – IV	**12 Hrs**

Equations of Change for Isothermal Systems: Equation of continuity, equation of motion, Navier-Stokes equation in Cartesian coordinates, Modifications of all these equations to spherical and cylindrical coordinates, Application of these equations to solve simple flow problems, Couette flow and rotating cylinder.

Unit – V	**10 Hrs**

The equations of change for non-isothermal systems: Energy Equation, special forms, Use of equation to solve steady state problems. Tangential flow in annulus with viscous heat, Transportation cooling

Course Outcomes **After going through this course the student will be able to:**	
CO1	Recall fundamentals of heat, mass and momentum transfer
CO2	Explain geometry, domain and flux distribution for transfer operations
CO3	Apply laws of conservation to carry out shell balance for transfer operations
CO4	Develop steady state models involving momentum, heat and mass transfer

Reference Books	
1.	Transport Phenomena, Bird R.B., W.E. Stewart and E.N. Lightfoot, 2nd Edition, 2002, John Wiley and Sons, ISBN 81-2654-0808-6
2.	Fundamental of Momentum, Heat and Mass Transfer, Welty, J.R., C.E. Wicks and R.E. Wilson, 5th Edition 2008, John Wiley and Sons, ISBN 13 978-0470128688
3.	Advanced Transport Phenomena, John C Slattery, Cambridge University Press, 2005, ISBN 978-0-521-63565-3

4.	Brodkey R.S. and H.C.Hershey, Transport Phenomena, A United Approach, Vol 2, McGraw Hill, 1988, ISBN 0-9726635-8-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
INTERNSHIP						
Course Code	**:**	**18MCH32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes **After going through this course the student will be able to:**	
CO1	Apply engineering and management principles
CO2	Analyze real-time problems and suggest alternate solutions
CO3	Communicate effectively and work in teams
CO4	Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):
The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

Course Outcomes **After going through this course the student will be able to:**	
CO1	Conceptualize, design and implement solutions for specific problems
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply project and resource managements skills, professional ethics, societal concerns
CO4	Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)
Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulation and Objectives	45%

SEMESTER : III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18MCH33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Review-II	Methodology and Report writing	55%

Scheme for Semester End Evaluation (SEE):
Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

Course Outcomes **After going through this course the student will be able to:**	
CO1	Understand basic concepts and use of tools of computational fluid dynamics
CO2	Apply engineering approximation to obtain discretized fluid dynamics equations
CO3	Explain characteristics of regimes covered by various discretized schemes
CO4	Develop computer code to solve the discretized equations.

Reference books

SEMESTER : III

COMPUTATIONAL FLUID DYNAMICS

(Professional Elective-E1)

Course Code	**: 18MCH3E1**	**CIE Marks**	**:**	**100**	
Credits L:T:P	**: 4:0:0**	**SEE Marks**	**:**	**100**	
Hours	**: 52**	**SEE Duration**	**:**	**3 Hrs**	

Unit – I **12 Hrs**

Introduction to CFD

Introduction to CFD, CFD Applications, Numerical vs Analytical vs Experimental analysis, Modeling vs Experimentation.

Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation.

Unit – II **10 Hrs**

Differential Equations and Physical Behavior

Mathematical classification of Partial Differential Equation, , Physical examples of elliptic, parabolic and hyperbolic partial differential equations, Error Minimization Principles, Approximate solution of differential equations through variational formulation, Boundary conditions in the variational form: Primary and secondary variables, Essential and natural boundary conditions, Properties of variational form, Weighted residual approach: trial function and weighting function, Requirement of trial function and weighting function, Least square method, Point Collocation method, Galerkin's method, Rayleigh-Ritz method

Unit – III **10 Hrs**

D**iscretization**

Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term , Discretization of Unsteady State Problems, Discretization of Time Dependent Problems.

Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm

Unit – IV **10 Hrs**

Introduction to Turbulence Modeling

Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, More two-equation models: RNG κ-ε model and κ-ω model, Reynolds stress model (RSM),Large eddy Simulation (LES),Direct numerical simulation (DNS)

Unit – V **10 Hrs**

Numerical grid generation; basic ideas; transformation and mapping.

About the CFD softwares for different applications and construction of geometry and Discretions using available commercial CFD solvers. Creating and meshing a basic geometry. Any 5 Basic problems (eg. Basic flow studies in pipe Modeling a mixing elbow (2-D). Modeling a three-pipe intersection (3-D).Modeling flow in a tank, Modeling a combustion chamber (3-D).

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) minor project.

1 Computational Fluid Dynamics: The Basics with Application, Anderson, J.D., 2010 McGraw-Hill Co. Inc., ISBN: 9788131720486, 8131720489

2 Numerical Heat Transfer and Fluid Flow, Patankar, S.V, 2017, Hemisphere Publishing Corporation, ISBN: 9781138564695, 1138564699

3 Computational Methods for Fluid Dynamics, Ferziger, J.H. and Peric, M., 2014, Springer, ISBN 978-3-540-42074-3

4 An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg, H.K. and Malasekera, W, Prentice-Hall Inc., ISBN 978-0-13-127498-3

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
SOLAR PHOTOVOLTAIC SYSTEMS AND TECHNOLOGY (Professional Elective-E2)						
Course Code	**:**	**18MCH3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Introduction

Types of material- classification of semiconductor-Crystals structures, atomic bonding, energy band diagram – direct & indirect band gap semiconductors. Doping and carrier concentration - Hall effect in semiconductors – diffusion and drift of carriers, continuity equation – optical absorption – carrier recombination-Effect of temperature. P-N junctions-I-V characteristics-Types of junctions-homojunction-heterojunctions-Rectifying- Schottky barriers, MIS, and its characteristics.

Unit – II **10 Hrs**

Photovoltaic Fundamentals

Photovoltaic effect - Choice of semiconductor materials for fabrication of homojunction solar cells - equivalent circuit of a solar cell. Solar cell output parameters -Fill-factor, conversion efficiency, quantum efficiency. Effect of series and shunt resistance on the efficiency of solar cells. Variation of Open-circuit voltage and short circuit current with intensity of incident light. Effect of temperature on I-V characteristics. p-n heterojunction solar cells - criteria for choosing absorber and window layers.

Unit – III **10 Hrs**

Silicon Photovoltaics

Single crystal silicon (c-Si) ingot growth – Float Zone and Czochrolski methods – silicon wafer fabrication – wafer to cell formation - I-V characteristics and spectral response of c-Si solar cells. Factors limiting the efficiency - Polysilicon wafer fabrication methods – EFG and SRG methods. Amorphous Silicon - differences in properties between crystalline silicon and amorphous (a-Si) silicon. a-Si deposition by glow discharge method – Electrical and optical properties of a-Si. Outline of a-Si solar module processing steps. Heterojunction Intrinsic Thin film solar cell –fabrication by PECVD - I-V characteristics

Unit – IV **10 Hrs**

Thin Film Solar Cells

Principle of multi-junction cells– Structure and fabrication of GaInP/GaAs/Ge triple junction solar cell –Metamorphic solar cells. CdTe/CdS and CuInGaSe/CdS (CIGS) solar cells - Cell configuration – techniques used for the deposition of each layer- cell characteristics. Organic solar cells – Configuration and principle – Types of organic solar cells, Dye-sensitized (DS) solar cells – Principle – Configuration and performance, Basic concept of quantum dot, nano wire (NW), hot carrier and plasmonic solar cells

Unit – V **12 Hrs**

Solar Photovoltaic Systems

Photovotaic Module Assembly: Description of steps involved in the fabrication of Silicon Photovoltaic Module - Performance of Photovoltaic Module - Module Protection - Modules in series and in parallel - Use of Bypass and Blocking Diodes, Solar photovoltaic system - components – PV Array, battery, invertor and load. Applications of solar photovoltaic systems. Stand alone, Hybrid and Grid connected PV systems

Course Outcomes **After going through this course the student will be able to:**	
CO1	Understand basic concepts and use of tools of computational fluid dynamics.
CO2	Understand basic concepts and use of tools of computational fluid dynamics
CO3	Explain characteristics of regimes covered by various discretized schemes
CO4	Develop computer code to solve the discretized equations

Reference Books	
1.	Introduction to semiconductor materials and devices, M. S. Tyagi, 2008, John Wiley & Sons, ISBN: 978-812-6518-678
2.	Fundamentals of solar cells, A.L. Farenbruch, R.H. Bube, 1983, Elsevier, ISBN 978032314538
3.	Solar photovoltaics: Fundamentals, technologies and applications C.S. Solanki, 2015, Prentice Hall India, ISBN: 978-812-0343-863
4.	Terrestrial solar photovoltaics, T. Bhattacharya,1998, Narosa, ISBN 978-8173192067

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
FOOD PROCESS ENGINEERING AND TECHNOLOGY (Professional Elective-E3)						
Course Code	**:**	**18MCH3E3**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Formation and chemistry of food: Properties and significance of constituents of food -Carbohydrates, Lipids, Proteins, Vitamins, Minerals and Moisture. Nutritive aspects of food constituents.	
Unit – II	**10 Hrs**
Quality attributes of food: Appearance factors, Textural factors, Flavor factors. Visual and objectively measurable attributes. Additional quality; quality standards, quality control. Food laws and standards. Introduction to sensory evaluation of foods. **Food contamination and adulteration**: Types of adulterants and contaminants, Intentional adulterants, incidental adulterants and its effects	
Unit – III	**10 Hrs**
Food preservation: Causes for food deterioration. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation –low temperature, high temperature, preservatives, food irradiation. **Food Processing:** Milk and dairy products, vegetables and fruits, cereals, meat and meat products, fats and oils, beverages.	
Unit – IV	**10 Hrs**
Food additives: Introduction and need for food additives. Types of additives – antioxidants, chelatingagents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humecants and anti-caking agents, leavening agents, nutrient supplements, non - nutritive sweeteners, pH control agents,stabilizers and thickeners, other additives. Additives and food safety	
Unit – V	**12 Hrs**
Enzymatic and non-enzymatic reactions during storage: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases–Esterase, amylases, pectic enzymes. Proteases. Oxidoreductases–phenolases, glucose oxidase, catalos, peroxidase, lipoxygenase, oxidase. Immobilized enzymes. Uses of enzymes in food processing. Non-enzymatic reactions. Modern trends in food science: Biotechnology in food, Biofortification, Nutraceuticals, Organic foods, Packaging of foods and nutrition labeling.	

Course Outcomes

After going through this course the student will be able to:

CO1:	Comprehend the chemistry and the quality attributes of food.
CO2:	Apply biocompatible additives and packaging for food products
CO3:	Identify sources of contaminants, adulterants with its prevention for safe and healthy food.
CO4:	Evaluate different food processing and preservation technologies
CO5:	Design and develop new technologies involved in food processing

Reference Books

1.	Food Science, Norman N. Potter and Joseph H Hotchkin Avi Publishing Co., 5th Edition, 1995, ISBN: 0-8342-1265-X
2.	Foods, Facts and Principles, N. ShakuntalaManay and M. Sadaksharamurthy, 2nd Edition, 2005, New Age Publishers, , ISBN: 81-224-1325-0
3.	Food Science, B. Srilakshmi, 6th Ed., 2015, New Age International, ISBN: 978-81-224-3809-3

4.	Romeo T. Toledo; Fundamentals of Food Process Engineering; 2nd Edition, 2007, Springer, ISBN:978-0-387-29019-5

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: IV						
MAJOR PROJECT : PHASE II						
Course Code	**:**	**18MCH41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes
After going through this course the students will be able to:

CO1:	Conceptualize, design and implement solutions for specific problems.
CO2:	Communicate the solutions through presentations and technical reports.
CO3:	Apply project and resource managements skills, professional ethics, societal concerns
CO4:	Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)
Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	**Activity**	**Weightage**
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

Scheme for Semester End Evaluation (SEE):
Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1 Report Evaluation
Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2 Project Viva-voce
Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	**External Examiner**	**TOTAL**	
SEE Report Evaluation	100 marks	100 marks		200 marks
			(A)	(200/2) = 100 marks

Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator	(B)	100 marks
		Total Marks	**[(A)+(B)]/2 = 100**

SEMESTER : IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MCH42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1) The presentation shall be done by individual students.
2) The seminar topic shall be in the thrust areas of respective PG programs
3) The seminar topic could be complementary to the major project work
4) The student shall bring out the technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation along with the report.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes
After going through this course the student will be able to:

CO1:	Identify topics that are relevant to the present context of the world
CO2:	Perform survey and review relevant information to the field of study.
CO3:	Enhance presentation skills and report writing skills.
CO4:	Develop alternative solutions which are sustainable.

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.