DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

BMS COLLEGE OF ENGINEERING, BENGALURU
Autonomous College under VTU

VISION	MISSION
PROMOTING PROSPERITY OF MANKIND BY AUGMENTING HUMAN RESOURCE CAPITAL THROUGH QUALITY TECHNICAL EDUCATION & TRAINING	ACCOMPLISH EXCELLENCE IN THE FIELD OF TECHNICAL EDUCATION THROUGH EDUCATION, RESEARCH AND SERVICE NEEDS OF SOCIETY

DEPARTMENT OF CHEMICAL ENGINEERING
Program Accredited by NBA in Tier-1 format for 5 years

THIRD YEAR SYLLABUS BOOK
(5^{th} and 6^{th} Semesters)
With effect from the A.Y. 2016-17

CONTENTS PARTICULARS Pages

DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

DEPARTMENT VISION

Be a globally recognized Chemical Engineering Department by imparting quality education

DEPARTMENT MISSION

- High-quality education and experience to the budding Chemical Engineers
- Chemical Engineering graduates to assume positions in process and other allied industries
- Foster and encourage the pursuit of excellence in chemical science and engineering
- Inculcate global research potential

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates pursue profession in chemical & allied engineering
PEO2: Graduates work in diversified team
PEO3: Graduates will pursue higher education & research

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Graduates will be able to separate and purify petrochemicals, pharmaceuticals and health care products
PSO2: Graduates will automate and control processes by applying mathematics, process control, instrumentation, simulation and process modelling
PSO3: Graduates will design equipment for modern science applications

PROGRAM OUTCOMES (POs)

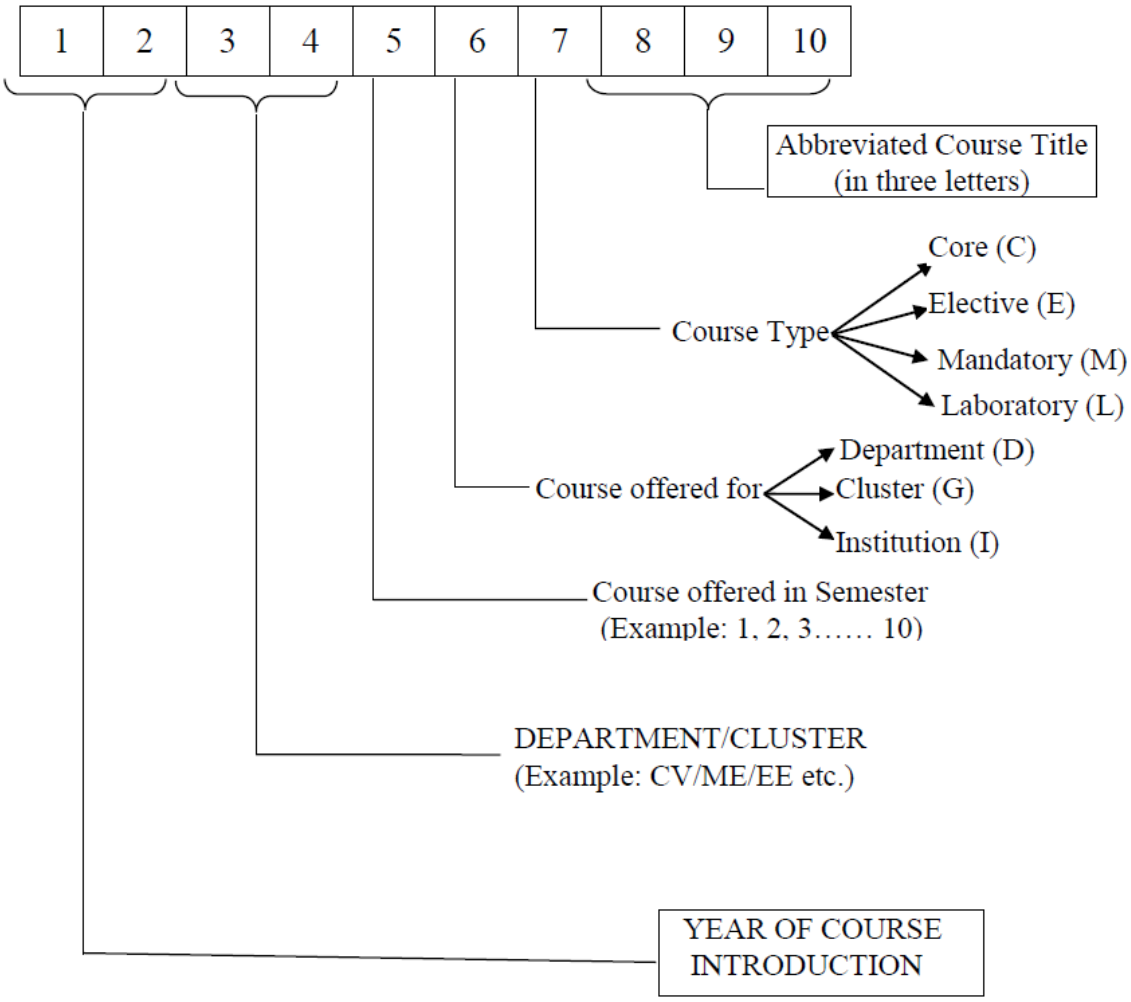
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

NOMENCLATURE FOR THE COURSE CODE



DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

SCHEME OF INSTRUCTION FOR FIFTH SEMESTER

Sl No	Subject Code										Subject Title	Credit Hours/Week				
												L	T	P	S	Total
1.	1	6	C	H	5	D	C	C	R	1	Chemical Reaction Engineering-I	3	0	1	2	6
2.	1	6	C	H	5	D	C	M	T	1	Mass Transfer-I	3	0	1	2	6
3.	1	6	C	H	5	D	C	C	E	D	Chemical Equipment Design	3	1	0	0	4
4.	1	6	C	H	5	D	C	P	C	M	Pollution Control & Management	3	0	0	0	3
Group A																
5.	1	6	C	H	5	D	E	L	A	1	Food Engineering	3	0	0	0	3
	1	6	C	H	5	D	E	L	A	2	Petroleum Refining					
Group B																
6.	1	6	C	H	5	D	E	L	B	1	Nano Materials and Technology	3	0	0	0	3
	1	6	C	H	5	D	E	L	B	2	Polymer Materials & Processing					
	Total											18	1	2	4	25

SCHEME OF INSTRUCTION FOR SIXTH SEMESTER

Sl No	Subject Code										Subject Title	Credit Hours/Week				
												L	T	P	S	Total
1.	1	6	C	H	6	D	C	C	R	2	Chemical Reaction Engineering-II	3	0	0	0	3
2.	1	6	C	H	6	D	C	P	C	E	Process Control Engineering	3	0	1	2	6
3.	1	6	C	H	6	D	C	M	T	2	Mass Transfer-II	3	0	1	2	6
4.	1	6	C	H	6	D	C	T	R	P	Transport Phenomena	3	1	0	0	4
Group C																
5.	1	6	C	H	6	D	E	L	C	1	Numerical Techniques in Chemical Engineering	3	0	0	0	3
	1	6	C	H	6	D	E	L	C	2	Operations Research					
Group D																
6.	1	6	C	H	6	D	E	L	D	1	Computer Interface in Chemical Engineering	3	0	0	0	3
	1	6	C	H	6	D	E	L	D	2	Interfacial Phenomena					
	Total											18	1	2	4	25

DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

Course Title	CHEMICAL REACTION ENGINEERING-I													
Course Code	1	6	C	H	5	D	C	C	R	1	Credits	06	L – T – P- S	3 – 0 – 1 - 2
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry, Engineering Maths and Technical Chemistry

SYLLABUS:

UNIT–I

Introduction: Scope of Chemical Reaction Engineering, Classification of reactions, Rate equation and rate of reaction, Factors affecting rate of reaction, Chemical kinetics and Thermodynamics Equilibrium, Temperature-dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reactions. 07 Hrs

UNIT-II

Non-Elementary reactions: Difference between elementary and non- elementary reactions. Kinetic models and mechanisms for non-elementary reactions and types of reactors. 06 Hrs

UNIT-III

Homogeneous reactions: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method, method of excess and method of isolation (for Reversible and Irreversible reactions up to second order).

Design of ideal reactors: Concept of ideality, Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors 10Hrs

UNIT – IV

Multiple reactor systems: Plug flow and Mixed flow reactors in Series & parallel reactions, Reactors of different types and sizes in series, Comparison of Ideal Reactors and General graphical comparison.

Design of reactors for multiple reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered). 10Hrs

UNIT- V

Non-isothermal reactors: Introduction, Material, Energy balances and conversions. Analysis of Non Isothermal Reactor: Design procedure (For single/simple reactions only). Optimum temperature Progression. 06 Hrs

LABORATORY COMPONENT

1. Batch Reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Semi batch reactor
5. Packed bed Reactor
6. RTD Studies in Tubular Reactor
7. Effect of temperature on Rate of reaction

8. RTD Studies in mixed flow reactor
9. RTD Studies in plug flow reactor

TEXT BOOK:

1. Octave Levenspeil, Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, 2001.

2. H. Scott Fogler, Elements of Chemical Reaction Engineering. 3rd Edition, Prentice Hall, 2001.

REFERENCE BOOKS:

1. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1984

2. K.A. Gavhane, Chemical Reaction Engineering-I, Volume-1, Nirali Prakashan., ISBN-13: 9788185790879, 2011.

E BOOKS

[1] Fundamentals of Chemical Reaction Engineering by M E Davis: http://authors.library.caltech.edu/25070/1/FundChemReaxEng.pdf
[2] Chemical Reaction Engineering: Beyond the Fundamentals by *Doraiswamy* : https://www.crcpress.com/Chemical-Reaction-Engineering-Beyond-the-Fundamentals/Doraiswamy-Uner/9781439831229
[3] Fundamentals of Chemical Reaction Engineering, Mark E. E. Davis, Robert J. J. Davis http://www.e-booksdirectory.com/details.php?ebook=2512

MOOC's &ONLINE COURSES:

1) http://ocw.mit.edu/courses/chemistry/5-68j-kinetics-of-chemical-reactions-spring-2003/index.htm

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Formulate and analyse the rate equations for different reactions using suitable mechanism for reaching a sustainable conclusions	PO2
CO2	Analyse and interpret the data to determine rate equation and estimate the performance equation of ideal systems	PO4
CO3	Develop optimal operational conditions for ideal reactor with single and multiple reactions	PO3
CO4	Predict reactor performance for non-isothermal conditions with consideration of public health and safety during operations	PO3
CO5	Conduct experiments in teams to collect kinetic data from both ideal and non-ideal reactors	PO9
CO6	Interpret experimental data to estimate and provide valid conclusions in terms of their kinetics and behaviour for ideal & non-ideal reactors	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	30%	Course Instructor
Self-Study Component	Open Ended Experiments/Term Papers/Modelling/Seminar/Mini projects.	20%	Committee constituted by HOD
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Theory (50%)			Practical (30%)		Self-Study (20%) by AAT	Total Marks
	Test 1	Test 2	Quiz	Records & Performances	Lab Test		
Max. Marks	20	20	10	20	10	20	100
Reduced CIE	10	10	5	10	5	10	50

Course Title	MASS TRANSFER-I													
Course Code	1	6	C	H	5	D	C	M	T	1	Credits	06	L – T – P- S	3 – 0 – 1 - 2
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Engineering Chemistry, Engineering Maths and Technical Chemistry

SYLLABUS:

UNIT–I

INTRODUCTION: Diffusion in fluids, Diffusion in solids, Measurement and Calculations of diffusivities. Eddy diffusion: Mass Transfer coefficients and their correlations, Theories of Mass Transfer, Interphase Mass Transfer, J-factor. Equipment: Membrane Operations-Ultrafiltration, microfiltration and reverse osmosis. 10Hrs

UNIT-II

HUMIDIFICATION OPERATIONS: Vapour pressure Curve, Enthalpy of pure substance, Humidity and related terminologies, Psychometric chart, Adiabatic-Saturation Curves, Wet bulb temperature, Lewis Relation and gas liquid contact operations. Equipment-Water Cooling towers and spray chamber. 07 Hrs

UNIT-III

DRYING: Introduction to drying operation, Equilibrium, Drying rate curves, Mechanism of drying. Equipment: Direct, and indirect batch driers, and rotary, spray and drum continuous driers.

07 Hrs

UNIT – IV

ADSORPTION AND ION EXCHANGE: Theories of adsorption, Industrial adsorbents. Material balance for co-current, cross current and counter current operations: Fixed Bed Adsorption, Adsorption of liquids and Ion Exchange. 08 Hrs

UNIT- V

CRYSTALLIZATION: Factors governing nucleation and crystal growth rates, Controlled growth of crystals, Incorporation of principles into design of equipment, Crystallizer equipment: Vacuum crystallizers and Draft Tube- Baffle Crystallizer. 07Hrs

LABORATORY COMPONENT

1. Diffusion co-efficient of organic vapour into air
2. Surface evaporation
3. Drying characteristics
4. Single stage adsorption
5. Solid dissolution
6. Multistage adsorption
7. Wetted wall column

TEXT BOOK:

1. Robert E. Treybal, “Mass transfer operations”, 3rd edition, McGraw Hill publications, 1980.

2. McCabe & Smith, “Unit operations in chemical engineering”, 6th edition, McGraw Hill publications, 2001.

REFERENCE BOOKS:

1. Coulson and Richardson, “Chemical Engineering”, Vol I, II , IV & V, 4th edition, Pergamon press.
2. Badger, W.L. and Banchero J.T.,"Introduction to Chemical Engineering", 3rd edition, McGraw Hill International Edition., 1999.

E BOOKS

[1] Mass Transfer in Chemical Engineering Processes, by Jozef Markoš
http://www.e-booksdirectory.com/details.php?ebook=6659

[2] Ion Exchange: Studies and Applications, Ayben Kilislioglu,
http://www.e-booksdirectory.com/details.php?ebook=10637

[3] Transport Processes and Unit Operations by Geankoplis
http://chembookneed.blogspot.in/2010/08/transport-processes-and-unit-operations.html

MOOC's & ONLINE COURSES:

[1] Mass Transfer operations 1 https://www.coursebuffet.com/sub/chemical-engineering/480/mass-transfer-operations-i

[2] Mechanical heat and mass transfer **https://www.springboard.com/udemy/mechanical-heat-and-mass-transfer/**

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Formulate equation to estimate diffusivities in fluids & solids using first principles of engineering sciences	PO2
CO2	Apprehend the analogies in transport processes for validating and reaching substantiated conclusions.	PO2
CO3	Apply mass transfer fundamentals to calculate rates of mass transfer and design the system components for various operations.	PO3
CO4	Apply of the principles of novel separation process to assess societal, health and safety by consequent responsibilities	PO7
CO5	Conduct experiments in teams related to various mass transfer operations.	PO9
CO6	Interpret experimental data to estimate mass transfer co-efficient and provide valid conclusions on suitability of the process.	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	30%	Course Instructor
Self-Study Component	Open Ended Experiments/Term Papers/Modelling/Seminar/Mini projects.	20%	Committee constituted by HOD
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Theory (50%)			Practical (30%)		Self-Study (20%) by AAT	Total Marks
	Test 1	Test 2	Quiz	Records & Performances	Lab Test		
Max. Marks	20	20	10	20	10	20	100
Reduced CIE	10	10	5	10	5	10	50

Course Title	CHEMICAL EQUIPMENT DESIGN													
Course Code	1	6	C	H	5	D	C	C	E	D	Credits	04	L – T – P- S	3 – 1 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Drawing and Process Equipment drawing

SYLLABUS:

UNIT – I

INTRODUCTION: Basic considerations in design, General design procedure, Equipment classification. Various components of process equipment, Design parameters and Pressure vessel codes. **[6L= 06Hrs]**

UNIT – II

DESIGN CONSIDERATIONS: Material selection, factors affecting design, Stresses due to static and dynamic loads (Internal & External), Temperature effects and Economic considerations.

DESIGN OF PRESSURE VESSELS: Design parameters, conditions & stresses, Design of shell and other vessel components. Design of vessel closures - Flat, Formed/Tori spherical heads, Elliptical, Hemispherical and Cylindrical heads. Numerical design problems using process parameters.
[11L+ 3T=14Hrs]

UNIT- III

VESSEL COMPONENT DESIGN: Design of supports for vessels - Bracket, Lug, Leg, Saddle and Skirt supports. Design of flanges & nozzles - Classification of flanges. Flange thickness calculation, Gasket selection and design, Bolt selection and calculation, Nozzle design.

REACTION VESSELS: Design of reaction tanks with agitator, Types of agitators, baffles, Power requirement calculations with tank dimensions, Numerical problems. **[11L+3T=14Hrs]**

UNIT – IV

STORAGE VESSELS: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases, Design of cylindrical tanks with fixed roofs, Annular ring, Base plate and selection of vessels accessories & mountings. Numerical problems with bill of materials and cost estimation.
[7L+2T=09Hrs]

UNIT - V

PIPE LINE DESIGN: Economic Pipe line sizing, Optimum size of delivery line in pumping operations with rating. Concepts of P&I Diagrams with P&I Diagram for simple processes.
[7L+2T=09Hrs]

TEXT BOOKS:

1. V V Mahajani & S B Umarji, “Joshi’s Process Equipment Design” – Trinity Press, Delhi, India 4th edition.
2. S. D. Dawande, “Process Design of Equipment”, Vol 1, Central Techno Publications. 3rd edition, 2003.
3. Brownell & Young, “Process equipment design” Willy student, 1st edition, 2009.

REFERENCE BOOKS:

1. Don W. Green & Robert H. Perry, "Chemical Engineers Handbook", 8th edition, McGraw Hill, 2014.
2. Code for United Pressure Vessel, IS 2825, Bureau of Indian standards, , New Delhi, 1969.

E BOOKS

[1] Joshi's Process equipment design
https://books.google.co.in/books/about/Joshi_s_Process_Equipment_Design.html?id=UTC1bc3PCNcC&redir_esc=y

MOOC's and ONLINE COURSES:

[1] http://nptel.ac.in/courses/103103027/28

[2] http://nptel.ac.in/courses/103103027/8

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Realize the practical applications of basic engineering design principles using first principles of mathematics and engineering sciences.	PO2
CO2	Apply reasoning and select suitable materials based on the process to assess the health and safety of the society.	PO6
CO3	Design on various reaction/pressure vessel components with environmental consideration.	PO3
CO4	Estimation of sizing of pipes, pumps & storage vessel with its accessories to provide the valid conclusions for their use.	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment by
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	POLLUTION CONTROL & MANAGEMENT													
Course Code	1	6	C	H	5	D	C	P	C	M	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Engineering Physics

SYLLABUS:

UNIT - I

WATER POLLUTION: Water as Resource, Drinking water quality, water consumption standards, Types of Water Pollutants and sources, State and central wastewater quality and its various discharge standards. Wastewater Sampling and Characteristics - Physical, Chemical and Biological characteristics of wastewater: Solving numerical on the sampling, characteristics and estimation of wastewater flow rates. 06Hrs

UNIT – II

WASTEWATER TREATMENT: Preliminary/Primary/physical unit operations, Chemical unit processes, Secondary/Biological treatment process, aerobic/anaerobic attached and suspended growth process, Sludge treatment & Disposal. Numerical problems. 07Hrs

UNIT- III

TERTIARY/ADVANCED WASTEWATER TREATMENT: Ultrafiltration, Filtration, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis, Electro dialysis cell. Wastewater treatment in Industries: Paper and Pulp, distillery, Leather, Food processing such dairy and fruit processing and Textile processing. 09Hrs

UNIT- IV

AIR POLLUTION: Definition, Sources, Classification, Properties of air pollutants, and Effects of air pollution on health, vegetation and materials. Air pollution sampling: Ambient sampling and Stack sampling, Analysis of air pollutants, Control methods and Equipment for particulates and gaseous pollutants, Applications to Industries: Thermal power plants, Metallurgical and Cement industries.

NOISE POLLUTION: Definition, Sources, Effects of Noise, Equipment for Noise Measurement, Approaches for Noise Control. 10Hrs

UNIT –V

SOLID WASTE MANAGEMENT: Definitions, Characteristics and perspectives, Types of solid wastes, Sources of Solid waste, Properties of solid waste –Numerical problems, Solid waste Management – An Overview:- Material flow in society, Reduction in raw material usage, Solid waste generation, and reuse with materials, energy recovery. 07Hrs

TEXT BOOKS:

1. Environmental Engineering by Howard S. Peavey, Donald R. Rowe, George Techobanolous, McGraw-Hill International Editions.

2. Wastewater Engineering – Treatment, Disposal and Reuse, METCALF AND EDDY, INC. 3rd Edition Tata McGraw-Hill Publishing Company Limited.

REFERENCE BOOKS:

1. C S Rao, Environmental Pollution Control Engineering, New Age International Publisher, 2011.
2. M N. Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited

E BOOKS

[1] Air Pollution by Mn Rao and Hvn Rao: http://www.avlib.in/ebook/title/air-pollution-mn-rao-and-hvn-rao-.html

[2] https://www.free-ebooks.net/ebook/introduction-to-wastewater-treatment

MOOC's & ONLINE COURSES:

[1] http://www.openculture.com/free_certificate_courses
[2] https://www.class-central.com/subject/civil-environmental-engineering
[3] https://www.class-central.com/subject/environmental-science

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Apply reasoning to identify the components of environmental eco systems and effect of pollutant on environment.	PO6
CO2	Characterize the various parameters for treatment of water, waste water and solid waste from their sources to provide valid conclusions.	PO4
CO3	Understand the impact of recovery, recycle of the useful resources from the wastes by adopting advanced techniques to demonstrate the need for sustainable development.	PO7
CO4	Identify and demonstrate the knowledge to use suitable equipment for abatement and control of air & noise pollution	PO7

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	FOOD ENGINEERING													
Course Code	1	6	C	H	5	D	E	L	A	1	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Technical Chemistry

SYLLABUS:

UNIT - I

INTRODUCTION TO FOOD ENGINEERING: Introduction: general aspects of food industry, world food demand and Indian scenario, Physical properties of food materials: Rheological models, Water activity, Fluid Flow in Food Processing: Liquid Transport Systems; Pipes for Processing Plants, Pumps for food plants; Numerical on fluid flow in food processing. 05Hrs

UNIT – II

FOOD PROCESSING AND PRESERVATION: Food deterioration – Causes, Aims and objectives of preservation and processing.

FOOD CONTAMINATION AND ADULTERATION: Types of adulterants and contaminants, Intentional adulterants, Metallic contamination, Incidental adulterants, Nature and effects, food laws and standards, Hazard analysis and critical control points or HACCP**,** Food Safety and Standards Authority of India (FSSAI) 07Hrs

UNIT- III

HIGH-TEMPERATURE PRESERVATION: Introduction to Thermal Processing; Pasteurisation; Commercial Sterilization Kinetics of Microbial Death; Thermal Death Time; Heat Transfer in Thermal Processing; Integrated F Value; Numericals; Batch & continuous Retorts for Thermal processing; Cold sterilization: Gamma irradiation; Microwave & Ohmic heating

LOW-TEMPERATURE PRESERVATION: principles of low temperature preservation; freezing rate & freezing point; physical properties of frozen food; food quality during frozen storage; freezing equipment, plate freezer, blast freezer, fluidised bed freezer, scraped surface freezer; cryogenic and immersion freezing; prediction of freezing time using Plank's equation & Nagaoka's equation.
10Hrs

UNIT- IV

FOOD ADDITIVES: Introduction and need for food additives, Types of additives – antioxidants, chelating agents, colouring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti-caking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH control agents. Preservatives: types and applications, Stabilizers and thickeners, other additives, Additives and food safety. 07Hrs

UNIT –V

EXTRUSION PROCESSES: Introduction to Extrusion, Basic Principles, Extrusion Systems, Cold Extrusion, Extrusion Cooking, Single Screw Extruders, Twin-Screw Extruders.

PACKAGING CONCEPTS: Introduction to packaging, food protection, product containment, commutation, convenience, mass transfer in packaging materials, and permeability of packaging material to fixed gases, innovations in food packaging, passive packaging, active packaging, intelligent packaging, food packaging and product shelf-life. Advances in aseptic processing and packaging, nutrition labelling. 10Hrs

TEXT BOOKS:

1. R.Paul Singh and Dennis R. Introduction to Food Engineering, Elsevier Science & Technology, 5th Edition, ISBN: 9780123985309, 2013.

REFERENCE BOOKS:

1. P.G. Smith, Introduction to Food Process Engineering Second Edition, Springer Press, ISBN 978-1-4419-7661-1, 2009
2. Subbulakshmi G. and Shobha A. Udupi, Food Processing and Preservation, New Age International Pvt. Ltd., ISBN: 8122412831, 2001

E BOOKS

[1] Food Engineering 1, Gustavo V. Barbosa-Canovas & Pablo Juliano
http://www.eolss.net/ebooklib/ebookcontents/e5-10-themecontents.pdf
[2] Food Processing, Carl J. Schaschke: **http://bookboon.com/en/food-processing-ebook**

MOOC's & ONLINE COURSES:

[1] **https://www.coursetalk.com/subjects/food-nutrition/courses**
[2] **https://www.springboard.com/topic/food-engineering**
[3] **http://elearning.vtu.ac.in/06BT74.html**

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Identify sources of contaminants, adulterants and hazard analysis to ensure the safe food processing.	PO2
CO2	Comprehend the engineering solutions involved in the packaging improvements for sustainable development of food industry.	PO7
CO3	Understand the impact of nutritional properties of food on societal and health	PO6
CO4	Discern different technological change and recent advancements involved in food preservation	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PETROLEUM REFINING													
Course Code	1	6	C	H	5	D	E	L	A	2	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Technical Chemistry

SYLLABUS:

Unit - I

COMPOSITION of CRUDE: Classification, Evaluation of petroleum, UOP-k factor. TBP analysis, EFV analysis, Average boiling point, ASTM curves, Thermal properties of petroleum fractions 06Hrs

Unit – II

PRODUCT PROPERTIES AND TEST METHODS: Reid vapor pressure analysis, Octane Number, Oxidation stability, Additives for gasoline. Characterization: flash point, fire point, Diesel and its properties, Grades of diesel, Diesel additives. 07Hrs

Unit- III

CRUDE PRETREATMENT: Pumping of crude oil, Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter. Heating of crude and crude distillation

TREATMENT TECHNIQUES: Types of impurities present, Production and treatment of LPG and LNG technology. Sweetening operations for gases: Catalytic desulphurisation 10Hrs

Unit- IV

CATALYTIC CRACKING: Various catalytic cracking processes: Fluid catalytic cracking-flexi cracking. Theory of coking, various types of coking processes. Naphtha cracking, theory and catalyst used for hydro cracking

CATALYTIC REFORMING: Theory of reforming, Factors influencing reforming, catalysts, feedstock requirements. 10Hrs

UNIT -V

THERMAL PROCESSES: Reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. 06Hrs

TEXT BOOKS:

1. Bhaskara Rao, Modern Petroleum Refining Processes Oxford & IBH Publication, 3rd Edition, Reprint, 1999.

2. Nelson, Petroleum Refinery Engineering - McGraw Hill, 4l Edition, 14th ' Reprint, 1982.

REFERENCE BOOKS:

1. Ram Prasad, Petroleum Refining Technology- Khanna Publishers, 1st Edition, 2000.

2. Sland W.F. and Davidson R.L. Petroleum Processing - McGraw Hill, 1967

E BOOKS

[1] http://www.ebooksbucket.com/engineering/petroleum-engineering

[2]Fundamentals of Petroleum Refining, http://ebookchemical.blogspot.in/2015/05/free-download-fundamentals-of-petroleum.html

[3] Handbook of Petroleum Refining Processes, Robert A. Meyers http://www.amazon.com/Handbook-Petroleum-Processes-McGraw-Hill-Handbooks-ebook/dp/B000TO0T12

MOOC's & ONLINE COURSES:

[1]. https://www.mooc-list.com/tags/refining?static=true

[2] https://www.class-central.com/subject/engineering

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Infer & identify data of composition and thermal properties in refining during treatment of petroleum.	PO2
CO2	Familiarise with the different reforming techniques used for petroleum industries that meet the specific needs with approximate considerations.	PO3
CO3	Get acquainted with cracking processes to obtain desired products, considering the impact of the processes on environment to assess the society	PO6

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	NANO MATERIALS AND TECHNOLOGY													
Course Code	1	6	C	H	5	D	E	L	B	1	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry, Technical Chemistry and Engineering Physics

SYLLABUS:

UNIT - I

INTRODUCTION: Beginning of Nanotechnology, Feynman's predictions, Moore's Law, atomic size and crystallography.

INSTRUMENTS FOR CHARACTERIZATION: Particle size determination, Surface structure, Microscopy: Transmission Electron Microscopy, Field Ion Microscopy, Scanning Microscopy; Spectroscopy: Infrared and Raman Spectroscopy, Photoemission and X-ray Spectroscopy, Magnetic resonance. 07Hrs

UNIT – II

PROPERTIES OF INDIVIDUAL NANOPARTICLES: Metal nanoclusters, Semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis: RF Plasma, Chemical Methods, Thermolysis, Pulsed Laser methods.

CARBON NANOSTRUCTURES: Carbon molecule, Clusters, Carbon nanotubes, Applications Bulk nanostructured materials: Solid disordered nanostructures, nanostructure crystals. 10Hrs

UNIT- III

NANOSTRUCTURED FERROMAGNETISM: Basics of ferromagnetism, Effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets. Optical and vibrational spectroscopy: Infrared frequency range, luminescence, nanostructures in zeolite cage. 06Hrs

UNIT- IV

QUANTUM WELLS, WIRES AND DOTS: Preparation of quantum nanostructures, Excitons, Single electron tunneling, applications: Infrared Detectors and Quantum dot lasers.

BIOLOGICAL MATERIALS: Biological building blocks, biological nanostructures. Microelectromechanical systems (MEMSs): Fabrication, Devices and Applications, Nanoelectromechanical Systems (NEMSs) - Fabrication, Devices, Applications. 10Hrs

UNIT -V

APPLICATIONS OF NANOTECHNOLOGY: Nanosensors: Chemical, Mechanical, biological and gas sensors, Drug delivery Nanoparticles, Nano-porous solids for catalysis and Nanocosmetics. 06Hrs

TEXT BOOKS:

1. Charles P. Poole, Jr., Frank J. Owens, Introduction to Nanotechnology, John Wiley and Sons, 2009.

2. Manasi Karkare, Nanotechnology – Fundamentals and Applications, International Publishing House Pvt. Ltd., 2010

REFERENCE BOOKS:

1. Handbook of Nanostructured Materials and Nanotechnology, Vol. 1-5, Academic Press, Boston, 2000.

2. CNR Rao, Nanoworld: An introduction to nanoscience and technology, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, 2010.

E BOOKS

[1]. http://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php

[2] http://www.e-booksdirectory.com/listing.php?category=238

MOOC's & ONLINE COURSES:

[1] https://www.class-central.com/subject/engineering

[2] https://www.mooc-list.com/course/nanotechnology-basics-coursera?static=true

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Understand the nanoscale hypothesis and its future	PO2
CO2	Comprehend/select the suitable fabrication technique for the synthesis of nanoparticles and nanomaterial	PO2
CO3	Identify and apply approximate instrumental techniques for characterization of nanoparticles with an understanding of their limitations to assess for future reasoning	PO6
CO4	Demonstrate the applications of nanotechnology to engineering and medical systems to assess the societal health and safety	PO7

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	POLYMER MATERIALS & PROCESSING													
Course Code	1	6	C	H	5	D	E	L	B	2	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Technical Chemistry

SYLLABUS:

UNIT – I

PRINCIPLES OF PROCESSING OF POLYMERS: Melt processing of thermoplastics. Classification of processes, crystallization, orientation & shrinkage, Co polymers blendings, Compounding for engineering application, Stress – strain behavior, Practical assessment for long term behavior. 06Hrs

UNIT – II

POLYMER EXTRUSION: Single screw and double screw extruders, Extruder zones, Extruder screws, Power calculation. Die and calibration equipment, Co extrusion, Extrusion coating, Extrusion film blowing, Reactive extrusion, Extrusion blow moulding for PET bottles, Wire drawing-PVC, Spinning . Application of various extruded products, Rheological aspects of extrusion and extrusion defects, Operations and maintenance of extrusion equipment. 09Hrs

UNIT- III

INJECTION MOULDING: Reciprocating screw injection moulding, Single impression mould, Multi-impression moulds. Hot runner moulds, gates, mould Clamping force calculations, Control of pressure, Temperature and time of injection. Thermoset and Fiber reinforced polymer injection moulding, Sandwich moulding and Injection blow moulding, Rheological aspects and defects of injection, Comparison of injection moulding and extrusion injection moulding, Operations and maintenance of injection moulding equipment, Reaction injection moulding, Applications of all Operations. 10 Hrs

UNIT- IV

COMPRESSION MOULDING, TRANSFER MOULDING, CALENDERING: Compression moulding: Applications, Principles, Derivation of compression mould thickness or compaction force, Transfer moulding, Principles and operation of calendaring, Derivation of film thickness and pressure required for rollers, Guage control during calendaring, Application of PVC calendered products. 07Hrs

UNIT –V

THERMOFORMING AND ROTATIONAL MOULDING: Thermoforming: Basic principles, Vacuum forming, Pressure forming, Description of operations. Product design.Application. Derivation of thermoformed product thickness. Rotational moulding: Principles. Operation & applications. 07Hrs

TEXT BOOKS:

1. Morton Jones, 'Principles of Polymer Processing, Chapman & Hall; 1st edition, 1989 (December 31, 1989), ISBN-13: 978-0412267000.
2. R,J. Crawford, 'Plastic Engineering, 2nd Edition, Pergamon Press, 1987, ISBN: 0080326269, 9780080326269.

REFERENCE BOOKS:

1. 'Principles of Polymer Engineering', N. G. McCrum, C. P. Buckley and C. B. Bucknall, 2nd Edition, Oxford University Press 1998, ISBN-13: 9780198565260.

E BOOKS

[1]. Principles of Polymer Processing, by Zehev Tadmor Author · Costas G. Gogos Author https://www.overdrive.com/media/105670/principles-of-polymer-processing

[2] Polymer Processing and Characterization, Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah: https://www.crcpress.com/Polymer-Processing-and-Characterization/Thomas-Ponnamma-Zachariah/9781926895154

MOOC's & ONLINE COURSES:

https://www.quora.com/Are-there-any-good-online-polymer-introductory-courses#!n=12

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Apprehend molten flow behaviour of polymer materials to design processes that meets the specific needs.	PO3
CO2	Familiarise with various processing techniques by applying reasoning informed by the contextual knowledge to assess the society.	PO6
CO3	Select suitable techniques by understanding their applications and impact of the processes to demonstrate the knowledge of need for sustainable development	PO7

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CHEMICAL REACTION ENGINEERING-II													
Course Code	1	6	C	H	6	D	C	C	R	2	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Chemical Reaction Engineering-1 and Engineering Mathematics

SYLLABUS:

UNIT - I

BASICS of NON-IDEAL FLOW: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation, Dispersion model. Tanks in series model, Conversion in non- ideal flow reactors for simple systems. 06Hrs

UNIT – II

NON CATALYTIC SYSTEMS: Introduction to Fluid-Fluid reactions, Kinetics for straight mass transfer without reaction, Kinetics for direct mass transfer with reaction for all types of reactions, significance of Hatta Number and related problems on fluid-fluid reactions,

FLUID PARTICLE REACTIONS: Introduction to Fluid-Particle reactions, selection of suitable model, Kinetics for different rate controlling steps for spherical particles of unchanging size and shrinking spherical particles, limitation of the shrinking core model, rate determining steps with combination of resistances and related problems. 10Hrs

UNIT- III

CATALYSIS: Introduction to catalysis, Properties of catalysts, Estimation methods for catalytic properties, Promoters, inhibitors etc., Mechanism of catalysis, Rate equations for different rate controlling steps. 06Hrs

UNIT- IV

DEACTIVATION: Deactivating catalyst, Mechanism, rate & performance equation,

SOLID CATALYZED REACTIONS: Rate equation for surface kinetics, heterogeneous systems, Pore diffusion resistance combined with surface kinetics, Thiele modulus and enhancement factor. 10Hrs

UNIT -V

PERFORMANCE EQUATION FOR DIFFERENT REACTION SYSTEMS: Performance equations for reactors containing porous catalyst particles, Experimental methods for finding rates, Packed bed catalytic reactor & reactors with suspended solid catalyst.

GAS-LIQUID REACTORS: Trickle Bed, Slurry reactors. Three phase fluidized bed. 07Hrs

TEXT BOOK:

1. Octave Levenspeil, Chemical Reaction Engineering, 3rd Edition, Jhon Wiley & Sons, 2001.

2. H. Scott Fogler, Elements of Chemical Reaction Engineering. 3rd Edition Prentice Hall, 2001.

REFERENCE BOOKS:

1. J.M. Smith, Chemical Engineering Kinetics -3rd Edition, McGraw Hill., 1984

2. K.A. Gavhane, Chemical Reaction Engineering-I, series Volume-1, Nirali Prakashan., ISBN-13: 9788185790879, 2011.

E BOOKS

[1] Fundamentals of Chemical Reaction Engineering by M E Davis: http://authors.library.caltech.edu/25070/1/FundChemReaxEng.pdf

[2] Chemical Reaction Engineering: Beyond the Fundamentals by *Doraiswamy* : https://www.crcpress.com/Chemical-Reaction-Engineering-Beyond-the-Fundamentals/Doraiswamy-Uner/9781439831229

[3] Fundamentals of Chemical Reaction Engineering, Mark E. E. Davis, Robert J. J. Davis http://www.e-booksdirectory.com/details.php?ebook=2512

MOOC's &ONLINE COURSES:

2) http://ocw.mit.edu/courses/chemistry/5-68j-kinetics-of-chemical-reactions-spring-2003/index.htm

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Apply knowledge of material balance to design non-ideal systems & analyse/ interpret its performance with ideal systems.	PO4
CO2	Develop rate expression for different reaction mechanisms using suitable models for catalytic & non catalytic reactions with an understanding of the their limitations	PO5
CO3	Develop design equation using models for heterogeneous reaction systems that meets the specific needs with approximate consideration of economics and safety	PO3

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

DEPARTMENT OF CHEMICAL ENGINEERING

BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

Course Title	PROCESS CONTROL ENGINEERING													
Course Code	1	6	C	H	6	D	C	P	C	E	Credits	06	L – T – P- S	3 – 0 – 1 - 2
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Maths and Basic Electrical Engineering

SYLLABUS:

UNIT–I

FIRST ORDERSYSTEMS: Thermometer level in a tank, mixing tank, STR, Linearization of I-order systems in series, Response for various input forcing functions 05Hrs

UNIT-II

SECOND ORDER SYSTEMS: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case-terms associated, transportation lag. 10Hrs

UNIT – III

CLOSED LOOP SYSTEM: Basic components, Servo and regulator control, Controllers- P, I, D and On-Off modes, Controller combinations-Final control elements-Valves, actuators and valve positioners. 07Hrs

UNIT – IV

CLOSED LOOP RESPONSE: Block diagram, closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and their characteristics. 07Hrs

UNIT- V

STABILITY: Stability of linear control systems, RouthTest, Frequency Response- Bode diagrams,

CONTROL SYSTEM DESIGN BY FREQUENCY RESPONSE: Bode criterion, Gain and Phase margins. Ziegler-Nichols controller tuning, Cohen-Coon controller tuning

ROOTLOCUS: Rules for plotting and problems. 10Hrs

LABORATORY COMPONENT

1. Thermometer
2. Single tank-Step Response
3. Non Interacting Tanks-Step Response
4. Interacting Tanks-Step Response
5. Pressure Vessel
6. Single tank-Impulse Response
7. Non Interacting Tanks-Impulse Response
8. Interacting Tanks-Impulse Response
9. Level control-P controller, PI controller, PD controller, PID controller
10. Valve characteristics
11. Temperature Control-P Controller, PI Controller, PID Controller

TEXT BOOK:

1. Coughner & Koppel, Process System Analysis and Control-McGrawHill, New Delhi, 2nd Edition,1991.

REFERENCE BOOKS:

1. Coulson& Richardson, Chemical Engineering Vol 3, 3rd Edition-Pergamon Pess, 1998.

2. George Stephanopoules, Chemical Process Control-and Introduction to Theory & Practical, Prentice Hall NewDelhi, 1998.

E BOOKS

[1] http://www.ourmumbaicity.com/ebooks

[2] http://www.leka.lt/sites/default/files/dokumentai/process-control.pdf

MOOC's &ONLINE COURSES:

[1]. https://www.mooc-list.com/

[2] http://elearning.vtu.ac.in/06IT64.html

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Formulate transfer functions, predict responses to various forcing functions to interpret the data to provide valid conclusions.	PO4
CO2	Select suitable controller and evaluate the response behaviour of the controllers to model complex engineering problems with an understanding of the limitations	PO5
CO3	Verify the stability of control systems to understand the impact of the professional engineering solutions and demonstrate the knowledge of need for sustainable development	PO7
CO4	Conduct experiments in teams to collect data for different functional inputs to various process with and without controllers	PO9
CO5	Interpret experimental data to estimate and provide valid conclusions which encourages to recognise the need to engage in independent and life-long learning	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	30%	Course Instructor
Self-Study Component	Open Ended Experiments/Term Papers/Modelling/Seminar/Mini projects.	20%	Committee constituted by HOD
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Theory (50%)			Practical (30%)		Self-Study (20%) by AAT	Total Marks
	Test 1	Test 2	Quiz	Records & Performances	Lab Test		
Max.Marks	20	20	10	20	10	20	100
Reduced CIE	10	10	5	10	5	10	50

Course Title	MASS TRANSFER-II													
Course Code	1	6	C	H	6	D	C	M	T	2	Credits	06	L – T – P- S	3 – 0 – 1 - 2
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Mass Transfer-1 and Engineering Maths

SYLLABUS:

UNIT–I

GAS LIQUID CONTACTING SYSTEMS: Liquid and gas dispersion: Types, construction and working of tray and packed columns, types and properties of packing, tray efficiencies, HETP and HTU concepts, Concept of flooding, weeping, and entrainment, Comparison of tray and packed columns.

ABSORPTION: Equilibrium solubility of gases in liquids, One component transferred: Material balances, Counter current multistage operations: Isothermal only, Continuous contact equipment: Absorption of one component, Overall coefficients and transfer units, dilute solutions, Overall heights of transfer units, Design of packed towers from the data of NTU. Absorption with chemical reaction 10Hrs

UNIT-II

DISTILLATION: Introduction, Vapour liquid equilibrium, Estimation of VLE data, VLE for multicomponent systems, Flash vapourisation, Simple or differential distillation, Steam distillation, Continuous rectification, Design using McCabe Thiele method for binary mixtures and related problems. 09Hrs

UNIT-III

DESIGN OF DISTILLATION COLUMN: Ponchon-Savarit method, Efficiencies- overall, local, and Murphree plate efficiencies: Reboilers, Use of open steam, Vacuum, Molecular, Extractive and Azeotropic distillations. 07Hrs

UNIT-IV

LIQUID-LIQUIDEXTRACTION: Introduction, Ternary equilibrium, Solvent selection, Equipment and flow sheets: Single stage, Multi-stage cross-current, Insoluble systems, Continuous counter current multistage extraction, Equipment: Stage efficiency, stage type extractors (no design aspects): Mixer-settler cascades, Continuous contact equipment: packed towers, Rotating disc contactor, Pulsed column, Sheibel extractor, and centrifugal extractor. 07Hrs

UNIT- V

LEACHING OPERATION: Introduction, Preparation of solid, Equipment for unsteady state operation and steady state operation, Methods of calculation: Equilibrium diagrams, Single stage and multi-stage cross and counter current operations, Counter current, constant underflow case, leaching operation. 06Hrs

LABORATORY COMPONENT

1. Simple distillation
2. Steam distillation
3. Single stage leaching
4. Packed column distillation
5. Single stage extraction
6. Multistage extraction
7. Multistage Leaching

TEXT BOOK:

1. Robert E Treybal, Mass Transfer Operations-3rd edition, McGrawHill, 1981.
2. McCabe & Smith, Unit Operations in Chemical Engineering, 6th edition, McGraw Hill, 2001

REFERENCE BOOKS:

1. Coulson and Richardson, Chemical Engineering, Vol-II and V-4th Edition PergamonPress, 1998.

2. Badger & Banchero, Introduction to Chemical Engineering-TMH, 1998.

E BOOKS

[1] Mass Transfer in Chemical Engineering Processes, by Jozef Markoš
http://www.e-booksdirectory.com/details.php?ebook=6659
[2] Ion Exchange: Studies and Applications, Ayben Kilislioglu,
http://www.e-booksdirectory.com/details.php?ebook=10637
[3] Transport Processes and Unit Operations by Geankoplis
http://chembookneed.blogspot.in/2010/08/transport-processes-and-unit-operations.html

MOOC's & ONLINE COURSES:

[1] http://elearning.vtu.ac.in/BT32.html
[2] http://nptel.ac.in/courses/103104046/

COURSE OUTCOMES (COs):

	COURSE OUTCOMES	PROGRAMME OUTCOMES
CO1	Design various mass transfer equipment that meets the specific needs with approximate consideration of economics, public health and safety	PO3
CO2	Use the knowledge of mass balance and composition balance in interfacial mass transfer to analyse and interpret experimental and theoretical data	PO4
CO3	Apply the concept of interfacial mass transfer in multiphase contact processes to understand the impact of engineering solutions in environmental contexts and society	PO7
CO4	Conduct experiments in teams to collect data for different mass transfer operations	PO9
CO5	Interpret experimental data to estimate and provide valid conclusions which encourages to recognise the need to engage in independent and life-long learning	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	30%	Course Instructor
Self-Study Component	Open Ended Experiments/Term Papers/Modelling/Seminar/Mini projects.	20%	Committee constituted by HOD
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Theory (50%)**			**Practical (30%)**		**Self-Study (20%) by AAT**	**Total Marks**
	Test 1	**Test 2**	**Quiz**	**Records & Performances**	**Lab Test**		
Max.Marks	20	20	10	20	10	20	100
Reduced CIE	10	10	5	10	5	10	50

Course Title	TRANSPORT PHENOMENA													
Course Code	1	6	C	H	6	D	C	T	R	P	Credits	04	L – T – P- S	3 – 1 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Drawing and Process Equipment drawing

SYLLABUS:

UNIT – I

INTRODUCTION: Momentum, Energy and Mass Transport operations, Newton's law of viscosity(NLV), Newtonian and Non-Newtonian fluids, Fourier's law of heat conduction(FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids. Numerical problems. **[6L+1T=07Hrs]**

UNIT – II

VELOCITY DISTRIBUTION IN LAMINAR FLOW: Different Flow situations, Steady state Shell momentum balances Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus. Flow between parallel plates and a slit. Numerical problems. **[11L+ 3T=14Hrs]**

UNIT- III

STEADY STATE SHELL ENERGY BALANCES: General Boundary conditions applicable to energy transport problems of chemical engineering, Heat conduction through compound walls, Overall heat transfer coefficient based on inner and outer surface area.

TEMPERATURE DISTRIBUTION IN SOLIDS AND IN LAMINAR FLOW: Heat conduction with internal generation by electrical, nuclear, viscous energy sources, Numerical problems. Heat conduction in cooling fin, forced and free convection heat transfer. **[10L+4T=14Hrs]**

UNIT – IV

CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW: Steady state shell mass balances, General Boundary conditions applicable to mass transport problems of chemical engineering, Diffusion through stagnant gas and liquid films, Equimolar counter diffusion. Numerical problems.

CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW: Diffusion with homogeneous and heterogeneous reaction. Diffusion into falling film- Forced convection masstransfer. Numerical problems. **[7L+3T=10Hrs]**

UNIT - V

ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT: Reynold's, Prandtl's and Chilton & Colburn analogies.

EQUATIONS OF CHANGE: Equation of continuity, Equation of motion; Navier-Stokes equation, Euler's equation. **[5L+2T=07Hrs]**

TEXT BOOKS:

1. Bird, Stewart and Lightfoot,'TransportPhenomena',2nd Edition, AcademicPress,1994

REFERENCE BOOKS:

1. Welty, Wikes and Watson,'Momentum Heat and Mass Transport, 4th Edn. John Wileyr

E BOOKS

[1]. http://www.freeengineeringbooks.com/Chemical/Transport-Phenomena.php
[2] http://www.hailienene.com/resources/transport-phenomena.pdf

MOOC's and ONLINE COURSES:

[1]. https://www.mooc-list.com/course/basics-transport-phenomena-edx?static=true
[2]. https://www.springboard.com/topic/transport-phenomena

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Analyze the steady state operations for momentum, heat & mass transfers to interpret practical data to provide valid conclusions	PO4
CO2	Apply appropriate reasoning for shell momentum, energy & mass balances for laminar flows across various geometry and boundary conditions to predict and model the behaviour.	PO5
CO3	Understand the impact of equation of changes in various co-ordinate systems with its influence on analogies between momentum, heat and mass transport which encourages them to engage in independent and life-long learning	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment by
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	NUMERICAL TECHNIQUES IN CHEMICAL ENGINEERING													
Course Code	1	6	C	H	6	D	E	L	C	1	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Heat Transfer**,** Chemical Reaction Engineering-1, Chemical Reaction Engineering 2, and Engineering Mathematics

SYLLABUS:

UNIT - I

MATHEMATICAL FORMULATION OF THE PHYSICAL PROBLEMS: Applications of law of conservation of mass in: mixing tank system, equilibrium batch still and single stage extraction. Applications of law of conservation of energy in: Gas compression, system, and Flow of heat from a fin and related numerical problems for all above physical systems.

07 Hrs

UNIT – II

MATHEMATICAL FORMULATION OF COMPLEX PROBLEMS: Mass transfer with reaction for gas-liquid contact, heat transfer through multiwall cylinders and spheres, heat transfer in a jacketed vessel, rate expression for series and parallel homogenous reactions and related numerical problems. 06 Hrs

UNIT- III

APPLICATION OF NON LINEAR ALGEBRAIC EQUATION: Pressure drop in pipe, Minimum fluidization velocity – Use of Newton – Raphson method.

APPLICATION OF INITIAL VALUE PROBLEMS: Stirred tank with coil heater, Series of stirred tanks with coil heaters, Batch reactors, Plug flow reactors and unsteady state stirred tank reactors – Use of RK method.

APPLICATION OF FINAL VALUE PROBLEMS: One dimensional steady state heat conduction, Chemical reaction and diffusion in a pore – Use of discretization technique. 10Hrs

UNIT- IV

FORMULATIONS OF PARTIAL DIFFERENTIAL EQUATIONS: Formulations of partial Differential equations for the continuity equation, Fick's second law of diffusion and heat conduction in rectangular coordinates.

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: Solution for heat conduction equation, solution for Laplace's equation using finite difference method.

FINITE DIFFERENCES METHOD FOR STAGE PROCESSES: Analysis of stage-wise Processes like multistage counter-current extraction, stirred-tank reactor system.

10 Hrs

UNIT –V

Applications of Laplace Transforms: Applications to chemical engineering like level/temperature in a single tank system, mixing tank, CSTR with first order reaction, interacting system and non-interacting system. 06Hrs

TEXT BOOKS:

1. Mickley H.S., Sherwood T.K. and Reed C.E., Applied Mathematics in Chemical Engineering - 3rd Edition, Tata McGraw Hill, 1999.
2. Jenson V.G. &Jeggreys G.V., Mathematical Methods in Chemical Engineering, 1977

REFERENCE BOOKS:

1. Rose L.M. Applications of Mathematical Modeling to Process Development and Design,- AppliedSciencePublishersLtd.,London,1998.
2. William. L Luyben, Process Modeling Simulation and Control for Chemical Engineering 2nd Edition, McGraw Hill, 1990.

E BOOKS

[1] http://www.amazon.in/Applied-Mathematics-Modeling-Chemical-Engineers-ebook/dp/B009I06RKU

[2]. http://www.worldcat.org/title/applied-mathematics-in-chemical-engineering/oclc/557742198

MOOC's & ONLINE COURSES:

[1] https://www.mooc-list.com/categories/mathematics?static=true

[2] http://www.moocs.co/Higher_Education_MOOCs.html

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Develop ordinary and partial differential equations to solve chemical engineering problems for reaching substantiated conclusions using first principles of mathematics	PO2
CO2	Use knowledge of numerical methods to solve the developed differential equations to analyse and interpret the behaviour of different processes.	PO4
CO3	Apply finite difference method to predict and model various unit operations and processes by understanding the limitations	PO5

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	OPERATIONS RESEARCH													
Course Code	1	6	C	H	6	D	E	L	C	2	Credits	03	L – T – P- S	3 – 0 – 0 - 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics and

SYLLABUS:

UNIT - I

INTRODUCTION: Definition. Scope of Operations Research, Approach and limitations of O.R-Models, Characteristics and phases of O.R, Linear Programming Problems: Mathematical formulation of L.P, Problems and Graphical solution method. 06Hrs

UNIT – II

ASSIGNMENTPROBLEMS: Balanced and Unbalanced assignment problems, Maximization assignment problems, travelling salesman problems. 06Hrs

UNIT- III

TRANSPORTATION PROBLEM: Basic feasible solutions by different methods, finding optimal solution, MODI method, Degeneracy, Unbalanced transportation problems, Maximization Problems. 09Hrs

UNIT- IV

SEQUENCING: Johnson's algorithm, njobs-2machines, njobs-3, machines and njobs-n machines without passing sequence, 2jobs-n, machines, Graphical solutions. 08Hrs

UNIT –V

PERT-CPM TECHNIQUES: Network construction, Determining time estimates and critical path, in network analysis, Variance and probability of completing the project, Calculation of different floats, Project duration, Crashing of simple networks. 10Hrs

TEXT BOOKS:

1. S.D.Sharma, Operation Research-8th Edition, Kedarnath & Co,2003.
2. Kantiswaroop, P. K.Gupta and Manmohan, Operation Research-9th Edition, S Chand & Co.1999

REFERENCE BOOKS:

1. L.S.Srinath, Introduction to Pert and CPM-3rd Edition,EastWest,1998
2. Hospach Buchan and Earnest Koenigberg, Scientific Inventory Management-1989.

E BOOKS

[1] http://www.faadooengineers.com/threads/3345-Operations-Research-(OR)-Ebook-Lecture-Notes-Handouts-Full-Syllabus

[2] http://www.freetechbooks.com/operations-research-f54.html

MOOC's & ONLINE COURSES:

[1] https://www.springboard.com/topic/operations-research

[2] https://www.quora.com/Are-there-good-online-courses-for-Operations-Research

COURSE OUTCOMES (COs):

	COURSE OUTCOMES	Programme Outcomes
CO1	Use knowledge of linear programming to formulate, analyse complex problems to obtain optimum solutions for numerical problems	PO3
CO2	Apply appropriate techniques to solve assignment, transportation and sequencing problems for prediction its optimal solutions by understanding their limitations	PO5
CO3	Illustrate network constructions and find feasible Engineering solutions for optimization of societal problems	PO6

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	**COMPUTER INTERFACE IN CHEMICAL ENGINEERING**														
Course Code	**1**	**6**	**C**	**H**	**6**	**D**	**E**	**L**	**D**	**1**	**Credits**	**03**	**L – T – P- S**	**3 – 0 – 0 - 0**	
CIE	**100 marks (50% weightage)**										**SEE**	**100 marks (50% weightage)**			

PREREQUISITES: Chemical Reaction Engineering, Mass Transfer and Engineering Mathematics

SYLLABUS:

UNIT - I

REVIEW ON C–PROGRAMMING: Constant and name variable declaration, basic input and output statement, operators. Conditional statements: if-else, nested if-else and switch/case statements. Looping Statements: for loop, while loop and do-while loop statements. Arrays: Declaration of arrays, storing values in arrays, operations that can be performed on arrays, dimensional arrays for inter-function. Creating functions in C. 06Hrs

UNIT – II

NUMERICAL COMPUTATION USING C: Non-linear algebraic equation using Newton Raphson. Ordinary Differential Equation using R-K Method, Numerical Integration using Simpson's 1/3 Rule. Curve fitting using linear regression and non-linear regression methods. Algorithm and C–programs for all numerical methods. 06Hrs

UNIT- III

PREDICTION OF PHYSICAL PROPERTIES USING C: Vapor- Liquid equilibria for binary mixtures, Calculation of Bubble Pressure and Bubble Point. Calculation of Dew Pressure and Dew point for Ideal Binary and multi-component system, Flash Vaporization for multi-component system. 07Hrs

UNIT- IV

APPLICATIONS OF C IN HEAT AND MASS TRANSFER OPERATIONS: Design of Distillation column, Design of single stage Evaporation, design of double pipe heat exchanger (Area, Number of tubes, Pressure drop) and design of shell and tube heat exchanger(Area, Number of tubes, Pressure drop).

APPLICATION OF C IN REACTOR DESIGN: Design of ideal isothermal Batch, plug flow and CSTR rectors. C-programing for CSTRs in series for both constant and variable volume. 10Hrs

UNIT -V

INTRODUCTION TO MAT LAB: MAT Lab environment, developing M-files, Basic output and input statements, conditional statements, looping statements and plotting.

APPLICATIONS USING MAT LAB IN CHEMICAL ENGINEERING: Specific volume of real gases, bubble point and dew point calculation, simple differential distillation, reactor tanks, crystallization. 10Hrs

TEXT BOOKS:

1. Raul Raymond Kapuno., "Programming for Chemical Engineers Using C, C++, and MATLAB", Infinity Science Press, 2010.
2. Pradeep Ahuja, "Introduction to Numerical Methods in Chemical Engineering", PHI Learning Pvt. Ltd., 2010

REFERENCE BOOKS:

1. William. L Luyben, "Process Modeling Simulation and Control for Chemical Engineering", 2nd Edition., McGraw Hill, 1990

E BOOKS

[1]. http://www.amazon.in/Programming-Chemical-Engineers-MATLAB-Engineering/dp/1934015091
[2] http://www.jblearning.com/catalog/9781934015094/

MOOC's & ONLINE COURSES:

[1]. http://ocw.mit.edu/courses/
[2]. http://www.openculture.com/engineering_free_courses

COURSE OUTCOMES (COs):

	COURSE OUTCOMES	Programme Outcomes
CO1	Select and apply approximate C-programmes and MAT lab codes for solving complex chemical engineering problems	PO5
CO2	Use suitable numerical methods to solve iterative chemical engineering problems to provide valid conclusions	PO4
CO3	Apply the knowledge of C-programming concepts to design and interpret the behavior of mass, heat transfer and reaction engineering operations to assess societal, health, safety and legal issues.	PO6

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	**INTERFACIAL PHENOMENA**													
Course Code	**1**	**5**	**C**	**H**	**6**	**D**	**E**	**L**	**D**	**2**	**Credits**	**03**	**L – T – P- S**	**3 – 0 – 0 - 0**
CIE	**100 marks (50% weightage)**										**SEE**	**100 marks (50% weightage)**		

PREREQUISITES: Chemical Reaction Engineering-1 and Engineering Mathematics

SYLLABUS:

Unit - I

INTRODUCTION: Concept of Interface, Surface Tension, Equivalence in the concepts of surface energy and surface tension, Applications on interfacial science in industries.

EXCESS PRESSURE: Generalized equation for excess pressure across a curved surface-the equation of Young and Laplace and its application, Kelvin's equation and its application, Capillary condensation, Super Saturation, Nucleation. 07Hrs

UNIT – II

MEASUREMENT OF INTERFACIAL TENSION: Capillary rise method, Drop weight method, Wilhelmy plate method, Du Nuoy method, Methods based on shape of static drops or bubbles. 06Hrs

UNIT- III

WETTING FUNDAMENTALS AND CONTACT ANGLES: Work of adhesion, cohesion, criteria for spreading of liquids, kinetics of spreading, lens formation-three phase systems. Young's equation, contact angle hysteresis

EMULSIONS AND MICRO EMULSIONS: The conditions required to form emulsions and micro-emulsions, charged colloids, emulsions in food science, photographic emulsions. 10Hrs

UNIT- IV

Electrical aspects of surfaces: The electrical double layer, Stern treatment of electrical double layer, Free energy of a diffused double layer, Repulsion between two plane double layers, colloidal dispersions, combined attractive and electrical interaction-DLVO theory. 07Hrs

UNIT -V

SURFACTANTS: Introduction to surfactants, common properties of surfactant solution, Thermodynamics of surfactant self-assembly, self-assembled surfactant structures, surfactants and detergency.

SURFACTANT BASED SEPARATIONS: Fundamentals, Classification of surface active molecules like proteins and enzymes, Surfactants at interphases and in-bulk, Liquid membrane permeation, Foam separations, Micellar separations, Soil remediation. 09Hrs

TEXT BOOKS:

1. Pallab Ghosh, Colloids and Interface Science, Prantice Hall Publications

REFERENCE BOOKS:

1. A.W. Adamson, Physical chemistry of surfaces, John Wiley,1997.edition,
2. Duncan J. Shaw, Butter worth Heinemann, Introduction to colloid and surface chemistry,4th edition.

E BOOKS

[1].http://www.freebookcentre.net/chemistry-books-download/An-Introduction-to-Surface-Chemistry.html

[2] https://archive.org/details/introductiontosu017148mbp

MOOC's & ONLINE COURSES:

[1]. http://www.rsc.org/eic/2015/03/mooc-massive-open-online-course

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Comprehend the concept of surface and interfacial tension to identify and select surface tension measuring instruments for measuring tensions.	PO2
CO2	Understand the impact of factors influencing stability of emulsions to demonstrate their engineering solutions in environmental context.	PO7
CO3	Comprehend about detergency, surfactants and their applications which encourages to engage in lifelong learning in the context of technological change	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50