KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

Great Place To Work Certified MAR 2022 - MAR 2023 INDIA

B.TECH. – Chemical Engineering

Curriculum and Syllabi

Regulations – 2021

KPRIET
Learn Beyond

I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of industry, society, the nation and the world at large

Mission

- Commitment to offer value-based education and enhancement of practical skills.
- Continuous assessment of teaching and learning processes through scholarly activities.
- Enriching research and innovation activities in collaboration with industry and institutes of repute.
- Ensuring the academic processes to uphold culture, ethics and social responsibilities.

II. Vision and Mission of the Department

Vision

To become a center of academic and research excellence in chemical engineering, empowering students, supporting innovation, and making meaningful contributions to industry, society, and the global community.

Mission

- Providing quality education that integrates values and practical skills to ensure effective learning outcomes
- Promoting research, innovation, and collaboration with industry and reputed institutes to bridge academia and industry.
- Inculcating professionalism, ethics, lifelong learning and social responsibilities.

III. Program Educational Objectives (PEOs)

Graduates of B.Tech. Chemical Engineering will

PEO1: Apply knowledge of mathematics, science, and engineering to solve complex chemical engineering problems in diverse chemical and its allied industries.

PEO2: Design, develop, and optimize chemical processes and products that meet realistic constraints such as economic, environmental, social, ethical, health safety and sustainability

PEO3: Exhibit a commitment to lifelong learning and professional development, and will contribute to the advancement of the field of chemical engineering and allied engineering through research, development, and innovation.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

IV. Program Outcomes (POs)

Graduates of B.Tech. Chemical Engineering will be able to

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 and 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 **Engineer and society:** Apply reasoning informed by the contextual knowledge to access 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.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VII. Mapping of Course Outcomes with Program Outcomes

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Calculus and Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	✓
	Basics of Mechanical Engineering	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	✓
	English for Technologists	-	-	-	-	-	-	-	-	✓	✓	-	✓	✓	✓
	Engineering Physics	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓
	Engineering Chemistry	✓	✓	-	-	-	-	✓	-	✓	-	-	✓	✓	✓
	Problem Solving and C Programming	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Engineering Graphics	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	✓
SEM II	Laplace Transforms and Complex Variables	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
	Materials Science	✓	✓	-	-	-	✓	-	-	-	-	-	✓	✓	✓
	Basics of Electrical and Electronics Engineering	-	-	-	-	-	-	✓	✓	✓	-	-	✓	✓	✓
	Introduction to Chemical Engineering	✓	✓	✓	✓	✓	-	✓	✓		✓	-	✓	✓	✓
	Personality Enhancement	-	-	-	-	-	-	-		✓	✓	-	✓	✓	✓
	Chemistry for Technologists	✓	✓	-	-	-	-	✓	-		-	-	✓	✓	✓
	Python Programming	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Manufacturing Practices	✓	✓	✓	-	✓	-	✓	-	✓	✓	-	✓	✓	✓
	Environmental Sciences	✓	✓	-	✓	✓	-	-	-	✓	-	-	✓	✓	✓

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

V. Program Specific Outcomes (PSOs)

Graduates of B.Tech. Chemical Engineering will be able

PSO 1: To identify, formulate, and solve chemical engineering problems, including those related to process design and optimization, materials selection and synthesis, and energy and environmental systems.

PSO 2: To use modern engineering tools and techniques to solve chemical engineering and allied engineering problems and engage in life-long learning by innovative practices for process and product development to stay current with advancements in the field.

VI. PEO/PO Mapping

Following three levels of correlation should be used:

1. Low
2. Medium
3. High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	1	2	2	-	-	-	-	-	-	-
PEO2	-	-	2	1	2	3	2		2	2	-	-
PEO3	-	-	-	-	-	2	2	3	3	2	2	2

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM III	Probability and Statistics	✓	✓	-	-	-	-	-	-	-	-	-		✓	✓
	Process Calculations	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	Mechanical Operations	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	Fluid Mechanics for Chemical Engineers	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	Environmental Science and Engineering	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	✓	✓	✓
	Technical Analysis Laboratory	✓	✓	✓	-	-	✓	✓	-	✓	-	-	✓	✓	✓
	Basic Electrical and Electronics Engineering Laboratory	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Essence of Indian Traditional Knowledge	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
SEM IV	Partial Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
	Chemical Engineering Thermodynamics - I	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓
	Engineering Materials	✓	✓	✓	-	✓	✓	✓	-	✓	✓	-	-	✓	✓
	Mass Transfer I	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Process Heat Transfer	✓	✓	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓
	Fluid Mechanics Laboratory	✓	-	✓	✓	-	-	-	-	✓	-	-	-	✓	✓
	Mechanical Operations Laboratory	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	✓	✓
	Soft Skills – I	-	-	-	-	-	-	-	-		✓	-	✓	✓	✓
	Indian Constitution	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM V	Computational Techniques	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
	Chemical Engineering Thermodynamics II	✓	✓	✓	-		-	-	-	✓	-	-	✓	✓	✓
	Mass Transfer - II	✓	✓	-	-	✓	-	-	-	-	✓	-	-	✓	✓
	Mass Transfer Laboratory	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	✓	✓
	Heat Transfer Laboratory	✓	✓	-	✓	-	-	-	-	✓	✓	-	✓	✓	
	Soft Skills – II	-	-	-	-	-	-	-	-	✓	✓	-	-		
	Cyber Security Essentials	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
SEM VI	Chemical Reaction Engineering I	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓
	Chemical Process Industries	✓	✓	-	-	-	-	-	-	✓	✓	✓	-	✓	✓
	Process Instrumentation Dynamics and Control	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Chemical Reaction Engineering Laboratory	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓
	Soft Skills - III	-	-	-	-	-	-	-	-	✓	✓	-	-	✓	✓
	Introduction to UNSDGs: An Interrogative Approach	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	✓
SEM VII	Process Engineering Economics	✓	✓	✓	✓	-	-	-	✓	✓	-	-	-	✓	✓
	Chemical Reaction Engineering II	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓
	Process Equipment Design	✓	✓	✓	✓	-	-	-	✓	✓	-	-	✓	✓	✓
	Process Control Laboratory	✓	✓	✓		✓	-	-	-	-	-	-	✓	✓	✓
	Project work Phase - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VIII	Project work Phase - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VERTICAL I	Polymer Science Engineering	✓	✓	✓	-	-	✓	✓	-	-	-	-	-	✓	-
	Chemical Metallurgy	✓	✓	✓	-	-	✓	-	-	-	-	-	-	✓	-
	Fluidization Engineering	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Process Plant Utilities	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Industrial Safety	✓	✓	✓	-	-	-	✓	✓	-	-	-	-	✓	-
	Pulp and Paper Technology	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	-
VERTICAL II	Fertilizer Technology	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Biochemical Engineering	✓	✓	✓	-	-	-	-	✓	✓	✓	✓	-	-	-
	Nanoscience and Nanotechnology	✓	✓	-	✓	-	✓	✓	✓	-	-	-	-	-	-
	Enzyme Engineering	✓	-	-	-	-	✓	✓	✓	-	-	-	-	✓	-
	Fermentation Engineering	✓	✓	-	-	-	✓	✓	-	-	-	-	-	✓	-
	Drugs and Pharmaceutical Technology	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	✓
VERTICAL III	Corrosion Engineering	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	✓	-
	Petroleum Equipment Design	-	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Oil and Gas Engineering	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
	Supply Chain Management	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Petroleum Refining and Petrochemicals	✓	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	-
	Piping and Instrumentation in Chemical Plants	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
VERTICAL IV	General Aspects of Energy Manufacturing and Energy Audit	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	✓	✓	-
	Energy Efficiency in Electrical and Thermal Utilities	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
	Energy Performance Assessment for Equipment and Utility Systems	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓
	Bioenergy	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓
	Renewable and Non-Renewable Energy Resources	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	Hydrogen and Fuel Cell Technologies	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
VERTICAL V	Water Conservation and Management	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Modern Separation Techniques	✓	✓	-	-	-	-	✓	-	-	-	-	✓	✓	-
	Wastewater Treatment	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
	Waste Management	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Risk and Hazop Analysis	✓	✓	✓	-	✓	-	-	✓	-	-	-	-	-	✓
	Air Pollution, Monitoring and Control	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-
VERTICAL VI	Computer Applications in Chemical Engineering	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-
	Artificial Intelligence in Chemical Engineering	✓	✓	✓	-	-	✓	-	-	-	-	-	✓	✓	-
	Optimization of Chemical Process	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓
	Computational Fluid Dynamics in Process Industries	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓
	Process Modeling and Simulation	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	IoT in Chemical Engineering	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

KPR Institute of Engineering and Technology * Coimbatore * Centre for Academic Courses

B.TECH. CHEMICAL ENGINEERING

REGULATIONS – 2021

For the students admitted 2021 onwards

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I - VIII SEMESTERS

SEMESTER I

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA101	Calculus and Differential Equations	BSC	3	1	0	0	4
2	U21MEG05	Basics of Mechanical Engineering	ESC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
3	U21EN101	English for Technologists	HSMC	1	0	2	0	2
4	U21PH101	Engineering Physics	BSC	2	0	2	0	3
5	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
6	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
7	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
8	U21MYC01	Induction program	MNC	Three Weeks				
TOTAL				13	1	12	0	20

SEMESTER II

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA201	Laplace Transforms and Complex Variables	BSC	3	1	0	0	4
2	U21PH201	Materials Science	BSC	2	0	0	0	2
3	U21EEG01	Basics of Electrical and Electronics Engineering	ESC	3	0	0	0	3
4	U21CH201	Introduction to Chemical Engineering	PCC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
5	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
6	U21CY202	Chemistry for Technologists	BSC	2	0	2	0	3
7	U21CSG02	Python Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
8	U21MEG02	Manufacturing Practices	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC02	Environmental Sciences	MNC	1	0	0	0	0
			TOTAL	17	1	10	0	22

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MAG01	Probability and Statistics	BSC	3	1	0	0	4
2	U21CH301	Process Calculations	PCC	3	1	0	0	4
3	U21CH302	Fluid Mechanics for Chemical Engineers	PCC	3	1	0	0	4
4	U21CH303	Mechanical Operations	PCC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
5	U21CH304	Environmental Science and Engineering	ESC	2	0	0	2	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
6	U21CH305	Technical Analysis Laboratory	PCC	0	0	4	0	2
7	U21CH306	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
8	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
TOTAL				15	3	8	2	22

SEMESTER IV

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA402	Partial Differential Equations	BSC	2	0	0	0	2
2	U21CH401	Chemical Engineering Thermodynamics I	ESC	2	1	0	0	3
3	U21CH402	Engineering Materials	PCC	3	0	0	0	3
4	U21CH403	Mass Transfer I	PCC	3	1	0	0	4
5		Open Elective - I	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
6	U21CH404	Process Heat Transfer	PCC	2	1	0	2	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21CH405	Fluid Mechanics Laboratory	PCC	0	0	2	0	1
8	U21CH406	Mechanical Operations Laboratory	PCC	0	0	2	0	1
9	U21SSG01	Soft Skills - I	HSMC	0	0	2	0	1
	MANDATORY NON CREDIT COURSES							
10	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
TOTAL				16	3	6	2	22

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA502	Computational Techniques	BSC	2	0	0	0	2
2	U21CH501	Chemical Engineering Thermodynamics II	PCC	3	1	0	0	4
3		Professional Elective - I	PEC	3	0	0	0	3
4		Professional Elective - II	PEC	3	0	0	0	3
5		Open Elective - II	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
6	U21CH502	Mass Transfer II	PCC	2	1	0	2	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21CH503	Mass Transfer Laboratory	PCC	0	0	4	0	2
8	U21CH504	Heat Transfer Laboratory	PCC	0	0	4	0	2
9	U21SSG02	Soft Skills - II	HSMC	0	0	2	0	1
	MANDATORY NON CREDIT COURSES							
10	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
			TOTAL	17	2	10	2	24

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21CH601	Chemical Reaction Engineering I	PCC	3	1	0	0	4
2	U21CH602	Chemical Process Industries	PCC	3	0	0	0	3
3	U21CH603	Process Instrumentation, Dynamics and Control	PCC	3	0	0	0	3
4		Professional Elective - III	PEC	3	0	0	0	3
5		Professional Elective - IV	PEC	3	0	0	0	3
6		Open Elective - III	OEC	3	0	0	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21CH604	Chemical Reaction Engineering Laboratory	PCC	0	0	2	0	1
8	U21SSG03	Soft Skills - III	HSMC	0	0	2	0	1
9	U21MYC06	Introduction to UNSDGs: An Interrogative Approach	MNC	1	0	0	0	0
			TOTAL	19	1	4	0	21

SEMESTER VII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21CH701	Chemical Reaction Engineering II	PCC	3	0	0	0	3
2	U21CH702	Process Engineering Economics	HSMC	3	0	0	0	3
3		Professional Elective – V	PEC	3	0	0	0	3
4		Professional Elective - VI	PEC	3	0	0	0	3
5		Open Elective - IV	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
6	U21CH703	Process Equipment Design	PCC	2	1	0	2	4
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21CH704	Process Control Laboratory	PCC	0	0	2	0	1
8	U21CH705	Project work Phase - I	EEC	0	0	0	4	2
			TOTAL	17	1	2	6	22

SEMESTER VIII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CH801	Project work Phase - II	EEC	0	0	0	20	10
			TOTAL	0	0	0	20	10

INDUSTRIAL TRAINING / INTERNSHIP

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHI01	Industrial Training / Internship *	EEC	0	0	0	0	2
			TOTAL	0	0	0	0	2

***Four Weeks during any semester vacation from III to VI Semester**

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

NCC CREDIT COURSES:

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	NCC Credit Course Level I	-	1	0	2	0	2
2	U21NCC02	NCC Credit Course Level II	-	1	0	2	0	2
3	U21NCC03	NCC Credit Course Level III	-	1	0	2	0	2
4	U21NCC04	NCC Credit Course Level IV	-	2	0	2	0	3
5	U21NCC05	NCC Credit Course Level V	-	1	0	2	0	2
6	U21NCC06	NCC Credit Course Level VI	-	2	0	2	0	3
				8	-	6	-	14

TOTAL CREDITS: 165

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

KPR Institute of Engineering and Technology
Centre for Academic Courses
Coimbatore

PROFESSIONAL ELECTIVES COURSES: VERTICALS

Vertical I Design & Manufacture	Vertical II Bioprocess Engineering	Vertical III Oil, Gas & Petroleum	Vertical IV Energy Systems Engineering	Vertical V Environmental Engineering	Vertical VI Computational Chemical Engineering
Polymer Science Engineering	Fertilizer Technology	Corrosion Engineering	General Aspects of Energy Manufacturing and Energy Audit	Water conservation and management	Computer Applications in Chemical Engineering
Chemical Metallurgy	Biochemical Engineering	Petroleum Equipment Design	Energy Efficiency in Electrical and Thermal Utilities	Modern separation techniques	Artificial Intelligence in Chemical Engineering
Fluidization Engineering	Nanoscience and Nanotechnology	Oil and Gas Engineering	Energy Performance Assessment for Equipment and Utility Systems	Wastewater Treatment	Optimization of Chemical Process
Process Plant Utilities	Enzyme Engineering	Supply Chain Management	Bioenergy	Waste Management	Computational Fluid Dynamics in Process Industries
Industrial Safety	Fermentation Engineering	Petroleum Refining and Petrochemicals	Renewable and Non-Renewable Energy Resources	Risk and HAZOP analysis	Process Modeling and Simulation
Pulp and Paper Technology	Drugs and Pharmaceutical Technology	Piping and Instrumentation in Chemical Plants	Hydrogen and Fuel Cell Technologies	Air Pollution, Monitoring and Control	IoT in Chemical Engineering

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: DESIGN & MANUFACTURE

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP01	Polymer Science Engineering	PEC	3	0	0	0	3
2	U21CHP02	Chemical Metallurgy	PEC	3	0	0	0	3
3	U21CHP03	Fluidization Engineering	PEC	3	0	0	0	3
4	U21CHP04	Process Plant Utilities	PEC	3	0	0	0	3
5	U21CHP05	Industrial Safety	PEC	3	0	0	0	3
6	U21CHP06	Pulp and Paper Technology	PEC	3	0	0	0	3

VERTICAL 2: BIOPROCESS ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP07	Fertilizer Technology	PEC	3	0	0	0	3
2	U21CHP08	Biochemical Engineering	PEC	3	0	0	0	3
3	U21CHP09	Nanoscience and Nanotechnology	PEC	3	0	0	0	3
4	U21CHP10	Enzyme Engineering	PEC	3	0	0	0	3
5	U21CHP11	Fermentation Engineering	PEC	3	0	0	0	3
6	U21CHP12	Drugs and Pharmaceutical Technology	PEC	3	0	0	0	3

VERTICAL 3: OIL, GAS & PETROLEUM

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP13	Corrosion Engineering	PEC	3	0	0	0	3
2	U21CHP14	Petroleum Equipment Design	PEC	3	0	0	0	3
3	U21CHP15	Oil and Gas Engineering	PEC	3	0	0	0	3
4	U21CHP16	Supply Chain Management	PEC	3	0	0	0	3
5	U21CHP17	Petroleum Refining and Petrochemicals	PEC	3	0	0	0	3
6	U21CHP18	Piping and Instrumentation in Chemical Plants	PEC	3	0	0	0	3

VERTICAL 4: ENERGY SYSTEMS ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP19	General Aspects of Energy Manufacturing and Energy Audit	PEC	3	0	0	0	3
2	U21CHP20	Energy Efficiency in Electrical and Thermal Utilities	PEC	3	0	0	0	3
3	U21CHP21	Energy Performance Assessment for Equipment and Utility Systems	PEC	3	0	0	0	3
4	U21CHP22	Bioenergy	PEC	3	0	0	0	3
5	U21CHP23	Renewable and Non-Renewable Energy Resources	PEC	3	0	0	0	3
6	U21CHP24	Hydrogen and Fuel Cell Technologies	PEC	3	0	0	0	3

VERTICAL 5: ENVIRONMENTAL ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP25	Water conservation and management	PEC	3	0	0	0	3
2	U21CHP26	Modern separation techniques	PEC	3	0	0	0	3
3	U21CHP27	Wastewater Treatment	PEC	3	0	0	0	3
4	U21CHP28	Waste Management	PEC	3	0	0	0	3
5	U21CHP29	Risk and HAZOP analysis	PEC	3	0	0	0	3
6	U21CHP30	Air Pollution Monitoring and Control	PEC	3	0	0	0	3

VERTICAL 6: COMPUTATIONAL CHEMICAL ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHP31	Computer Applications in Chemical Engineering	PEC	3	0	0	0	3
2	U21CHP32	Artificial Intelligence in Chemical Engineering	PEC	3	0	0	0	3
3	U21CHP33	Optimization of Chemical Process	PEC	3	0	0	0	3
4	U21CHP34	Computational Fluid Dynamics in Process Industries	PEC	3	0	0	0	3
5	U21CHP35	Process Modeling and Simulation	PEC	3	0	0	0	3
6	U21CHP36	IoT in Chemical Engineering	PEC	3	0	0	0	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHX01	Introduction to Food Processing Techniques	OEC	3	0	0	0	3
2	U21CHX02	Energy Conservation in Process Industries	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHX03	Environmental Impact Assessment	OEC	3	0	0	0	3
2	U21CHX04	Industrial Wastewater Treatment	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHX05	Industrial Management	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: VII)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21CHX06	Food Safety and Quality Regulations	OEC	3	0	0	0	3
2	U21CHX07	Safety and Hazard Management in Process Industries	OEC	3	0	0	0	3

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

B.TECH. – CH – R2021 – CBCS

Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester								Credits
		I	II	III	IV	V	VI	VII	VIII	
1.	Humanities and Social Sciences including Management (HSMC)	2	2	-	1	1	1	3	-	**10**
2.	Basic Science Courses (BSC)	10	9	4	2	2	-	-	-	**27**
3.	Engineering Science Courses (ESC)	8	8	5	3	-	-	-	-	**24**
4.	Professional Core Courses (PCC)	-	3	13	13	12	11	8	-	**60**
5.	Professional Elective Courses (PEC)	-	-	-	-	6	6	6	-	**18**
6.	Open Elective Courses (OEC)	-	-	-	3	3	3	3	-	**12**
7.	Employability Enhancement Courses (EEC)	-	-	-	-	-	-	2	10	**12**
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	2	**2**
9.	Mandatory Non-Credit Course (MNC)	1	1	1	1	1	1	-	-	-
Total		**20**	**22**	**22**	**22**	**24**	**21**	**22**	**12**	**165**

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

24.07.2023
Head
Centre for Academic Courses
KPR Institute of Engineering and Technology
Coimbatore - 641 407

SEMESTER I

		Category: BSC				
U21MA101	**CALCULUS AND DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**J**	**C**
		3	**1**	**0**	**0**	**4**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- To understand the methodologies involved in solving problems related to fundamental principles of calculus
- To develop confidence to model mathematical pattern and give appropriate solutions

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the knowledge of matrices with the concepts of eigenvalues to study their problems in core areas (Apply)

CO2: Apply the basic techniques and theorems of functions of several variables in other areas of mathematics (Apply)

CO3: Analyze the triple integrals techniques over a region in two dimensional and three dimensional geometry (Apply)

CO4: Apply basic concepts of integration to evaluate line, surface and volume integrals (Apply)

CO5: Solve basic application problems described by second and higher order linear differential equations with constant coefficients (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I MATRICES **9 + 3**

Eigenvalues and eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications

UNIT II FUNCTIONS OF SEVERAL VARIABLES **9 + 3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

UNIT III MULTIPLE INTEGRALS **9 + 3**

Double integrals – Change of order of integration – Triple integrals – Applications in area and volume

UNIT IV LINE AND SURFACE INTEGRALS **9 + 3**

Line integrals – Surface integrals – Green's theorem in a plane – Gauss divergence theorem – Stokes' theorem (excluding proofs)

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **9 + 3**

Second and higher order linear differential equations with constant coefficients – Variable coefficients – Euler Cauchy equation – Legendre's equation – Method of variation of parameters – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley India Pvt Ltd, New Delhi, 2018.
2. Grewal B S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016.
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India, 2018.
3. Maurice D Weir, Joel Hass and Christopher Heil, "Thomas Calculus", 14th edition, Pearson Education, India, 2018.
4. James Stewart, "Calculus: Early Transcendental", 7th edition, Cengage Learning, New Delhi, 2015.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

		Category: ESC				
U21MEG05	**BASICS OF MECHANICAL ENGINEERING**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with basic mechanical elements and power plants
- To understand the principles of IC Engines, refrigeration & air conditioning
- To know different types of manufacturing processes, industrial safety and computer applications in mechanical engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Recognize various mechanical elements and list out the applications and functions (Understand)

CO2: Understand the construction and working of power plants and its components (Understand)

CO3: Explain the working of an IC engine and a RAC system (Understand)

CO4: Discuss about traditional and additive manufacturing processes (Understand)

CO5: Recall various safety requirements and software required for mechanical engineering (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO2	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO3	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO4	3	1	-	-	-	1	-	-	-	-	-	1	1	1
CO5	3	1	-	-	-	1	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BASIC MECHANICAL ELEMENTS **9**

Basic Concepts and demonstration: Bearings – Gears – Belt drives – Chain drives – Cable drives – chain block – Conveyers – Shafts – Keys – Spline shafts – Springs – Fasteners – Screws – Bolts – Nuts and their specifications – Fundamental Hydraulics and Pneumatics – Valves and Cylinders – FRL units.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II POWER GENERATION AND DISTRIBUTION 9

Classification of power Plants – Working principle of steam – Gas – Diesel – Hydroelectric and Nuclear Power plants – Renewable energy – Solar – Wind – Tidal – OTEC – Boilers – Turbines and Pumps – Working and classification.

UNIT III IC ENGINES AND RAC 9

IC Engine as power plant – Petrol and Diesel Engines – Four stroke and two stroke cycles – Working and Comparison – Refrigeration and Air Conditioning – Refrigerants – Vapour compression and absorption system – Types of refrigeration and AC systems – Applications.

UNIT IV MANUFACTURING PROCESS 9

Principles of casting process – Metal rolling process – Introduction to CNC machines – Laser Cutting and EDM process – Metal joining process – Welding and Soldering Process – Introduction to 3D printing and Rapid prototyping.

UNIT V INDUSTRIAL ENGINEERING 9

Introduction to safety engineering – Evolution of Safety – Improvements Required – Safety Organization – Safety Functions – Workplace Operations Requiring Safety – Safety Benefits – Software in Mechanical Industry – Introduction to Modelling and Analysis software – Basic Concepts and Application of IoT to industrial processes.

Contact Periods:

Lecture:	45 Periods	Tutorial	– Periods	Practical	– Periods	Project	– Periods
						Total	45 Periods

TEXT BOOKS:

1. Basant Agarwal and C.M. Agarwal, "Basics of Mechanical Engineering", 3rd Edition, Wiley India Pvt. Ltd, New Delhi, 2018.
2. Venugopal K. and Prabhu Raja V., "Basic Mechanical Engineering", 1st Edition, Anuradha Publishers, Kumbakonam, 2010.

REFERENCES:

1. Palanikumar, K. Basic Mechanical Engineering, 1st Edition, ARS Publications, 2010.
2. P.N. Rao., "Manufacturing Technology – Vol. 1", 1st Edition, Tata McGraw Hill Education India Pvt Ltd, 2013.
3. Mikell P. Groover, "Automation, Production Systems, and Computer–Integrated Manufacturing, 4th Edition, Pearson, 2014.
4. ShanthaKumar SRJ., "Basic Mechanical Engineering" 1st Edition, Hi–tech Publications, Mayiladuthurai, 2010.
5. Alasdair Gilchrist., "Industry 4.0: The Industrial Internet of Things", 1st Edition, Apress, 2016.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering

KPRIET
LearnBeyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

		Category: HSMC				
U21EN101	ENGLISH FOR TECHNOLOGISTS	L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To infer and interpret the meaning of Technical, Business, Social and Academic contexts.
- To enhance the listening skills and facilitate effective pronunciation.
- To make effective presentation and conversation in technical and professional environment.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Comprehend language and learn strategies for error-free communication (Understand)

CO2: Improve speaking skills in academic and social contexts (Apply)

CO3: Enhance both reading and writing skills to excel in professional career (Analyse)

CO4: Evaluate different perspectives on a topic (Analyse)

CO5: Develop listening skills to understand complex business communication in a variety of global English accents through Personality Development (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	1	1
CO2	-	-	-	-	-	-	-	-	2	3	-	-	1	1
CO3	-	-	-	-	-	-	-	-	2	3	-	1	1	1
CO4	-	-	-	-	-	-	-	-	2	3	-	-	1	1
CO5	-	-	-	-	-	-	-	2	-	3	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SUBJECTIVE INTROSPECTION **9**

Module:1 Vocabulary Building

Activity: Word Puzzles, Snappy words, Word Sleuthing

Module:2 Introducing and Sharing Information

Activity: Get to know oneself, Introducing Peer Members

Module:3 Opinion Paragraph

Activity: Note making, analyzing and writing a review

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II CAREER ENHANCEMENT 9

Module:4 Reading Comprehension

Activity: Reading Newspaper articles/Blogs, Sentence completion

Module:5E-mail Communication

Activity: Drafting personal and professional emails

Module:6 Career Profiling

Activity: Resume Writing & Digital Profiling

UNIT III LANGUAGE ADEPTNESS 9

Module:7 Rewriting passages

Activity: Conversion of voices & Rephrasing Articles

Module:8 Enhancing Pronunciation skills

Activity: Listening to short technical Reels and reproducing it

Module:9 Making Conversations

Activity: Role play & Narrating Incidents

UNIT IV TECHNICAL WRITING 9

Module:10 Spotting Errors

Activity: Proof reading, Rewriting sentences

Module:11 Data interpretation

Activity: Interpretation of Graphics/Charts/Graphs

Module:12 Expository Writing

Activity: Picture inference, Captions for Posters& Products

UNIT V LANGUAGE UPSKILLING 9

Module:13 Listening for Specific Information

Activity: TED talks/Announcement/Documentaries

Module:14 Presentation

Activity: Extempore & Persuasive Speech

Module:15 Team Communication

Activity: Team building activities, Group Discussion

LIST OF EXERCISES

1. Introducing oneself
2. Role play
3. Listening to short technical Reels
4. Listening to TED Talks/ Announcements/ Documentaries
5. Presentation
6. Group Discussion

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 45 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

TEXT BOOKS:

1. Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, Mc Graw – Hill. India 2017.
2. Rod Ellis, "English for Engineers & Technologists", Vol. II: (English for Engineers and Technologist: A Skills Approach). 2nd Edition, Orient Black Swan, 1990.

REFERENCES:

1. Raymond Murphy, "Intermediate English Grammar", 2nd Edition, Cambridge University Press, 2009.
2. Thomas L Means, "English and Communication for Colleges", 4th Edition, Cengage 2017.
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st Edition, Orient Black Swan, 2017.

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations

(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record

(Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

U21PH101	ENGINEERING PHYSICS	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental principles of laser and fibre optics with their applications
- To acquire the knowledge of ultrasonic waves, thermal conductivity and properties of liquids
- To understand the concepts of crystals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate the types of laser for various industrial and medical applications (Understand)

CO2: Apply the concepts of fibre optics in engineering (Understand)

CO3: Understand the production methods of ultrasonic waves and uses in engineering and medicine (Understand)

CO4: Apply the concepts of thermal conductivity in hybrid vehicles and viscosity of liquids in engineering applications (Understand)

CO5: Explain the basic concepts of crystals and its growth techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO5	3	2	1	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I LASER 6

Laser characteristics – Spontaneous and stimulated emission – Pumping methods – CO_2 laser – Semiconductor laser – Material Processing – Selective laser Sintering – Hologram – Medical applications (Opthalmology)

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II FIBER OPTICS 6

Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers (Materials, modes and refractive index profile) – Fiber optical communication system – Displacement and temperature sensor – Medical Endoscopy

UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Piezoelecrtic generator – Acoustic grating – Applications of ultrasonics in industry– SONAR – NDT – Ultrasonic scanning methods – Fetal heart movement

UNIT IV THERMAL PHYSICS AND PROPERTIES OF FLUIDS 6

Modes of heat transfer – Thermal conductivity – Lee's disc method – Solar thermal power generation – Hybrid vehicles – Microwave oven – Surface tension and coefficient of viscosity – Poiseuille's flow experiment

UNIT V CRYSTAL PHYSICS 6

Unit cell – Bravais lattices – SC, BCC, FCC structures – Miller indices – d spacing in cubic lattice – Crystal growth from melt: Bridgeman Technique – Silicon ingots from Czochralski method – Silicon wafers from ingots and its applications.

LIST OF EXPERIMENTS

1. Determination of the wavelength of a given laser source
2. Determination of acceptance angle and numerical aperture of an optical fibre
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic interferometer
4. Determination of thermal conductivity of a bad conductor using Lee's disc method
5. Determination of viscosity of the given liquid using Poiseuille's flow method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Bhattacharya D K and Poonam Tandon, "Engineering Physics", 2nd Edition, Oxford University Press, Chennai, 2017
2. Marikani A, "Engineering Physics", 3rd Edition, PHI publishers, Chennai, 2021

REFERENCES:

1. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", 2nd Edition, Pearson India Education Services Private Limited, Chennai, 2018

2. Avadhanulu M N, Kshirsagar P G and Arun Murthy TVS, "A Text book of Engineering Physics", 2nd Edition, S Chand Publishing, New delhi, 2018
3. Thyagaran K, Ajoy Ghatak, "Lasers – Fundamantals and Applications", 2nd Edition, Laxmi Publications Pvt Limited, New delhi, 2019
4. https://nptel.ac.in/downloads/104104085/
5. https://nptel.ac.in/courses/122107035/8/

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th><th rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</th><th rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

		Category: BSC				
U21CY101	ENGINEERING CHEMISTRY	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and alloys
- To acquire knowledge about the properties of fuels and applications of polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water (Apply)

CO2: Describe the principles and applications of electrochemical cells, fuel cells and solar cells (Understand)

CO3: Outline the different types of corrosion processes and preventive methods adopted in industries (Understand)

CO4: Explain the analysis and calorific value of different types of fuels (Understand)

CO5: Classify the polymers and their engineering applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	1	-	-	1	1	1
CO2	3	1	-	-	-	-	2	-	1	-	-	1	1	1
CO3	3	1	-	-	-	-	2	-	1	-	-	1	1	1
CO4	3	1	-	-	-	-	2	-	1	-	-	1	1	1
CO5	3	1	-	-	-	-	2	-	1	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I CHARACTERISTICS OF WATER AND ITS TREATMENT 6

Characteristics of water – Hardness – Types – Dissolved oxygen – Total dissolved solids – Disadvantages due to hard water in industries – (Scale, Sludge, Priming, Foaming and Caustic embrittlement) – Water softening methods – Lime-soda, Zeolite, Ion exchange processes and reverse Osmosis and their applications – Specifications of domestic water (ICMR and WHO).

Water treatment for municipal supply – Sedimentation with coagulant – Sand Filtration – Chlorination, Disinfection methods – UV treatment – Ozonolysis – Electro dialysis

UNIT II ELECTROCHEMISTRY AND ENERGY STORAGE SYSTEMS 6

Introduction, Electrodes – (Calomel electrode) – Electrochemical series and its applications, Brief introduction to conventional primary and secondary batteries – (Pb acid, Lithium)

Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells – Working principles – Advantages, applications – Solar cells – Dye sensitized solar cells – Working principles – Characteristics and applications

UNIT III CORROSION AND ITS CONTROL 6

Types – Dry – Chemical corrosion and Wet – Galvanic and differential aeration (Pitting – Crevice – pipeline) – Factors influencing rate of corrosion – Corrosion control methods – Sacrificial anode and impressed current method – Protective coating – Electroplating – Ni plating.

Alloys – Ferrous (stainless steel) – Heat treatment – Non-ferrous alloys (Brass -Dutch metal – German Silver) – Composition, properties and uses

UNIT IV FUELS AND COMBUSTION 6

Fuels- Solid fuel – Coal – Analysis of coal (Proximate analysis only) – Liquid fuel – Manufacture of synthetic petrol (Bergius process) – Octane number – Cetane number – Knocking in engines – Anti-knocking agents – Gasoline additives – Gaseous fuel – Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Composition only.

Calorific value – Higher and lower calorific values – Flue gas analysis (ORSAT method). Measurement of calorific value using bomb calorimeter – Three-way catalytic converter – Selective catalytic reduction of NOx

UNIT V POLYMERS 6

Introduction – Monomer – Dimers – Functionality – Degree of polymerization – Transition glass temperature Classification of polymers – Difference between thermoplastics and thermosetting plastics – Engineering application of plastics - ABS, PVC, PTFE and Bakelite.

Types of compounding of plastics – Moulding – Injection moulding – Extrusion moulding – Compression moulding – Conducting polymers – Polypyrrole – Polyacetylene – Polyaniline – Structure and applications, Composites – FRP – Properties and applications

LIST OF EXPERIMENTS

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Estimation of ferrous ion by potentiometric titration
3. Estimation of Copper in Brass by EDTA method
4. Determination of percentage of moisture, volatile, ash and carbon content in a given sample of

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering

coal.

5. Determination of molecular weight and degree of polymerization of an oil sample by viscosity measurement (Ostwald's viscometer).
6. Determination of chloride content in the water sample
7. Determination of strength of HCl by pH metric method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, 2014

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd Edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st Edition, Cengage Learning India, Pvt. Ltd, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015
4. https://nptel.ac.in/courses/113/104/113104008/

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

U21CSG01	PROBLEM SOLVING AND C PROGRAMMING Common to All Branches	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure to problem-solving through programming
- To develop computational thinking perspective of one's own discipline
- To write, compile and debug programs using C language

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Formulate the algorithmic solutions for a given computational problem (Understand)

CO2: Describe modularization, structures and pointers in C language (Understand)

CO3: Design and implement algorithms for a given problem using C control structures (Apply)

CO4: Apply the C programming constructs for searching and sorting techniques (Apply)

CO5: Solve real time problems using suitable non-primitive data structures in C (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	3	2	2
CO2	2	1	1	2	-	-	-	1	2	2	-	2	2	2
CO3	3	2	2	2	-	2	-	1	2	2	-	2	2	2
CO4	3	2	2	2	-	-	-	1	2	2	-	2	2	2
CO5	3	2	2	2	-	-	-	1	2	2	-	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I COMPUTATIONAL THINKING 6

Computational Thinking – Modern Computer – Information based Problem solving – Real world information and Computable Data – Data types and data encoding – Number Systems – Introduction to programming languages – Basics of C programming – Variables – Data types – Keywords – C program structure – Simple programs in C.

UNIT II ALGORITHMIC APPROACH 6

Logic – Boolean Logic – Applications of Propositional logic – Problem Definition – Logical Reasoning and Algorithmic thinking – Pseudo code and Flow chart – Constituents of algorithms – Sequence,

Selection and Repetition – Problem understanding and analysis – Control structures in C – Algorithm design and implementation using control structures

UNIT III SEARCHING, SORTING, AND MODULARIZATION 6

Data Organization – Arrays – Introduction to Searching and Sorting – Linear Search, Binary Search – Basic sorting techniques – Two-dimensional arrays – Matrix manipulation – Modularization – Functions – Function prototype – Function definition – Function call – Built-in functions (string functions and math functions) – Recursion

UNIT IV STRUCTURES AND POINTERS 6

Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program – Sorting of names – Parameter passing – Pass by value – Pass by reference – Structure – Nested structures – Pointer and Structures – Array of structures – Example Program using structures and pointers – Unions

UNIT V FILES 6

Files – Types of file processing – Sequential access – Random access – Sequential access file – Example Program – Finding average of numbers stored in sequential access file – Random access file – Example Program – Transaction processing using random access files – Command line arguments

LIST OF EXPERIMENTS

A. Lab Programs

1. Using IO Statements, get higher secondary marks of a student. Calculate and display the medical and engineering cut-off marks. [Assume the calculation formula]
2. Develop a C program to emulate the operations of an ATM using control structures. Authentication, Deposit, Withdrawal, and Balance check and pin change operations are to be supported.
3. Develop a calculator to perform the operations including addition, subtraction, multiplication, division and square of a number.
4. Given different prices of a vegetable which is varying through the day (from morning to evening), find out the best buy price and sell price for the maximum profit. Eg. For the prices [33, 35, 28, 36, 39, 25, 22, 31], best buy is at 28 and best sell is at 39.
5. Collect height and weight of 4 of your friends and calculate their body mass index. Use 2 dimensional array to store the values.
6. Weights of 10 students of your class who are standing in a line is given in a random order. Find out if there is a heavy person whose weight is the sum of previous two persons.
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
8. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words.

b) Capitalize the first word of each sentence.

9. Solve Towers of Hanoi using recursion.
10. Develop an expense manager which reads date, product, price and product category. The program should display the total expense amount based on product category or date as per user's selection. Use structures.
11. Develop a banking application to store details of accounts in a file. Count the number of account holders based on a search condition such as - whose balance is less than the minimum balance.

B. Mini Project (SAMPLE)

Create a Railway Reservation system with the following modules of Booking,

- Availability checking
- Cancellation
- Prepare chart

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. David D. Railey and Kenny A.Hunt , "Computational Thinking for Modern problem Solver", 1st Edition, CRC Press, 2014
2. Brian W. Kernighan and Dennis Ritchie, " The C Programming Language" , 2nd Edition, Pearson, 2015

REFERENCES:

1. Paolo Ferragina and Fabrizio Luccio, "Computational Thinking First Algorithms", Then Code" ,1st Edition,Springer International Publishing, 2018
2. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2016
3. Paul Deitel and Harvey Deitel, "C How to Program", 7th Edition, Pearson Publication
4. Juneja, B. L and Anita Seth, "Programming in C",1st Edition, Cengage Learning India Pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 1st Edition, Oxford University Press, 2009

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER I

U21MEG01	ENGINEERING GRAPHICS	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To expose the standards and conventions followed in preparation of engineering drawings
- To develop graphic skills for communication of concepts, ideas and engineering drawings
- To expose on 2D & 3D drawings and its projections

COURSE OUTCOME:

Upon completion of the course, the student will be able to

CO1: Sketch the curves and orthographic projections of points as per BIS conventions (Apply)

CO2: Illustrate the orthographic projections of straight lines and plane surfaces (Apply)

CO3: Sketch the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development (Apply)

CO4: Develop the lateral surfaces of simple solids (Apply)

CO5: Interpret the orthographic and isometric views of simple components (Apply)

CO PO Mapping:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	-	-	1	-	2	-	1	2	1
CO2	3	2	2	-	3	-	-	-	-	2	-	1	2	1
CO3	3	2	2	-	3	-	-	-	-	3	-	1	2	1
CO4	3	2	2	-	3	-	-	-	-	3	-	1	2	1
CO5	3	2	2	-	3	-	-	-	-	3	-	1	2	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination)

Introduction – Drawing instruments and its uses – Sheet layout – BIS conventions – Lines – Lettering and dimensioning practices – Lines – Co – Ordinate points – Axes – Poly lines – Square – Rectangle – Polygons – Splines – Circles – Ellipse – Text – Move – Copy – Off – Set – Mirror – Rotate – Trim – Extend – Break – Chamfer – Fillet – Curves – Constraints viz. agency – Parallelism – Inclination and perpendicularity

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

UNIT I CONICS, SPECIAL CURVES AND PROJECTION OF POINTS 12

Construction of parabola – Ellipse and hyperbola using eccentricity method – Construction of involutes for squares and circles – Construction of Tangent and normal to the above curves – Introduction – Method of projection – Planes of projection – Reference line and notations – Orthographic Projection of points – Points in all four quadrants

UNIT II PROJECTION OF STRAIGHT LINES AND SURFACES 12

Projection of straight lines – Lines inclined to HP / VP plane – Inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only) – Projection of planes – Projection of square – Rectangle – Pentagon – Hexagon and circular plane – Inclined to both the plane by change of position method

UNIT III PROJECTION OF SOLIDS 12

Introduction – Projection of solids – Prisms – Pyramids – Cylinders and cones with axis inclined to both the planes (Solids resting on HP only)

UNIT IV DEVELOPMENT OF LATERAL SURFACES OF SOLIDS 12

Introduction – Cutting plane – Sectional views of right regular solids resting with base on HP – Prisms – Pyramids – Cylinder and cone – True shapes of the sections – Development of lateral surfaces of right regular prisms – Pyramids – Cylinders – Cones resting with base on HP only – Development of the frustums and truncations

UNIT V ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS 12

Orthographic projection – Simple machine components using free hand sketching – Isometric projection – Simple Solid exercises and combination of solids

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: – 60 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. ND Bhat & VM Panchal, "Engineering Drawing", 51st Edition, Charotar Publishing House, Gujarat, 2013.
2. Venugopal K. and Prabhu Raja V, "Engineering Graphics", 6th Edition, New Age International (P) Limited, 2019.

KPRIET
Learn Beyond

REFERENCE BOOKS:

1. Natrajan K.V., A text book of Engineering Graphics, 21st edition, Dhanalakshmi Publishers, Chennai, 2017.
2. Sam Tickoo, AutoCAD 2013 for Engineers and Designers, 1st Edition, Dream tech Press, 2013.
3. M.H.Annaiah & Rajashekar Patil, Computer Aided Engineering Drawing, 4th Edition, New Age International Publishers, 2012.
4. Basant Aggarwal, Engineering Drawing, , 1st Edition, Tata Mc Graw Hill Education Private Limited, 2010.
5. D.M.Kulkarni, A.P.Rastogi, A.K.Sarkar, "Engineering Graphics with AutoCAD", , 1st Edition, PHI Learning Private Limited, New Delhi, Revised Edition,2010.

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	**Test**	
75	**25**	
100		**100**
60		**40**
100		

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
LearnBeyond

SEMESTER II

		Category: BSC				
U21MA201	LAPLACE TRANSFORMS AND COMPLEX VARIABLES	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the mathematical aspects of conversion time domain to frequency domain using Laplace transform and Inverse Laplace transform vice versa
- To use the concepts of complex analysis, in the study of heat flow, fluid dynamics and electrostatics
- To understand the concepts of singularities in the various domains of engineering fields

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the concepts of Laplace transform in core engineering applications (Apply)

CO2: Apply the concepts of Inverse Laplace transform with their properties in engineering field (Apply)

CO3: Analyze the complex functions and their mapping in certain complex planes (Understand)

CO4: Evaluate complex contour integrals directly and use the Cauchy integral theorem in its various versions (Understand)

CO5: Compute the residues of a function at given points or singularities and use the residue theoremto evaluate a contour integral (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	1	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
LearnBeyond

SYLLABUS:

UNIT I LAPLACE TRANSFORM **9 + 3**

Laplace transform – Conditions for existence – Transform of elementary functions – Standard properties (statement only) – Transforms of unit step function – Impulse function – Periodic function – Initial and final value theorems – Convolution theorem (without proof)

UNIT II INVERSE LAPLACE TRANSFORM **9 + 3**

Inverse Laplace transform – Standard properties (statement only) – Second order linear differential equations with constant coefficients

UNIT III COMPLEX DIFFERENTIATION **9 + 3**

Analytic functions – Cauchy-Riemann equations (Cartesian form) and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Bilinear transformations

UNIT IV COMPLEX INTEGRATION **9 + 3**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula

UNIT V SINGULARITIES AND RESIDUES **9 + 3**

Taylor's and Laurent's series expansions – Singular points – Classification of singularities – Residues – Cauchy's residue theorem

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd, New Delhi, 2018.
2. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th Edition, Laxmi Publications, 2016.
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th Edition, Pearson Education India, 2018.
3. James Stewart, "Calculus: Early Transcendental", 7th Edition, Cengage Learning, New Delhi, 2015.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
Individual Assignment / Seminar / MCQ	Written Test	Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

U21PH201	**MATERIALS SCIENCE**	**Category: BSC**				
		L	**T**	**P**	**J**	**C**
		2	**0**	**0**	**0**	**2**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain the knowledge of conducting and semiconducting materials
- To understand the concepts of magnetic, dielectric and optical properties of materials
- To enhance the knowledge of new engineering materials

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate the electrical characteristics of conducting materials (Understand)

CO2: Interpret the properties and types of semiconducting materials (Understand)

CO3: Compare various types of magnetic materials for engineering applications (Understand)

CO4: Explain the fundamental concepts of dielectric and optical materials (Understand)

CO5: Examine new engineering materials for industrial applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO2	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO3	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO4	3	2	-	-	-	1	-	-	-	-	-	1	1	1
CO5	3	2	-	-	-	1	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I CONDUCTING MATERIALS 6

Classical free electron theory – Expression for electrical conductivity and thermal conductivity – Wiedemann - Franz law – Drawbacks – Fermi distribution function – Density of energy states in metals

UNIT II SEMICONDUCTING MATERIALS 6

Intrinsic and Extrinsic semiconductor – Carrier concentration in n-type semiconductor – P-type semiconductor(qualitative) – Applications of semiconductors – Solar cell – LED – Hall effect and its experimental determination

UNIT III MAGNETIC MATERIALS 6

Origin of magnetism – Dia, para and ferro magnetic materials – Domain theory – Soft and hard magnetic materials – Magnetic bubble memories – GMR sensor

UNIT IV DIELECTRIC AND OPTICAL MATERIALS 6

Dielectrics – Types of polarisation – Electronic polarisation – Dielectric breakdown – Ferroelectrics – Applications of dielectrics – Classification of optical materials – Nonlinear optics – Applications

UNIT V NEW ENGINEERNG MATERIALS AND CHARACTERIZATION TECHNIQUES 6

SMA – SiC – GaN – Rheological materials – Nanomaterials – Synthesis (Ball milling and CVD) – Quantum dot, quantum wire and quantum well(qualitative) – Characterisation techniques – Powder XRD(qualitative) – SEM

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Wahab M A, "Solid State Physics: Structure and Properties of Materials", 3rd Edition, Narosa Publishing House, Chennai, 2018
2. Marikani A, "Materials Science", 1st Edition, PHI publishers, Chennai, 2017

REFERENCES:

1. Pillai S O "Solid State Physics", 9th Edition, New Age International Publishers, New Delhi, 2020
2. Bangwei Zhang, "Physical Fundamentals of Nanomaterials", 1st Edition, Chemical Industry Press, China, 2018
3. Joginder Singh Galsin, "Solid State Physics – An Introduction to Theory", 1st Edition, Academic Press, India, 2019
4. https://nptel.ac.in/courses/108/108/108108122/
5. https://nptel.ac.in/courses/113/105/113105081/

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
Individual Assignment / Seminar / Mini Project / MCQ	Written Test	Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

		Category: ESC				
U21EEG01	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To solve an electric network by applying basic laws
- To acquire the knowledge of operating principle, characteristics, starting, methods of DC and AC machines
- To acquire the knowledge of construction, operating principle, characteristics of semiconductor devices and its applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve an electric network by applying basic laws (Apply)

CO2: Acquire the knowledge of operating principles, characteristics, starting, and speed control methods of DC motors (Understand)

CO3: Explain the operating principles of AC motor and characteristics, starting methods of induction motor (Understand)

CO4: Summarize the construction, principle and characteristics of semiconductor devices (Understand)

CO5: Interpret the applications of semiconductor devices (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	3	-	2	-	3	1	1
CO2	-	-	-	-	-	-	3	3	-	2	-	3	1	1
CO3	-	-	-	-	-	-	3	3	-	2	-	3	1	1
CO4	-	-	-	-	-	-	3	3	-	2	-	3	1	1
CO5	-	-	-	-	-	-	3	3	-	2	-	3	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I BASIC CONCEPTS OF ELECTRIC CIRCUITS 9

Active elements – Passive elements – Sources – Elements in series and parallel connections – Star and delta conversion – Ohm's law and Kirchhoff's laws – Mesh and Nodal analysis in DC Networks

UNIT II DC MOTOR 9

DC motor – Construction – Principle of operation – Types – Torque equation – Characteristics and its applications – Starters for DC motor – Two point – Three point – Speed control – Armature and field control (Qualitative Analysis only)

UNIT III Transformer and AC MOTOR 9

Single phase transformer – Three phase induction motor – Construction, principle of operation – Characteristics and applications – Starters – DOL – Star – Delta (Qualitative Analysis only)

UNIT IV SEMICONDUCTOR DEVICES 9

Construction operation and characteristics: PN Junction, Zener Diode - BJT - FET

UNIT V APPLICATIONS OF SEMICONDUCTOR DEVICES 9

Rectifier- Half wave – Full wave – Filters – Voltage regulator – Series and shunt – CE , CB and CC Configuration

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", 5th Edition, McGraw-Hill Education, New Delhi, Jul 2017.
2. R.K.Rajput, "Electrical Machines", 6th Edition, Laxmi Publications, Jan 2016.
3. V.K Metha and Rohit Metha, "Principles of Electronics", 12th Edition, S.Chand Publications, 2020.

REFERENCES:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", 8th Edition, McGraw-Hill Education, New Delhi, Aug 2013
2. S.K. Bhattacharya, "Electrical Machines", 4th Edition, McGraw-Hill Education, New Delhi, July2017
3. R.Sedha, "A text book of Applied Electronics", 4th Edition, S.Chand Publications, Revised edition, Jul 2017

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SEMESTER II

		Category: PCC				
U21CH201	**INTRODUCTION TO CHEMICAL ENGINEERING**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To get an overview of Chemical Engineering
- To learn the history of Chemical Engineering
- To understand the principles of unit operations and unit processes
- To introduce computational tools used in Chemical Engineering domain

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Define the basic principles of Chemical engineering (Understand)
CO2: Explain the concepts of Unit Operations (Understand)
CO3: Understand the concepts of Unit Processes (Understand)
CO4: Know the design and process control concepts (Apply)
CO5: Learn the various computational tools (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2	-	3	3	-	2	-	3	2	2
CO2	2	2	2	2	2	-	3	3	-	2	-	3	2	2
CO3	2	2	2	2	2	-	3	3	-	2	-	3	2	2
CO4	2	2	2	2	2	-	3	3	-	2	-	3	2	2
CO5	2	2	2	2	2	-	3	3	-	2	-	3	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I **INTRODUCTION** **9**

History of Chemical Engineering – Great Personalities of Chemical Engineering – Chemist and Chemical Engineer – Role of Chemical Engineering in this world – Applications and Achievements.

KPRIET
Learn Beyond

UNIT II UNIT OPERATIONS 9

Basic definitions and basic concepts – Description of different Unit Operations – Fluid mechanics – Mechanical Operations – Heat Transfer and Diffusion Mass Transfer principles

UNIT III UNIT PROCESSES 9

Description of different Unit Processes – Chemical Kinetics – Basic principles and reaction mechanism – Thermodynamics concepts used in Chemical Engineering

UNIT IV DESIGN AND PROCESS CONTROL 9

Range of scale – Lab scale, pilot plant and large scale – Equipment Design and process variables – Process dynamics and control – Basic principles – Chemical Process Industries – Flow sheet representation – Evolution of an Industry – Sulphuric acid and Soda ash manufacture

UNIT V COMPUTATIONAL CHEMICAL ENGINEERING 9

Chemical Engineering Software – Computational tools used like MATLAB, ASPEN PLUS, ANSYS CFD, SCILAB, DWSIM – Applications of Chemical Engineering in various fields like Food, Water, Medical, Energy, and Agriculture and its future scope

CONTACT PERIODS:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Salil K Ghosal, Syamal K Shanyal and Siddhartha Datta "Introduction to Chemical Engineering", 1st Edition, Tata McGraw- Hill education, 1993
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, 1997
3. Pushpavanam S, "Introduction to Chemical Engineering" 1st Edition, Prentice Hall India Learning Private Limited, 2012

REFERENCES:

1. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", 7th Edition, McGrawHill, 2001.
2. Bruce A Finlayson, "Introduction to Chemical Engineering Computing", 1st Edition, John Wiley and Sons, 2014.
3. K. A. Solen and J. N. Harb, "Introduction to Chemical Engineering – Tools for Today and Tomorrow",5th Edition, Wiley, 2011.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

		Category: HSMC				
U21EN201	PERSONALITY ENHANCEMENT	L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop of personality traits that contributes in the professional environment
- To create a basic awareness about the significance of soft skills in professional and interpersonal communications
- To enhance the level of self-confidence that helps to excel in the leadership skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Nurture a deep understanding of personality development and interpersonal relationship for overall self-development (Understand)

CO2: Communicate proficiently in high-end interviews and in all social situations (Understand)

CO3: Synthesize complex concepts and present them in speech and writing (Analyse)

CO4: Negotiate and lead teams towards success (Understand)

CO5: Present ideas in an effective manner using web tools (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	1	1	1
CO2	-	-	-	-	-	-	-	1	2	3	-	1	1	1
CO3	-	-	-	-	-	-	-	-	2	3	-	-	1	1
CO4	-	-	-	-	-	-	-	-	2	3	-	-	1	1
CO5	-	-	-	-	-	-	-	1	-	3	-	-	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I LEXICAL REASONING 9

Module:1 Establishing Associations

Activity: Verbal Analogy, Logical Reasoning

Module:2 Lateral Thinking

Activity: Reasoning and Assertions

Module:3 Sentence Completion

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Activity: Cloze Test, Single Word Substitutes

UNIT II SOCIAL CORRESPONDENCE 9

Module:4 Etiquettes

Activity: Brain storming & performing in actions

Module:5 Introspection

Activity: SWOT Analysis, Goal Setting

Module:6 Co-verbal Gesture

Activity: Body Language, Non verbal cues

UNIT III ART OF NETWORKING 9

Module:7 Addressing a Multitude

Activity: Welcome address, Vote of Thanks, Public Speaking

Module:8Persuasive Communication

Activity: Making Technical Presentation

Module:9 Career Oriented Communication

Activity: Face to face Conversation, Mock Interview

UNIT IV CRITICAL THINKING 9

Module:10 Organizing ideas

Activity: Mind Mapping

Module:11 Problem Solving Skills

Activity: Conflict management, Case Study

Module:12 Critical Review

Activity: Book/ Movie Review, Comparative Analysis

UNIT V CONTENT WRITING 9

Module:13 Reports

Activity: Writing Event Report, Project Report

Module:14 Writing for Digital platform

Activity: Writing Posts, Blogs

Module:15 Developing Content

Activity: Product Description, Writing Proposals

LIST OF EXERCISES

1. Listening to Inspirational Speech
2. Listening to Product Description
3. Book/Movie Review
4. Presentation
5. Mock Interview
6. Public Speaking

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

ontact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Meenakshi Raman & Sangeetha Sharma. "Professional English: for AKTU", 1st Edition, Oxford University Press. 2018.
2. Barun. K.Mitra. "Personality Development and Soft Skills", 2nd Edition, OUP India 2016.

REFERENCES:

1. Mathew Allen. "Smart Thinking: Skills for Critical Understanding and Writing", 2nd Edition, OUP India, 2016.
2. Means, Thomas L, "English and Communication for Colleges", 4th Edition, Cengage, 2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st Edition, Orient Black Swan, 2017.

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="3">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

U21CY202	CHEMISTRY FOR TECHNOLOGISTS	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire basic knowledge of organic intermediates, reactions mechanism and their applications
- To understand the classification and chemical properties of biomolecules
- To gain knowledge about the synthesis and applications of drugs

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the various reaction intermediates involved in chemical reactions (Understand)

CO2: Illustrate the different electrophilic and nucleophilic reactions (Understand)

CO3: Outline the classification, structure and properties of carbohydrates, amino acids and proteins (Understand)

CO4: Estimate the saponification value, iodine value, total fatty acid content in the soap, oil and explain the cleansing mechanism of soap and detergents (Understand)

CO5: Classify the drugs, their synthesis and their mode of action (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	-	-	-	2	1	1
CO2	3	1	-	-	-	-	2	-	-	-	-	2	1	1
CO3	3	1	-	-	-	-	2	-	-	-	-	2	1	1
CO4	3	1	-	-	-	-	2	-	1	-	-	2	1	1
CO5	3	1	-	-	-	-	2	-	1	-	-	2	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I STRUCTURE AND REACTIVITY **6**

Homolytic and heterolytic fission of a covalent bond – Generation – Structure and stability – Free radicals, carbocations, carbanions and carbenes, Classification of organic reactions, Electrophiles and nucleophiles – Types – Aromaticity – Huckel's rule for aromaticity in benzenoid and non-benzenoid compounds – Antiaromaticity and homo-aromaticity – Application of intermediates – Carbocation – Pinacol – Pinacolone reaction, Benzilic acid – Carbanion – Michael reaction,

Knoevenagel reaction – Free radical – Wohl-Ziegler bromination reaction – Carbene – Reimer-Tiemann reaction – Wolff rearrangement

UNIT II REACTION MECHANISMS 6

Electrophilic Reactions: S_E1, S_E2, S_EAr – Mechanism, Electrophilic addition – Halogenation of alkene, hydrohalogenation – (addition of HBr on alkene- Markovnikov's rule and anti-Markovnikov'srule) – Electrophilic addition – Halogenation of ketones, Aromatic substitution – Nitration, Friedel Crafts alkylation – Acylation and halogenation – Nucleophilic Reactions: S_N1, S_N2, S_NAr, & benzyne- mechanism – Nucleophilic addition of carbonyl – Ammonia derivatives – Grignard's reagent

UNIT III BIOMOLECULES 6

Introduction – Classification, structure and chemical properties of monosaccharides – Glucose, fructose, disaccharides – Sucrose and polysaccharides – Starch and cellulose, cellulose derivatives – Carboxy methyl cellulose and gun cotton

Amino acids – Classification – Preparation – Strecker, Gabriel phthalimide and physical and chemical properties – Proteins – Composition – Classification – Chemical reactions and structure

UNIT IV OILS, FATS, SOAPS AND DETERGENTS 6

Lipids, Fatty Acids – Introduction – Structure and chemical composition of oils and fats – Types, physical and chemical properties – Salt formation, esterification, halogenation, oxidation, analysis of oils, fats and its significance (Acid, Iodine, Saponification values, Reichert- Meissl value) Soaps – Types of soaps, Manufacture of soap – Hot process, Cleansing action of soaps, Detergents – Types of detergents – Cationic, anionic, amphoteric, neutral detergents, Comparison between soaps and detergents

UNIT V MEDICINAL CHEMISTRY 6

Drugs – Requirements of drug – Classification based on chemical structure and therapeutic action, Antibacterial agents – Definition – Mode of action – Synthesis and properties – Sulfonamides, Antimalarial – Definition – Mode of action – Synthesis and properties (Chloroquinine), Analgesics – Definition – Mode of action – Synthesis and properties – Acetaminophen, Cardiovascular drugs – Definition – Mode of action – Synthesis and properties – Barbiturates, Anti-inflammatory definition – Mode of action – Synthesis and properties – Salicylic acid

LIST OF EXPERIMENTS

1. Synthesis of cinnamic acid from benzaldehyde
2. Halogenation - Preparation of 2,4,6- tribromo aniline from aniline & Acetylation – Preparation of acetanilide from aniline and bromination.
3. Qualitative tests for carbohydrates and proteins
4. Determination of saponification value of oil / fat
5. Synthesis of Barbituric acid from malonic acid
6. Synthesis of acetaminophen or paracetamol
7. Nitration – Preparation of picric acid

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Bhal B.S and Arun Bhal, "A Text Book of Organic Chemistry", 22nd Edition, S.Chand & Co. New Delhi, 2018
2. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Organic Chemistry, Oxford University Press, 2nd Edition, New Delhi, 2013

REFERENCES:

1. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015.
2. Ashutosh Kar, "Medicinal Chemistry", 7th Edition, New Age International Pvt, Ltd., 2010.
3. Sharma B.K, Industrial chemistry, 19th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2011.
4. https://nptel.ac.in/courses/104/106/104106131

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

U21CSG02	PYTHON PROGRAMMING	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand syntax and semantics of python programming
- To implement programs using python data structures
- To gain expertise in using python libraries for solving real time problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic operations of tokens in python (Understand)

CO2: Demonstrate the programs using control statements (Apply)

CO3: Develop programs using python data structures (Apply)

CO4: Implement the exceptions in file-handling concepts (Apply)

CO5: Apply the python libraries in real-world problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	2	2	2
CO2	2	1	1	2	-	-	-	1	2	2	-	2	2	2
CO3	3	2	2	2	-	-	-	1	2	2	-	2	2	2
CO4	3	2	2	2	-	-	-	1	2	2	-	2	2	2
CO5	3	2	2	2	1	-	-	1	2	2	-	2	2	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I LANGUAGE BASICS 6

Python interpreter and interactive mode – Tokens – Data types – Numbers and math functions – Input and Output operations – Comments – Reserved words – Indentation – Operators and expressions – Precedence and associativity – Type conversion – Debugging – Common errors in Python

UNIT II CONTROL STATEMENTS, FUNCTIONS, AND MODULES 6

Selection – Conditional branching statements – if – if-else – Nested-if – if-elif-else statements – Iterative statements – while – for loop – break – continue and pass statements – Functions – Function Definition and Function call – Variable scope and Lifetime – Return statement – Lambda functions or Anonymous functions – Recursion – Modules and Packages

UNIT III PYTHON DATA STRUCTURES 6

Strings – Slicing – Immutability – Built-in string methods and functions – Concatenating – Appending and Multiplying strings – String modules – List – Creation – Accessing values – Slicing – List methods – In-built functions for Lists – Tuples – Creation – Operations on tuples – Traversing – Indexing and Slicing – Tuple assignment – In-built functions for tuples – Sets – Creation – Operations – Dictionaries – operations and methods

UNIT IV EXCEPTION AND FILE HANDLING 6

Exceptions – Errors and Exceptions – Handling exception – Built-in and User-defined exceptions – Files – Types – Operations – Open – Read – Write – Close

UNIT V NUMPY and PANDAS 6

Numpy – Introduction – Computations using NumPy functions – Computation on Arrays – Aggregation – Indexing and Sorting – Pandas – Introduction and Basic Pandas Concepts – Data frames – Data Handling

LIST OF EXPERIMENTS

1. Programs on selection and Iteration operations.
2. Get an integer input from a user. If the number is odd, then find the factorial of a number and find the number of digits in the factorial of the number. If the number is even, then check the given number is palindrome or not.
3. Strings and its operations.
4. Given two strings, PRINT (YES or NO) whether the second string can be obtained from the first by deletion of none, one or more characters.
5. List and its operations.
6. Programs for positive and negative indexing.
7. Program to check if the given list is in Ascending order or Not.
8. Tuples and its operations.
9. Python program to convert a tuple to a string.
10. Python program to reverse a tuple.
11. Sets and its operations.
12. Python program to check if a set is a subset of another set.
13. Dictionaries and its operations.
14. Python program to iterate over dictionaries using for loops.
15. Computations using NumPy functions.
16. NumPy program to convert a list of numeric value into a one-dimensional NumPy array.
17. NumPy program to convert a list and tuple into arrays.
18. Data manipulations using Pandas.
19. Program to convert a NumPy array and series to data frames.
20. Program to add, subtract, multiple and divide two Pandas Series.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

21. Program to retrieve and manipulate data using dataframes.

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Python programming: Using problem solving approach", 1st Edition, Oxford Press, 2017
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition, Shroff/O'Reilly Publication, 2017

REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd Edition, McGrawHill Education, 2018
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach",1st Edition, Pearson India Education Services Pvt. Ltd., 2016
4. https://python-iitk.vlabs.ac.in/List%20of%20experiments.html
5. http://greenteapress.com/wp/think-python/

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td><td>Theory Examinations (Examinations will be conducted for 100 Marks)</td><td>Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER II

		Category: ESC				
U21MEG02	**MANUFACTURING PRACTICES**	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure on workshop tools and additive manufacturing processes
- To provide hands on training experiences in sheet metal, carpentry welding and plumbing operations
- To provide hands on experience on soldering and simple electrical circuit wiring

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: identify the various tools and measuring equipment used for assembly and dismantling practice (Apply)

CO2: Develop simple components using 3D printer (Apply)

CO3: Fabricate products using sheet metal and carpentry (Apply)

CO4: Perform operations such as welding and plumbing (Apply)

CO5: Connect and test the electrical and electronics components for the given circuit diagram (Apply)

CO PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	1	-	1	-	1	1	-	1	1	1
CO2	3	1	1	-	3	-	1	-	2	1	-	2	1	1
CO3	3	1	1	-	1	-	1	-	3	2	-	1	1	1
CO4	3	1	1	-	1	-	1	-	3	2	-	1	1	1
CO5	3	1	1	-	1	-	1	-	3	2	-	1	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I PRODUCT WORKSHOP **12**

Disassemble the product of sub assembly – Measure various dimensions using measuring instruments. Free hand rough sketch of the assembly and components – Name of the components and indicate thevarious materials used – Study the functioning of the assembly and parts – Study the assembly and components design for compactness – Processing – Ease of assembly and disassembly – Assemble the product or subassembly

UNIT II ADDITIVE MANUFACTURING WORKSHOP 12

Study of 3 axis 3D printing machine – Methods of 3D printing – SLA and FDM methods – Pre – processing – Geometry creation – Support generation and slicing – Post Processing – Requirement and Techniques Support Removal – Sanding – Acetone treatment – Polishing

UNIT III SHEET METAL AND CARPENTRY WORKSHOP 12

Study of tools and equipment – Draw development drawing of simple objects on sheet metal (cone – Cylinder – Pyramid – Prism – Tray etc.) – Fabrication of components using small shearing and bending machines – Riveting practice – Study of carpentry process – Fabrication of wood joints like Lap – Tee – Dovetail and mortise & tenon joint

UNIT IV WELDING AND PLUMBING WORKSHOP 12

Study of tools and equipment – Study of various welding – Arc welding practice – Fitting – Square butt joint and lap joint – Plumbing tools – Make a piping joint to a simple piping layout (should include cutting – Threading and pipe fixing)

UNIT V ELECTRICAL AND ELECTRONICS ENGINEERING WORKSHOP 12

Study of tools and equipment – Study of basic electrical components and symbols – Simple Wiring – Staircase Wiring – Fluorescent wiring – Study of soldering tools and methods of soldering

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Period Project: – Periods

Total: 60 Periods

LIST OF EXPERIMENTS

1. Study on measuring instruments used in workshop practices.
2. Dismantling, measuring and reassembling of centrifugal pump.
3. 3D prototyping of simple components using FDM method.
4. 3D Printing of simple geometric shapes using SLA printer.
5. Fabrication of sheet metal tray and funnel.
6. Fabrication of wood joints.
7. Preparation of MS plate for Lap, butt and Tee joints using arc welding
8. Installation of water lines for washbasin and showers faucets.
9. Preparation of wiring for tube light, staircase and electric fan.
10. Soldering of a simple circuit consists of THC and SMD components.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Mechanical Engineering", 11th Edition, Media Promoters, 2010.
2. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy the Elements of Workshop Technology – Vol I & II, 11th Edition, Media Promoters and Publishers, Mumbai, 2001

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	**Test**	
75	**25**	
100		**100**
60		**40**
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

		Category: BSC				
U21MAG01	PROBABILITY AND STATISTICS	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of probability, random variable and distributions that are applicable in the field of engineering
- To understand the concepts of testing of hypothesis for small and large samples which plays an important role in testing of industrial products
- To understand the concepts in design of experiments in the field of engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply probability axioms and the moments of discrete and continuous random variables to core engineering problems (Apply)

CO2: Use discrete probability distributions including requirements, mean and variance for making decisions (Understand)

CO3: Compare correlation and linear regression with respect to two dimensional random variables (Understand)

CO4: Analyze large and small sample tests and perform small sample tests based on Chi-square, t and F distributions (Apply)

CO5: Design an experiment with proper observations and measurement to get a valid result using various design methods (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	3

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I PROBABILITY **9 + 3**

Probability – Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions

UNIT II DISTRIBUTION FUNCTIONS **9 + 3**

Binomial distribution – Poisson distribution – Geometric distribution – Uniform distribution – Exponential distribution – Normal distribution

UNIT III TWO – DIMENSIONAL RANDOM VARIABLES **9 + 3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression

UNIT IV TESTING OF HYPOTHESIS **9 + 3**

Large sample test for single mean and difference of means – Small sample test: t distribution – F distribution – Chi square distribution

UNIT V DESIGN OF EXPERIMENTS **9 + 3**

One way and two-way classifications – Completely randomized design – Randomized block design – Latin square design

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Milton J S and Arnold J C, "Introduction to Probability and Statistics", 4th Edition, Tata McGraw Hill, 2008
2. Gupta S C and Kapoor V K, "Fundamentals of Mathematical Statistics", 11th Edition, S Chand & Sons, 2013

REFERENCES:

1. Johnson R A, "Miller and Freund's Probability and Statistics for Engineers", 8th Edition, Pearson Education, Asia, 2015
2. Devore J L, "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, New Delhi, 2014
3. Ross S M, "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2010
4. Walpole R E, Myers R H, Myers S L and Ye K, "Probability and Statistics for Engineers and Scientists", 10th Edition, Pearson Education, Asia, 2012

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

U21CH301	PROCESS CALCULATIONS	Category: PCC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To use the knowledge of laws of chemistry
- To apply mass and energy balance equations for single and network of units
- To understand and apply the basics of calculations in combustion solid, liquid and gaseous fuels

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the conversions of basic units and dimensions (Understand)

CO2: Apply the concept of material balance calculations in unit operations (Apply)

CO3: Interpret the parameters of humidity using humidity chart (Analyze)

CO4: Apply the concept of energy balance calculations in unit operations (Apply)

CO5: Solve problems in products of combustion of solid, liquid and gaseous fuels (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO2	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO4	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	1	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I UNITS AND DIMENSIONS **9 + 3**

Units, dimensions and conversions – Process variables and properties – Ideal gas laws – Mole fractions and partial pressures – Application of Dalton's and Amagat's law

UNIT II MATERIAL BALANCES **9 + 3**

Introduction to material balances: Material balance problems for single units – Stoichiometry and chemical reaction equations – Material balance for process involving reaction – Bypass, purge and recycle operations

UNIT III HUMIDITY **9 + 3**

Calculation of absolute humidity – Molal humidity – Relative humidity and percentage humidity – Use ofhumidity in condensation and drying – Humidity chart – Dewpoint

UNIT IV ENERGY BALANCES **9 + 3**

Heat capacities of gases as a function of temperature – Mean heat capacity, heat capacity of mixture of gases – Heat capacities of solid and liquids – Kopp's rule and Trouton's rule – Standard heat of reaction – Formation and combustion – Hess's law of heat summation and its application – Energy balance for systems with and without chemical reaction

UNIT V COMBUSTION **9 + 3**

Determination of composition by Orsat analysis of products of combustion of solid – Liquid and gas fuels – Calculation of theoretical and excess air requirements – Problems on sulphur and sulphur burning compounds

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Himmelblau DM, Riggs JB., "Basic principles and calculations in chemical engineering", 8th Edition, Prentice Hall International, 2012
2. Bhatt, B. L., Vora, S. M., "Stoichiometry", 4th Edition, Tata McGraw-Hill, 2004.

REFERENCES:

1. Felder, R. M., Rousseau, R. W., "Elementary Principles of Chemical processes", 4th Edition, John Wiley & Sons, 2020.
2. Narayanan, K. V., Lakshmikutty, B., "Stoichiometry and Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2016.
3. Hougen, O. A., Watson & Ragatz, "Chemical Process Principles", Part I, 1st Edition, CBS publishers, 1973.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

		Category: PCC				
U21CH302	FLUID MECHANICS FOR CHEMICAL ENGINEERS	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire sound knowledge on fluid properties, fluid statics and characteristics during fluid flow
- To know the concepts of flow measurement and fluid machinery
- To understand the mechanisms of fluid flow through pipes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand and define various concepts associated with fluid mechanics (Understand)

CO2: Apply fluid statics principles to determine pressure distribution in compressible and incompressible fluids (Apply)

CO3: Derive various mathematical principles of internal and external viscous flow (Apply)

CO4: Understand principles of flow meters and pumps during fluid transportation (Understand)

CO5: Integrate fluid mechanics parameters by dimensional and similarity analysis (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO2	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO4	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	1	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION **9 + 3**

Introduction: Nature of fluids – Thermodynamic properties of a fluid – Understand incompressible and compressible nature of fluids – Newton's law of viscosity – Newtonian and Non-Newtonian fluids – Basic elements of fluid flow: streamline – Streakline and pathline – Laminar and turbulent flows. Introduction to units and dimensions

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

UNIT II FLUID STATICS AND FLUID FLOW 9 + 3

Fluid Statics – Equilibrium of a fluid element – Pressure variation in a static fluid – Liquid and gas – Applications of fluid statics – U-tube manometer – Inclined U-tube manometer – Fluid Flow – Differential analysis of fluid motion – Equation of continuity derivation – Equation of motion – 1D Bernoulli equation

UNIT III FLUID FLOW: INTERNAL AND EXTERNAL 9 + 3

Internal viscous flow through pipes: Reynolds number regimes – Boundary layer growth into a fully developed flow – Pressure drop under laminar condition (Hagen-Poiseuille relation) – Pressure drop in turbulent flow (friction factor) – Major and minor losses due to pipe fittings. External viscous flow over a flat plate – Boundary layer thickness in laminar and turbulent flow (Blasius equation) – Drag forceand drag coefficient

UNIT IV FLOW MEASUREMENT AND TRANSPORTATION 9 + 3

Flow measurement: rotameter – Orifice meter – Venturimeter and Pitot tube (local velocity measurement). Packed bed: derivation of Ergun Equation – Minimum fluidization velocity – Fluidization types and pneumatic conveyors – Valves – Types and schematics – Pumps – Types and performance curves – Suction – Cavitation – Net positive suction head for centrifugal pumps – Introduction and use ofcompressors and fans

UNIT V DIMENSIONAL ANALYSIS 9 + 3

Dimensional analysis – Principle of dimensional homogeneity – Rayleigh method – Buckingham pi theorem – Non dimensionalization of equation of motion to give Reynolds number – Similarity analysis – Introduction – Types of similarities and use of dimensional analysis for scale-up studies

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 2nd Edition, McGraw Hill, 1991
2. McCabe, Smith and Harriot, "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill, 2005

REFERENCES:

1. White F.M., "Fluid Mechanics", 8th Edition, McGraw Hill, 2017
2. Munson, Young, Okiishi, "Fundamentals of Fluid Mechanics", 9th Edition, Wiley, 2021
3. James Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers", 2nd Edition, Prentice Hall 1999.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

U21CH303	MECHANICAL OPERATIONS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To study the characterization of particles
- To analyze the concept of filtration and separation
- To understand the process of mixing and agitation of solids and liquids

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Characterization of solids particles (Understand)

CO2: Apply the laws of size reduction in energy calculation (Apply)

CO3: Explain the concepts settling and sedimentation (Understand)

CO4: Understand the theory of filtration (Understand)

CO5: Explain the concepts mixing and agitation (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO2	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO4	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	1	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I CHARACTERISTICS OF SOLIDS **9**

General characteristics of solids – Different techniques of size analysis – Shape factor – Surface are determination – Estimation of particle size – Screening methods and equipment – Screen efficiency ideal and actual screens

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

UNIT II SIZE REDUCTION IN SOLDS 9

Laws of size' reduction – Energy relationships in size reduction – Methods of size reduction – Classification of equipment's – Crushers – Grinders and its application in cement industries – Size enlargement – Importance of size enlargement – Principle of granulation – Pelletization and flocculation

UNIT III SETTLING AND SEPARATIONS 9

Settling: gravity settling – Sedimentation – Thickening, Elutriation: Double cone classifier – Rake classifier – Bowl classifier – Centrifugal separation – Cyclones and hydro cyclones – Electrostatic and magnetic separators – Heavy media separations – Floatation – Jigging

UNIT IV FILTRATION 9

Filtration: theory of filtration – Batch and continuous filters – Flow through filter cake and filter media –compressible and incompressible filter cakes – Filtration equipments – Selection – Operation – Filter aids

UNIT V MIXING, AGITATION AND STORAGE 9

Mixing and agitation – Mixing of liquids (with or without solids) – Mixing of powders Selection of suitable mixers – Storage and Conveying of solids – Bunkers – Silos – Bins – Hoppers – Conveyer selection

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 1st Edition, Tata McGraw Hill,1997.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol.II, 4th Edition, Asian Books Pvt. Ltd., India, 1988.
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1994.
3. Hiroaki Masuda, Kohigashitani and Hideto Yoshida, Powder Technology Handbook, 3rdEdition, CRC Press, 2006.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

		Category: ESC				
U21CH304	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	J	C
		2	0	0	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the nature and facts about environment
- To find and implement scientific, technological, economic and political solutions to environmental problems
- To study the interrelationship between living organism and environment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the nature and facts about environment (Understand)

CO2: Implement scientific, technological, economic and political solutions to environmental problems (Apply)

CO3: Study the interrelationship between living organism and environment (Understand)

CO4: Appreciate the importance of environment by assessing its impact on the human world (Understand)

CO5: Envision the surrounding environment, its functions and its value (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO2	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO3	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO4	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO5	2	1	1	1	-	3	3	2	3	1	-	1	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 6

Definition – Scope and importance of environment – Need for public awareness – Concept of a ecosystem – Structure and function of an ecosystem – Producers – Consumers and decomposers – Ecological succession – Food chains – Food webs and ecological pyramids – Introduction – Types characteristic features – Structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global – National and local levels – Hot-spots of biodiversity – Threats to biodiversity – Conservation of biodiversity – Elements of Environmental Science

UNIT II ENVIRONMENTAL POLLUTION 6

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Solid waste management: causes – Effects and control measures of municipal solid wastes – Role of an individual in prevention of pollution – Disaster management: floods, earthquake – Cyclone and landslides – Pollution standards – Particulate matters 10 and 2.5 – Pollution monitoring equipment such as Ozone analyzer – High volumeanalyzer and continuous monitoring system for air and water

UNIT III NATURAL RESOURCES 6

Forest resources: Use and over-exploitation, deforestation – Water resources: Use and over-utilization of surface and ground water, floods, drought – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources – Food resources: World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture – Fertilizer – Pesticide problems – Energy resources: Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Land resources: Land as a resource – land degradation – Man induced landslides – Soil erosion and desertification – Role of an individual in conservation of natural resources

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 6

From unsustainable to sustainable development – Urban problems related to energy – Automobile exhaust pollution and social issues – Water conservation, rain water harvesting – Environmental ethics: Issues and possible solutions – Climate change – Global warming – Acid rain – Ozone layer depletion – Nuclear accidents and holocaust – Biological – Chemical and physical conservation and reclamation of land – Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – environmental legislation, Environmental audit

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – Population explosion – Family welfare program – environment and human health – Human rights – Value education – HIV / AIDS – Women and child welfare

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: 30 Periods

Total: 60 Periods

PROJECT TOPICS:

1. Nature's value in policy and practice: Evaluating interaction between different ecosystems.
2. Demonstrate innovative waste management solutions.
3. Strategic plans to conserve natural resources: Role of an individual.
4. Chemical Engineers can save the world from climate change: Issues and possible solutions.
5. A case study on the effects of population growth, environmental pollution and poverty relationship

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering, 1st Edition, Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", 2nd Edition, Prentice hall of India Pvt. Ltd, 2007.
2. ErachBharucha, Text book of Environmental Studies, 1st Edition, Universities Press (I), Pvt. Ltd., 2015
3. Rajagopalan, R, "Environmental Studies - From Crisis to Cure", 1st Edition, Oxford University Press, 2005.

EVALUATION PATTERN:

Continuous Internal Assessments					**End Semester Examinations**
Assessment I (Theory) (100 Marks)		**Assessment II (Project) (100 Marks)**			**Theory Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	**60**	**15**	**25**	**60**	
25		**25**			**50**
50					**50**
Total: 100					

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

U21CH305	TECHNICAL ANALYSIS LABORATORY	Category: PCC					
		L	T	P	J	C	
		0	0	4	0	2	

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To make the student acquire practical skills in the wet chemical and \ instrumental methods
- To familiarize the quantitative/qualitative analysis of different categories of chemicals like coal, ore, phenol, oil, soap and drug.
- To gain knowledge on the quantitative analysis of heavy metals (iron) and pollutants (water pollutants, COD of water)

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Develop the skills to handle the equipment like UV-visible spectrophotometer, viscometers, nephelometer, bomb calorimeter etc. (Apply)

CO2: Analyze different chemical like ore, drug, oil, coal, soap etc. using simple techniques (Apply)

CO3: Attain knowledge on the quantitative as well as qualitative analysis of different categories of chemicals (Apply)

CO4: Experiment calorimetric analysis technique (Apply)

CO5: Use the methods for water pollutant analysis (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	2	2	-	3	-	-	2	2	1
CO2	3	2	1	-	-	2	2	-	3	-	-	2	2	1
CO3	3	2	1	-	-	2	2	-	3	-	-	2	2	1
CO4	3	2	1	-	-	2	2	-	3	-	-	2	2	1
CO5	3	2	1	-	-	2	2	-	3	-	-	2	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

LIST OF EXPERIMENTS:

1. Determination of Redwood / Saybolt numbers, kinematic viscosity and viscosity index of Lubricating oils.
2. Analysis of water (pH, turbidity, conductivity, resistivity, suspended particles)
3. Determination of acid value and iodine value of oils.
4. Determination of COD of water samples.
5. Proximate analysis of coal
6. Soap Analysis a. Estimation of total fatty acid b. Estimation of percentage alkali content.
7. Estimation of sulphate by digital turbidity meter
8. Estimation of phenol.
9. Determination of calorific value using bomb calorimeter.
10. Determination of iron in water using UV-Visible Spectrophotometer.
11. Estimation of Aspirin drug in tablets using pH meter.
12. Estimation of manganese in the given sample of ore.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. S.M.Khopkar, "Environmental pollution analysis", 1st Edition, New age international. 2011
2. N.C Aery, "Manual of environmental analysis", 2nd Edition, Ane books. 2010
3. J.Mendham, "Text book of quantitative chemical analysis", 1st Edition, Pearson education 2008

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER III

U21CH306	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**	**Category: ESC**				
		L	**T**	**P**	**J**	**C**
		0	**0**	**4**	**0**	**2**

PRE–REQUISITES:

- U21EEG01 – Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

- To acquire the knowledge on testing of various DC machines and transformers
- To understand the working principle of DC motors and transformers
- Analyze the performance of semiconductor devices and its characteristics

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the characteristics of DC shunt motor (Analyze)

CO2: Choose the different speed control methods for various applications (Analyze)

CO3: Estimate the efficiency of transformer & induction motor (Apply)

CO4: Assess the performance characteristics of PN diode and SCR (Analyze)

CO5: Identify the applications of half wave and full wave rectifier (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

LIST OF EXPERIMENTS:

1. Load test on DC shunt motor.
2. Speed control of DC shunt motor.
3. Load test on single phase transformer.
4. Load test on three phase induction motor.
5. Characteristics of PN Junction diode.
6. Half wave and full wave rectifier.
7. VI characteristics of SCR

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

REFERENCES:

1. J. B. Gupta, "A Text book of basic Electrical and Electronics Engineering", 1st Edition, S. K. Kataria and Sons, 2013.

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	**Test**	
75	**25**	
100		**100**
60		**40**
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET

SEMESTER IV

		Category: BSC				
U21MA402	**PARTIAL DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**J**	**C**
		2	**0**	**0**	**0**	**2**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of partial differential equations in diffusion and concentration of chemicals
- To understand the concepts of Fourier series to obtain solution of one-dimensional wave and heat equation
- To understand the concepts Fourier series to obtain solution of two-dimensional heat equations

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the formation of differential equation from the given problems and to solve first order ordinary differential equation by various methods (Apply)

CO2: Apply a range of techniques to find solutions of standard partial differential equations (Apply)

CO3: Demonstrate accurate and efficient use of Fourier series analysis techniques and their applications in the theory of PDE's (Apply)

CO4: Apply Fourier series to solve an initial–boundary value problem for one dimensional wave equation (Apply)

CO5: Apply Fourier series to solve an initial–boundary value for two dimensional heat equations (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I FORMATION OF PARTIAL DIFFERENTIAL EQUATIONS 6

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations

UNIT II SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 6

Lagrange's linear equation – Solution methods for second order homogeneous equations with constant coefficients

UNIT III FOURIER SERIES 6

General Fourier series – Full range series *(0,2l)* – Half range Sine and Cosine series *(0,l)*

UNIT IV ONE DIMENSIONAL BOUNDARY VALUE PROBLEMS 6

Fourier series solution – Vibration of strings – One dimensional wave equation – One dimensional heat flow equation (unsteady state)

UNIT V TWO-DIMENSIONAL BOUNDARY VALUE PROBLEMS 6

Fourier series solution – Two-dimensional (steady state) heat flow equation (Cartesian form only) – Separation of variables

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017
2. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2018

REFERENCES:

1. Bali N P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt Ltd, 2014
2. Peter V O Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage, New Delhi, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER IV

U21CH401	CHEMICAL ENGINEERING THERMODYNAMICS I	Category: ESC				
		L	T	P	J	C
		2	1	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the basic knowledge on various laws of thermodynamics and PVT behaviour of fluids.
- To provide the knowledge on thermodynamic property relations and their application to fluid flow.
- To show the Power generation and refrigeration processes

COURSE OUTCOMES:

Upon completion of the course, the student will be

able toCO1: Define the basic principles clearly

(Understand)

CO2: Apply the PVT behaviour concepts clearly food (Apply)

CO3: Apply second law and analyze the feasibility of systems/devices (Apply)

CO4: Analyze the concept of thermodynamic property relation to fluid flow (Analyze)

CO5: Understand the real gas behaviour (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
CO2	2	2	2	-	-	-	-	-	-	-	-	-	1	1
CO3	1	1	1	-	-	-	-	-	-	-	-	-	1	1
CO4	2	3	1	-	-	-	-	-	-	-	-	-	1	1
CO5	1	2	1	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I INTRODUCTION **6+3**

Scope of Thermodynamics – Definition of system – Control volume, state and path function –Equilibrium – Reversibility – Energy – Work and heat – Zeroth law – Temperature scales

UNIT II PVT BEHAVIOUR OF FLUIDS **6+3**

PVT behaviour of fluids – Mathematical representation of PVT behaviour – Generalized compressibility factor correlations – Generalized equations of state

UNIT III SECOND AND THIRD LAW OF THERMODYNAMICS **6+3**

Joule's experiment – Internal energy – First law – Energy balance for closed systems – Mass and energy balance for open systems Statements of the second law Thermodynamic

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Heat engine and Refrigerator – Carnot cycle and Carnot theorems – Thermodynamic temperature scale – Entropy and its calculation – Second law of thermodynamics for a control volume – Third law of thermodynamics – Entropy from a microscopic point of view

UNIT IV THERMODYNAMIC PROPERTY RELATIONS **6+3**

Thermodynamic potentials – Internal energy – Enthalpy – Helmholtz free energy – Gibbs free energy – Thermodynamic property relations – Maxwell relations – Partial derivatives and Jacobian method – Residual properties – Thermodynamic property tables and diagrams

UNIT V POWER GENERATION AND REFRIGERATION PROCESSES **6+3**

Duct flow of compressible fluids – Compression and expansion processes – Steam power plant – Internal combustion engines – Jet and rocket engines

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", 6th Edition McGraw Hill Publishers, 2003.
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics, 1st Edition, Prentice Hall India, 2004

REFERENCES:

1. Kyle, B.G., "Chemical and Process Thermodynamics 3rd Edition", Prentice Hall of India Pvt. Ltd.,1999.
2. Elliott J.R., Lira, C.T., "Introductory chemical engineering thermodynamics", 1st Edition, Prentice Hall, 1998.
3. Rao, Y.V.C., "Chemical Engineering Thermodynamics" 1st Edition, Universities Press, 2005.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components basedon the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET

SEMESTER IV

		Category: ESC				
U21CH402	ENGINEERING MATERIALS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide the knowledge on the properties of materials and choose as per requirement
- To describe the making, shaping and treating processes of alloys
- To identify the various properties of special materials like ceramics, refractories, and polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Choose materials required for chemical plants based on their properties (Apply)

CO2: Understand various processes associated with metals and their alloys (Understand)

CO3: Understand properties and uses of polymers and fibers (Understand)

CO4: Know the constituents and use of various refractory materials (Understand)

CO5: Analyze various novel materials including shape memory alloys and explainthe reason for their novelty (Anayze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	2	1	2	-	1	1	-	-	1	1
CO2	3	2	2	-	2	1	2	-	1	1	-	-	1	1
CO3	3	2	2	-	2	1	2	-	1	1	-	-	1	1
CO4	3	2	2	-	2	1	2	-	1	1	-	-	1	1
CO5	3	2	2	-	2	1	2	-	1	1	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS

UNIT I PROPERTIES AND SELECTION OF MATERIALS 9

Properties of materials: physical (density) – Thermal (conductivity) – Mechanical (stress-strain diagram) –Electrical (conductivity, dielectric constant) and chemical properties – Methods to choose process materials relevant for a chemical plant

UNIT II METALS AND ALLOYS 9

Metals – Making – Shaping and treating processes associated with Iron – Steel – Aluminum – Aluminum alloys – Copper – Copper alloys – Nickel alloys – Chromium alloys and Titanium alloys

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT III POLYMERS: NATURAL AND SYNTHETIC 9

Rubber and other natural elastomers – Properties and uses of synthetic polymers such as poly vinyl chloride (PVC) – Polyesters – Nylon – Teflon – Properties and uses of natural fibers like silk – jute – Cotton and other synthetic fibers

UNIT IV CERAMICS AND REFRACTORIES 9

Classification – Manufacture and properties of refractive materials – Constituents and applications ofsilica – Alumina – Tar – Dolomite and other special refractories such as glasses – Constituents of cement

UNIT V NEW MATERIALS 9

Composites – Classification – Types of matrix and reinforcement materials – Processing methods and applications of composites – Smart materials such as piezoelectric – Electro strictive – Fibre optics and shape memory alloys – Introduction to biomaterials

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. O.P. Khanna, "A Textbook of Material Science and Metallurgy", 1st Edition, Dhanpat Rai Publications, New Delhi, 1999.
2. W.D. Callister Jr., "Materials Science and Engineering", 5th Edition, John Wiley & Sons, 2001.
3. V. Raghavan, "Physical Metallurgy: Principles and Practice", 3rd Edition, PHI Learning, 2015.

REFERENCES:

1. Sidney Avner, "Introduction to Physical Metallurgy", 2nd Edition, McGraw Hill Education, 2017.
2. W.C. Richards, "Engineering Materials Science", 1st Edition, Literary Licensing, LLC, 2012.
3. H. VanVlack, "Elements of Materials Science and Engineering", 6th Edition, Pearson Education India, 2002.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

KPRIET

SEMESTER IV

		Category: PCC				
U21CH403	MASS TRANSFER I	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallizers
- To develop knowledge for application of mass transfer principles
- To impart the significance of mass transfer principles used in Chemical Engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamentals, types and mechanism of mass transfer operations (Understand)

CO2: Understand the theories of mass transfer and the concept of inter- phase mass transfer (Understand)

CO3: Understand the basics of humidification process and its applications. (Understand)

CO4: Understand the concept and mechanism of drying operations (Understand)

CO5: Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	1	1
CO2	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO4	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	1	1	1	-	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS

UNIT I MOLECULAR DIFFUSION **9+3**

Introduction to mass transfer operations – Molecular diffusion in gases – Liquids and solids – Diffusivity measurement and prediction; multi-component diffusion

UNIT II CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER **9+3**

Eddy diffusion – Concept of mass transfer coefficients – Theories of mass transfer – Different transport analogies – Application of correlations for mass transfer coefficients – Inter phase mass transfer –

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

relationship between individual and overall mass transfer coefficients – NTU and NTP concepts, Stage-wise and differential contractors

UNIT III HUMIDIFICATION OPERATIONS **9+3**

Humidification – Equilibrium – Humidity chart – Adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers – Dehumidifiers and humidifiers using enthalpy transfer unit concept

UNIT IV DRYING **9+3**

Drying – Equilibrium – Classification of dryers – Batch drying – Mechanism and time of cross through circulation drying – Theoretical estimation of drying rate and time – Continuous dryers – Material and energy balance – Advance drying techniques such as freeze drying – Microwave drying

UNIT V CRYSTALLIZATION **9+3**

A Crystal geometry – Equilibrium – Yield and purity of products – Theory of super saturation – Nucleation and crystal growth – Classification of crystallizers – Design of batch crystallizers and continuous crystallizers

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, 2007 (reprint).
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., 2003

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., 1998.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Edition, John Wiley, 2006.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER IV

		Category: PCC				
U21CH404	PROCESS HEAT TRANSFER	L	T	P	J	C
		2	1	0	2	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental concepts of heat transfer viz., conduction, convection, radiation
- To understand and apply the concepts of boiling, condensation and radiative heat transfer
- To develop sound practical knowledge on different types of heat transfer equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamental concepts of heat transfer and steady state heat conduction in solids (Understand)

CO2: Explain the convective heat transfer and heat transfer coefficients for laminar and turbulent flows(Understand)

CO3: Describe the heat transfer in boundary layer and heat transfer involving phase change (Understand)

CO4: Understand the radiative heat transfer including black body radiation and Kirchoff's law (Understand)

CO5: Calculate and use overall heat transfer coefficients in designing heat exchanger equipment (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO2	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO3	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO4	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO5	3	2	2	2	2	-	1	-	1	1	2	2	2	2
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)					

SYLLABUS

UNIT I INTRODUCTION AND CONDUCTION **6+3**

Importance of heat transfer in Chemical Engineering operations – Modes of heat transfer – One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres – Thermal conductivity measurement – Effect of temperature on thermal conductivity – Heat transfer in extended surfaces – Transient heat conduction

UNIT II HEAT TRANSFER BY CONVECTION **6+3**

Concepts of heat transfer by convection – Natural and forced convection – Hydrodynamic and thermal Boundary layers – Analogies between transfer of momentum and heat – Reynold's analogy – Prandtl and Coulburn analogy – Dimensional analysis in heat transfer – Heat transfer coefficient for flow througha pipe – Flow past flat plate and flow through packed beds and fluidized beds

UNIT III HEAT TRANSFER BY PHASE CHANGE **6+3**

Heat transfer to fluids with phase change – Heat transfer from condensing vapours – Drop wise and filmwise condensation – Nusselt equation for vertical and horizontal tubes – Condensation of super-heated vapours – Heat transfer to boiling liquids – Mechanism of boiling – Nucleate boiling and film boiling

UNIT IV EVAPORATION AND RADIATION 6+3

Evaporation – Single and multiple effect operation – Material and Energy balance in evaporators – Boilingpoint elevation – Duhring's rule – Radiation heat transfer – Black body radiation – Emissivity – Stefan – Boltzman law – Plank's law – Radiation between surfaces

UNIT V HEAT EXCHANGERS **6+3**

Heat Exchangers – Classification and design – Overall and individual film coefficients – Mean temperature difference – LMTD correction factor for multiple pass exchanger – NTU and efficiency of heat exchangers

LIST OF EXPERIMENTS

1. Demo by experiment difference in thermal conductivity of a metal, polymer and refractory
2. Build a composite wall to maintain room temperature 5°C less than outer temperature
3. Energy analysis and comparison of a natural and convective drying equipment
4. Perform energy analysis or build a prototype of a 10 kg/day coconut jaggery evaporator by using microwave radiation
5. Critically analyze: solar irradiation for electricity generation in India is insufficient
6. Cross cut section of a double pipe, single / multi pass shell and tube heat exchanger
7. Perform heat energy balance for a sodium hydroxide manufacturing plant involving multi effect evaporator or a petroleum distillation column.
8. Optimize heat energy in a chemical process plant using PINCH technology
9. Design a passive cooling of an electric vehicle battery with fins
10. Critically review the list of text and reference books available for heat transfer in Library
11. Perform a literature review on recent trends in heat transfer research
12. Critically analyze the tools used in recent publications in Journal of Heat Transfer
13. Develop a virtual heat transfer lab experiment in MATLAB / python / simulink
14. Create a 2 minute 3D animation video to explain an heat transfer concept in AutoDesk / Maya / Blender
15. Write a MATLAB / SCILAB / PYTHON / OCTAVE CODE to solve ordinary or partial derivative equation involving temperature

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: 30 Periods

Total: 75 Periods

TEXT BOOKS:

1. Holman, J. P., "Heat Transfer", 10th Edition, McGraw Hill, 2010.
2. Ozisik, M. N., "Heat Transfer: A Basic Approach", 5th Edition, McGraw-Hill, 1984.

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edition, McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edition, Asian Books Pvt. Ltd., India, 1998.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			50
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER IV

		Category: PCC				
U21CH405	FLUID MECHANICS LABORATORY	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21CH302 - Fluid Mechanics for Chemical Engineers

COURSE OBJECTIVES:

- To calibrate flow meters
- To find pressure drop for various flow situations
- To determine pump characteristics

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand and select flow meters (Understand)

CO2: Understand the flow behaviour in open channels and drum (Understand)

CO3: Select pumps for transportation of fluids based on their characteristics (Apply)

CO4: Compare pressure loss during fluid flow in various situations (Analyze)

CO5: Determine viscosity of unknown fluids (Evaluate)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	2	-	-	-	-	1	-	-	1	2	1
CO2	3	-	-	2	-	-	-	-	1	-	-	-	2	1
CO3	3	-	1	2	-	-	-	-	1	-	-	-	2	1
CO4	3	-	-	3	-	-	-	-	1	-	-	-	2	1
CO5	3	-	-	3	-	-	-	-	1	-	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

LIST OF EXPERIMENTS

1. Viscosity measurement of fluids
2. Drag studies on falling spherical particle
3. Calibration of constant head flow meters
4. Calibration of variable head flow meters
5. Calibration of weirs and notches
6. Open drum orifice and draining time
7. Pressure drop for flow through straight pipe
8. Pressure drop for flow through helical and spiral coil

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

9. Losses in pipe fittings and valves
10. Characteristic curves of pumps (centrifugal / gear / reciprocating)
11. Pressure drop in packed bed column
12. Pressure drop in fluidized bed

Contact Periods:

Lecture: Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

REFERENCES:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 2nd Edition, McGraw Hill, 1991.
2. McCabe, Smith and Harriot, "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill, 2005.
3. White F.M., "Fluid Mechanics", 8th Edition, McGraw Hill, 2017
4. Munson, Young, Okiishi, "Fundamentals of Fluid Mechanics", 9th Edition, Wiley, 2021

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER IV

		Category: PCC				
U21CH406	MECHANICAL OPERATIONS LABORATORY	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21CH303 - Mechanical Operations

COURSE OBJECTIVES:

- To calibration of the units
- To determine the Elutriator Characteristics
- To find the size separation of Sub - Sieving

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand and select size separation (Understand)

CO2: Understand the filtration studies (Understand)

CO3: Apply reduction ratio in crusher and mill (Apply)

CO4: Compare Filtration and separation (Analyze)

CO5: Determine characteristic of Elutriator (Evaluate)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	2	-	-	-	-	1	-	-	1	2	1
CO2	3	-	-	2	-	-	-	-	1	-	-	-	2	1
CO3	3	-	1	2	-	-	-	-	1	-	-	-	2	1
CO4	3	-	-	3	-	-	-	-	1	-	-	-	2	1
CO5	3	-	-	3	-	-	-	-	1	-	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Sieve analysis
2. Size separation using Sub-Sieving
3. Batch filtration studies using a Leaf filter
4. Batch filtration studies using a Plate and Frame Filter press
5. Characteristics of batch Sedimentation
6. Reduction ratio in Jaw Crusher
7. Reduction ratio in Ball mill
8. Separation characteristics of Cyclone separator

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

9. Determination of specific surface area using air permeability set up
10. Separation characteristics of Elutriator

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, 7th Edition, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill. 5th Edition, 1997.
3. Coulson,J.M. and Richardson, J.F., "Chemical Engineering" Vol II, Asian Books Pvt.Ltd., India, 4th Edition, 1988.
4. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", John Wiley & Sons, 2nd Edition, 1994.

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	**Test**	
75	**25**	
100		**100**
60		**40**
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER IV

		Category: HSMC				
U21SSG01	SOFTSKILLS – I	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate potential skills and to work as a team effectively.
- To develop confidence and enhance interpersonal skills.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Enhance decision making and negotiation skills (Analyze)

CO2: Maintain open, effective, and Professional Communication (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	2	2	1
CO2	-	-	-	-	-	-	-	-	2	3	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I VERBAL COMPETENCE **10**

Verbal Analogy – Spotting Errors – Ordering of Sentences – Cloze Test – Effective Listening – Reading Comprehension

UNIT II EFFECTIVE COMMUNICATION **10**

Overcoming Communication Barriers – Body Language and its Etiquettes – Contextual Communication – 7C's of Communication – Listening to Documentaries

UNIT III INTERPERSONAL SKILLS **10**

Group Decision Making – Paralanguage – Negotiation Skills – Preparation & Planning, Bargaining & Problem Solving –Self Grooming – SWOT Analysis

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical 30 Periods Project: – Periods

Total: 30 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", 1st Edition, BPB Publications, 2022.
2. Suresh Kumar E, Sreehari P and Savithri J, "Communication Skills and Soft Skills: An Integrated Approach", 1st Edition, Dorling Kindersley, 2011.

REFERENCES:

1. Jeff Butterfield, "Problem Solving and Decision Making", 2nd Edition, Course Technology, 2010.
2. Wushow Bill Chou, "Fast-Tracking your Career: Soft Skills for Engineering and IT Professionals", 1st Edition, IEEE Press, 2013.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET

SEMESTER V

U21MA502	COMPUTATIONAL TECHNIQUES	Category: BSC				
		L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of direct and iterative method for solving algebraic and transcendental equations using numerical methods of interpolation
- To obtain the solution of differentiation and integration using standard numerical techniques in solving kinematics simulation and composite materials
- To understand the concepts of ordinary and partial differential equations in elastic beams and elastic bars using numerical techniques

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the concepts of algebraic and transcendental equations to solve core engineering problems (Understand)

CO2: Use concepts of interpolation for mathematical problems arising in various field (Understand)

CO3: Utilize differentiation and integration methods for finite difference and finite element method (Understand)

CO4: Solve initial value problems of ordinary differential equations using numerical techniques (Understand)

CO5: Use finite difference techniques, implicit and explicit methods for solving boundary value problem of partial differential equations (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	3

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I SYSTEM OF EQUATIONS **6**

Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Gauss Seidel method

UNIT II INTERPOLATION 6

Interpolation with equal intervals – Newton's forward and backward difference formulae – Interpolation with unequal intervals – Lagrange interpolation

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 6

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal rule – Simpson's 1/3 rule – Evaluation of double integrals by Trapezoidal rule

UNIT IV NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 6

Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations

UNIT V NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 6

Finite difference method – Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – 1D wave equation by explicit method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Burden R L and Faires J D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016
2. Grewal B S and Grewal J S, "Numerical Methods in Engineering and Science", 10th Edition, Khanna Publishers, New Delhi, 2015

REFERENCES:

1. Jain M K, Iyengar S R K. and Jain R K, "Numerical Methods for Scientific and Engineering computation", 6th Edition, New Age International Publishers, 2019
2. Sastry S S, "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd, 2012
3. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr.S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore – 641407

KPRIET
Learn beyond

SEMESTER V

		Category: PCC				
U21CH501	CHEMICAL ENGINEERING THERMODYNAMICS II	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- The behavior of fluids under PVT conditions and also apply them for practical purpose
- The concepts of thermodynamics
- The principles of refrigeration and to evaluate their performance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply mass balances to flow processes (Apply)

CO2: Understand the entropy and enthalpy balances to flow processes (Understand)

CO3: Implement the chemical reaction equilibria in engineering systems (Apply)

CO4: Discuss about phase equilibria in engineering aspects (Understand)

CO5: Understand the principles of refrigeration (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO2	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO3	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO4	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO5	3	3	-	-	2	-	-	-	-	1	-	-	1	3
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I PROPERTIES OF SOLUTIONS **9 + 3**

Partial molar properties – Ideal and non-ideal solutions – Standard states definition and choice – Gibbs – Duhem equation.

UNIT II PHASE EQUILIBRIA **9 + 3**

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity – Application of phase rule – Vapour-liquid equilibrium – Liquid-liquid equilibrium – Ternary liquid-liquid equilibrium

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA **9 + 3**

Thermodynamic consistency of phase equilibria – Application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes

UNIT IV CHEMICAL REACTION EQUILIBRIA **9 + 3**

Definition of standard state – Standard free energy change and reaction equilibrium constant – calculation of equilibrium compositions for homogeneous chemical reactors – Thermodynamic analysis of simultaneous reactions

UNIT V REFRIGERATION **9 + 3**

Principles of refrigeration – Methods of producing refrigeration – Evaluation of the performance of vapor compression and gas refrigeration cycles.

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Smith J.M., Van Ness, H.C., Abbot M.C, "Introduction to Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, 2004.
2. Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" 1st Edition, Prentice Hall of India Pvt. Ltd. 2001.

REFERENCES:

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., "Chemical Process Principles Part II", Thermodynamics, 1st Edition, John Wiley, 1970.
2. Dodge, B.F., "Chemical Engineering Thermodynamics", 1st Edition, McGraw-Hill, 1960.
3. Sandler, S.I., "Chemical and Engineering Thermodynamics", 2nd Edition, Wiley, 1989.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learnbeyond

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations Assessment (100 Marks)
Assessment I (100 Marks)		Assessment II (100 Marks)		Assessment I (100 Marks)	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER V

U21CH502	MASS TRANSFER II	Category: PCC				
		L	T	P	J	C
		2	1	0	2	4

PRE–REQUISITES:

- U21CH403 - Mass Transfer I

COURSE OBJECTIVES:

- To impart the basic concept of conventional mass transfer operations
- To learn the equilibrium characteristics of two phase mass transfer processes
- To understand the hydrodynamics and modes of operations in mass transfer equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process (Understand)

CO2: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower (Apply)

CO3: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process (Apply)

CO4: Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation (Analyze)

CO5: Understand the concept of adsorption techniques, various isotherms and ion exchange process (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO5	3	1	1	-	-	-	-	-	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I ABSORPTION 9

Equilibrium and operating line concept in absorption calculations; Types of contactors – Design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors – Concepts of NTU – HTU and overall volumetric mass transfer coefficients – Multicomponent absorption – Mechanism and model of absorption with chemical reaction – Thermal effects in absorption process.

UNIT II DISTILLATION 9

Design of Distillation – Stage-wise and continuous Differential contact operations – Design calculationsusing Ponchon-Savarit and Mc-Cabe Thiele Methods – Separation efficiency – Murphree Plate Efficiency – Point and overall efficiency interrelations – Reboilers and condensers – Open steam Distillation – Design of Packed bed distillation towers – HTU and NTU calculations

UNIT III LIQUID-LIQUID EXTRACTION 9

Extraction- Theory – LLE for different systems – Effect of Pressure and Temperature on LLE – Solubilitycriteria – Design of Batch and continuous extraction towers for miscible and immiscible systems – Industrial Applications

UNIT IV LEACHING 9

Leaching – Theory – Mechanism – Types of leaching – Solid – Liquid equilibria – Design of Batch andcontinuous extractors – Equipment and industrial applications.

UNIT V ADSORPTION– ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES 9

Adsorption – Types of adsorption – Nature of adsorbents-Adsorption hysteresis – Adsorption isotherms – Operation of adsorption columns – Design of Batch and continuous adsorbers – Principle of Ion exchange – Techniques and applications – Solid and liquid membranes – Concept of osmosis – Reverse osmosis – Electro dialysis – Ultrafiltration.

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: 30 Periods

Total: 75 Periods

TEXT BOOKS:

1. R.E. Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., New York, 1981.
2. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

REFERENCES:

1. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol - II, 5th Edition, Pergamon Press, New York, 2002.
2. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edition, Prentice Hall of India, 2004.
3. W.L. Mccabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engg.", 7th Edition, McGraw Hill Book Co., New York, 2004.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			50
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER V

U21CH503	MASS TRANSFER LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21CH403 – Mass Transfer I
- U21CH502 – Mass Transfer II

COURSE OBJECTIVES:

- To impart the practical experience for the students to apply the concepts of mass transfer principles
- To develop sound practical knowledge for students on different types of mass transfer equipments
- To estimate the mass transfer parameters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Determine the diffusivity practically and compare the results with the empirical correlations (Understand)

CO2: Estimate the mass transfer rate and mass transfer co-efficient (Understand)

CO3: Evaluate the performance/calculate the parameters in different distillation processes (Apply)

CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations (Apply)

CO5: Estimate the drying characteristics (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO2	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO3	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO4	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO5	3	3	-	2	-	-	-	-	2	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation Heat transfer in a shell and tube heat exchanger
2. Separation of binary mixture using Steam distillation

3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Solid Liquid mass transfer studies
10. Water purification using ion exchange columns
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. R.E. Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., New York, 1981.
2. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", 2nd Edition, Printice Hall of India Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol - II, 5th Edition, Pergamon Press, New York, 2002
2. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edition, Prentice Hall of India, New Delhi, 2004.
3. W.L. Mccabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engg.", 7th Edition, McGraw Hill Book Co., New York, 2004

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		**100**
60		**40**
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER V

U21CH504	**HEAT TRANSFER LABORATORY**	**Category: PCC**					
		L	**T**	**P**	**J**	**C**
		0	**0**	**4**	**0**	**2**

PRE–REQUISITES:

- U21CH404 – Process Heat Transfer

COURSE OBJECTIVES:

- Gain hands on experience on operation of different heat transfer equipment
- Determine rate or coefficients that characterize performance of heat transfer equipment
- Analyze the key performance indicators of various heat transfer equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Estimate rate of heat transfer in various heat exchanger equipment (Apply)

CO2: Estimate thermal conductivity of plate, fins and powder material (Apply)

CO3: Estimate the performance of different evaporator configurations (Apply)

CO4: Determine the heat transfer through different condenser arrangements (Apply)

CO5: Understand the working principles of multiple heat transfer equipment (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	3	-	-	-	-	3	1	-	1	3	-
CO2	3	2	-	3	-	-	-	-	3	1	-	1	3	-
CO3	3	2	-	3	-	-	-	-	3	1	-	1	3	-
CO4	3	2	-	3	-	-	-	-	3	1	-	1	3	-
CO5	3	2	-	3	-	-	-	-	3	1	-	1	3	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

LIST OF EXPERIMENTS

1. Heat transfer in a double pipe heat exchanger
2. Heat transfer in a shell and tube heat exchanger
3. Heat transfer through a helical coil setup
4. Estimating thermal conductivity of a hot plate
5. Estimating heat transfer rate through a fin
6. Estimating heat transfer through a spher
7. Heat transfer through an insulating powder placed inside a sphere
8. Heat transfer in an open pan evaporator
9. Experiment on a single effect evaporator
10. Experiment on heat transfer in a horizontal condenser
11. Experiment on heat transfer in a vertical condenser
12. Heat transfer in a jacketed vessel

Contact Periods:

Lecture: –Periods Tutorial:–Periods Practical: 60 Periods Project: . – Periods

Total: 60 Periods

REFERENCES:

1. Donald Kern, "Process heat transfer", 8th Edition,McGraw Hill, 2017.
2. J P Hollman and Souvik Bhattacharyya, "Heat transfer", 10th Edition, McGraw Hill, 2017.

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	**Test**	
75	**25**	
100		**100**
60		**40**
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SEMESTER V

		Category: HSMC				
U21SSG02	SOFTSKILLS - II	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Understand the importance of communication and enhance self confidence
- Acquire employability skills

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO1: Actively participate in Group Discussion (Analyze)

CO2: Enhance interview skills and make effective Presentation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PRESENTATION SKILLS **10**

Presentation Techniques- Time Management Techniques- Body language – Managerial Skills- Making Effective Presentation

UNIT II GROUP DISCUSSION **10**

Introduction to Group Discussion- Understanding Group Dynamics- Brain Storming the Topics- Group Discussion Strategies- Activities to Improve GD Skills

UNIT III INTERVIEW SKILLS **10**

Preparation for the Interview- Interview Techniques and Etiquettes – Mock Interview

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Sharma, Prashant. "Soft Skills: Personality Development for Life Success." 1st Edition, BPB Publications, 2022.
2. "Leader Interpersonal and Influence Skills: The Soft Skills of Leadership." 2nd Edition, Routledge Publications, 2014.

REFERENCES:

1. Ghosh, B.N. "Managing Soft Skills for Personality Development." 1st Edition, Tata McGraw-Hill, 2012.
2. Bhatnagar, Nitin and MamtaBhatnagar. "Effective Communication and Soft Skills Strategies for Success" 3rd Edition, Pearson Education, 2012.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VI

		Category: PCC				
U21CH601	CHEMICAL REACTION ENGINEERING I	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain knowledge on different types of chemical reactors, the development of design equation of chemical reactors under isothermal and non-isothermal conditions
- To develop rate laws for heterogeneous reactions
- Enabled to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Build the knowledge in developing rate laws for first, second, third order of reaction and to analyze about the comparison of elementary and non-elementary reactions (Apply)

CO2: Apply the Knowledge of basic design equation to CSTR and PFR in series and parallel (Apply)

CO3: Design of reactors in multiple reaction under parallel and series conditions (Apply)

CO4: Apply the Knowledge of thermodynamic effects in selection and design of reactors (Apply)

CO5: Apply the principles of RTD factor in reactor and for non-ideal flow systems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	-	-	-	-	-	-	-	2	2
CO2	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO3	2	3	2	1	-	-	-	-	-	-	-	-	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	-	2	2
CO5	2	2	1	1	-	-	-	-	-	-	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
LearnBeyond

SYLLABUS:

UNIT I INTRODUCTION TO CHEMICAL REACTION ENGINEERING 9+3

Rate equation – Elementary – Non-elementary reactions – Theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors – Analysis of experimental kinetics data – Integral and differential analysis

UNIT II IDEAL REACTORS 9+3

Design of continuous reactors – Stirred tank and tubular flow reactor – Recycle reactors – Equal sized CSTRs in series and parallel – Equal sized PFRs in series and parallel – Size comparison of reactors

UNIT III MULTIPLE REACTIONS 9+3

Design of reactors for multiple reactions – Consecutive – Parallel and mixed reactions – Factors affecting choice – Optimum yield and conversion – Selectivity – Reactivity and yield.

UNIT IV NON-ISOTHERMAL REACTORS 9+3

Non-isothermal homogeneous reactor systems – Adiabatic reactors – Rates of heat exchanges for different reactors – Design for constant rate input and constant heat transfer coefficient – Operation of batch and continuous reactors – Optimum temperature progression.

UNIT V IDEAL FLOW AND NON-IDEAL FLOW 9+3

The residence time distribution as a factor of performance – Residence time functions and relationship between them in reactor – Basic models for non-ideal flow – Conversion in non-ideal reactors

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley Eastern Ltd., 2006.
2. Fogler.H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India Ltd., 2015.

REFERENCES:

1. Smith, J.M, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, 1981.
2. Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", 1st Edition, John Wiley and Sons, 1979.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
LearnBeyond

SEMESTER VI

U21CH602	CHEMICAL PROCESS INDUSTRIES	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the fundamental concepts and principles of chemical production process including unit operation and unit process with their symbols in chemical process industries (Inorganic and Organic) and the role of chemical engineers in the industry.
- To impart knowledge on the process flow diagrams that are used to communicate the production processes in chemical process industries.
- To understand the importance of chemical process industries, and their significance in modern society.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Recognize general anatomy of chemical production, the role of chemical engineers, interpret process flow diagrams used to communicate production processes involved in chemical process industries and demonstrate an understanding of the manufacturing processes of sulfur, sulfuric acid, and cement industries. (Understand)

CO2: Explain the basic process and steps involved in the industrial production of fertilizers (NPK) (Understand)

CO3: Illustrate the process of manufacture of pulp, paper, sugar and starch with the help of a process flow diagram (Understand)

CO4: Describe the petroleum refining process and the production of petrochemicals with the help of a process flow diagram (Remember)

CO5: Explain the various process steps and sequence of operations involved in the industrial production of fuels and industrial gases (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO2	1	2	2	-	-	-	1	-	2	1	-	2	3	1
CO3	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO4	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO5	1	2	-	-	-	-	-	-	2	1	-	-	3	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

KPRIET
Learn Beyond

SYLLABUS:

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur – Raw materials Sources – Mining and production of Sulfur – Sulfuric acid – Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – Properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY 9

Major Components of Fertilizer industries – Nitrogen industries – Ammonia – Nitric acid – Urea – Phosphorus industries - Phosphorus – Phosphoric acid – Super Phosphate – Potassium chloride – Potassium Sulphate.

UNIT III PULP, PAPER, SUGAR, AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – Types of paper products –Raw materials – Methods of production. Sugar – Methods of production – By products of the Sugar industry – Starch – Methods of production – Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition – Classification of crude petroleum – Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking – Reforming Polymerization – isomerization and Alkylation – Petrochemicals – Methanol – Chloro methanol – Acetylene and ethylene –Isopropanol – Acrylonitrile – Butadiane – Chemicals from Aromatics – Benzene – Toluene and Xylene.

UNIT V FUEL AND INDUSTRIAL GASES 9

Fuel Gases – Producer gas – Water gas – Coke oven gas – Natural gas – Liquefied natural gas – Industrial gases – Carbon dioxide – Hydrogen – Nitrogen and oxygen

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, 2nd Edition, Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, 1st Edition, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's , Chemical Process Industries, 5th Edition McGraw-Hill, 1998.
2. SrikumarKoyikkal, Chemical Process Technology and Simulation, 2nd Edition, PHI Learning Ltd, 2001
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", 7th Edition McGraw Hill, 2005.

KPRIET
LearnBeyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore 641407

SEMESTER VI

U21CH603	PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the concept of Laplace transforms for solving differential equations
- To develop dynamic modeling of physical processes
- To analyze control system stability

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO1: Understand the concept of Laplace transform (Understand)

CO2: Apply the first principles method to develop the transfer function of the process (Apply)

CO3: Develop block diagram and analyze transient response of control schemes (Apply)

CO4: Analyze stability of control systems and perform tuning of controllers (Analyze)

CO5: Understand the applications of advanced control system in process industries (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	1	-	-	-	-	-	-	-	3	2
CO2	3	3	2	-	1	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	1	-	-	-	-	-	-	-	3	2
CO4	3	3	2	-	1	-	-	-	-	-	-	-	3	2
CO5	3	3	2	-	1	-	-	-	-	-	-	-	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments – Measurement of temperature – Pressure – Fluid flow – Liquid weight and weight flow rate – Viscosity – pH – Concentration – Electrical and thermal conductivity – Humidity of gases

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control – First order systems and their transient response for standard input functions – First order systems in series – Linearization and its application inprocess control – Second order systems and their dynamics; transportation lag

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems – Development of block diagram for feed-back control systems – Servoand regulatory problems – Transfer function for controllers and final control element – Transient response of closed – loop control systems and their stability

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems – Control system design by frequency response techniques – Bode diagram – Stability criterion – Tuning of controllers Z-N tuning rules – C-Ctuning rules

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems – Cascade control – Feed-forward control – Ratio control; control – Control of chemical processes

Contact Periods:

Lecture: 45 Periods Tutorial:– Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Coughnowr, D., "Process Systems Analysis and Control ", 3rd Edition, McGraw Hill, New York, 2008.
2. Stephanopoulos, G., "Chemical Process Control ", 1st Edition, Prentice Hall of India, 2003.
3. Sudhakar A and Shyammohan S Palli, "Circuits and Network Analysis", 5th Edition, McGraw-Hill Education, New Delhi, 2019.

REFERENCES:

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp , "Process dynamics and control I", 2nd Edition, John Wiley & ampsons, Inc.
2. Marlin, T. E., "Process Control ", 2nd Edition, McGraw Hill, New York, 2000.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn beyond

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment Ii (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VI

		Category: PCC				
U21CH604	CHEMICAL REACTION ENGINEERING LABORATORY	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21CH601 – Chemical Reaction Engineering I

COURSE OBJECTIVES:

- To analyse and performing the experiments and estimation of reaction kinetics
- To find out the residence time distribution in various reactor system
- To understand various types reactor used in industries

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Determine the rate constant experimentally in a batch reactor (Apply)

CO2: Apply and determine the conversion of a reaction in various combination of reactors (Batch, CSTR, PFR) (Apply)

CO3: Study of temperature dependence of rate constant (understand)

CO4: Determine the non-ideal behavior and residence time distribution in PFR and CSTR (Apply)

CO5: Determine the conversion of packed bed reactor (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	2	1
CO2	3	2	2	2	-	-	-	-	-	-	-	-	2	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	2	2
CO4	3	2	2	2	-	-	-	-	-	-	-	-	2	1
CO5	3	2	2	2	-	-	-	-	-	-	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

Lab Cycle 1

1. Kinetic studies in isothermal batch reactor
2. Kinetic studies in single CSTR
3. Kinetic studies in series of CSTR
4. Kinetic studies in PFR
5. Kinetic studies in PFR followed by CSTR

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Lab Cycle 2

1. RTD in a CSTR
2. Kinetic studies in a packed bed reactor
3. RTD in a packed bed.
4. RTD in a PFR
5. Temperature dependency of reaction rate

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley Eastern Ltd., 2006.
2. Smith, J.M, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, 1981.

REFERENCES:

1. Fogler. H. S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India Ltd., 2015.
2. Froment. G.F. & K. B. Bischoff, "Chemical Reactor Analysis and Design", 1st Edition, John Wiley and Sons, 1979

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VI

U21SSG03	SOFTSKILLS – III	Category: HSMC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Improve language adeptness and to enhance fluency in language
- Gain emotional intelligence and to manage stress

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Write reports and make reasoning and assertions (Analyze)

CO2: Overcome stress and attain work-life balance (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-	-
CO2	-	-	-	-	-	-	-	1	-	3	-	2	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LANGUAGE ADEPTNESS 10

Sentence Completion – Report Writing – Logical Reasoning – Cause and Effect – Assertion and Reasoning

UNIT II STRESS MANAGEMENT 10

Factors Causing Stress – Positive and Negative Stress – Effects of Stress – Stress Overcoming Techniques – Context Based Assessments

UNIT III EMOTIONAL INTELLIGENCE 10

Leadership effectiveness – Self-awareness – Self-management- Self-motivation – Empathy and Social Skills

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Goleman, Daniel "Emotional Intelligence: Why it Can Matter More Than IQ." Bloomsbury, 2009.
2. Barker, Alan. "Improve Your Communication Skills: Present with Confidence; Write with Style; Learn Skills of Persuasion." Kogan Page, 2010.

REFERENCES:

1. Stranks, Jeremy." Stress at Work: Management and Prevention." Butterworth-Heinemann, 2005.
2. Watson, Edward J. "Emotional Intelligence: A Practical Guide on How to Control Your Emotions and Achieve Lifelong Social Success." Amazon Digital Services LLC, 2016.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	100

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VII

		Category: PCC				
U21CH701	CHEMICAL REACTION ENGINEERING II	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21CH601 - Chemical Reaction Engineering I

COURSE OBJECTIVES:

- To gain the knowledge in finding the rate of adsorption and rate controlling parameters of heterogeneous reaction
- To understand the mechanism of gas-solid catalytic reaction
- To understand the basics of non-catalytic reactors and gas-liquid reactors

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Classify various types of catalysts and analyze physical properties of catalyst (Understand)

CO2: Apply the various contacting pattern for two phase system and predict the rate equation for heterogeneous reactions (Apply)

CO3: Apply the best kinetic regimes for mass transfer and reaction for a given reaction and predict the rate equation (Apply)

CO4: To study the effect of rate controlling steps in Gas-Liquid reactions (Understand)

CO5: To gain knowledge about the various experimental methods involved for rate determination (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	2	-	-	-	-	-	-	2	2	1	1
CO2	2	2	1	2	-	-	-	-	-	-	2	2	2	2
CO3	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	1	1
CO5	2	3	2	-	-	-	-	-	-	-	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I CATALYST 9

Nature of catalyst – Surface area and pore volume distributions – Catalyst preparation.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II HETROGENEOUS REACTORS 9

Rate equation for Hetrogeneous reactions – Adsorption isotherms – Rate of adsorptions and desorption – Surface reaction analysis of rate equations and enzyme reaction (Michaelis-Menten Equation).

UNIT III GAS-SOLID CATALYTIC REACTORS 9

Diffusion with catalyst particle – Effective thermal conductivity– Mass and heat transfer within catalyst pellets – Effectiveness factor– Thiele modulus– Fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 9

Models for explaining kinetics – Volume and surface models – Controlling resistances and rate controlling steps – Time for complete conversion for single and mixed sizes – Fluidised and static reactors.

UNIT V GAS-LIQUID REACTORS 9

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants – Application of film – Penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction; tower reactor design.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley Eastern Ltd., 2006.
2. Fogler.H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India Ltd., 2015.

REFERENCES:

1. Smith, J.M, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, 1981.
2. Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", 1st Edition, John Wiley and Sons, 1979.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VII

		Category: HSMC				
U21CH702	PROCESS ENGINEERING ECONOMICS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To make the students to understand the principles of management
- To provide the concepts of process engineering economics to the students
- To impart the knowledge on production planning and control employed in typical process and allied industries

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the theory behind principles of management (Understand)

CO2: Calculate the capital cost and recovery cost (Apply)

CO3: Calculate the project profitability (Apply)

CO4: Relate the economic balance concepts in process industries (Apply)

CO5: Understand the theory of Production Planning & Control (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	1	-	-	-	-	2	2
CO2	3	2	2	2	-	-	-	1	2	2	2	2	2	2
CO3	3	2	2	2	-	-	-	1	2	2	2	2	2	2
CO4	3	2	2	2	-	-	-	1	2	2	2	2	2	2
CO5	3	2	2	2	-	-	-	1	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I PRINCIPLES OF MANAGEMENT 9

Principles of management – Planning – organizing – Staffing – Coordinating – Directing – Controlling and communicating – Types of organizations – Management information systems.

UNIT II INTEREST AND PLANT COST 9

Time value of money – Equivalence – Depreciation – Depletion – Estimation of capital cost – Capital requirement for complete plant – Cost indices – Capital recovery – Problems.

UNIT III PROJECT PROFITABILITY AND FINANCIAL RATIOS 9

Estimation of project profitability – Investment alternatives – Income statement and financial ratios – Balance sheet preparation - problems.

UNIT IV ECONOMIC BALANCE IN EQUIPMENTS 9

Essentials of economic balance – Economic balance in batch operations – Cyclic operations – Economic balance for insulation – Evaporation – Heat transfer equipment's – Case Study.

UNIT V PRODUCTION PLANNING CONTROL 9

Work measurement techniques – Motion study – Principles of time study – Elements of production control – Forecasting – Planning – Routing – Scheduling – Dispatching – Inventory and control – Control charts Role of control charts in production and quality control – Case Study.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Max S. Peters and Klaus D. Timmerhaus, "Plant design and Economics for Chemical Engineers", 5th Edition, McGraw – Hill, Inc. 2017.
2. Ahuja K.K, "Industrial management and Organisational Behaviour", 7th Edition, Khanna publishers, New Delhi, 1998.

REFERENCES:

1. Kenneth K. Humphreys, "Project and Cost Engineers Handbook", Marcel Dekker, New York, 10th Edition, 2005.
2. R. Panneerselvam, "Engineering Economics", 13th Edition, PHI Learning Pvt. Ltd, 2012.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn.Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VII

U21CH703	PROCESS EQUIPMENT DESIGN	Category: PCC				
		L	T	P	J	C
		2	1	0	2	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Study the different aspects of process design that impact process safety
- Implement a fundamentally safer design for the operation of the entire process plant
- Assess the mechanical reliability of process equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyse the design of a Piping System (Analyze)

CO2: Acquire the knowledge in the design and drawings of Heat Exchangers (Understand)

CO3: Understand the concept of Evaporation (Understand)

CO4: Apply the concepts involved in phase separation and design of Distillation, and Absorption Columns (Apply)

CO5: Apply the skills in mechanical design of Pressure Vessels (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO2	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO3	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO4	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO5	3	3	3	3	-	-	-	1	1	1	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION **6 + 3**

Importance of Process Diagrams in Process Engineering, Process Design of piping system

UNIT II HEAT TRANSFER EQUIPMENT – I **6 + 3**

Process design of double pipe Heat Exchangers and Shell and Tube Heat Exchangers.

UNIT III HEAT TRANSFER EQUIPMENT – II **6 + 3**

Process design of Condensers and Evaporators (single effect & multi-effect evaporator).

UNIT IV MASS TRANSFER EQUIPMENTS **6 + 3**

Process design of Distillation Column and Absorption Column

UNIT V STORAGE EQUIPMENTS **6 + 3**

Process design of Pressure Vessels and Storage Vessels.

LIST OF EXPERIMENTS

1. Design and drawing of piping system
2. Design and drawing of double pipe heat exchanger
3. Design and drawing of shell and tube heat exchanger
4. Design and drawing of condenser
5. Design and drawing of evaporator
6. Design and drawing of distillation column
7. Design and drawing of absorption column
8. Design and drawing of pressure vessel
9. Design and drawing of storage vessel

Contact Periods:

Lecture:	30 Periods	Tutorial:	15 Periods	Practical:	– Periods	Project:	30 Periods
						Total:	75 Periods

TEXT BOOKS:

1. Coulson Richardson's., "Chemical Engineering Design, Vol.6, 4th Edition, Elsevier, 2005.
2. D. Q. Kern, "Process Heat Transfer" 21st Edition, McGraw Hill International Book Company, 1983.

REFERENCES:

1. Green D. W., "Perry's Chemical Engineer's Handbook," 9th Edition, McGraw Hill, 1934.
2. McCabe W.L., Smith J.C., Harriott P. Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2017.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			50
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VII

U21CH704	PROCESS CONTROL LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21CH603 – Process Instrumentation, Dynamics and Control

COURSE OBJECTIVES:

- To determine experimentally the methods of controlling the processes
- To measure parameters using process simulation techniques
- To tune the process for better performance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the response of first and second systems (Understand)

CO2: Understand the response of interacting and non-interacting systems (Understand)

CO3: Understand the response of closed loop systems (Understand)

CO4: Perform the tuning of flow, pressure and level system (Apply)

CO5: Understand the characteristics of control valves (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	2	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	2	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	2	-	-	-	-	-	-	-	1	1
CO5	3	2	1	-	2	-	-	-	-	-	-	-	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

LIST OF EXPERIMENTS

1. Response of Non-Interacting level system
2. Response of Interacting level system
3. Response of first order system
4. Response of second order system
5. Tuning of a level system

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

6. Tuning of a pressure system
7. Tuning of a thermal system
8. Characteristics of different types of control valves
9. Closed loop response of cascade control system
10. Flow co-efficient of control valves

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp , Process dynamics and control I, 2nd Edition John Wiley & Sons, Inc, 2013.
2. Marlin, T. E., "Process Control ", 2nd Edition, McGraw Hill, New York, 2000.

REFERENCES:

1. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edition, John Wiley, New York, 1997.
2. Joseph A. Edminister, Mahmood Nahvi, "Electric Circuits", 5th Edition, Schaum's outline series, McGraw Hill Education, New Delhi, 2017

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VII

		Category: EEC				
U21CH705	PROJECT WORK PHASE - I	L	T	P	J	C
		0	0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve a specific problem in the field of Chemical Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the leading problems related to Chemical Engineering (Apply)

CO2: Identify, discuss and justify the technical aspects of the chosen project with comprehensive and systematic approach (Apply)

CO3: Work as an individual or in a team in development of technical projects (Apply)

CO4: Gain practical professional experience in Chemical Engineering (Apply)

CO5: Develop the solution for the problem identified in Chemical Engineering (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO2	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO3	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO4	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO5	3	2	2	3	2	2	2	2	3	3	2	3	3	3
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

STRATEGY

To identify a topic of interest in consultation with Faculty/Supervisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design / fabrication or develop computer code. Demonstrate the novelty of the project through the results and outputs

Contact Periods:

Lecture: - Periods Tutorial: – Periods Practical: – Periods Project: 60 Periods

Total: 60 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments (100 Marks)			
Review I	**Review II**	**Review III**	**Total Assessment**
30	30	40	100

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SEMESTER VIII

		Category: EEC				
U21CH801	PROJECT WORK PHASE - II	L	T	P	J	C
		0	0	0	20	10

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve a specific problem in the field of Chemical Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Practice acquired knowledge within the chosen area of technology for project development (Apply)

CO2: Identify, discuss and justify the technical aspects of the chosen project with comprehensive and systematic approach (Apply)

CO3: Reproduce, improve and refine technical aspects for engineering projects (Apply)

CO4: Work as an individual or in a team in development of technical projects (Apply)

CO5: Communicate and report effectively project related activities and findings (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO2	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO3	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO4	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO5	3	2	2	3	2	2	2	2	3	3	2	3	3	3
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

STRATEGY

To identify a topic of interest in consultation with Faculty/Supervisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design / fabrication or develop computer code. Demonstrate the novelty of the project through the results and outputs

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: - Periods Project: 300 Periods

Total: 300 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments (40 Marks)			End Semester Examinations (60 Marks)	
Review I	Review II	Review III	Project Report	Viva-Voice
10	15	15	10	50
Total: 100 Marks				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

PROFESSIONAL ELECTIVE

VERTICAL I

		Category: PEC				
U21CHP01	**POLYMER SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic concepts of polymer structure and properties
- To understand the Mechanism of various Polymerizations
- To understand the manufacturing processes techniques and kinetics of various polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic concepts of polymer science, thermodynamics, phase separations and conformational analysis (Understand)

CO2: Describe the physico-chemical, morphology, rheology, and mechanical properties of bulk polymers by evaluating through respective experimentations (Understand)

CO3: Classify the polymers, polymerization techniques and perform the kinetic and statistical considerations of polymers (Understand)

CO4: Compare and analyze the properties and performance of commercial polymers (Analyze)

CO5: Modify the recent advancements and apply in polymeric processing techniques like moulding, compounding, and vulcanizing (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	1	-	2	-	-	-	-	-	-	1	1
CO2	2	1	-	2	-	2	-	-	-	-	-	-	1	1
CO3	2	2	-	2	-	2	-	-	-	-	-	-	1	1
CO4	2	2	-	2	-	2	-	-	-	-	-	-	1	1
CO5	2	2	-	2	-	2	-	-	-	-	-	-	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I INTRODUCTION 9

Basic Concepts and classification of polymers – Functionality – Number and weight average – Sedimentation and viscosity average molecular weights – Molecular weight and degree of polymerization – Glass transition temperature – Addition – Condensation – Step-growth and chain growth polymerization – Molecular weight estimation

UNIT II POLYMER STRUCTURE 9

Polymer chains and their characterization – The science of large molecules – Basic concepts of polymer science – History of macromolecular science – Molecular forces and chemical bonding in polymers – Polymer solutions – Criteria for polymer solubility – Conformations of dissolved polymer chains – Thermodynamics of polymer solutions – Phase separation in polymer solutions

UNIT III POLYMERIZATION KINETICS 9

Polymerization Step-reaction (Condensation) polymerization – Classification of polymers and polymerization mechanisms – Chemistry of step wise polymerization – Kinetics and statistics of linear stepwise polymerizations – Radical chain (Addition) polymerization – Chemistry of vinyl polymerization – Laboratory methods in vinyl polymerization – Steady state kinetics of vinyl radical polymerization – Copolymerization – Kinetics of copolymerization – Composition of copolymers, Chemistry of copolymerization

UNIT IV SYNTHETIC FIBRES 9

Properties of commercial polymers – Hydrocarbon plastics and elastomers – Low density (branched) polyethylene – High density (linear) polyethylene – Polypropylene – Natural rubber and other polyisomers – Rubbers derived from butadiene – Other carbon chain polymers – Polystyrene and related polymers – Acrylic polymers, poly(vinyl esters) and derived polymers – Heterochain thermoplastics – Polyamides – Thermosetting resins – Phenolic resins – Amino resins

UNIT V PLASTICS 9

Polymer processing Plastic Technology – Molding, other processing methods – Fillers – Plasticizers and other additive – Fiber Technology – Textile and fabric properties – Spinning – Fiber after treatments – Elastomer technology – Compounding and elastomer properties – Vulcanization – Reinforcement

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

TEXT BOOKS:

1. Charles E., Carraher Jr., " Seymour/carraher's polymer chemistry" , 7th Edition, CRC Press, 2012
2. Bhatnagar M.S., "A Textbook of Polymers", 1st Edition, S. Chand and Company Ltd., 2012

REFERENCES:

1 Fried J.R., "Polymer Science and Technology" , 7th Edition, Prentice Hall of India Pvt Ltd., 2003
2 Billmeyer F.W., "Textbook of Polymer Science" , 3rd Edition, Wiley Inter science, 1984

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL I

U21CHP02	CHEMICAL METALLURGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basics of metallurgy.
- To know the techniques of extraction from its ores.
- To understand the method of operation of various converters and furnaces.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify, which sequence of metallurgical processes should be applied for the production of a specific metal (Understand)

CO2: Infer the various extraction and processing techniques (Understand)

CO3: Interpret alternative processes for production of a metal from its mineral (Understand)

CO4: Apply principles to chemical systems and processes (Apply)

CO5: Design metallurgical processes considering the materials, reactors, temperatures and other factors (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	1	-	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I PYRO METALLURGY **9**

Classification of ores – Basics of pyro metallurgy – Calcination – Roasting and types of roasting – Thermodynamics of extraction

UNIT II STEPS OF METALLURGY **9**

Sintering – Palletisation and Smelting – Basic principles with examples – Slags – Classification – Properties and uses

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT III HYDRO METALLURGY 9

Hydrometallurgy: Advantages and disadvantages – Principles and types of leaching – Solution, purification by ion exchange and solvent extraction – Cementation

UNIT IV EXTRACTION PROCESSES 9

Extraction of Iron from ores next word capital letter Operation of Coke Ovens – Blast Furnaces – Sintering Plants – Pig Casting Machine – Slag removal and Disposal – Steel Making Processes – Bessemer convertor – Open Hearth Furnaces and LD convertor – Alloy Steel Production

UNIT V NON-FERROUS METALS 9

Extraction of nonferrous metals from ores – Copper, Aluminium, Lead and Zinc – Electro metallurgy of extraction and refining

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods **Practical:** – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. D. Swarup.Joseph J, Massie, "Essentials of Management" , 1st Edition, Prentice Hall of India Pvt. Ltd. 1985
2. Bequette. B.W, "Process Dynamics Modelling, Analysis and Simulation" , 1st Edition, Prentice Hall, 1998

REFERENCES:

1. A.R. Bailey, "Introduction to Metallurgy" ,1st Edition,1987
2. Franks, R. G. E., "Mathematical Modeling in Chemical Engineering" ,1st Edition, John Wiley, 1967

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL I

U21CHP03	FLUIDIZATION ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the design aspects of fluidized beds
- To understand the industrial applications of fluidized bed systems
- To become familiar with the concept of heat and mass transfer in fluidized systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fluidization phenomenon (Understand)

CO2: Apply various correlations involved in the fluidization engineering (Apply)

CO3: Identify the behaviour of fluidized beds (Understand)

CO4: Apply the industrial applications of fluidized systems (Apply)

CO5: Analyze the design aspects of fluidized bed system (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO2	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO3	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO4	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO5	2	2	-	-	1	-	-	-	-	1	-	-	1	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I BASICS OF FLUIDIZATION **9**

Packed bed – Velocity – Pressure drops relations – Correlations of Ergun – Kozney karman Development of fluidization from fixed bed

UNIT II FLUIDIZED BED TYPES **9**

Minimum fluidization conditions – Expanded bed – Moving solids and dilute phase

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT III DESIGN ASPECTS 9

Channelling – Bed expansion in liquid – Solid fluidizations – Design aspects of fluidized bed systems

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9

Heat and mass transfer in fluidized bed systems – Industrial applications of fluidized bed systems

UNIT V OTHER TYPES OF FLUIDIZATIONS 9

Single stage and multistage fluidization – Collection of fines – Use of cyclones

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth - Heinmann, 1991
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill, International, 1997
3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition, John Wiley, 2006

REFERENCES:

1. Rowe and Davidson, "Fluidization", 1st Edition, Academic Press ,1981.
2. Leva, M., "Fluidization", 1st Edition, McGraw Hill Book Co, 1989.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL I

U21CHP04	PROCESS PLANT UTILITIES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand about plant utilities like steam, compressed air etc.
- To understand about important of utilities
- To know about fuel and waste disposal

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the importance of health, safety and the environment in process industries (Understand)

CO2: Describe about steam, power, water, air is extensively used in process industries (Understand)

CO3: Explain about efficient operation is imperative for economic and safe operation is essential for the survival of industries (Understand)

CO4: Understand about fuels and waste management (Understand)

CO5: Integrate with utilities used in the industries (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO2	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO3	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO4	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO5	1	2	-	-	-	1	2	1	2	2	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I IMPORTANCE OF UTILITIES 9

Hard and Soft water – Requisites of Industrial Water and its uses – Methods of water Treatment such as Chemical Softening and Demineralization – Resins used for Water Softening and Reverse Osmosis – Effects of impure Boiler Feed Water

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam – Problems based on Steam – Types of Steam Generator such as Solid Fuel Fired Boiler – Waste Gas Fired Boiler and Fluidized Bed Boiler – Scaling and Trouble Shooting. Steam Traps and Accessories

UNIT III REFRIGERATION 9

Refrigeration Cycles – Methods of Refrigeration used in Industry and Different types of Refrigerants such as Monochlorodifluro Methane – Chlorofluro Carbons and Brins – Refrigerating Effects and Liquefaction Processes

UNIT IV COMPRESSED AIR 9

Classification of Compressor – Reciprocating Compressor – Single Stage and Two Stage Compressor – Velocity Diagram for Centrifugal Compressor – Silp Factor – Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart – Equipment used for Humidification – Dehumidification and Cooling Towers

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas – Liquid Petroleum Fuels – Coal and Coke – Internal Combustion Engine – Petrol and Diesel Engine – Waste Disposal

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control", 1st Edition, McGraw-Hill: New York, 1966
2. P. L. Ballaney, "Thermal Engineering", 1st Edition, Khanna Publisher New Delhi, 1986

REFERENCES:

1. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", 1st Edition, Tata McGraw Hill, New Delhi, 2007
2. Jack Broughton, "Process Utility Systems - Introduction to Design Operation and Maintenance", Institution of Chemical Engineers, UK,1994.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL I

U21CHP05	INDUSTRIAL SAFETY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To give an idea about different hazards and other safety procedures to be followed in any industry.
- To have a comprehensive knowledge of industrial safety and occupational health will be immensely useful for the students from all fields
- To impart knowledge to the students about source of hazards and control techniques

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify hazardous conditions and practices affecting people, property and the environment, develop and evaluate appropriate strategies designed to mitigate risk (Understand)

CO2: Identify the hazardous element due to fire, radiation, electrical and atmospheric contaminants (Understand)

CO3: Apply the knowledge on handling and storage of chemical hazards (Apply)

CO4: Analyze qualitative risk assessment using HAZOP, FMEA and fault tree analysis (Analyze)

CO5: Apply the safety principles to identify the fire hazards and its safety protecting system in practices (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	2	-	-	-	-	-	-	1	1
CO2	3	-	-	-	-	2	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	2	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I ACCIDENT STATISTICS 9

Introduction – Safety program – Engineering ethics – Accident and loss statistics: acceptable risk, public perception, chemical hazards – Toxic chemicals – Dust – Gases – Fumes – Vapours and

smoke – The concept of threshold limits – Acute and chronic exposure effects – Personal monitoring – Biological sampling – Control measures

UNIT II TOXICOLOGY 9

Industrial safety Chemical hazards classification – Hazards due to fire – Explosion – Toxic chemicals and radiation – Toxicology Dose vs. Response – Effects of Toxicant on Human – Toxicants Entry Route – Models for Dose and Response Curves – TLV and PEL

UNIT III BASICS OF FIRES AND EXPLOSION 9

Handling and storage of hazardous chemicals – Fire Triangle – Definitions – Flammability Characteristics of Liquid and Vapors – LOC and Inerting – Types of Explosions – Designs for Fire Prevention and Control

UNIT IV RISK ASSESSMENT 9

Risk analysis Risk assessment – Qualitative – Reconnoitres – Rapid and comprehensive risk assessment techniques: checklists – Indices – HAZOP – Maximum credible accident analysis – Fault tree analysis – Past accident analysis – FMEA (failure mode and effect analysis) – Quantitative risk assessment

UNIT V CONTROL OF FIRE AND EXPLOSION 9

Protection systems Emergency preparedness: Fire and explosion – Fire hazards – Fire pyramid. Types of fires – Types of fire extinguishers and its handling – Types of built in extinguishing system. Fire-fighting techniques – Emergency procedures and types of alarm systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Crowl, Daniel A. and Louvar, Joseph F., "Chemical process safety fundamentals with applications" , 3rd Edition, Prentice Hall, 2015
2. Kletz, Trevor, "Histories of process plant disasters and how they could have been avoided" , 1st Edition, Gulf Professional Publishing, 2003

REFERENCES:

1. Lees, F.P., "Loss Prevention in Process Industries" , 3rd Edition, Butterworths, NewDelhi, 2005
2. Buschmann, "Loss Prevention and Safety Promotion in the Process Industries" , Elsevier Scientific, New York,2005

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL I

U21CHP06	PULP AND PAPER TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To apply basic concepts of pulp and paper technology to produce paper
- To the reactions and unit operations steps appropriately in manufacturing of paper
- To perform various chemical tests to monitor quality of raw material, output quality and influent/effluent

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understating the paper and pulp technology (Understand)

CO2: Describe the pulping process analysis with different types (Understand)

CO3: Apply the wet process application of paper products (Apply)

CO4: Explain the applications of cellulose and Lignin chemicals (Understand)

CO5: Understand the pollution potentials of Indian pulp and paper industry and waste disposal techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I BASICS OF PULP AND PAPER TECHNOLOGY 9

Pulp and paper industry Consumption pattern of paper – Cellulose raw material – Problems and scope of pulp and paper industries in India

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II PULP 9

Pulping process: Sulphite pulping – Semichemical pulping – Mechanical and Thermo – mechanical pulping – Secondary fibber pulping – R.A.G. pulping- Dissolving pulp – Kraft pulping process– Comparison of different types of pulps – Black liquor recovery process

UNIT III PAPER 9

Types of paper products – Various raw materials: Fibrous and Non-Fibrous – Wet process for paper Manufacture – Fourdrinier machine – Economics of paper industry

UNIT IV CELLULOSE AND LIGNIN CHEMICALS 9

Properties of cellulose – Preparation of chemical cellulose – Lignin chemicals: Types – Properties of Di-methyl sulphides and Di- methyl sulfoxide – Applications of cellulose and Lignin chemicals

UNIT V WASTE DISPOSAL TECHNIQUES 9

Pollution potentials of Indian pulp and paper industry – Characteristics of Industrial Lignin water– Bio-technical approach for pollution – Enzymology for Lignin waste treatment.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rao M.Gopal, Sitting, Marshall, "Dryden's outlines of Chemical",1st Edition, Affilated East-West Press Pvt. Ltd., 1997
2. Austin, George T, "Shreves' Chemical Process Industries" , 5th Edition, McGraw-Hill Education India Pvt. Ltd, 2017

REFERENCES:

1. Bhatia, S.C., "Environmental Pollution and Control in Chemical Process Industries" , 1st Edition, Khanna Publishers, 2011
2. Trivedi, R.K., "Pollution Management in Industries" , 1st Edition, Environmental Publication, 2007
3. Christopher J., "Handbook of Pulping and Paper making" ISBN-13: 978- 0120973620

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL II

		Category: PEC				
U21CHP07	FERTILIZER TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- Learn the fertilizer manufacturing including new or modified fertilizer products
- Understand the practical methods of production in a chemical factory
- Learn about the importance of nutrients

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the classification of fertilizers and its application (Understand)

CO2: Understand process and properties of synthesis condition of different fertilizers (Understand)

CO3: Identify the manufacturing of potassium chloride and Sulphate (Understand)

CO4: Analyze the manufacturing of NPK and Ammonium Sulphate Phosphate (Analyse)

CO5: Analyze the Biofertilizer and preparation of Biofertilizer (Analyse)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	-	-	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I OVERVIEW OF FERTILIZER 9

Synthetic fertilizers – Classification of fertilizers – Role of essential Elements in plant Growth – Application of fertilizers considering Nutrient – Development of fertilizer industry – Fertilizer production and consumption in India – Nutrient contents of fertilizers

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II NITROGENOUS FERTILIZERS 9

Physical & Chemical properties – Synthesis gas by Catalytic partial oxidation – Kellogg process and Haldor Topsoe process – Storage and Transportation of Ammonia – Manufacturing of Nitric Acid by Pressure ammonia oxidation process and Intermediate pressure ammonia oxidation process

UNIT III POTASSIUM FERTILIZERS 9

Physical, Chemical properties and uses of Potassium Chloride – Potassium nitrate – Potassium sulphate – Manufacturing of potassium chloride from sylvinite – Preparation of Potassium nitrate – Potassium sulphate

UNIT IV MISCELLANEOUS FERTILIZER 9

Manufacturing of NPK – Ammonium Sulphate Phosphate (ASP) – Calcium Ammonium Nitrate (CAN)

UNIT V BIO FERTILIZERS 9

Biofertilizers – Types of Biofertilizers – Nitrogen fixing Biofertilizers – Phosphate-solubilizing Biofertilizers – Preparation of a Biofertilizers

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ranjan Kumar Basak., "Fertilizer A textbook", 5th Edition, Kalyani Publishers, Chennal, 2016
2. Gustafson A.F., "Handbook of Fertlizers-Their sources, Make-up, Effects, and Use", 8th Edition, Read Books Ltd, New Delhi, 2010

REFERENCES:

1. Austin G. T, "Shreve's Chemical Process Industries", 5th Edition, McGraw Hill Publications, New Delhi, 2017
2. Pandey & Shukla, "Chemical Technology", 2nd Edition, Vani Books Company, India, 1997
3. Subba Rao N S, "Bio fertilizers in Agriculture", 6th Edition, Oxford & IBH Publishing Company, New Delhi, 1998
4. https://nptel.ac.in/courses/103107086
5. https://iopscience.iop.org/article/10.1088/1755-1315/250/1/012048/pdf

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL II

U21CHP08	BIOCHEMICAL ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the basic concepts of biochemical engineering
- To develop understanding about biochemistry and bioprocess
- To analysis oxygen transfer and power consumption

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Fundamentals of microbial growth, batch and continuous culture (Understand)

CO2: Metabolism and bio-energetics, Synthesis and regulation of biomolecules (Understand)

CO3: Enzyme kinetics: Simple enzyme kinetics, Enzyme reactor with simple kinetics. Inhibition of enzyme reactions (Understand)

CO4: Cell kinetics and fermenter design (Analyse)

CO5: Oxygen transfer rate and Power consumption (Analyse)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	1	1
CO2	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO4	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO5	3	1	1	1	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MICROBIAL GROWTH AND PURIFIACATION 9

Introduction to Bioscience – Types of Microorganisms– Structure and function of microbial cells – Fundamentals of microbial growth – Batch and continuous culture

UNIT II METABOLISM AND BIO-ENERGITICS 9

Functioning of Cells and Fundamental Molecular Biology – Metabolism and bio-energetics – Photosynthesis – Carbon metabolism – EMP pathway – Synthesis and regulation of biomolecules

UNIT III ENZYME KINETICS AND IMMOBILIZATION 9

Enzyme kinetics: Enzyme reactor with simple kinetics – Inhibition of enzyme reactions – Other influences on enzyme activity – Immobilization of enzymes – Industrial applications of enzymes

UNIT IV FERMENTOR DESIGN AND MODEL 9

Cell kinetics and fermenter design: Growth cycle for batch cultivation – Stirred-tank fermenter – Multiple fermenters connected in series – Structured Model.

UNIT V OXYGEN TRANSFER RATE AND POWER CONSUMPTION 9

Determination of volumetric mass transfer rate of oxygen from air bubbles – Aeration on oxygen transfer rate – Heat transfer and power consumption

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. J. E. Bailey and D. F. Ollis., "Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill, New York, 1986
2. Trevan, Boffey, Goulding and Stanbury., "Biotechnology", 1st Edition, Tata McGraw Hill Publishing Co., New Delhi, 1987

REFERENCES:

1. H. W. Blanch and D. S. Clark, "Biochemical Engineering", Vol 1, Marcel Dekker, Inc., New York, 1996
2. M. L. Shuler and F. Kargi, "Bio Process Engineering: Basic concepts", 2nd Edition., Prentice Hall of India, New Delhi, 2002.
3. Missen, R.W., Mims, C.A. and Saville, B.A, "Introduction to Chemical Engineering and Kinetics", 4th Edition, John Wiley and Sons, New Delhi, 1999
4. https://nptel.ac.in/courses/103107086

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL II

		Category: PEC				
		L	T	P	J	C
U21CHP09	NANOSCIENCE AND NANOTECHNOLOGY	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop knowledge on nanomaterials synthesis
- To develop knowledge on characterization of various techniques
- To know the applications of nanomaterials

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the various synthesis materials of nanomaterials (Understand)

CO2: Apply various techniques for characterization nanomaterials (Understand)

CO3: Analyze and evaluate the synthesized nanomaterials in agriculture, textile and cosmetics (Analyse)

CO4: Analyze and evaluate the synthesized nanomaterials in healthcare, food and environment (Analyse)

CO5: Analyze and evaluate the synthesized nanomaterials in biomedical applications (Analyse)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO2	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO3	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO4	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO5	1	-	-	-	-	1	2	1	1	-	-	-	2	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO NANOMATERIALS 9

Introduction to nanoscience and nanotechnology: Definition of nanomaterials – Properties of nanoscale – Synthesis of nanomaterials: top down and bottom up approaches – Mechanical alloying and mechanical ball milling. Chemical approaches – Sol-gel method – Spray pyrolysis – Precipitation

and electro spraying – Physical approaches – Vapour deposition – CVD and pulsed laser deposition

UNIT II CHARACTERIZATION TECHNIQUES 9

X-ray diffractometer (XRD) – Four Transform Infrared Spectroscopy (FTIR) – Scanning Electron Microscopy (SEM) – Transmission Electron Microscopy (TEM) – Energy Dispersive Spectroscopy (EDAX) – Atomic Force Microscopy (AFM) and particle size analyzer

UNIT III NANOTECHNOLOGY IN AGRICULTURE AND ENVIRONMENT 9

Nanotechnology in agriculture – Precision forming – Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers – Nanotechnology in environment – Nanomaterials and Nanomembranes in waste water treatment

UNIT IV NANOTECHNOLOGY IN HEALTHCARE AND FOOD INDUSTRY 9

Drug delivery: Nanoscale devices for drug delivery – Micelles for drug delivery, targeting, bioimaging – Nanotechnology in food industry: packaging, food processing, food safety and bio-security – Contaminant detection – Smart packaging

UNIT V NANOTECHNOLOGY IN TEXTILE AND COSMETICS 9

Nanofibre preparation: Electrospinning – Controlling morphologies of nanofibres – Tissue engineering application – Cosmetics: Formulation of gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) – Sun-screen dispersions for UV protection using Titanium Oxide – Colour cosmetics

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Guozhong C., "Nanostructures and Nanomaterials: synthesis, properties and applications", Vol 1, Imperial College Press, 2004
2. Zhen Guo and Li Tan, "Fundamentals and Applications of Nanomateials", 1st Edition, Artech House, 2009.

REFERENCES:

1. M.A. Shah and Tokeer Ahmad, "Principles of Nanoscience and Nanotechnology", 1st Edition, Alpha Science International Ltd, 2010
2. Edelstein A S, Cammaratra R C, "Nanomaterials: Synthesis, Properties and Applications", 2nd Edition, CRC Press, 1998.
3. Charles P Poole and Frank J Owens, "Introduction to Nanotechnology", 4th Edition, Wiley inter-science, 2003
4. https://nptel.ac.in/courses/103107086

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL II

		Category: PEC				
U21CHP10	ENZYME ENGINEERING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide students with a basic understanding of classification, nomenclature, mechanism and specificity of enzyme-coenzyme action, extraction, purification and characterization of enzymes
- To introduce and understand the mechanism of enzyme action, protein folding and unfolding and their biological significances
- To demonstrate their basic knowledge and skill on the kinetics, mechanism and function of enzyme action and improve their self-learning and understanding skills on biochemical engineering and promote employability in biotech research areas

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the concept of classification and mechanism of enzyme action (Understand)

CO2: Apply the kinetics of multi substrate reactions: mechanisms, ping-pong, random order, compulsory order, steady state kinetics (Analyze)

CO3: Understand the production and purification of crude enzyme extracts (Understand)

CO4: Understand the physical and chemical technique for enzyme immobilization (Understand)

CO5: Understand the application of enzymes and synthesis of artificial enzymes (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	1	1
CO2	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO4	3	1	1	-	-	-	-	-	-	-	-	-	1	1
CO5	3	1	1	1	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I INTRODUCTION TO ENZYMES **9**

Classification and nomenclature of enzymes – General properties of enzymes – Mechanism of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory – Transition state theory

UNIT II ENZYME KINETICS 9

Kinetics of single substrate reactions: Michelis – Menten parameters – Lineweaver Burk plot, Turnover number – Kinetics of multi substrate reactions: mechanisms, ping-pong, random order, compulsory order, steady state kinetics – Types of enzyme inhibition, and Allosteric inhibition – Binding of ligands to proteins: Hill equation and adair equation – Sigmoidal kinetics: Monod Changeux Wyman model

UNIT III PURIFICATION AND CHARACTERIZATION OF ENZYMES 9

Production and purification of crude enzyme extracts from plants, animals and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays – Production of recombinant enzymes: Serine protease – Lysozyme

UNIT IV ENZYME IMMOBILIZATION 9

Physical and chemical technique for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding – Advantages and disadvantages of immobilized enzymes – Effect of biotic and abiotic factors on enzyme immobilization

UNIT V INDUSTRIAL APPLICATIONS OF ENZYMES 9

Application of enzymes in food industry, medicine, environmental – Design of enzyme electrodes and their applications – Forensic science – Biotechnological applications of enzymes – Synthesis of artificial enzymes

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ashok Pandey., "Enzyme Technology", 1st Edition, Springer Science & Business Media ,2004
2. Guo Yong., "Enzyme Engineering", 3rd edition , Alpha Science International Ltd, 2013.

REFERENCES:

1. Palmer, T. and Bonner, P, "Enzymes: Biochemistry, Biotechnology and Clinical chemistry", Affiliated East – West Press Pvt. Ltd, New Delhi, India, 2008
2. Voet, D. and Voet, G, "Biochemistry", 3rd Edition, John Wiley and Sons, Singapore, 2001.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

3. Nicholas, Price, C. and Lewis Stevens, "Fundamentals of Enzymology", 1st Edition, Oxford University Press Publication, New Delhi, India, 2001
4. https://nptel.ac.in/courses/103107086

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL II

U21CHP11	FERMENTATION ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To Learn the basics of the various aspects of microbiology and biosystems
- Impart experimental design thinking capability in relation to various fermenter configurations modes of operation, growth kinetics and product recovery
- Extrapolate the design thinking skills to bio related processes with chemical engineering background

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the importance of fermentation with reference to industrial microbiology (Understand)

CO2: Summarize kinetics prevalent in microbial processes (Understand)

CO3: Understand the process to select and manage microorganisms from natural source to fermentation (Understand)

CO4: Interpret the acquired knowledge on fermenter configuration for different types of cells and enzymes (Apply)

CO5: Design of fermentor and the downstream processing of fermentation products. Create innovative applications for fermentation technologies for novel products (Analyse)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I FERMENTATION AND ITS TYPES 9

Development of fermentation process – Range of processes under fermentation – Types of Fermentation.

UNIT II MICROBIAL GROWTH KINETICS 9

Microbial growth – Batch – Continuous and types of fed batch culture – Design and kinetics – Comparison of the modes of culture.

UNIT III INDUSTRIAL MICROORGANISM 9

Industrial microorganisms – Isolation, preservation and improvement of strains – Storage methods and improvement strategies

UNIT IV MEDIA FORMULATION 9

Media formulation – Energy – Carbon and nitrogen sources – Micro nutrients; oxygen requirements – Other non-nutrient and functional components – Effects of media composition on penicillin production – Media optimization.

UNIT V MEDIA STERLIZATION AND DESIGN 9

Preparation of media and air for pure culture fermentation – Media sterilization – Batch and continuous sterilization processes – Sterilization of fibrous filters and their design – Development of inocula – Processes involving yeast – Bacterial – Fungi – Aseptic inoculation of plant fermentations.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Stanbury P.F, Whitaker A, Steve H., "Principles of Fermentation Technology", 3rd Edition, Butterworth-Heinemann, USA, 2017
2. El-Mansi E., Bryce C.F.A, Arnold L.D., Allman A.R., "Fermentation Microbiology and Biotechnology", 2nd Edition, CRC Press, USA, 2007.

REFERENCES:

1. Ashok P, Christian L, Carlos R.S, "Advances in Fermentation Technology", 1st Edition, Asiatech Publishers Inc., India, 2008
2. Presscott, D, "Industrial Microbiology", 3rd Edition, CBS Publishers, New Delhi, 1999.
3. Rhodes A and Pletcher. D.L, "Principles of Industrial Microbiology", 3rd Edition, Pergamon Press, UK, 1987
4. https://nptel.ac.in/courses/103107086

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL II

U21CHP12	DRUGS AND PHARMACEUTICAL TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide the basic knowledge on functional group identification, chemical bonding with their mechanism
- To provide the basic knowledge of principles involved in the identification and estimation of pharmaceutical substances.
- To understand the properties and principles of medicinal agents that originates from organic and inorganic sources and their application in pharmaceutical industry

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Acquire basic knowledge of preformulation and formulation of drugs, pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage forms (Understand)

CO2: Acquire a knowledge on pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage forms (Understand)

CO3: Trained to conceptualize, design, build up, maintain and operate various industrial processes and machineries involved in the process (Apply)

CO4: Understand and apply the various processing and manufacturing techniques (Apply)

CO5: Formulate a pure drug substance into a dosage form (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PHARMACEUTICALS, BIOLOGICS AND BIOPHARMACEUTICALS 9

Introduction to pharmaceutical products – Biopharmaceuticals and pharmaceutical biotechnology – Biopharmaceuticals: current status and future prospects – Pharmaceuticals of animal origin – Pharmaceutical substances of plant origin – Pharmaceutical substances of microbial origin – Drug discovery.

UNIT II DRUG CHARACTERISTICS AND KINETICS 9

Diffusion and dissolution – Kinetics and drug stability – Viscosity and rheology – Polymer science and applications.

UNIT III THE DRUG MANUFACTURING PROCESS 9

International pharmacopoeia – The manufacturing facility – Cleaning – Decontamination and sanitation (CDS) – Documentation – Specifications – Records – Additional production systems: yeasts – Fungal production systems – Transgenic animals – Transgenic plants – Immunological approaches to detection of contaminants – Pyrogen detection – Validation studies

UNIT IV BLOOD PRODUCTS AND THERAPEUTIC ENZYMES 9

Platelets and red blood cells – Blood substitutes – Tissue plasminogen activator (tPA) – Urokinase – Staphylokinase – Antibodies – Vaccines and adjuvants – Therapeutic application of monoclonal antibodies – Traditional vaccine preparations – Toxoids – Antigen-based and other vaccine preparations – Oil-based emulsion adjuvant.

UNIT V BIOPHARMACEUTICALS 9

Various categories of therapeutics like vitamins – Laxatives – Analgesics – Contraceptives – antibiotics – Ormones and biologicals.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Alfred N.Martin., "Physical Chemical and Biopharmaceutical Principles in the Pharmaceutical Sciences" , 6th Edition , Lippincott Williams & Wilkins, 2006
2. David B. Troy., "Remington: The Science and Practice of Pharmacy", 1st Edition, Lippincott Williams & Wilkins,1984

REFERENCES:

1. Sidney James Carter, "Cooper and Gunn's Tutorial Pharmacy", 1st Edition, CBS Publishers & Distributors, 1986
2. Gareth Thomas, "Medicinal Chemistry. An introduction", 1st Edition, John Wiley, 2000.

3. Katzung B.G, "Basic and Clinical Pharmacology", Prentice Hall of International,1995
4. https://nptel.ac.in/courses/103107086

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the cours

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

		Category: PEC				
		L	T	P	J	C
U21CHP13	CORROSION ENGINEERING	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Understanding of basic concepts of Corrosion, Corrosion in different materials
- Corrosion Electrochemistry, Corrosion Thermodynamics, Kinetics and Applications.
- Corrosion evaluation and corrosion in steel materials, Methods and Materials to prevent the Corrosion

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve problems involving various types of corrosion (Apply)

CO2: Select corrosion resistant materials for a given application (Understand)

CO3: Able to select technique for corrosion prevention and minimize corrosion (Apply)

CO4: Students shall understand how to prevent the corrosion and able to Estimate the rate of corrosion (Apply)

CO5: Selection of materials for corrosion prevention, how to alter the environment for minimal rate of corrosion, different protection techniques and coating to prevent corrosion (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	2	-	-	-	-	-	-	1	1
CO2	3	2	-	-	2	2	-	-	-	-	-	-	1	1
CO3	3	-	2	2	2	2	-	-	-	-	-	-	1	1
CO4	3	-	2	2	2	-	-	-	-	-	-	-	1	1
CO5	3	-	2	2	2	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

SYLLABUS:

UNIT I INTRODUCTION TO CORROSION 9

Introduction and Scope: Corrosion definition – Wet and dry corrosion- mechanisms – Electro-chemical principles and aspects of corrosion – Faradays laws – Specific conduction specific resistance – Transport number. Mobility – Various forms of corrosion.

UNIT II THERMODYNAMIC AND KINETICS 9

Thermodynamic aspects of corrosion equilibrium potential – Nernst equation for electrode potential – EMF series – Over voltage – Application of Nernst equation to corrosion reactions – Calculation of Corrosion Rates – Corrosion rate expression.

UNIT III CORROSION AND ITS TYPES 9

Polarization and Corrosion potentials – Reference electrodes for corrosion measurements – Types of polarization – Concentration – Activation and resistance polarizations – Tafel equation – Tafel constant – Evans diagrams – Anodic control– cathodic control – Mixed control: Fourbaix diagram for Fe-H2O system – Galvanic corrosion – Uniform attack – Pitting corrosion – Dezincification– cavitation erosion – Fretting corrosion – Inter-granular and stress corrosion cracking – Some remedial measures.

UNIT IV CORROSION MECHANISM AND TESTING 9

High temperature oxidation – Pilling bed-worth ratio – Mechanisms of oxidation – Corrosion testing Procedures evaluation – Corrosion of iron and steel in aqueous media – Effect of velocity– temperature and composition of media.

UNIT V PREVENTION OF CORROSION 9

Prevention techniques – Modification of the material – Alloying – Appropriate surface or core treatment – Chemical and mechanical methods of surface treatment – Coatings – Metallic– Non-metallic linings – Cathodic protection – Passivity and anodic protection.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Mars Fontana, "Corrosion Engineering" , 3rd Edition, McGraw-Hill Publication, 2003
2. Uhling H H and Revie R W, "Corrosion & Corrosion Control" , 1st Edition, John Wiley & sons, 2001

REFERENCES:

1. Pierre Roberge, "Handbook of Corrosion Engineering" , 1st Edition, McGraw-Hill Publication, 2012

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

U21CHP14	PETROLEUM EQUIPMENT DESIGN	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce basic concepts, and design calculations piping system
- To familiarize basic knowledge on design of storage Tanks
- To enumerate different factors considered in design pressure vessels

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Estimate pressure loss in pipeline networks (Understand)

CO2 : Select proper pipe and pipe fitting based on pressure loss in pipeline (Understand)

CO3: Analyse various factors effect selection of storage vessels and suggest thickens and dimensional requirement of storage vessels (Analyze)

CO4: Design pressure vessels based on process and external conditions (Apply)

CO5: Analyse various factors to Analyse be considered in the design of reacting vessels (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO2	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

Syllabus

UNIT I FUNDAMENTALS OF PIPING 9

Friction factor, pressure drop for flow of non-compressible and compressible fluids – (Newtonian Fluids) – Pipe sizing– Pipes and Tube Standards – Types of valve fittings and Valves – Selection of

fittings – Economic velocity of liquid and gas handling. Pipe line networks and their analysis for flow in branches – Pipe supports – Pressure drop calculations for Non-Newtonian fluids.

UNIT II STORAGE TANKS 9

Study of various types of storage vessels and applications – Atmospheric vessels – Vessels for storing volatile and non-volatile liquids – Storage of gases – Losses in storage vessels – Various types of roofs used for storage vessels –. Vessel supports – Introduction and classification of supports – Design of skirt supports considering stresses due to dead weight – Wind load – Seismic load.

UNIT III PRESSURE VESSELS 9

Stresses due to static loads – Thermal stresses – Stresses caused by bending and wind loads – Thin and thick wall cylinders under internal and external pressure – Thin and thick-walled spherical shells under internal and external pressure – Prediction of failure of vessels by maximum normal stress theory and maximum strain theory

UNIT IV REACTOR VESSELS 9

Reaction vessels: Classification – Heating systems – Design of vessels – Study and design of various types of jackets like plain – Half coil – Channel – Limpet oil – Study and design of internal coil reaction vessels – Heat transfer coefficients in coils

UNIT V AGITATORS 9

Agitators: a study of various types of agitators – Their selection – Application – Baffling – Agitator – Shaft diameter calculations – Twisting moment – Equivalent bending moment – Power requirement calculations for agitation systems.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. M V Joshi & V V Mahajani, "Process Equipment Design" , 5th Edition, Trinity Press, 2017

2. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", 3rd Edition, Gulf Professional Publishing , 2001.

REFERENCES:

1. S B Thakore and B I Bhatt, "Introduction to Process Engineering and Design" , 1st Edition, Tata McGraw Hill, 2007

2. R K Sinnott, "Coulson & Richardson's Chemical Engineering" , Vol. 6, CBSPD, 2006

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

3. L.E. Brownell and E. Young, "Process equipment design" , 1st Edition, John Wiley, New York, 1963

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

U21CHP15	OIL AND GAS ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- Various sources of oil and gas nationally and globally.
- To study the various exploration techniques of Oil and Gas.
- Understanding the Storage and Separation Mechanism of Oil and Gas and Transportation.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: The students develop the knowledge base about the development of oil and gas fields and technological innovations in exploration and drilling etc (Remember)

CO2: The students understand the different drilling methodologies for crude oil production (Apply)

CO3: The students understand the separation methodologies oil and gas (Understand)

CO4: The students understand the storage mechanism of crude oil and gas (Understand)

CO5: Different method of Transportation of crude oil and gas (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	2	3	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

UNIT I RESERVOIR 9

Petroleum Reserve Estimation Reserve categories – Proven and unproven reserve – Type of reserve – Prognostic reserves – Commercial reserves – Balance reserve – Reserve estimation: Volumetric method – Material balance method – Decline curve analysis – Numerical simulation techniques– Monte Carlo approach etc.

UNIT II EXPLORATION 9

Drilling Introduction to on-shore and offshore drilling operations – Onshore drilling techniques– Cable tool drilling – Rotary drilling – Vertical drilling – Directional drilling – Horizontal drilling– Offshore drilling rigs – Drilling accessories components – Drilling fluid circulation system – Functions of drilling fluids – Mud parameters

UNIT III OIL AND GAS SEPARATION 9

Oil and Gas separators: Principal of separation– Types of separators – Their description – Various control and vessel internals – Oil and gas gravitational separator – Vertical two and three phase separator – Horizontal three phase separator etc.

UNIT IV STORAGE OF PETROLEUM PRODUCTS 9

Classification of inflammable liquids – Classification of storage tank – Floating roof tank – Fixed roof tank– Semi buried tank – Import/export loss – Breathing losses – Hazards and non-hazards area– and underground storage tank etc.

UNIT V TRANSPORTATION 9

Transportation of oil and natural gas by rai l– Road and pipeline – Various type of pipelines – Pipe line automation – Lease Automatic Custody Transfer units – SCADA – Batch transport of petroleum products – Multiproduct pipelines – Product handling – Pumping cycle – Interface – Problems in waxy crude – Role of flow behaviour etc.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Andrew Palmer, "Introduction to Petroleum Exploration and Engineering" , 1st Edition, World Scientific, 2017.
2. John R Fanchi, "Introduction to Petroleum Engineering" , 1st Edition, John Wiley, 2016.

REFERENCES:

1. J. H. Gary, G. E. Handwork and M. J. Kaiser, "Petroleum Refining: Technology and Economics" , 5th Edition, CPR Press, Taylor and Francis Group,200.
2. Conaway C.F., "The Petroleum Industry: A Non- Technical Guide", 1st Edition, Penn Well, 1999

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

U21CHP16	SUPPLY CHAIN MANAGEMENT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand about the product Life cycle and factors affecting the supply chain.
- To impart knowledge in Risk management in source freight, transportation networks.
- To understand about the network design in Supply chain Management and Risk Management in transportation.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline the manufacturing and product life cycle management process involved in a product (Understand)

CO2: Formulate the forecasting methods and inventory modelling (Understand)

CO3: Estimate the right procurement and logistics strategy based on the supply chain and product criterion requirements (Analyze)

CO4: Design and analyze the right supply chain structure for the product along with distribution network (Apply)

CO5: Produce the supply chain network diagram incorporating supply chain strategy and competitive strategies involving material and information flow lines (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	2	-	-	-	-	-	-	1	1
CO2	3	-	-	–	-	2	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	2	-	-	-	-	-	-	1	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO SUPPLY CHAIN 9

Supply Chain – Objectives & Stages – Power of SCM – Process views of a supply chain – Strategic

planning – Achieving a strategic fit in a supply chain and factors affecting the strategic fit – Value chain – Supply chain flow lines – Understanding a product – Product life cycle

UNIT II SUPPLY CHAIN PROCESS 9

Forecasting in supply chain – Forecast error distribution order quantity and reorder point characteristics & components of forecasting – Time series methods of forecasting – Demand Management in MPC – MTS – ATO – MTO – Inventory – Role of cycle inventory – Economies of scale to exploit fixed costs

UNIT III PRODUCT PROCUREMENT & TRANSPORTATION 9

Procurement process – EOQ – Sourcing in a supply chain – Deciding factors for In-house or outsourcing – Supplier selection – Auctions and negotiations – Risk management in sourcing Freight management – Transportation networks – Milk run – Cross Docking

UNIT IV DESIGNING A SUPPLY CHAIN 9

Supply chain drivers – Supply chain performance measures – SCOR Model – Network design in a supply chain – Factors influencing design – Framework for network design network – Models for facility location and capacity allocation – Uncertainty in network

UNIT V INFORMATION TECHNOLOGY IN SUPPLY CHAIN 9

Lean Supply Chain – Agile supply chain – Dynamic supply chain design – Impact of technology on SCM – Key trends in SCM – IT in supply chain coordination and design – MRP– ERP– CRM– ISCM – Performance metrics.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Ayers J., "Hand Book of Supply Chain Management", 1st Edition, The St. Lencie Press/ APICS Series on Resource Management, 2000.

REFERENCES:

1. Burt N.D., Dobler. W.D. and Starling L.S., "World Class Supply Chain Management, The Key to Supply Chain Management", 1st Edition, Tata McGraw Hill Publishing Company Limited, 2005
2. Chopra S., Meindl P. and Kalra, D.V., "Supply Chain Management, Strategy, Planning and Operation",1st Edition, Pearson Education, 2008
3. Monczka R., Trent R. and Handfield R., "Purchasing and Supply Chain Management", 3rd Edition, Thompson Learning , 2007

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

		Category: PEC				
U21CHP17	PETROLEUM REFINING AND PETROCHEMICALS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Introduction of various testing methods of crude oil and its products, and refining of crude oil
- Understanding the Mechanism of different Cracking operation
- Different treatment technology for sulphur removal and Manufacture of various petrochemicals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Have a knowledge on the past, present and future of petroleum industry nationally and globally and study the nature of crude oil components and understand the various process of refining (Understand)

CO2: Able to select process technique for corrosion prevention and minimize corrosion (Understand)

CO3: Understand the process technology involved in production and storage of LPG and LNG from its raw material Acquire knowledge of process involved in converting crude oil to various products (Apply)

CO4: Know the principles and technologies involved in Fluid catalytic cracking, hydro desulphurization and other processes in cracking of crude oil and gas (Analyze)

CO5: Sketch the flow-sheets for the manufacture of various industrially important petrochemicals (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO2	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

KPRIET
Learn Beyond

SYLLABUS:

UNIT I CLASSIFICATION AND TESTING 9

Indian petroleum industry – Prospects and future– Exploration – Composition of crude and classification of crude oil – Evaluation of crude oil and testing of petroleum products – Refining of petroleum – Atmospheric and vacuum distillation

UNIT II CRACKING PROCESS 9

Thermal cracking – Visbreaking – Coking – Catalytic cracking (FCC) – Hydrocracking – Cracking of naphtha and gas for the production of ethylene – Propylene isobutylene and butadiene

UNIT III SWEETENING PROCESS 9

Treatment techniques for removal of sulphur compounds to improve performance – Production and treatment of LPG – LNG technology – Sweetening operations for gases including merox– ethanolamine – Copper chloride.– Storage and stability

UNIT IV HYDRO-TREATMENT AND ASPHALT TECHNOLOGY 9

Product treatment processes – Various solvent treatment processes – De-waxing–Clay treatment– hydro treatment and Hydro fining – Asphalt treatment process – Air blowing of bitumen

UNIT V PETROCHEMICALS 9

Isomerization – Alkylation and polymerization – Process types – Chemistry – Commercial processes – Catalysts – Production of petrochemicals like dimethyl terephathalate (DMT) – Ethylene glycol – Synthetic glycerine – Linear alkyl benzene (LAB) – Acrylonitrile – Methyl methacrylate (MMA)

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Nelson, W.L., " Petroleum refinery engineering" , 4th Edition, Mcgraw Hill, New York, 1995
2. Bhaskara Rao, B.K., "Modern petroleum refining processes" , 6th Edition, Oxford and IBH publishing company, New Delhi, 2018

REFERENCES:

1. Ram Prasad, "Petroleum Refining Technology" , 1st Edition, Khanna publishers, 2010
2. C.S. Hsu and P.R. Robinson, "Practical advances in petroleum processing" , Vol. 1 & 2, Springer publications, 2006.
3. G.N. Sarkar, "Advanced Petroleum Refining" , Khanna publishers, 2008

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL III

U21CHP18	PIPING AND INSTRUMENTATION IN CHEMICAL PLANTS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge on piping technology and instrumentation on pipelines
- To introduce the concept of Laplace, Transform for solving differential equations
- To develop dynamic modeling of physical processes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand fundamentals of piping engineering (Understand)

CO2: Apply the concepts of pipe hydraulics and sizing (Apply)

CO3: Able to develop the plot plan for different types of fluid storage (Understand)

CO4: Analyze the piping support based on requirement and its calculation (Analyze)

CO5: Understand the process flow diagram and instrumentation (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO2	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO3	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO5	1	2	1	-	-	-	-	-	-	-	-	-	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

Syllabus

UNIT I FUNDAMENTALS OF PIPING ENGINEERING 9

Definitions Piping Components their introduction – Applications – Piping MOC – Budget Codes and Standards – Fabrication and Installations of piping

UNIT II PIPE HYDRAULICS AND SIZING 9

Pipe sizing based on velocity and pressure drop consideration cost – Least annual cost approach, pipe drawing basics – Development of piping general arrangement drawing – Dimensions and drawing of piping

UNIT III PLOT PLAN 9

Development of plot plan for different types of fluid storage – Equipment layout – Process piping layout – Utility piping layout – Stress analysis - Different types of stresses and its impact on piping, methods of calculation – Dynamic analysis and flexibility analysis

UNIT IV PIPING SUPPORT 9

Different types of support based on requirement and its calculation

UNIT V INSTRUMENTATION 9

Final Control Elements; Measuring devices – Instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. M.L. Nayyar, P.E., "Piping Handbook" , 6th Edition, Mc Graw-Hill,1996
2. Johan J McKetta, "Piping Design Handbook", Vol.1, CRC Press, 1992

REFERENCES:

1. Luyben, W. L.," Process Modeling Simulation and Control for Chemical Engineers" , 1st Edition, McGraw Hill, 1990
2. Marlin, T. E., " Process Control ", 2nd Edition, McGraw Hill, New York, 2000
3. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edition, John Wiley, New York, 1997

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL IV

U21CHP19	GENERAL ASPECTS OF ENERGY MANUFACTURING AND ENERGY AUDIT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To Understand the need for energy management and audit and its importance in optimizing energy efficiency and minimizing energy costs.
- To Develop an understanding of energy management tools, techniques, and instruments to assess and evaluate energy performance and identify opportunities for improvement.
- To understand the financial and project management aspects related to energy efficiency, such as investment appraisal, criteria, financial analysis techniques, and the role of ESCOs.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the global and Indian energy scenario and its impact on the environment and climate change (Understand)

CO2: Understand the Energy Conservation Act, Electricity Act, 2003, and National Action Plan on Climate Change (NAPCC) (Understand)

CO3: Understand the principles and techniques of energy management and audit, including benchmarking, energy performance, and monitoring and targeting (Understand)

CO4: Understand to manage energy efficiently, including assessing energy profiles, establishing baselines, planning, implementation, evaluation, and recognizing (Understand)

CO5: Understand the financial and project management aspects of energy efficiency, including investment appraisal, financial analysis techniques, and the role of ESCOs in energy performance contracting (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I ENERGY SCENARIO AND ENERGY CONSERVATION ACTS 9

Primary and secondary, Renewable and Non-Renewable, Commercial and Non-commercial energy – Global and Indian energy scenario – Integrated energy policy – Energy intensity on Purchasing Power Parity (PPP) – Energy conservation Act – Electricity Act, 2003 – National Action Plan on Climate Change (NAPCC)

UNIT II ENERGY MANAGEMENT AND AUDIT 9

Need for Energy Management and Audit – Types – Understanding energy costs – Instruments and metering for energy audit – Benchmarking – Energy performance – Matching energy usage to requirement – Maximizing system efficiencies. Bureau of energy efficiency Regulations, 2008 – Energy Analysis and Sankey diagram

UNIT III ENERGY MANAGEMENT 9

Top management commitment and support – Assessing energy profile and establishing baseline – Planning, implementation – Evaluation and Recognizing – Management tools for effective implementation – Monitoring and targeting – Energy Management Information System (EMIS).

UNIT IV FINANCIAL AND PROJECT MANAGEMENT 9

Investment Need – Appraisal and criteria – Financial analysis techniques – Energy performance contracting and Role of ESCOs – Developing a typical ESCO contract – Case study – Project Development Cycle (PDC).

UNIT V ENERGY EFFICIENCY AND CLIMATE CHANGE 9

Energy and Environment – Global environmental issues – Impacts – The Intergovernmental panel on Climate Change (IPCC) – United Nations Framework Conventions on Climate Change (UNFCCC) – The Conference of Parties (COP) – The Kyoto protocol – CDM methodology and procedure – Sustainable Development.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. C.B.Smith, "Energy Management Principles", Pergamon Press, 2nd Edition, 2015.
2. Dale R. Patrick, S. Fardo, Ray E. Richardson, "Energy Conservation Guidebook", Fairmont Press, 3rd Edition, 2015.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

REFERENCES:

1. Wayne C. Turner, "Energy Management Handbook", 5th Edition, The Fairmont Press, Georgia, 2001
2. Abbi Y. A., Jain Shashank, "Handbook on Energy Audit and Environment management", 5th Edition, TERI Press, New Delhi, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL IV

		Category: PEC				
U21CHP20	ENERGY EFFICIENCY IN ELECTRICAL AND THERMAL UTILITIES	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamentals of energy efficiency in electrical and thermal utilities.
- To learn about energy-efficient technologies and their application in industrial systems.
- To analyze and assess energy use in different systems and identify opportunities for energy conservation.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the theory behind principles of electrical systems (Understand)

CO2: Understand energy-efficient technologies such as variable speed drives, energy-efficient motors, and automatic power factor controllers in industrial systems to optimize energy use and reduce waste (Understand)

CO3: Understand the energy conservation measures in thermal utilities such as boilers, furnaces, heat exchangers, and thermic fluid heaters (Understand)

CO4: Relate the technical and economic feasibility of cogeneration and waste heat recovery systems and their potential benefits for industrial applications (Understand)

CO5: Understand the waste heat recovery system and select appropriate commercial waste heat recovery devices to improve energy efficiency and reduce environmental impact (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I ELECTRICAL SYSTEMS 9

Introduction to electric power supply systems – Electricity billing – Electrical load management and maximum demand control – Power factor improvement and benefits – Transformers – Distribution losses in industrial system – Assessment of transmission and distribution losses in power systems – Estimation of technical losses in distribution system – Demand side management – Harmonics – Analysis of electrical power systems

UNIT II ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS 9

Electric motors – Compressed air system – Fans and Blowers– Pumps and Pumping system– Cooling Tower: components – Types – losses – Efficiency – Factors affecting performance– control strategies– energy conservation opportunities – Energy Efficient Technologies in Electrical Systems – Maximum demand controllers – Automatic power factor controllers – Energy efficient motors – Soft starters with energy saver – Variable speed drives – Energy efficient transformers – Electronic ballast – Occupancy sensors – Energy efficient lighting controls – Energy saving potential of each technology

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9

Thermal systems – Fuels and Combustion – Boilers– Furnaces – Heat exchangers and Thermic Fluid heaters - Efficiency computation and energy conservation measures; Steam distribution and usage – Steam traps – Condensate recovery – Flash steam utilization – Insulation & Refractories – Energy conservation in major utilities; Pumps – Fans – Blowers – Compressed air systems– Refrigeration and Air Conditioning systems – Cooling Towers – DG sets

UNIT IV COGENERATION 9

Need for Cogeneration – Principle – Types – Factors affecting cogeneration – Important technical parameters for cogeneration – Prime movers for cogeneration – Steam turbine efficiency – Cogeneration heat rate and efficiency assessment – Illustrative case – Trigeneration – Microturbine

UNIT V WASTE HEAT RECOVERY 9

Introduction – Types and applications – Benefits – Development of a waste heat recovery system – Commercial waste heat recovery devices.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Frank Kreith and D. Yogi Goswami, Energy Management and Conservation Handbook, 2nd Edition,CRC Press, 2008

2. Zoebelein, Hans, "Guide books for National Certification Examination for Energy Manager", 4th Edition, Bureau of Energy Efficiency, 2015

REFERENCES:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 2nd Edition, 1991
2. Shobh Nath Singh, "Non-Conventional Energy Resources", Pearson Education India, 1st Edition 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL IV

		Category: PEC				
U21CHP21	ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT & UTILITY SYSTEMS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the various types of equipment used in industries such as boilers, furnaces, heat exchangers, electric motors, fans, blowers, pumps, compressors, and HVAC systems, and their performance testing methods and standards.
- To gain knowledge about the major areas and equipment used in thermal power stations, including coal handling plants, coal mills, boilers, turbines, and condensers, and the processes involved in iron and steel making and cement manufacturing.
- To understand the energy consumption patterns, material and energy balance, and performance monitoring of process equipment and utilities in industries such as the textile, pulp and paper, and fertilizer industries.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamental principles and working mechanisms of various equipment used in industries such as boilers, furnaces, cogeneration systems, heat exchangers, electric motors, fans and blowers, pumps, compressors, and HVAC systems (Understand)

CO2: Understand the major areas/equipment involved in thermal power stations and steel, cement, pulp and paper, and fertilizer industries, along with their material and energy balance (Understand)

CO3: Understand the energy consumption patterns in different industries and how to monitor and optimize the energy consumption of production processes, process equipment, and utilities (Understand)

CO4: Understand the financial analysis of energy efficiency projects, including fixed and variable costs, interest charges, simple payback period, and discounted cashback methods (Understand)

CO5: Understand the energy performance of buildings and commercial establishments, including the determination of energy performance index and annual average hourly energy use, and the assessment of HVAC and lighting systems (Understand)

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

CO-PO MAPPING:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION 9

Boilers – Furnaces – Cogeneration systems – Heat Exchangers – Electric motors and variable speed drives – Fans and blowers – Pumps – Compressors – HVAC System – Purpose of the performance test – Testing methods – Scope – Standards – Factors.

UNIT II THERMAL POWER STATION AND STEEL INDUSTRY 9

Thermal Power station: Major area/equipment – Coal handling plant – Coal Mills – Boilers – Draft system – Water pumping system – LP and HP heaters – Turbine – Condensers.

Steel Industry: Iron and Steel making routes – Primary steel process and secondary steel process – Case example.

UNIT III CEMENT INDUSTRY AND TEXTILE INDUSTRY 9

Cement Industry: Cement manufacturing process – Material and Energy balance – Raw mill.

Textile Industry: Textile manufacturing process – Monitoring of energy consumption in production process – Performance monitoring of process equipment – Performance monitoring of utilities.

UNIT IV PULP– PAPER AND FERTILIZER INDUSTRY 9

Pulp and Paper Industry: Pulp and paper manufacturing processes – Energy consumption pattern - Material and energy balance.

Fertilizer Industry: Fertilizer manufacturing processes – Energy flow – Material and Energy balance.

UNIT V FINANCIAL ANALYSIS, BUILDINGS AND COMMERCIAL ESTABLISHMENTS 9

Financial Analysis: Fixed and variable costs – Interest charges – Simple payback period – Discounted cashback methods – Factors.

Buildings and Commercial Establishments: Determination of EPI and AAHEPI – Significance of

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

building envelope – Assessment of HVAC systems – Performance assessment of lighting system.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. C.B.Smith, "Energy Management Principles", 2nd Edition, Pergamon Press, 2015.
2. Dale R. Patrick, S. Fardo, Ray E. Richardson, "Energy Conservation Guidebook", 3rd Edition, Fairmont Press, 2015.

REFERENCES:

2. Wayne C. Turner, "Energy Management Handbook", , 5th Edition,The Fairmont Press, Georgia, 2001.
3. Abbi Y. A., Jain Shashank, "Handbook on Energy Audit and Environment management", 5th Edition, TERI Press, New Delhi, 2006.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL IV

		Category: PEC				
U21CHP22	**BIOENERGY**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the classification, structure, properties, and functional roles of various biomolecules, including amino acids, carbohydrates, nucleotides, lipids, and fatty acids.
- To analyze and evaluate different techniques for biomass assessment, biochemical conversions, and thermochemical and chemical conversions, including biocatalysis by enzymes and pathways, fermentation and bioprocess engineering, and thermochemical conversion processes.
- To demonstrate an understanding of the physical and chemical characteristics of biofuels, including their Indian and international standard specifications, and assess their adaptation in various applications, including power generation, sustainable co-firing of biomass with coal, and biomass integrated gasification/combined cycles systems.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamentals of biological systems necessary to grasp bioenergy concepts global bioenergy scenario and relate to bioenergy resources in India (Understand)

CO2: Understand the various biofuel types and its characteristics (Understand)

CO3: Understand the various types of bioenergy conversion systems in practice (Understand)

CO4: Understand the basic knowledge on algal culture, biomass harvest and biodiesel production (Understand)

CO5: Understand the national and international standards of biodiesel (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

KPRIET
Learn Beyond

SYLLABUS:

UNIT I INTRODUCTION TO BIOMOLECULES 9

Classification of amino acids – Carbohydrates and nucleotides; Structure and properties of carbohydrate polymers – Proteins and nucleic acids; Classification and utility of lipids and fatty acids; Functional roles of biomolecules – Energy carriers – Enzyme cofactors and biochemical regulation. Biosynthesis and Metabolism.

UNIT II BIOMASS 9

Biomass resources; classification and characteristics – Techniques for biomass assessment; Application of remote sensing in forest assessment – Biomass estimation – Biomass to biofuel; Source and classification of biofuels and their characteristics.

UNIT III BIOCHEMICAL CONVERSIONS 9

Biocatalysis by enzymes and pathways – Fermentation and bioprocess engineering – Chemical kinetics – Mathematical modelling of biochemical reactions – Bioreactor designs; Biodegradation and biodegradability of substrate; Anaerobic digestion – Bioconversion of lignocellulosic feedstock to sugars – Bioconversion of sugars and starches to fuels – Difference of the technologies of starch ethanol and cellulosic ethanol.

UNIT IV THERMOCHEMICAL AND CHEMICAL CONVERSIONS 9

Thermochemical Conversion: Direct combustion – Incineration – Pyrolysis – Gasification and liquefaction; Economics of thermochemical conversion – Biogasification: Biomethanation process– biogas digester types – Biogas utilisation; Waste to energy. Chemical Conversion: Hydrolysis & hydrogenation; Solvent extraction of hydrocarbons; Solvolysis of wood – Biocrude – Biodiesel production via chemical process – Catalytic distillation – Transesterification methods; Fischer-Tropsch diesel – Chemicals from biomass.

UNIT V BIOFUEL STANDARDS AND POWER GENERATION 9

Physical and chemical characteristics of biofuels – Biomass – Wood gas – Biomethane; Ethanol–biodisel – Wood oil; Bioblends – Indian and International standard specifications – Bioblends; Adaptation of biofuel in various applications – Biomass integrated gasification/combined cycles systems - Sustainable co-firing of biomass with coal; Biofuel economy – Case studies.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

TEXT BOOKS:

1. David L. Nelson and Michael M. Cox, "Lehninger's Principles of Biochemistry" , 1st Edition, Macmillan Worth publisher, 2009.
2. Jeremy M Berg, LubertStryer, John L. Tymoczko, "Biochemistry", 6th Edition, W. H. Freeman, 2008.
4. D. Voet and J. Voet, "Voet and Voet's Biochemistry", 3rd Edition, John Wiley and Sons , 2005.

REFERENCES:

1. Bent Sorensen, "Renewable Energy", Academic Press, 3rd Edition,W. H. Freeman, 2004.
2. Zoebelein, Hans, "Dictionary of Renewable Resources" , 2nd Edition, Wiley-VCH,2009.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL IV

U21CHP23	RENEWABLE AND NON – RENEWABLE ENERGY RESOURCES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the global and Indian energy scenario, and the present and future energy demands.
- To familiarize with renewable and non-renewable energy sources and their classification, including their patterns of consumption and utilization.
- To introduce various non-conventional energy resources, including solar, geothermal, wind, bioenergy, tidal, and waste recycling plants, and their thermodynamics, working principles, performance, and limitations.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the current energy scenario in India and globally, and assess the present and future energy demands (Understand)

CO2: Compare the renewable and non-renewable energy sources, and evaluate the relative merits and demerits of each type (Understand)

CO3: Understand the thermodynamics of energy conversion processes for various energy sources, including coal, petroleum, and solar energy (Understand)

CO4: Understand the performance and limitations of various energy conversion systems, such as wind turbines, geothermal energy plants, and wave/tidal energy converters (Understand)

CO5: Evaluate the impact of energy utilization on the environment, and develop strategies for sustainable energy management and conservation (Evaluate)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

KPRIET
Learn Beyond

SYLLABUS:

UNIT I INTRODUCTION 9

Energy Scenario: Indian and global, Present and future energy demands – Energy crisis– Classification of various energy sources – Renewable and non-renewable energy sources – Pattern of energy consumption.

UNIT II RENEWABLE ENERGY RESOURCES 9

Solid Fuels: Coal: Origin – Formation – Analysis – Classification – Washing and carbonization– Treatment of coal gas – Recovery of chemicals from coal tar – Coal gasification – Liquid fuel synthesis from coal – Carbonization of coal – Briquetting of fines. Liquid and Gaseous Fuels: Crude petroleum – Physical processing of crude petroleum – Fuels from petroleum – Storage and handling of liquid fuels – Natural and liquefied petroleum gases – Gas hydrates – Gasification of liquid fuels – Carbureted water gas – Non Renewable Energy Resources: Fossil fuels and their reserves nuclear energy – Types – Uses and effects Energy utilization and its effects on environment Energy crisis

UNIT III NON – RENEWABLE ENERGY RESOURCES 9

Introduction: Various non-conventional energy resources – Introduction – Availability – Classification – Relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials – Solar cell array – Solar cell power plant – Limitations. Solar Thermal Energy: Solar radiation – Flat plate collectors and their materials – Applications and performance – Focusing of collectors and their materials – Applications and performance; Solar thermal power plants

UNIT IV GEOTHERMAL ENERGY AND WIND ENERGY 9

Geothermal Energy: Resources of geothermal energy – Thermodynamics of geothermal energy conversion – Electrical conversion – Non-electrical conversion – Environmental considerations. Wind power and its sources – Site selection – Criterion – Momentum theory – Classification of rotors – Concentrations and augments – Wind characteristics. Performance and Limitations of energy conversion systems.

UNIT V BIOENERGY AND TIDAL ENERGY 9

Bio-mass: Availability of bio-mass and its conversion theory. Ocean Thermal Energy Conversion (OTEC): Availability – Theory and working principle – Performance and limitations. Wave and Tidal Wave: Principle of working – Performance and limitations – Waste Recycling Plants

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

TEXT BOOKS:

1. Raja, "Introduction to Non-Conventional Energy Resources" , 1st Edition, Scitech Publications, 2015
2. John Twidell and Tony Weir, "Renewal Energy Resources" , 3rd Edition, BSP Publications, 2015
3. M.V.R. Koteswara Rao, "Energy Resources: Conventional and Non-Conventional", 1st Edition, BSP Publications, 2006

REFERENCES:

1. Godfrey Boyle," Renewable Energy Power For A Sustainable Future", 3rd Edition, Oxford University Press, 2012
2. Rao, S. and Parulekar, B.B., "Energy Technology - Non-conventional Renewable and Conventional ", 3rd Edition, Khanna Publishers, 2000

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL IV

		Category: PEC				
U21CHP24	HYDROGEN AND FUEL CELL TECHNOLOGIES	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the hydrogen fundamentals, storage and applications.
- To identify different areas of fuel cell technology.
- To find the applications of all the areas in day-to-day life.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the physical and chemical properties of hydrogen, its production and storage options, and safety and management concerns related to hydrogen applications (Understand)

CO2: Understand the different hydrogen storage methods and their applications (Understand)

CO3: Understand the principles, working, thermodynamics, and kinetics of different types of fuel cells, and evaluate their relative merits and demerits (Understand)

CO4: Compare different hydrogen storage technologies such as pressure cylinders, liquid hydrogen, metal hydrides, and carbon fibers, and analyze different reformer technologies for hydrogen production (Understand)

CO5: Understand fuel cycle analysis to fuel cell technology and compare it with other competing technologies such as battery-powered vehicles, SI engines fueled by natural gas and hydrogen, and hybrid electric vehicles (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO2	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO3	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO4	2	2	2	1	-	2	2	2	2	2	2	2	2	2
CO5	2	2	2	1	-	2	2	2	2	2	2	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I HYDROGEN FUNDAMENTALS 9

Hydrogen as a source of energy – Physical and chemical properties – Salient characteristics– Relevant issues and concerns.

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water– Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride– Chemical storage – Safety and management of hydrogen – Applications of hydrogen.

UNIT III FUEL CELLS - TYPES 9

Brief history – Principle – Working – Thermodynamics and kinetics of fuel cell process – Types of fuel cells; AFC – PAFC – SOFC – MCFC– DMFC – PEMFC – Relative merits and demerits– Performance evaluation of fuel cell – Comparison of battery Vs fuel cell.

UNIT IV FUEL CELLS – APPLICATION AND ECONOMICS 9

Fuel cell usage for domestic power systems – Large scale power generation – Automobile – Space applications – Economic and environmental analysis on usage of fuel cell – Future trends of fuel cells.

UNIT V FUELING AND FUEL CYCLE ANALYSIS 9

Hydrogen storage technology – Pressure cylinders – Liquid hydrogen – Metal hydrides – Carbon fibers – Reformer technology – Steam reforming – Partial oxidation – Auto thermal reforming – CO removal – Fuel cell technology based on removal like bio-mass – Introduction to fuel cycle analysis – Application to fuel cell and other competing technologies like battery powered vehicles – SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Supramaniam Srinivasan, "Fuel Cells: From fundamentals to applications",1st Edition, Springer, 2010
2. Viswanathan B, "Fuel Cells – Principles and Applications", 1st Edition, Universities press, 2007

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

REFERENCES:

1. Bent Sorensen (Sorensen), "Hydrogen and Fuel Cells: Emerging Technologies and Applications", 5th Edition, Elsevier Academic Press, UK, 2011
2. Kordesch, K and G.Simader, "Fuel Cell and Their Applications" , 1st Edition, Wiley-Vch, Germany, 1996
3. Hart, A.B and G.J.Womack, "Fuel Cells: Theory and Application", 2nd Edition, Prentice Hall, NewYork Ltd., London, 1989

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

U21CHP25	WATER CONSERVATION AND MANAGEMENT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- The objective of the course is to provide the student with an understanding of the concepts and practices in Methodology of water conservation and water management
- To understand the various methods of water harvesting and Water resource development
- To understand the Different methods of water reuse and recycling and water management

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: To understand the Various methods of conservation of water and different models (Understand)

CO2: To understand the Different Methods of water Harvesting (Understand)

CO3: Plan and design Conservation and augmentation of water resources, water harvesting and groundwater recharge structures (Apply)

CO4: Students able to understand the different methodology of treatment of waste water (Understand)

CO5: Analysing the complex issues in water management (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	2	-	-	-	-	-	-	1	1
CO2	2		-	-	2	-	-	-	-	-	-	-	1	1
CO3	2	2	-	-	2	2	1	2	-	-	-	-	1	1
CO4	2	-	-	-	2	-	-	-	-	-	-	-	1	1
CO5	3	-	-	-	2	2	-	-	-	-	-	-	1	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION 9

Water and life– Management and conservation of water – Climate data– Conceptual models of runoff hydrograph– Dynamic models.

UNIT II WATER HARVESTING 9

Storage structures – Percolation Tanks – Yield from catchments – Diversion of runoff – Ponds and reservoirs – Earth embankments

UNIT III WATER RESOURCES PLANNING 9

Statement of objectives – Data requirements – Project formulation – Environmental considerations in planning – Systems analysis – Pitfalls in project planning – Conservation and augmentation of water resources – Multipurpose projects – Functional requirements in multi-purpose project. Compatibility of multipurpose uses – Application of water resources systems engineering to practical problems

UNIT IV RECYLING AND REUSE 9

Recycling and reuse of water – Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies – Economic and social dimensions – Packaged treatment units – Reverse osmosis and desalination in water reclamation

UNIT V WATER MANAGEMENT 9

Water quality management – Principles of water quality – Water quality classification – Water quality standards – Water quality indices – TMDL Concepts – Water quality models

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. R.K. Linsley and Franzini, "Water Resources Engineering" , 1st Edition, McGraw-Hill Book Co.,2005
2. Hall and Dracup, "Water Resources Systems Engineering", 1st Edition, McGraw Hill Book Co.,2007

REFERENCES:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, "Wastewater Engineering: Treatment and Reuse", 1st Edition, McGraw-Hill, 2002.
2. Suresh. R, "Soil and water conservation engineering" , 1st Edition, Standard publication, New Delhi, 2007
3. Chatterjee, S. N., Water Resources Conservation and Management, 1st Edition, Atlantic Publishers, 2008

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

		Category: PEC				
		L	T	P	J	C
U21CHP26	MODERN SEPARATION TECHNIQUES	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Gain knowledge about recent separation methods
- Gain knowledge about various techniques used for separation
- To know about advanced mass transfer operations

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand about modern separation techniques use in the industry (Understand)

CO2: Analyze the separation processes for selecting optimal process for new and innovative applications (Analyze)

CO3: Apply the latest concepts like super critical fluid extraction, evaporation, lyophilisation etc., in Chemical process industries (Apply)

CO4: Understand Innovative techniques of controlling and managing oil spills (Understand)

CO5: Ability to exhibit the skill to develop membrane processes, adsorption process and inorganic separation process (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO2	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO3	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO4	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO5	2	1	2	2	3	-	-	1	-	-	-	-	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BASICS OF SEPARATION PROCESS 9

Review of Conventional Processes – Recent advances in Separation Techniques based on size –

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

surface properties – Ionic properties and other special characteristics of substances – Process concept – Theory and Equipment used in cross flow Filtration – Cross flow Electro Filtration– Surface based solid – Lliquid separations involving a second liquid

UNIT II MEMBRANE SEPARATIONS 9

Types and choice of Membranes – Plate and Frame – Tubular – Spiral wound and hollow fibre Membrane Reactors and their relative merits – Commercial – Pilot Plant and Laboratory Membrane permeators involving Dialysis – Reverse Osmosis – Nanofiltration – Ultra filtration and Micro filtration – Ceramic – Hybrid process and Biological Membranes

UNIT III SEPARATION BY ADSORPTION 9

Types and choice of Adsorbents – Adsorption Techniques – Dehumidification Techniques – Affinity Chromatography and Immuno Chromatography – Recent Trends in Adsorption

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors – Applications – Types of Equipment employed for Electrophoresis – Di-electrophoresis – Ion Exchange Chromatography and Electrodialysis – EDR – Bipolar Membranes

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation – Pervaporation and Permeation Techniques for solids – Liquids and gases – Zone melting – Adductive Crystallization – Other Separation Processes – Supercritical fluid Extraction – Oil spill Management – Industrial Effluent Treatment by Modern Techniques

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Lacey, R.E. , S.Looeb, "Industrial Processing with Membranes" , Vol.1, Wiley Inter Science, 1972
2. King, C.J. , " Separation Processes" , 1st Edition, Tata McGraw–Hill Publishing Co. Ltd., 1982

REFERENCES:

1. King, C. J., "Separation Processes", 1st Edition, Tata McGraw Hill, 1982
2. Roussel, R. W., "Handbook of Separation Process Technology", 1st Edition, John Wiley, New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology", 1st Edition, Marcel Dekkar, 1992

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

U21CHP27	WASTEWATER TREATMENT	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To know about the basics of biological water treatment methods
- To know about the applications of biological water treatment methods.
- To understand about various equipment used in water treatment methods.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understanding the Biochemical fundamentals and its operation (Understand)

CO2: Analysis of modeling of ideal suspended growth reactors (Analyze)

CO3: Design and Evaluation of suspended growth processes (Apply)

CO4: Analysis of modeling of Ideal attached growth reactors (Analyze)

CO5: Applications of Bioreactor for water treatment (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO BIOCHEMICAL OPERATIONS 9

Classification of Biochemical Operations – Fundamentals of Biochemical Operations

UNIT II TRADITIONAL BIOLOGICALTREATMENT 9

Theory – Modeling of Ideal Suspended Growth Reactors: Modeling Suspended Growth Systems – Aerobic Growth of Heterotrophy in a Single Continuous Stirred Tank Reactor – Receiving Soluble Substrate – Multiple Microbial Activities in a Single and Continuous Stirred Tank Reactor

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT III APPLICATION OF TRADITIONAL BIOLOGICAL TREATMENT 9

Suspended Growth Reactors: Design and Evaluation of Suspended Growth Processes – Activated Sludge – Biological Nutrient Removal – Aerobic-digestion – Anaerobic Processes – Lagoons

UNIT IV BIOREACTORS FOR WATER TREATMENT 9

Modeling of Ideal Attached Growth Reactors: Bio-film Modeling. Aerobic Growth of Biomass in Packed Towers – Aerobic Growth of Heterotrophs in Rotating Disc Reactors – Fluidized Bed Biological Reactors

UNIT V APPLICATIONS OF BIOREACTORS FOR WATER TREATMENT 9

Attached Growth Reactors: Trickling Filter – Rotating Biological Contactor – Submerged Attached Growth Bioreactors

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Grady Jr, C. L., Daigger, G. T., Love, N. G., & Filipe, C. D. "Biological wastewater Treatment" . CRC press, 2018

2. Patwardhan, A. D., " Industrial wastewater treatment" . 1st Edition, PHI Learning Pvt. Ltd., 2017

REFERENCES:

1. Muga, H. E., & Mihelcic, J. R., " Sustainability of wastewater treatment technologies" , Vol 1, . Journal of Environmental Management, 2008

2. Cheremisino, N. P., " Handbook of water and wastewater treatment technologies" 1st Edition, .Butterworth – Heinemann, 2001

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

		Category: PEC				
U21CHP28	WASTE MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Identify different types of waste and their environmental impacts.
- Implement effective waste collection, segregation, and recycling techniques.
- Develop sustainable waste management strategies that prioritize waste reduction and resource recovery.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic principles and concepts of waste management, including the waste management hierarchy, waste reduction strategies, and the environmental and health (Apply)

CO2: Identify appropriate waste collection methods and segregation techniques, including source separation, recycling, and composting, in order to effectively manage different types of waste (Understand)

CO3: Evaluate different waste treatment and disposal methods such as landfilling, incineration, and composting, considering their environmental impacts, cost-effectiveness, and suitability for different types of waste (Apply)

CO4: Develop sustainable waste management strategies that prioritize waste minimization, recycling, resource recovery, and the use of renewable energy technologies, taking into account social, economic, and environmental factors (Analyze)

CO5: Identify and interpret waste management policies and regulations at the local, national, and international levels, understanding their implications for waste management practices and the responsibilities of different stakeholders (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	2	-	-	-	-	-	-	1	1
CO2	3	2	-	-	-	2	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	2	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I INTRODUCTION TO WASTE MANAGEMENT 9

Definition and scope of waste management– Types and sources of waste – Environmental and health impacts of improper waste management – Waste management hierarchy: Reduce – Reuse– recycle and disposal – Waste management regulations and policies

UNIT II WASTE COLLECTION AND SEGREGATION 9

Waste collection systems: Municipal – Residential – commercial and industrial – Collection methods: Curbside pickup – Drop-off centers waste transfer stations – Waste segregation techniques: source separation – Recycling and composting – Waste collection equipment and technology – Community engagement and awareness program

UNIT III WASTE TREATMENT AND DISPOSAL 9

Waste treatment methods: Landfilling – Incineration and composting – Landfill design and operation: liner systems – Leachate collection and gas management – Incineration processes and emission control – Composting techniques and organic waste management – Hazardous waste treatment and disposal

UNIT IV Recycling and Resource Recovery 9

Recycling processes and technologies – Recycling of different materials: Paper – Plastics – Glass– metals – Challenges and opportunities in recycling.

UNIT V Sustainable Waste Management Strategies 9

Waste minimization and prevention strategies – Waste-to-energy technologies and renewable energy generation – Integrated waste management systems – E-waste management and recycling – International perspectives on waste management

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. John Pichtel, "Waste Management Practices: Municipal, Hazardous and Industrial", 2nd Edition CRC Press, 2014

2. Tchobanoglous G., Theisen H., and Vigil S.A., "Integrated Solid Waste Management, Engineering Principles and Management", 2nd Edition, McGraw-Hill, USA, 2014

REFERENCES:

1. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, "Environmental Engineering", 1st Edition McGraw Hill Education, 2017
2. Thomas Christensen, "Solid Waste Technology & Management", Vol.1, John Wiley & sons, USA, 2011

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

		Category: PEC				
U21CHP29	RISK AND HAZOP ANALYSIS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To become a skill and person in hazard and HAZOP analysis and to find out the root cause of an accident.
- To gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant.
- To understand safety handling and storage of chemicals.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand industrial safety procedure (Understand)

CO2: Identify hazed and analyze HAZOP (Analyze)

CO3: Manage the risk factors in industry (Apply)

CO4: Proceed the safety procedures in industry (Analyze)

CO5: Handle the chemicals in industry (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	2	-	-	-	-	-	-	1	1
CO2	3	2	-	-	-	2	-	-	-	-	-	-	1	1
CO3	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO4	2	2	-	-	-	2	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	2	-	-	-	-	-	-	1	1
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INDUSTRIAL SAFETY 9

Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II HAZARD IDENTIFICATION AND CONTROL 9

HAZOP – Job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Plant inspection – Past accident analysis

UNIT III RISK MANAGEMENT 9

Overall risk analysis – Chapains model, E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids

UNIT IV SAFETY PROCEDURES 9

Safety in plant design and layout – Safety provisions in the factory act 1948 – Indian explosive act 1884 – ESI act 1948 – Advantages of adopting safety laws.

UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS 9

Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Blake, R.P., "Industrial Safety", 3rd Edition, Prentice Hall, 2000.
2. Lees, F.P., "Loss Prevention in Process Industries", 4th Edition, Butterworth Heinemann, 2012.

REFERENCES:

1. Geoff Wells, "Hazard Identification and Risk Assessment", Institute of Chemical Engineers,1996
2. John Ridley and John Channing, "Safety at Work", 6th Edition, Butterworth Heinemann, 2003.
3. Raghavan, K.V. and Khan, A.A., "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL V

U21CHP30	AIR POLLUTION, MONITORING AND CONTROL	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide an understanding of the basic concepts of air pollution and its adverse effects on human health and the environment.
- To introduce various air pollution control technologies and their principles.
- To enable students to design and implement air pollution control strategies

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the sources and types of air pollutants and their effects on human health and the environment (Understand)

CO2: Analyze the principles and working mechanisms of various air pollution control technologies, such as scrubbers, electrostatic precipitators, and catalytic converters (Analyze)

CO3: Design and evaluate air quality monitoring programs using appropriate methods and instruments (Apply)

CO4: Explain the regulatory framework and policies for air pollution control at national and international levels (Understand)

CO5: Ability to exhibit the skill to develop membrane processes, adsorption process and inorganic separation process (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO2	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO3	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO4	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO5	2	1	2	2	3	-	-	1	-	-	-	-	3	3
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)							

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

SYLLABUS:

UNIT I Introduction 9

Introduction: Sources – Effects on – Ecosystems – Characterization of atmospheric pollutants – Air pollution episodes of environmental importance – Indoor Air Pollution – Sources – Effects

UNIT II Air Pollution Control Technologies 9

Principles and working mechanisms of various air pollution control technologies – Types of control devices (e.g.– Scrubbers – Electrostatic precipitators – Catalytic converters) – Evaluation of control technologies

UNIT III Air Quality Monitoring 9

Sampling and analysis of air pollutants – Air quality monitoring networks and methods – Data analysis and interpretation

UNIT IV Regulatory Framework and Policies 9

National and international regulations and policies for air pollution control – Emission standards and permits – Economic instruments for pollution control

UNIT V Air Pollution Control Strategies 9

Control strategies for different sources of air pollution (e.g., Industrial emissions – Transportation) – Cost-benefit analysis of control measures – Case studies of successful air pollution control programs

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Noel De Nevers, "Air Pollution Control Engineering", 2nd Edition, Waveland Pr Inc. 2010
2. Anjaneyulu Y, "Text book of Air Pollution and Control Technologies", 1st Edition, Allied Publishers, 2000

REFERENCES:

1. M. N. Rao and H V N Rao, "Air pollution", 2nd Edition, Tata Mc-GrawHill Publication. 2010
2. H. C. Perkins, "Air pollution", 1st Edition, Tata McGraw Hill Publication, 2006

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL VI

19CHP31	COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING	Category: PEC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To obtain skills in creating database retrieval of data
- To solve Mathematical models through linear and Non-linear Programming
- To obtain skills in preparing plant layout

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the command-line interfaces, including their structure, syntax, and basic commands (Understand)

CO2: Understand the principles of efficient data organization and be able to construct spreadsheets that effectively analyze and present data (Understand)

CO3: Perform descriptive statistics, such as calculating measures of central tendency and dispersion, and generate graphical representations of data using charts and graphs (Apply)

CO4: Understand the fundamental database concepts, including data models, schemas, tables, records, and fields (Understand)

CO5: Understand the fundamental concepts and principles of mathematical programming (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO2	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO3	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO4	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO5	3	3	3	-	3	-	-	-	-	-	-	-	1	2
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION 9

Review on Programming languages – Basic- Fortran – Review on operating system commands

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II SPREAD SHEETS 9

Application in Density – Molecular weight – Mole and percentage compositions – Empirical and Molecular formula calculations – Heat of mixing – Gas laws – Vapour pressure – Chemical Kinetics calculations

UNIT III SPREAD SHEETS (DATA ANALYSIS) 9

Application in data processing – Statistical analysis of data – Regression – Analysis of variance – Interpolation – Graphical representations of various Chemical Engineering problem both in laboratory exercise and core subjects such as Mechanical operation – Reaction Engineering – Distillation etc

UNIT IV DATABASE 9

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database In report – Query and other formats – Interfacing with other software. Preparation of Material and energy Balances preparation of plant layout Introduction to frequency response of closed-loop systems – Control system design by frequency response techniques– Bode diagram – Stability criterion – Tuning of controllers Z-N tuning rules – C-C tuning rules

UNIT V MATHEMATICAL PROGRAMMING 9

Design and developments of simple databases on Chemical and Physical properties of substances – Retrieval and Database in report – Query and other formats – Interfacing with other software– Preparation of Material and energy Balances preparation of plant layout

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Hanna, O.T. Scandell, O.C., "Computational Methods in Chemical Engineering" , 1st Edition, Prentice Hall,1995

2. R.K. Taxali, T.K.Base, " IV made simple" , 1st Edition, Tata McGraw-Hill, 1991

REFERENCES:

1. Jerry, O., Breneman, G.L., "Spreadsheet Chemistry" , 1st edition, Prentice Hall, 1991

2. Myers, A.L. Seider W.D., " Introduction to Chemical engineering and Computer Calculations" , 3rd Edition, Prentice Hall, 1998

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL VI

		Category: PEC				
U21CHP32	ARTIFICIAL INTELLIGENCE IN CHEMICAL ENGINEERING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify problems that are amenable to solution by AI methods (Apply)

CO2: Identify appropriate AI methods to solve a given problem (Apply)

CO3: Formalize a given problem in the language/framework of different AI methods (Understand)

CO4: Implement basic AI algorithms (Understand)

CO5: Design and carry out an empirical evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO2	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO3	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO4	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO5	3	3	3	-	3	-	-	-	-	-	-	-	1	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION **9**

Introduction – Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II PROBLEM SOLVING METHODS 9

Problem solving Methods – Search Strategies – Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems – Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha - Beta Pruning – Stochastic Games

UNIT III KNOWLEDGE REPRESENTATION 9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

UNIT IV SOFTWARE AGENTS 9

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V APPLICATIONS & CHEMICAL ENGINEERING APPLICATIONS 9

AI applications – Language Models – Information Retrieval – Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Chemical Engineering Applications.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Mc Graw Hill, Prentice Hall, 2009.
2. Thomas Quantrille Y. Liu, "Artificial Intelligence in Chemical Engineering", 1st Edition, 1992

REFERENCES:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)" , 1st Edition, Mc Graw Hill, 2008
2. Deepak Khemani, "A First Course in Atificial Intelligence" , 1st Edition, Tata McGraw Hill Education, 2013

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL VI

		Category: PEC				
U21CHP33	OPTIMIZATION OF CHEMICAL PROCESS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop objective functions and use linear programming for solution to chemical engineering problems
- To apply geometric, dynamic and integer programming and genetic algorithms for solution to chemical engineering problems
- To apply optimization techniques for real world problems and be knowledgeable to use software packages for their solution

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Frame mathematical models and formulate optimization models for chemical processes / equipment (Apply)

CO2: Understand the concept of optimum and extremum and the necessary and sufficient conditions for extremum and solve single and multivariable optimization problems through various techniques (Understand)

CO3: Apply various search methods to solve unconstrained single variable optimization and unconstrained multi variable optimization (Apply)

CO4: Apply higher order techniques like geometric programming, dynamic and integer programming and genetic algorithms (Apply)

CO5: Able to use the principles of engineering and in particular chemical engineering to develop equality and inequality constraints for an optimization problem (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO3	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO5	3	2	1	-	2	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

KPRIET
Learn Beyond

SYLLABUS:

UNIT I INTRODUCTION TO OPTIMIZATION 9

Introduction to optimization – Applications of optimization in chemical engineering – Classification of optimization problems – Developing models for optimization

UNIT II CONTINUITY OF FUNCTIONS 9

Continuity of Functions; NLP Problem Statement Convexity and Its Applications – Interpretation of the Objective Function in Terms of its Quadratic Approximation – Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function – Region elimination methods; interpolation methods – Direct root methods

UNIT III DIFFERENT METHODS USING FUNCTION VALUES 9

Methods Using Function Values Only – Random Search – Grid Search – Univariate Search – Simplex Search Method – Conjugate Search Directions – Methods That Use First Derivatives – Steepest Descent – Conjugate gradient Methods – Newton's Method and Quasi Newton's Method

UNIT IV SOLUTIONS OF PROBLEM USING EXCEL 9

Introduction to geometric – Dynamic and integer programming and genetic algorithms – Linear Programming – Solution of Problems using Excel solver

UNIT V FORMULATION OF OBJECTIVE FUNCTIONS 9

Formulation of objective functions; fitting models to data; applications in fluid mechanics – Heat transfer– Mass transfer – Reaction engineering – Equipment design – Reaction engineering– Resource allocation and inventory control.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Rao, S. S., Engineering Optimization - Theory and Practice, 3rd Edition, John Wiley & Sons, New York, 1996.
2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ",1st Edition, McGraw-Hill Book Co., New York, 2003
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", 1st Edition, John Wiley, New York, 1980

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

REFERENCES:

1. Venkataraman, P., "Applied optimization with MATLAB programming" ,1st Edition, John Wiley & Sons, 2007
2. Ferris, M. C., Mangasarian, O. L., & Wright, S. J., "Linear programming with MATLAB" ,Vol.7, 2007

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL VI

		Category: PEC			
U19CHP34	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To make the students to demonstrate competence in setting up computational fluid dynamics models for some industrially important applications.
- This technical competence in building and conducting CFD simulations is a skill which enhances employability.
- To know about recent software tool techniques used in fluid flow operations.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamental conservation laws in fluid dynamics, including conservation of mass, momentum, and energy (Understand)

CO2: Understand the principles and techniques of finite difference approximation, including forward, backward, and central difference schemes (Understand)

CO3: Apply the finite volume method to solve a range of engineering problems, such as steady-state and transient flow simulations, heat transfer problems, and multi-phase flow problems (Apply)

CO4: Apply their knowledge and skills to solve real-world engineering problems involving fluid flows (Apply)

CO5: Understand the various grid generation techniques used in computational fluid dynamics (CFD) and other engineering disciplines (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO2	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO3	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO4	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO5	3	3	2	3	3	-	-	-	-	2	-	-	2	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

Syllabus:

UNIT I CONSERVATION LAWS AND TURBULENCE MODELS 9

Governing equations of fluid flow and heat transfer – Mass conservation – Momentum and energy equation – Differential and integral forms – Conservation and non-conservation form. Characteristics of turbulent flows – Time averaged Navier Strokes equations – Turbulence models-one and two equation – Reynolds stress – LES and DNS.

UNIT II FINITE DIFFERNCE APPROXIMATION 9

Mathematical behaviour of PDE – Finite difference operators – Basic aspects of discretization by FDM – Explicit and implicit methods – Error and stability analysis.

UNIT III FINITE VOLUME METHOD 9

Diffusion problems – Explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes – Central – Upwind – Hybrid – QUICK schemes; Solution of discretised equations.

UNIT IV FLOW FIELD COMPUTATION 9

Pressure velocity coupling – Staggered grid – SIMPLE algorithm – PISO algorithm for steady and unsteady flows.

UNIT V GRID GENERATION 9

Physical aspects – Simple and multiple connected regions – Grid generation by PDE solution – Grid generation by algebraic mapping.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Anderson, J. D., "Computational Fluid Dynamics: The Basics with Applications", 1st Edition, McGraw-Hill, 1995.
2. Fletcher, C. A. J., "Computational Techniques for Fluid Dynamics", 1st Edition, Springer Verlag, 1997.

REFERENCES:

1. Versteeg, H.K. and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education Ltd., 2007.
2. Chung T.J., Computational Fluid Dynamics, 1st Edition, Cambridge University Press, 2003.
3. Taylor, C and Hughes, J.B. "Finite Element Programming of the NavierStock Equation", 1st Edition, Pineridge Press Limited, U.K., 1981.

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

VERTICAL VI

		Category: PEC			
		L	T	P	C
U19CHP35	PROCESS MODELING AND SIMULATION	3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop steady state and transient models for processes and unit operations
- To understand lumped and distributed parameter models and to seek solution of models using analytic and numerical techniques
- To construct data driven models and estimate the parameters.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the programming languages and operating system commands (Understand)

CO2: Able to create spread sheets for empirical and molecular formula calculations (Understand)

CO3: Analyze data using spread sheets for various chemical engineering problems (Analyse)

CO4: To design simple databases on chemical and physical properties of substances using software (Analyse)

CO5: Understand dynamic Programming in Chemical Engineering through PC based programs (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO3	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO5	3	2	1	-	2	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO MODELLING AND SIMULATION 9

Introduction to modelling and simulation – Classification of mathematical models – Conservation equations and auxiliary relations

UNIT II DEGREE OF FREEDOM ANALYSIS 9

Degree of freedom analysis – Single and network of process units – Systems yielding linear and nonlinear algebraic equations – Flow sheeting – Sequential modular and equation-oriented approach – Tearing – Partitioning and precedence ordering – Solution of linear and non-linear algebraic equations using Matrices and Numerical techniques – Error estimates.

UNIT III SOLUTION OF ODE 9

Analysis of liquid level tank– Gravity flow tank– jacketed stirred tank heater – Reactors – Flash and distillation column– Solution of ODE initial value problems – Matrix differential equations– simulation of closed loop systems – Solution of ODE using Eigen values – Jordan Canonical Form – Stiff equations – Gear's algorithm – Perturbation Methods

UNIT IV METHODS OF ANALYSIS 9

Analysis of compressible flow – Heat exchanger– Packed columns – Monolith Reactor Modelling – Pseudo – Homogeneous and Heterogeneous models for catalytic reactors – Plug flow reactor– solution of ODE boundary value problems – Shooting Method

UNIT V MODEL CLASSIFICATION AND DEVELOPMENT 9

Analysis laminar flow in pipe – Sedimentation – Boundary layer flow – Conduction – Heat exchanger– Heat transfer in packed bed – Diffusion – Packed bed adsorption – Plug flow reactor – Hierarchy in model development – Classification and solution of partial differential equations – Characteristic curves for parabolic – Elliptic and Hyperbolic equations – Empirical modelling– parameter estimation – Population balance and stochastic modelling – Principal Component Analysis.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Bequette, B.W., "Process Dynamics: Modelling, Analysis and Simulation," 1st Edition, Prentice Hall, 1998
2. Himmelblau D.M. and Bischoff K.B., " Process Analysis and Simulation" , Vol.1.,Wiley, 1988
3. Varma A. and Morbidelli M., "Mathematical Methods in Chemical Engineering" , 1st Edition, Oxford University Press, 1997

REFERENCES:

1. Golub G.H. and Van Loan C.F., "Matrix Computations" , 3rd Edition, Johns Hopkins University Press, 1996.
2. Ogunnaike B. and W. Harmon Ray., "Process Dynamics, Modeling, and Control" ,1st Edition, Oxford University Press, 1995

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

3. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers" , 3rd Edition, McGraw Hill, 2001

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

VERTICAL VI

U21CHP36	IoT IN CHEMICAL ENGINEERING	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To apply basic concepts of the Internet of Things (IoT) and its relevance to Chemical Engineering
- To learn about the integration of IoT with chemical processes for real-time monitoring, control, and optimization
- To explore industry-specific case studies and emerging trends in IoT for Chemical Engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able

CO1: To understating the principles and applications of IoT in Chemical Engineering (Understand)

CO2: To apply IoT hardware and software components in Chemical Engineering contexts (Apply)

CO3: To interpret IoT data for real-time monitoring and optimization of chemical processes (Apply)

CO4: To explain the challenges and opportunities in implementing IoT in Chemical Engineering (Understand)

CO5: To understand emerging trends and future directions of IoT in Chemical Engineering (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	-	-	-	-	-	-	-	-	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	-	1	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO IOT IN CHEMICAL ENGINEERING 9

Definition and significance of IoT in Chemical Engineering – Overview of IoT architecture and components – Challenges and opportunities in IoT applications.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

UNIT II SENSORS AND ACTUATORS FOR IOT 9

Types of sensors and their applications in chemical processes – Actuators and their role in IoT systems – Sensor calibration and data acquisition techniques.

UNIT III COMMUNICATION TECHNOLOGIES FOR IOT 9

Wireless communication protocols (e.g. Wi-Fi – Bluetooth – Zigbee) – Cloud computing and data storage for IoT applications – Security and privacy considerations in IoT systems

UNIT IV DATA ANALYSIS AND VISUALIZATION FOR IOT 9

Data pre processing and cleaning techniques – Statistical analysis and machine learning algorithms for IoT data – Data visualization tools and techniques.

UNIT V IOT APPLICATIONS IN CHEMICAL ENGINEERING 9

Real-time process monitoring and control using IoT – Predictive maintenance and asset management – Energy optimization and sustainability in chemical processes.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1 Bhushan– Aravind, Internet of Things for the Chemical Industry: Implementing Industry 4.0, 1st Edition, CRC Press, 2012

2 Lewis, Perry, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, 1st Edition, Packt Publishing, 2010

REFERENCES:

1 Wang, Sabina Jeschke, Gang Huang, Vincenzo Ciancaglini, and Yushun Fan Industrial Internet of Things: Cyber manufacturing Systems, 1st Edition, Springer , 2013

2 Yan Zhang, Houbing Song, and Daniel Liang, J. Internet of Things: Principles and Paradigms,1st Edition, Wiley, 2011

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPRIET
Learn Beyond

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Roll Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

Dr. S. Balasubramanian, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407

KPR Institute of Engineering and Technology

Learn Beyond

(Autonomous, NAAC "A")

0422 2635600, +91 75488 88444
admission@kpriet.ac.in
Avinashi Road, Arasur, Coimbatore - 641407

kpriet.edu.in /KPRIETonline