Master of Technology

in

Petroleum Processing & Petrochemical Engineering

SYLLABI

Department of Petroleum Studies

Zakir Hussain College of Engineering & Technology

Aligarh Muslim University

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY

ALIGARH MUSLIM UNIVERSITY, ALIGARH

CURRICULUM for M.Tech. (Petroleum Processing & Petrochemical Engineering) Program

Course No.	Course Title	Contact periods per week			Credits	Marks			
		Lecture L	Practical P	General G		Course work	Mid-Sem Exam	End-Sem Exam	Total
Semester - I									
AM641	Advance Mathematics	3	0	1	4	15	25	60	100
PK601	Fluid Flow and Heat Transfer	3	0	1	4	15	25	60	100
PK602	Petroleum Processing	3	0	1	4	15	25	60	100
PK603	Distillation and Extraction	3	0	1	4	15	25	60	100
	Elective -I				4				
	Elective-II				4				
	Total	**12**	**0**	**4**	**24**				
Semester - II									
PK604	Process Dynamics and Control	3	0	1	4	15	25	60	100
PK605	Reactor Analysis and Design	3	0	1	4	15	25	60	100
PK606	Petrochemical Processes	3	0	1	4	15	25	60	100
PK607	Polymer and Composites	3	0	1	4	15	25	60	100
PK608	Gas Processing	3	0	1	4	15	25	60	100
PK690	Petroleum Testing Laboratory	0	4	0	4	60		40	100
	Total	**15**	**4**	**5**	**24**				
Semester - III									
	Elective-III				4				
PK780P	General Seminar	0	0	2	2	60		40	100
PK791P	Lab/Project	0	3	0	3	60		40	100
PK781P	Preliminary Dissertation Seminar	0	0	3	3	60		40	100
	Total	**0**	**3**	**5**	**12**				
Semester - IV									
PK782P	Final Dissertation Seminar	0	0	0	2	60		40	100
PK798P	Dissertation	0	0	3	10	60		40	100
	Total	**0**	**0**	**3**	**12**				
	Grand Total				**72**				

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY

ALIGARH MUSLIM UNIVERSITY, ALIGARH

List of Possible Electives

Course No.	Course Title	Contact periods per week			Credits	Marks			
		Lecture	Practical	General		Course	Lecture	Practical	General
PK611	Modeling & Simulation of Separation Processes	3	0	1	4	15	25	60	
PK612	Alternate Fuels	3	0	1	4	15	25	60	
PK613	Materials of Construction in Petroleum & Petrochemical Plants	3	0	1	4	15	25	60	100
PK614	Petroleum Engineering	3	0	1	4	15	25	60	100
PK615	Reservoir Engineering	3	0	1	4	15	25	60	100
PK616	Process Modelling and Simulation	3	0	1	4	15	25	60	100
PK617	Process Optimization	3	0	1	4	15	25	60	100
PK618	Air Pollution and Control	3	0	1	4	15	25	60	100
PK619	Environmental Pollution and Impact Analysis	3	0	1	4	15	25	60	100
PK620	Environmental Chemistry								
PK621	Ecology and Environmental Microbiology								
PK731	Petroleum Refinery Engineering	3	0	1	4	15	25	60	100
PK732	Selected Topics in Petroleum Processing	3	0	1	4	15	25	60	100
PK733	Solids and Industrial Waste Management	3	0	1	4	15	25	60	100
PK734	Project Engineering of Petroleum and Petrochemical Plants	3	0	1	4	15	25	60	100
PK735	Rheology and Testing of Polymers	3	0	1	4	15	25	60	100
PK736	Multiphase Reactors	3	0	1	4	15	25	60	100
PK737	Thermodynamics of Fluids and Fluid Mixture	3	0	1	4	15	25	60	100
PK738	Mixing and Fluid Agitation	3	0	1	4	15	25	60	100
PK739	Advance Mass Transfer	3	0	1	4	15	25	60	100
PK740	Coal Conversion Processes	3	0	1	4	15	25	60	100
PK741	Heterogeneous Catalysis	3	0	1	4	15	25	60	100
PK742	Novel Separation Process in Hydrocarbon Industries	3	0	1	4	15	25	60	100
PK743	Safety and Hazard Assessment of Hydrocarbon Plants	3	0	1	4	15	25	60	100
PK744	Colloid and Interface Science and Technology	3	0	1	4	15	25	60	100
PK745	Bio-Chemical Engineering and Bio-Technology	3	0	1	4	15	25	60	100

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**ADVANCE MATHEMATICS**
Course Number:	**AM – 641**
Credits:	**04**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P):	**3-1-0**
Course Type:	**Theory**
Semester:	**I**

Course Objectives:

To learn vector spaces, matrices, numerical solutions of ordinary and partial differential equations and Fourier transforms.

Topics Covered:

Vector space matrix solution of ODE (IVP), partial differential equations. Sturm Louiville theory, separation of variables, Greens function, transform techniques, non – linear equation, continuous methods, bifurcation and Chaos Runge-Kutta, multistep methods, Gears algorithm, Finite difference, finite elements, shooting methods.

Textbook(s)/Reference Material(s):

Sastry, S.S., "Introductory Methods of Numerical Analysis", Prentice Hall of India Pvt. Ltd., 1983.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes:

1. Understand vector spaces and linear transformations
2. Understand matrices and its applications to chemical engineering problems
3. Solve ordinary and partial differential equations numerically
4. Use fourier transformations

AM641: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	M	M	M	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	M	M	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.					
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	H	H	H	H	H
e	An understanding of professional and ethical responsibilities in research and professional activities					
f	A capability for innovation and entrepreneurship.					
g	An ability to engage in lifelong learning	L	L	L	L	L

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**:**	**FLUID FLOW AND HEAT TRANSFER**
Course Number	**:**	**PK601**
Credits	**:**	**04**
Course Category	**:**	**DC**
Pre-requisite	**:**	**Nil**
Weekly Contact Hours (L-T-P)	**:**	**3-1-0**
Type of Course	**:**	**Theory**
Semester	**:**	**I**

Course Objectives

Apply scientific and engineering principles to analyze and design single and two phase Fluid Flow and Heat Transfer systems using appropriate analytical and computational tools to investigate Heat and Momentum Transport Phenomena; both competent and confident in interpreting results of investigations related to Heat Transfer, Fluid Flow and its application in the Design of Process equipment especially related to Energy Technology.

Topics Covered

Fluid flow phenomena, Equation of continuity and momentum transfer, Navier Stroke's equation and its solution to practical situation. Boundary layer theory, Von – Karmann theorem of integral momentum, Universal velocity profile. Turbulent boundary layer, Non – Newtonian Fluid Flow. Flow of two – phase gas – liquid mixture in pipes two phase two flow model and governing equations, flow transition pressure drop calculation. Forced Convection heat transfer, Introduction to compact heat exchanger employing extended surfaces, heat transfer by conduction, heat transfer to solids in packed and moving / fluidized beds. Heat transfer to boiling liquids, Pinch Technology and its application, concepts of energy conservation and its application in process equipment.

Textbook(s)/Reference Material(s):

1. F.A. Holland, Fluid Flow, Chemical Publishing Company, New York.
2. D. Butterworth & G.F. Hewitt, Two – phase Flow and Heat Transfer, oxford university Press, London

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Ability to do continuity and momentum transfer, Navier Stoke's equation and to determine Von – Karmann theorem, boundary layer profile thickness in steady flow over a flat plate and velocity and shear stress distribution in fluids for Couette flow and other flow systems.
2. Ability to calculate pressure drop for single and two phase flow systems.
3. Ability to understanding of Hear Transfer Processes (including boiling and condensation) and selection criteria, limitations, uses, operation, safety and design aspects of various types of device namely: Heat Exchangers including Compact, Packed and Fluidized Bed, Finned, Reboilers and Evaporators. Waste Energy utilization, conservation, recovery and its application in process equipment.
4. Ability to understand surface convection of fluid streams passing over objects (Nusselt, Prandtl, Reynold and Peclet Number and ability to analysis with approximate exact solution) and to analyze partial differential equation of Heat Conduction with and without Heat source and to solve these for Heat Transfer Rates.
5. To enable students to make analysis of Practical problems using these concepts.

Mapping of Course Outcomes with Program Outcomes

S. No	Program Outcome	Course Outcome				
		1	2	3	4	5
a.	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H*	H	H	H	
b.	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	M	M	M	
c.	An ability to conduct literature survey, prepare technical reports and communicate effectively.					
d.	A knowledge of relevant research tools, skills and techniques, and their application in analysis and design	M	M	M	M	
e.	An understanding of professional an ethical responsibilities in research and professional activities	L	L	L	L	
f.	A capability for innovation and entrepreneurship					
g.	An ability to engage in lifelong learning					H

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**PETROLEUM PROCESSING**
Course Number:	**PK602**
Credits:	**04**
Course Category:	**DC**
Pre requisite:	**NIL**
Weekly Contact Hours: (L-T-P)	**04**
Type of Course	**Theory**
Semester	**I**

Course Objective

To understand and know Origin, occurrence, Exploration, Drilling and Production of Crude Oil. Be aware of the challenges involved in refining from viewpoint of product specifications, economic considerations and environmental regulations

Topics Covered

Origin, occurrence, exploration, drilling & Production of Oil/ Gas Evaluation of oil, Petroleum refining in India, Refinery tests and crude distillation column, catalytic reforming for Gasoline upgrading and for aromatic production.

Textbook(s)/Reference Material(s):

1. Speight, J.C.; The Chemistry and Technology of Petroleum, Marcel Dekkar, New York, 1991.
2. Ram Prasad , Petroleum Refining Technology , Khanna Publishers , Delhi 2000
3. Rao, B.K.B; Modern Petroleum Refining Processes, 4/e, 2002, Oxford and IBH Company Pvt. Ltd.
4. G.D. Hobson, W. Pohl, Modern Petroleum Technology (Part I &II), John Wiley & Sons, N.Y., 1986.
5. Mall, I.D., “Petrochemical Process Technology”, First Edi., New Delhi, Macmillan India ,2007

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Know the Origin, occurrence, Exploration, Drilling and Production of Crude Oil.
2. Know the composition of crude oil and its products, along with its properties and characterization methods
3. Understand the process of fractionation of crude oil and Identify the specifications required for good quality petroleum product

PK602: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	M	M	M
g	An ability to engage in lifelong learning			

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**DISTILLATION AND EXTRACTION**
Course No.:	**PK-603**
Credits:	**04**
Course Category:	**DC**
Pre-requisite:	**NIL**
Weekly Contact Hours (L-T-P):	**3-1-0**
Type of Course:	**Theory**
Semester:	**I**

Course Objectives:

To learn conceptual design of distillation and extraction and design of equipment involved.

Topics Covered:

Thermodynamic equilibrium diagrams for binary and ternary system, analytical and graphical methods of calculation in distillation and extraction design of extractor's key components bubble points and dew point, stage and extraction examples from petroleum refining, Azeotropic and extractive distillation.

Textbook(s)/Reference Material(s):

1. Henley E.L., J.D. Seeder, Equilibrium – Stage separation operation in chemical engineering, John Wiley
2. King C.J. Separation Process, TMH New Delhi (1962)

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Able to understand the governing mechanisms and driving forces for distillation and Extraction.
2. Able to perform process and design calculations for multicomponent systems by approximate methods as well as by rigorous methods.
3. Able to design equipment for distillation and extraction.
4. Able to understand azeotropic distillation, extractive distillation etc.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H			M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		H	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M	H	M
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.		M	M	
g	An ability to engage in lifelong learning	M	M	M	M

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**PROCESS DYNAMICS AND CONTROL**
Course No.:	**PK-604**
Credits:	**04**
Course Category:	**DC**
Pre-requisite:	**NIL**
Weekly Contact Hours (L-T-P):	**04**
Type of Course:	**Theory**
Semester:	**II**

Course Objective:

To understand dynamic behavior of a physical processes, To design various control systems, To apply the advance control system in various processes. To understand computer control

Topics Covered:

Unit I: Dynamics behavior of processes, response of lumped parameter and distributed parameter systems, dynamic analysis of non-linear systems, state models etc.

Unit II: Overview of control system design, Stability analysis, design of control system, PID controller design, tuning and troubleshooting, Frequency response Analysis.

Unit III: Advanced Process control Techniques

Unit IV: Computer Control: sampling and z-transforms, response of discrete systems. Introduction to plant wide control.

Textbook(s)/Reference Material(s):

1. J.M. Douglas, Process Dynamics and control Vol – I Analysis of Dynamic system Vol - II Control System Synthesis, Prentice Hall (1972).
2. D.E. Seborg, T.F. Edger, and D.A. Millichamp, 'Process Dynamics and Control', John Wiley and Sons, 2nd Edition, 2004.
3. Stephanopolous, G., "Chemical Process Control", Prentice Hall of India, New Delhi, 1985.
4. Donald R. Coughnowr and L.B. Koppel, Process System Anaysis and control, McGraw Hill
5. W.L. Luyben Process Modeling, Simulation and control for Chemical Engineers, cGraw Hill Book Co. (1993)
6. John & Fredly, Dynamic Behavior of Process, Prentice Hall.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Able to develop and understand transfer functions and state models of dynamics processes
2. Able to analyze and design classical control methods and optimum controller settings
3. Able to understand and develop advanced control techniques
4. Able to understand and apply computer control in Petroleum and petrochemical process industries

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	M	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				H
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	L	H	M	M
e	An understanding of professional and ethical responsibilities in research and professional activities		M	M	M
f	A capability for innovation and entrepreneurship.			L	L
g	An ability to engage in lifelong learning	M	M	M	H

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**REACTOR ANALYSIS AND DESIGN**
Course Number:	**PK 605**
Credits:	**04**
Course Category:	**DC**
Pre-requisite:	**Nil**
Weekly Contact Hours (L-T-P):	**3-1-0**
Type of Course:	**Theory**
Semester:	**II**

Course Objectives:

To provide the students, a knowledge of RTD, external diffusion effects on heterogeneous reactions, non-isothermal design of chemical reactors and catalyst deactivation and be able to design a chemical reactor.

Topics Covered:

Unit I: Characteristics of RTD, RTD in ideal reactors, Reactor modelling with RTD, Zero parameter, one parameter and two parameter models, Other models of non-ideal reactors using CSTRs.

Unit II: External diffusion effects on heterogeneous reactions, Mass transfer to a single particle, mass transfer limited reaction in packed beds and metallic surfaces, Diffusion and reaction in porous catalysts, Estimation of diffusion and reaction limited regimes.

Unit III: Non isothermal design of chemical reactors, Maximum temperature in tubular reactor with heat exchange, control of hot spot temperature, Multiple steady states in CSTR, vanHeerden criterion for stability, Ignition and extinction of adiabatic CSTR, Hysteresis, Autothermal reactor operation, Unsteady state operation of tubular reactor,

Unit IV: Catalyst deactivation, Types of deactivation, order of deactivation, temperature-time trajectories, Moving bed reactors. Design of Slurry and trickle bed reactors.

Textbook(s)/Reference Material(s):

1. Elements of Chemical Reaction Engineering (4th Edition), Prentice Hall International Series, H. Scott Fogler.
2. Chemical Reaction Engineering, 3rd Edition, Octave Levenspiel, Wiley.
3. Chemical Reactor Theory: An introduction, second edition, K. G. Denbigh and J. C. R. Turner, Cambridge University Press, England (1971).
4. Fundamentals of Chemical Reaction Engineering, Charles D. Holland and Rayford G. Anthony, Prentice-Hall International Series.

Course Assessment:

Component	Marks
Home Assignments	15
Mid Semester Examination	25

End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes:

1. Ability to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
2. Understand various aspects associated with the design and operation of steady and unsteady –state non isothermal reactors.
3. Learn and apply external and internal mass transfer effects associated with the heterogeneous reactions while designing multiphase reactors.
4. Analyze and interpret deactivation kinetic data and use t for the design and sizing of industrial reactors.

Mapping of Course Outcome of PK-605 with Program Outcome

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	H	M	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	H	H	H	H
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			L	
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	M	M	M	H
e	An understanding of professional and ethical responsibilities in research and professional activities	L	L		L
f	A capability for innovation and entrepreneurship.				L
g	An ability to engage in lifelong learning			L	H

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**PETROCHEMICAL PROCESSES**
Course Number:	**PK606**
Credits:	**04**
Course Category:	**DC**
Pre requisite:	**NIL**
Weekly Contact Hours (L-T-P):	**3-1-0**
Type of Course	**Theory**
Semester	**II**

Course Objectives

To learn properties, application and production techniques of various Petrochemicals and to understand scientific and technological principles of organic synthesis and related unit processes.

Topics Covered:

Petrochemical Industry overview, feedstocks, Production of olefins, Petrochemicals from C1, C2, C3, C4 and cyclic hydrocarbon with unit processes involved. Petrochemical from the processes namely alkylation, dealkylation, disproportionation, carboxylation, Hydration, dehydration, hydrolysis, esterification, desertification, oxidation, hydroformylation, isomerization synthesis, LAB detergent. Chemicals from coal F & T process.

Textbook(s)/Reference Material(s):

1. Groogins, Unit Process in Organic Synthesis McGraw Hill Book Company, New York.
2. Hatch L.F. and MatarSarri, From Hydrocarbons to Petrochemicals, Gulf Publishing Co., Houston, London.
3. Channel, A & Lefebvre G. Petrochemical Process, Vol. I & II, Gulf Publishing Co., Houston, London.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B

45-59	C
35-44	D
< 35	E

Course Outcomes

1. Familiarize and understand various unit processes in synthesis of various Petrochemicals, with the present and emerging feed stock scenario and resource constraints
2. Understand and remember various properties and applications of second and third generation petrochemicals.
3. Acquainted with new and existing technologies used for the production of some commodity and engineering polymers

PK606: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	M	M	M
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**POLYMER AND COMPOSITE**
Course Number:	**PK 607**
Credits:	**04**
Course Category:	**DC**
Pre-requisite:	**Nil**
Weekly Contact Hours (L-T-P):	**3-1-0**
Type of Course:	**Theory**
Semester:	**II**

Course Objectives

To build strong fundamentals about polymeric materials, characterization methods and to impart in depth knowledge about micro & macro mechanical behavior of lamina and its failure theories.

Topics Covered:

Unit-I

Basic concepts of polymers. Classification of polymers, basic concepts of polymers such as structure, crystallinity, glass transition temperature, avg. molecular weights, polydispersity etc., types of polymerization reactions, polymerization techniques, applications of polymers, processing of polymers.

Unit-II

Polymer testing such as tensile, flexural, impact testing, and HDT / VSP, MFI etc., Characterization of polymers using X-ray diffraction (XRD), Differential scanning calorimetry (DSC), Dynamic mechanical analysis (DMA), Thermo-gravimetric analysis (TGA), SEM / TEM etc.

Unit-III

Introduction to composite materials, polymer composite and nanocomposites. Introduction of matrix and reinforcement. Elastic properties of unidirectional lamina-continuous fiber, discontinuous fiber and quasi-isotropic lamina.

Unit-IV

Macromechanical behavior of a lamina, strength of orthotropic lamina, Failure theories. Manufacturing techniques and applications of polymer composites.

Textbook(s)/Reference Material(s):

1. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International, 1986.
2. Joel R. Fried, Polymer Science and Technology (3rd Edition), Prentice Hall PTR, 2014.
3. Dan Campbell, Richard A. Pethrick, Jim R. White, Polymer Characterization: Physical Techniques, 2nd Edition, CRC Press, 2000.
4. Robert M. Jones, Mechanics Of Composite Materials, CRC Press, 1998.

5. P.K. Mallick, Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Second Edition, CRC Press, 1993.
6. A.A. Berlin, Principles of Polymer Composites, Springer, 2012.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Students will gain understanding of fundamental concepts about the polymers, its types, structure and properties.
2. Students will have in depth knowledge about polymer characterization such as mechanical testing, thermal testing and morphological characterization methods.
3. Students will be having knowledge about polymer composites and they will be conversant with quantitative aspects of micro mechanical behavior of various types of composite laminas.
4. Students will have ability to solve the design problems for macro mechanical behavior of lamina and failure theories.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M			
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M		
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	M		M	M

d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design				M
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning		M	M	

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**GAS PROCESSING**
Course Number	**PK608**
Credits	**04**
Course Category	**DC**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**04**
Type of Course	**Theory**
Semester	**II**

Course Objectives

The course objective is an opportunity to show your insight into the natural gas processing operations. This course deals with the fundamental design aspect of some of the common separator for gas processing systems. Other topics include the dehydration and desulfurization.

Topics Covered

Gas processing: gas & liquid separation, separation equipment, types of separators, separation principles, separator design, stage separation, low temperature separation, and gas cleaning.

Dehydration processing of gas- water system: water content of natural gas, gas hydrates, absorption dehydration, adsorption dehydration and dehydration by expansion, refrigeration.

Desulfurization processing: removal processes, solid bed sweetening processes and physical and chemical absorption processes.

Course Distribution

Unit01: NG Industry, Gas processing:
Unit02: Gas & liquid separation, separation equipment, types of separators, separation principles, separator design, stage separation, low temperature separation, and gas cleaning.
Unit03: Dehydration processing of gas- water system: water content of natural gas, gas hydrates, absorption dehydration, adsorption dehydration and dehydration by expansion, refrigeration.
Unit04: Desulfurization processing: removal processes, solid bed sweetening processes and physical and chemical absorption processes.

Textbook(s)/Reference Material(s):

1. Oil Field Processing Of Petroleum, Volume One: Natural Gas, Francis S Manning, Richard E Thomson, Penn Well Publishing House, Tulsa, Oklahoma, 1991
2. Gas Production Engineering, Sanjay Kumar, Gulf Publishing Company, 1987

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Recognize the fundamental of gas processing and its components.
2. Understand the various influential parameters in gas processing operation.
3. Able to design the gas processing equipment.

PK608: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	M	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	L		L
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			M
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**MODELLING & SIMULATION OF SEPARATION PROCESSES**
Course Number	**PK611**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

Learn to develop mathematical models of phenomena involved in various separation processes and design of equipment involved and solutions for these models.

Topics Covered

Thermodynamics of separation Processes: Property Calculation from various models. Single equilibrium stage and flash separation calculation. Modeling and separation cascades. Modeling of batch distillation. Advanced topics in Multicomponent staged separation processes such as distillation, absorption, extraction etc. Approximate (Shortcut) methods, rigorous methods, Rate based models for distillation, enhanced distillation and supercritical extraction modeling of membrane separation.

Textbook(s)/Reference Material(s):

1. Smith B.D. Design of Equilibrium Stage Processes, McGraw Hill Book company, New York (1985)
2. Holland C.D. and A.I. Liapis Computer Methods For Solving Dynamic Separation Problems, McGraw Hill Book company, New York (1983)
3. Seader, J.D. and E.J. Henley, Separation Processes Principles, John Wiley and Sons Inc. New York (1983)

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes:

1. Knowledge of various separation processes
2. Ability to Select appropriate separation technique for intended problem
3. Ability to design separation system for the effective solution of intended problem
4. Develop model equations for the given system
5. Demonstrate the model solving ability for various separation processes and the ability to use a process simulation.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H			M	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		H			H
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.					
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			M		
e	An understanding of professional and ethical responsibilities in research and professional activities					
f	A capability for innovation and entrepreneurship.					
g	An ability to engage in lifelong learning					

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**ALTERNATE FUELS**
Course Number	**PK612**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives:

To understand and analyze the present and future energy demand of the world and nation and techniques to exploit the available alternate fuels from renewable and non renewable sources such as solar, biofuels, wind power, tidal geothermal etc.

Topics Covered:

Introduction to alternate fuels, Need for a Global & National energy scenarios, the method of production, properties and characteristics of the different alternate fuels and proper handling procedures.

Gas to liquid Technology fuels- Introduction to GTL route for cleaner fuels, Gasification and liquefaction of coal and lignite, fuels from Biomass-thermal, chemical and biochemical conversions.

Coal Liquefaction technologies: carbonization and pyrolysis, Direct Liquefaction, Indirect Liquefaction

Textbook(s)/Reference Material(s):

1. T. N. Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1978.
2. Rao, S. and Parulekar, B.B., "Energy Technology", Khanna Publishers, Delhi.
3. Speight, J.G., "Fuel Science and Technology Handbook", Marcel and Dekker., New York, 1995.
4. Abbasi, S.A. & Abbasi, N., "Renewable Energy Sources and Their Environmental Impact", Prentice Hall of India, New Delhi, 2002.
5. Solar Energy S.P. Sukhatme Tata McGraw Hill

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

At the end the students will able to

1. After studying this course the student is able to know the energy demand of world, nation and available resources to fulfill the demand.
2. Understand the technologies and mechanism of solar, wind, geothermal and ocean energy sources.
3. Understand the methods to handle the biomass in a productive way.
4. To enlighten the knowledge of production, storage and transportation of alternate fuels

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M			
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design				L
e	An understanding of professional and ethical responsibilities in research and professional activities			L	
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning		L		

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**MATERIALS OF CONSTRUCTION IN PETROLEUM & PETROCHEMICAL PLANTS**
Course Number	**PK613**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

Provide fundamental understanding of aspects of materials of construction in petroleum and petrochemical plants. Provide methodologies for material specification and selection. Identify practices for the prevention and remediation techniques.

Topics Covered

Introduction to Materials of Construction, Chemical and Corrosive Environments, Material Selection, Principal Materials (Carbon and Low-Alloy Steels, Stainless Steels, Cast Irons, Copper and Aluminum Alloys, Nickel alloys, Titanium, etc), Construction Codes and Standards, Mechanical Properties of Construction Materials, Materials protection techniques.

Textbook(s)/Reference Material(s):

1. Corrosion in the Petrochemical Industry, Second Edition, by ASM International, Victoria Burt (Editor)
2. CRC Materials Science and Engineering Handbook
3. Materials Selection in Mechanical Design by M.R. Ashby, 4th edition, Elsevier (2011)
4. Perry's Chemical Engineers' Handbook, 8th edition

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C

35-44	D
< 35	E

Course Outcomes

1. Able to understand appropriate selection of materials of construction for petroleum and petrochemical plant.
2. Able to understand how materials affect safe, reliable and cost-effective plant operation
3. Able to understand awareness of key requirements of relevant design and operation standards and industry practices such as ASME B&PVC and B31.3; ASTM Material Specifications, API 571, 580, 581, 578 and 579, and others
4. Provide guidelines to participants to identify and locate in-service degradation and appropriate tools for condition assessment and making sound run/repair/replace decisions

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H			M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		L		M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			H	L
e	An understanding of professional and ethical responsibilities in research and professional activities	L	H		L
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning				

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**PETROLEUM ENGINEERING**
Course Number	**PK614**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

To provide a complete overview of petroleum engineering covering primary issues of reservoir, drilling, completion, and surface production

Topics Covered

Overview of petroleum engineering including geological and geophysical aspects. Presentation of the various stages of development of a petroleum reservoir including exploration drilling reservoir rock & fluid production and processing highlight of the petroleum industries.

Textbook(s)/Reference Material(s):

1. Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, 2/e, 2001, Penn Well Corporation, Oklahoma, USA.
2. The Petroleum Industry-A Nontechnical Guide, Charles F. Conaway, Penn Well Corporation, Oklahoma, USA.
3. Modern Petroleum Technology , edited by Richard A. Dawe , Volume 1 , sixth edition , John Wiley & Sons Limited , New York

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. To learn about major issues in petroleum engineering
2. To understand the various operations carried out during field development, from drilling to surface treatment
3. To learn the vocabulary needed to communicate with E&P professionals

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M		
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			H
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities	L		
f	A capability for innovation and entrepreneurship.	L		
g	An ability to engage in lifelong learning			

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**RESERVOIR ENGINEERING**
Course Number	**PK615**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

This course provides a solid understanding of the practical methods used in Reservoir Engineering for maximizing the ultimate hydrocarbon recovery

Topics Covered

Study of the phase behavior of hydrocarbon system as related to petroleum and gas recovery. Ideal and real gas behavior, single and Multicomponent two – phase systems properties of reservoirs fluids under various conditions and pressure and temperature. Laboratory tests on reservoir fluids.

Textbook(s)/Reference Material(s):

1. Modern Petroleum Technology , edited by Richard A. Dawe , Volume 1 , sixth edition , John Wiley & Sons Limited , New York
2. Production of Oil & Gas, F. Abdulin , Mir Publishers, Moscow
3. Petroleum Processing handbook for Practicing Engineer, M.A Mian

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Understand the fundamentals and applications of Reservoir Engineering.
2. Understand production optimization concept and applications
3. Lear well testing concept and Principles
4. Understanding of reservoir performance and simulation studies

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	M	M	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M		
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M		M
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning				

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Code	**:**	**PK616**
Course Title	**:**	**PROCESS MODELLING AND SIMULATION - I**
Course Category	**:**	**DE**
Course Type	**:**	**Theory**
Pre-requisite	**:**	**NIL**
Credits	**:**	**4**
Weekly Contact Hours (L-T-P):		**3-1-0**
Semeter	**:**	**I**

Course Objectives

Students should learn and understand the basic principles of process modelling and simulation, and effectively apply them to develop the models of various chemical engineering systems.

Topics Covered:

Process analysis and its basic principles. Description of systems, subsystems, scientific methods, system parameters, process analysis and simulation.
Different types of Models and their classifications. Model hierarchy and general steps followed in a model building process. Advantages and limitations of process modelling and simulation. Mathematical Models and their classifications: Transport phenomena based models, empirical models, and probabilistic models. Different levels of details of transport phenomena models.
Development of mathematical models of different chemical engineering systems. Mathematical representations of fundamental conservation laws, constitutive equations, rate equations and equilibrium relations. A brief description of mathematical techniques commonly employed for the simulation of developed models.

Textbook(s)/Reference Material(s):

1. Babu, B.V., 2004. Process Plant Simulation. Oxford University Press, New Delhi.
2. Bird, R.B., Stewart, W.E., Lightfoot, E.N., 2002. Transport Phenomena. Second ed. John Wiley & Sons, Inc., New York.
3. Finlayson, B.A., 1980. Nonlinear Analysis in Chemical Engineering. Mc Graw-Hill, New York.
4. Fogler, H.S., 1992. Elements of Chemical Reaction Engineering. Second ed., Prentice-Hall, New Jersey.
5. Gupta, S.K., 1995. Numerical Methods for Engineers. New Age International Publishers Ltd., New Delhi.
6. Himmelblau, D.M., Bischoff. K.B., 1967. Process Analysis and Simulation. JohnWiley & Sons, Inc., New York.
7. Levenspiel, O., 1999. Chemical Reaction Engineering. Third ed., John Wiley & Sons, Inc., New York.
8. Rice, R.G., Do, D.D., 1995. Applied Mathematics and Modeling for Chemical Engineers. John Wiley & Sons, Inc., New York.

Course Assessment:

Component	Marks
Lab Reports and Weekly Viva	60

End Semester Viva-Voce Exam	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes (COs)

After completing this course the students shall be able:

1. To know and learn about the basic definitions and fundamental principles related to process modelling and simulation.
2. To know and understand about different types of models and their hierarchy as well as the general steps followed in developing a process model.
3. To develop appropriate mathematical models of varying complexities for different chemical engineering systems.
4. To know and learn about the commonly available mathematical tools and techniques as used in the simulation of developed models.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	L	L	L	L
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	M	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	H	H	H	H
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning	L	L	L	L

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**PROCESS OPTIMIZATION**
Course Number:	**PK617**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**I**

Course Objectives

Explain the relevance and importance of designing of experiments (DOE) in optimization of chemical processes. This course deals the application of different techniques of DOE in process optimization through case studies and analysis of data using statistical tools and techniques.

Topics Covered

Unit 1. Design of experiments (DOE): Introduction to DOE and their significance, Brief history of DOE, Common steps in DOE, Cause-and-effect diagram, Understanding of design-space; Some basic concepts of statistics, Analysis of Variance (ANOVA) – One-way and Two-way ANOVA, F-test.

Unit 2.Full-Factorial and Fractional-Factorial Designs: Introduction to 2^k-and 3^k-factorial design, Blocking and Confounding; Fractional-factorial design, Resolution of design; Case studies.

Unit 3.Taguchi Method: Various orthogonal arrays and their properties, Inner and outer arrays; Different types of Signal-to-Noise ratios (S/N ratio); Additivity model, Model-adequacy check; Case studies; Introduction to quality control (off-line and on-line).

Unit 4. Response Surface Methodology (RSM): Single-order models (2^k-factorial design, Plackett-Burman design, and Simplex-design), Second-order models (Box-Behnken design, Central Composite Design – CCD), Analysis of response surfaces; Case studies.

Textbook(s)/Reference Material(s):

1. Douglas C. Montgomery, *Design and Analysis of Experiments*, 8th edition, John Wiley & Sons.
2. Jacques Goupy, Lee Creighton, *Introduction to Design of Experiments*, 3rd edition, SAS Publishing, NC, 2013.
3. Živorad R. Lazic´, *Design of Experiments in Chemical Engineering (A Practical Guide)*, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.
4. Philip J. Ross, *Taguchi Techniques for Quality Engineering*, McGraw Hill, USA, 1988.
5. Madhav S. Phadke, *Quality Engineering using Robust Design*, Low price edition - Pearson Education, Dorling Kindersley Publishing, New Delhi, 2008.
6. Mark J. Anderson, Patrick J. Whitcomb, *RSM Simplified: Optimizing Processes Using Response Surface Methods for Design of Experiments*, Productivity Press, New York, 2005.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Understand the fundamentals of "Design of Experiments (DOE)" and importance of its use in process optimization.
2. Able to perform critical analysis of data using statistical methods.
3. Able to apply different techniques of DOE (Factorial, RSM, and Taguchi method) to optimize the chemical processes and correlate the advantages and limitations of these techniques.

PK617: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	H	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	H	H
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		H	H
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			L

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**AIR POLLUTION AND CONTROL**
Course Number	**PK618**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objective

The course has been designed to improve the understanding of the students about different air pollution control strategies and the skills of application of remediation techniques to combat air pollution.

Topics Covered

Classification and sources of air pollutants, Principles of meteorology and diffusion of pollutants, Dispersion models, Theory and description of control devices and their applications, Sources and effects of noise pollution. Kinetics of noise, Measurement and control of noise pollution.

Textbook(s)/Reference Material(s):

Peavy, H. S., Rowe, D.R., Tchobanoglous, G., "Environmental Engineering", McGraw Hill.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Knowledge to assess air pollution: sources and effects
2. Able to understand the basic Meteorology, Transport, Dispersion and Transformation of pollutants in Air
3. Able to design equipment for air pollution control.
4. Understanding of air pollution control and health problems, risk assessment, and global atmospheric changes

PK618: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	L		M	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	L	L	H	L
e	An understanding of professional and ethical responsibilities in research and professional activities			L	
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning	H	M	L	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**ENVIRONMENTAL POLLUTION AND IMPACT ANALYSIS**
Course Number	**PK619**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution. The course will also be dealing about the sources of pollution in air, soil, water, solid-waste and noise and the impacts of these sources on the environment and health.

Topics Covered

Dispersal of pollutants in environment and their effects, principles of toxicology, air water quality criteria, standards framework for environmental assessment prediction and assessment of impact or air, water noise and biological environment, socioeconomic environment method of impact analysis.

Textbook(s)/Reference Material(s):

1. M.N. Rao and HVN Rao Air Pollution Tata McGraw Hill Publication Co, Ltd. New Delhi
2. L.Hodges Environment Population (Halt) and Winston Inc. New York 1973.
3. S.H. Stroke and S.L. Seager, Environment Chemistry Air and Water Pollution (Scott Foresman& Co. New York)

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Able to explain the major principles of environmental impact assessment in India
2. Able to understand the different steps within environmental impact assessment
3. Able to discuss the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment
4. Understand the management measures and engineering technologies available for pollution control

PK619: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	M		
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		L		M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		L		L
e	An understanding of professional and ethical responsibilities in research and professional activities	H		H	
f	A capability for innovation and entrepreneurship.		L		
g	An ability to engage in lifelong learning				

*H, M and L (High, Medium and Low) are qualitative degrees of matching

Course Title	**ENVIRONMENTAL CHEMISTRY**
Course Number	**PK620**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

The course objective is an opportunity to show your insight into the natural gas processing operations. This course deals with the fundamental design aspect of some of the common separator for gas processing systems. Other topics include the dehydration and desulfurization.

Topics Covered

Units of measurement, Chemical Kinetics, Acid base Chemistry, Solubility Concepts, Oxidation-reduction reactions, Chemical equilibria, Organic chemistry, Aquatic chemistry Atmospheric chemistry, Pesticides, Surfactants and their biodegradability, Laboratory practice for determination of ions and solids.

Unit I

Basic Principles, Chemical Kinetics, Reaction Rates, Oxidation-Reduction reactions, Redox Stoichiometry, Applications of redox Chemistry

Unit II

Chemical Equilibria, Basic concepts from Equilibrium Chemistry, Solubility Product, Common Ion Effect, Solubility Equilibria, Precipitation-Dissolution, Acid-Base Equilibria, Strong and Weak Acids, Carbonate System, pH, Buffers and Buffer Intensity

Unit III

Complex Formation, Log Concentration Diagrams, Metal Hydroxide Precipitation, Metal Speciation, Water stabilization, Langlier Saturation Index, Cadwell-Lawrence Diagram

Unit IV

Organic Chemistry, Aquatic chemistry, Atmospheric chemistry, Toxic Compounds, Organic Solvents, Pesticides, Dioxins, PCBs and PAHs, Surfactants,Laboratory practice for determination of ions and solids

Textbook(s)/Reference Material(s):

1. C. N. Sawyer and P. L. McCarty, Chemistry for Environmental Engineers, McGraw Hill.
2. Benefield, L.D. Judkins J.F. and Weand B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

On successful completion of the course the student will be able to:

1. Demonstrate knowledge of chemical principles of various fundamental environmental phenomena and processes
2. Apply basic concepts of chemical thermodynamics, kinetics, and photochemistry to analyze chemical processes involved in different environmental problems.
3. Describe the practical chemistry in and anthropogenic impact of industrial processes, water purification, waste treatment, energy production, and pollution mitigation strategies.
4. Critically discuss local and global environmental issues based on scientific principles and data.
5. Find and analyze physio-chemical and toxicological information and judge its reliability and significance.

PK620: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	H	M		
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		L		M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.					

d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design					
e	An understanding of professional and ethical responsibilities in research and professional activities	H		M	H	H
f	A capability for innovation and entrepreneurship.			L		
g	An ability to engage in lifelong learning					

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY**
Course Number	**PK621**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**I**

Course Objectives

The course objective is an opportunity to show your insight into the natural gas processing operations. This course deals with the fundamental design aspect of some of the common separator for gas processing systems. Other topics include the dehydration and desulfurization.

Topics Covered

Principles of ecology, Food chain, Trophic levels, Ecosystems, Biochemistry of natural compounds, Classification of microorganisms, Growth pattern of microorganisms, Biochemical reaction, Microbiology of aerobic and anaerobic processes, Biochemical pathways, Metabolism, Energy concepts, Pathogenic diseases, Basic microbiology of water, air and soil, Application of microbiology for pollution control, Laboratory Practice.

Unit I

Principles of ecology, Ecosystems, Biotic and Abiotic Components, Trophic Levels, Material and Energy Flow in Ecosystems, Nutrient Cycles, Food chain and Bio-magnification, Ecology of Population

Unit II

Microorganisms in Wastewater Treatment, Microbiological Concepts- cells, classification and characteristics of living organisms, Characterisation Techniques, Microbial Metabolism, Basic metabolic models, Chemistry of carbohydrates, proteins, fats and lipids, Population Dynamics

Unit III

Microbial Growth Kinetics, Role of Microorganisms in biogeochemical cycles, Microbiological Analysis, Chemical Composition of Biomass, Waterborne Pathogens, Bacteria, Fungi, Yeast, Algae, Protozoa, Enzymes, Microorganisms as Food, Water and Wastewater Treatment Microbiology, Microorganisms and Air Pollution

Unit IV

Microbiology of Anaerobic Digesters, Sludge Microbiology, Stress on the Microbial Community,Biochemical reactions, Microbiology of aerobic and anaerobic processes, Biochemical pathways, Application of microbiology for pollution control and environmental engineering, Laboratory Practice

Textbook(s)/Reference Material(s):

1. Pelczar, Microbiology Tata McGraw-Hill Education, Aug-1998
2. Bruce E. Rittmann , Perry L. Mccarty, Environmental Biotechnology: Principles and Applications McGraw-Hill Higher Education 2001
3. Ralph Mitchell, Environmental Microbiology, Wiley-Blackwell Publishing, 2nd Edition, 2009
4. Sawyer, C.N. and P.L. McCarty, G.F. Parkin 2003, Chemistry for Environmental Engineering, Fifth Edition, McGraw- Hill Book Company, New York.
5. Edward Kormondy, Concepts of Ecology, 4th Edition, Prentice Hall Publishing 6. Eugen Odum, Fundamentals of Ecology, 5th Edition, Brooks/Cole Publishers

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Recognize the fundamental of gas processing and its components.
2. Understand the various influential parameters in gas processing operation.
3. Able to design the gas processing equipment.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		L	

c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			H
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title:	**PETROLEUM TESTING LABORATORY**
Course Number:	**PK690**
Credits:	**04**
Course Category:	**DC**
Pre requisite:	**PK-602**
Weekly Contact Hours (L-T-P):	**0-0-4**
Type of Course:	**Laboratory**
Semester:	**II**

Course Objective

To perform various experiments related to Petroleum and its products according to ASTM or IP method and understand the significance of these test, and submit a report accordingly.

Experiments Covered

Various Experiments related to Analysis & Testing of Petroleum and Petroleum Products like Flash point, ASTM Distillation, Diesel index, Cloud and pour point, Smoke point, Cu strip corrosion test, Conradson carbon residue test, Ramps bottom test, Ried vapor pressure test, API gravity, Aniline point, Specific gravity, Kinematic viscosity, TBP test, Melting point of wax etc

Textbook(s)/Reference Material(s):

1. ASTM Standard Manual
2. JAMES G. SPEIGHT, "Handbook of Petroleum Product Analysis", JOHN WILEY & SONS, INC., PUBLICATION,2002
3. Rao, B.K.B., “Modern Petroleum Refining Processes”, Oxford & IBH Co. Pvt. Ltd., New
   Delhi, 4/e, 2002,
4. Prasad, R., “Petroleum Refining Technology”, Khanna Publishers, New Delhi, 2000.

Course Assessment:

Component	**Marks**
Lab Reports and Weekly Viva	60
End Semester Viva-Voce Exam	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C

35-44	D
< 35	E

Course Outcomes

1. To perform the ASTM standard test for petroleum products
2. Compare and Discuss the results obtained with standard value of the test
3. Able to understand the significance of experimental analysis of the petroleum products

PK690: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	M	M	M
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**PETROLEUM REFINERY ENGINEERING**
Course Number	**PK731**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**04**
Type of Course	**Theory**
Semester	**III**

Course Objectives

This course will present an overview of the modern, integrated petroleum refinery, its feedstocks, product slate and the processes employed to convert crude oil and intermediate streams into finished products.

Topics Covered

An overview to petroleum refining industry in India., distillation fractions and their quality control Thermal Conversion processes, Thermal cracking, Visbreaking delayed & flexicoking. Catalytic conversion processes, catalytic cracking, FCC, catalytic reforming, Hydrocarcking, Hydrodesulphurization, Reside upgradation. etc.

Textbook(s)/Reference Material(s):

1. Modern Petroleum Technology: G.D Hobson by. Who (Part I& II)
2. Petroleum refining Technology & Economics, J.H. Garry, G.E Handiwork, Marcel & Dekker Inc. New York.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

After the completion of the course, the students shall be able to:

1. Understand fundamental concepts of Petroleum Refining about processing, quality control and general overview of the industry
2. Understand thermal and catalytic conversion processes including latest engineering advancements and economic aspects
3. Understand the quality upgradation and residue conversion processes for better quality environmental friendly fuels

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities	L	L	L
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

Course Title	**SELECTED TOPICS IN PETROLEUM PROCESSING**
Course Number	**PK732**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**III**

Course Objectives

To acquire competency in selecting proper lubricant depending upon application for better performance and maintenance of automobiles. Be aware of the challenges involved in oil movement, storage, safety and regulations in Petroleum refining

Topics Covered

Treating Processes, Sweetening Processes Sulfur removal Process, Evaluation of crude for lube base stocks Processes for deasphaltization, solvent extraction Dewaxing and refining of lube oil stocks. Quality improvement of lubricants with additive agents Manufacturing of specialty products bitumen and waxes Hydrofinishing of lube-base stocks .Tests for finished lube oils .Grease and bitumen .oil movement storage and safety equipment, refining effluents and their treatment, statutory regulation in Petroleum refining practice.

Textbook(s)/Reference Material(s):

1. W.L. Nelson Petroleum Refining Engineering. 4th edition McGraw Hill(1961)
2. G.d. Hobson and D.R. Pehl Modern Petroleum technology
3. W.A. Gruse and D.R. Stevens Chemical Technology of Petroleum
4. R.J. Hengetback, Petroleum Processing Primcipal and Application McGarw Hill
5. V.A.Kalichesky amd K.A. kobe Petroleum Refining with Chemiclas Amsterdam Elsevier (1956)
6. E.A. Evens London Lubricating and oils Champment and Hall (1963)

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Understand in detail the manufacturing process of lube oil,Grease and Bitumen.
2. Know the challenges involved inoil movement, storage and safety.
3. Understand the process ofrefining effluents and their treatment together with statutory regulation in Petroleum refining.

PK732: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	M	M	M
g	An ability to engage in lifelong learning			

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**SOLIDS AND INDUSTRIAL WASTE MANAGEMENT**
Course Number	**PK733**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**III**

Course Objectives

This course is designed to provide students with the necessary background and knowledge pertaining to solid and other industrial waste management systems. After completing this course, the student should be able to: explain techniques of treatment, reduction and recycle of industrial wastes; describe legal and financial aspects of waste management; and explain air pollution control and wastewater treatment techniques.

Topics Covered

Introduction: Introduction to Waste Generation and Management; Environmental Policies and Laws; Role of Civic Bodies in Waste Management; Waste Stream Characteristics (Solid Wastes, Air Pollutants, Wastewater)

Special Solid Wastes: Household Hazardous Waste; Batteries; Used Oil; Scrap Tires; Construction/Demolition Debris; Electronic Solid Waste; Biomedical Waste; Plastics Waste

Solid Waste Management: Collection of Solid Waste; Recycling of Solid Waste; Waste Source Reduction in terms of Quality and Toxicity; Disposal Solutions (Composting, Conversion to Energy, Land Filling); Financial and Life-cycle costing of solid waste management systems

Air and Water Pollution Control: Air Pollution Control; Wastewater Treatment and Reuse

Textbook(s)/Reference Material(s):

1. Handbook of Solid Waste Management, George Tchobanoglous, Frank Kreith, McGraw-Hill Education, 2 edition, 2002
2. Solid Waste Management: An Indian Perspective, M. S. Bhatt, AsherefIlliyan, Synergy Books India, 2012
3. Integrated Solid Waste Management Handbook: For Engineers, Planners, Environmentalists, students and policy makers, Augustine Afullo, Wamra Technoprises, 2014

Course Assessment:

Component	Marks
Home Assignments	15

Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Understanding of the problems of solid and other industrial wastes and their environmental impact.
2. Knowledge of legal and institutional aspects of management of solid wastes.
3. Understanding the components of waste management systems to minimize the hazardous effects.
4. Knowledge of engineering, financial and technical options for waste management.
5. Become aware of the significance of recycling and reuse of the wastes.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	L			
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development					L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.					
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	L			M	
e	An understanding of professional and ethical responsibilities in research and professional activities	H	M	M		H
f	A capability for innovation and entrepreneurship.				L	
g	An ability to engage in lifelong learning					

*H, M and L (High, Medium and Low) are qualitative degrees of matching

Course Title	**PROJECT ENGINEERING OF PETROLEUM AND PETROCHEMICAL PLANTS**
Course Number:	**PK734**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

This course deals the project engineering and financial planning which involves various steps in commercialization of processes from R&D lab to operational plants in petroleum and petrochemical sector.

Topics Covered

Scope of project engineering project management plants techno-economic feasibility report, process refineries, Petrochemical Plants. Preliminary data for construction projects financial planning in project engineering problems in commercialization of Process developed by indigenous R&D evaluation and estimated material and energy balance equipment cost estimate waste study flow diagram Plot Plans Planning and Scheduling the project.

Textbook(s)/Reference Material(s):

1. Frederick Plummer, *Project Engineering – The Essential Toolbox for Young Engineers,* 1st Edition, Butterworth-Heinemann (Imprint of Elsevier), 2007.
2. Subhendu Moulik, *Project Engineering and Management Textbook,* Author House, 2012.
3. J.M. Coulson and J.F. Richardson, *Chemical Engineering Volume 6 - Chemical Engineering Design*, 4th Edition, Butterworth- Heinemen.
4. Mc Cabe, Warren L., Smith Julian C. and Peter Harriot, *Unit Operations of Chemical Engineering*, 7thEdition, McGraw Hill.
5. Max Peters, Klaus Timmerhaus and Ronald West , *Plant Design and Economics for Chemical Engineers*,5th Edition, McGraw-Hill Education, 2003.

Course Assessment:

Component	Marks
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60

Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Understand the fundamentals and importance of commercialization of potential R&D projects from lab-scale to commercial petroleum and petrochemical plants.
2. Able to perform critical analysis of available data/information, planning, and scheduling the project.
3. Able to apply knowledge of relevant tools, skills, and techniques in techno-economic feasibility analysis and designing of plants.

PK734: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	H	H
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.		H	M
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			M
e	An understanding of professional and ethical responsibilities in research and professional activities	H		L
f	A capability for innovation and entrepreneurship.			H
g	An ability to engage in lifelong learning	L	L	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching

Course Title	**RHEOLOGY AND TESTING OF POLYMERS**
Course Number:	**PK735**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

Gain a better understanding of polymer rheology, polymer structure and morphology, and, mechanical testing for their uses.

Topics Covered

Analysis and characterization of the flow of non-Newtonian fluids, Rheology measurements on polymers and their interpretation, analysis of experimental data and characterization of viscoelastic material. Mechanical, thermal electrical and optical properties of polymers and their evaluations.

Textbook(s)/Reference Material(s):

Introduction to Polymer Rheology, Introduction to Polymer Rheology, Montgomery T. Shaw, ISBN: 978-0-470-38844-0, 416 pages, December 2011.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. An understanding of analysis and characterization of flow of non-Newtonian fluids.
2. A knowledge of rheology measurements on polymers and their interpretation.
3. Ability to evaluate mechanical, thermal electrical and optical properties of polymers

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
A	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
B	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
C	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
D	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	L	L	L
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**MULTIPHASE REACTORS**
Course Number:	**PK736**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

Upon completion of the course, the participants will be able to:

1. Identify the different types of multiphase reactors and their operating parameters,
2. Learn about gas liquid trickle bed reactor, gas-solid fluidized bed and gas-liquid-solid fluidized bed, including flow regimes and technologies, in relation to processes such as hydrotreatment of distillates, hydroconversion of residue, FCC and Fischer Tropsch.

Topics Covered

Gas-liquid-solid catalytic and non-catalytic reacting systems Interaction of Physical and chemical inter-and inter-particle transport Development of Kinetic models. Isothermal systems Stability criteria. Flow Modeling Hydrodynamic, deterministic and stochastic description. Evaluation of Model parameters. Interfacial area Bubble/ Drop breakup, distributions, coalescence and dynamics.

Textbook(s)/Reference Material(s):

1. Chemical Reactor Design, Optimization, and Scaleup. E. Bruce Nauman, John Wiley & Sons, 2008
2. Design of Multiphase Reactors. Vishwas G. Pangarkar, John Wiley & Sons, 2015
3. Reaction Kinetics and Reactor Design, Second Edition. John B. Butt, CRC Press, 2000.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	Grade
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Establish and follow a selection process to determine the most appropriate reactor type for a specific process
2. Apply a general problem solving approach to design heterogeneous and multi-phase reactors
3. Carry out reactor sizing calculations to the level of detail required
4. Identify critical parameters affecting the performance of heterogeneous and multi-phase reactors

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M		M	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	H	H		H
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M	M	M
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning				

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**THERMODYNAMICS OF FLUIDS AND FLUID MIXTURE**
Course Number	**PK737**
Credits	**04**
Course Category	**DE**
Pre requisites	**Undergraduate Chemical Engineering Thermodynamics** **Undergraduate Ordinary Differential Equations**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**III**

Course Objectives

This course is designed to provide students with the understanding of usage of equations of states for pure fluids and mixtures. The course provides a knowledge of practical use of each type of equation and their strengths and weaknesses for fluids under chemically reacting and non-equilibrium conditions.

Topics Covered

Introduction: Basic Thermodynamics; Residual Properties; Vapor-Liquid Equilibrium; Solution Thermodynamics; Excess Properties; Chemical reaction equilibria

Equations of State: The Virial equation of state; Cubic Equations of state; Mixing and combining rules; The corresponding-states principle

Special Topics I: Thermodynamics of fluids at meso and nano scales; SAFT Associating Fluids and Fluid Mixtures; Polydisperse Fluids; Thermodynamic behavior of Fluids near Critical Points; Phase behavior of Ionic Liquid Systems

Special Topics II: Multi-parameter Equations of State for Pure Fluids and Mixtures; Equations of State in Chemical Reacting Systems; Non-Equilibrium Thermodynamics

Textbook(s)/Reference Material(s):

1. Applied Thermodynamics of Fluids; Editors: Anthony R. Goodwin, Jan Sengers, Cor J Peters; The Royal Society of Chemistry; 2010
2. Handbook of Applied Thermodynamics of Fluids, David Wallace; Auris Reference; 2016

Course Assessment:

Component	Marks
Home Assignments	15
Mid Semester Examination	25

End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Acquire a deeper understanding of equations of state for pure fluids and mixtures.
2. Acquire knowledge ofrecently developed concepts of thermodynamics,like: thermodynamics of fluids at meso and nano scales; SAFT Associating Fluids; Polydisperse Fluids; Fluids near Critical Points; and Ionic Liquid Systems
3. Understand the concepts of equations of state for chemically reacting and non-equilibrium fluids

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning		L	

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**MIXING AND FLUID AGITATION**
Course Number:	**PK738**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**I**

Course Objective

To study the various aspects of Mixing and Agitation of solids and liquids

Topics Covered

Basic concepts of fluid mixing Impeller characteristics power correlation Pumping capacity of impeller Mixing in agitated vessel scale up and operating characteristics of liquid mixing system Heal and Mass transfer in agitated vessels Mixing Chemical reactions.

Textbook(s)/Reference Material(s):

1. Unit Operations of Chemical Engineering, W.L. McCabe, Julian C. Smith & Peter Harriett, Sixth Edition, Mc Grew Hill, New Delhi.
2. Engineering Fluid Mechanics, K.L. Kumar, S.Chand & Company, New Delhi.
3. Mechanical Operations for Chemical Engineers, C.M. Narayanan, B.C. Bhattacharya, Khanna Publishers, Delhi.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Acquire knowledge about agitation and mixing different types of fluid mixing Impeller
2. Apply the knowledge of different blends and mixing techniques to liquids and solids
3. Able to design and scale up agitated vessel and utilize the results in laboratory or industrial practice.

Mapping of Course Outcomes with Program Outcomes

	Program Outcomes	**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	L	L
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			M
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.	M	M	M
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**ADVANCE MASS TRANSFER**
Course Number	**PK739**
Credits	**04**
Course Category	**DE**
Pre requisite	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**III**

Course Objectives

The course objective is an opportunity to show your insight into the advanced separation processes. This course deals with the advanced design aspect of chemical and petrochemical separation systems. Topics include the design of equilibrium-based multistage separations such as distillation, extraction, and adsorption processes; rate-based separations effected by membranes.

Topics Covered

Introduction to advanced separation processes, Phase equilibrium and thermodynamics, Multi-component distillation, Adsorption, Ion exchange method,Liquid-Liquid Extraction, Extractive solvent, Liquid-solid leaching operation, Membrane Separation Processes: Types of membrane process, liquid and gas permeation membrane process, Extractive distillation, azeotropic Distillation rtc.

Textbook(s)/Reference Material(s):

1. Treybal, Robert E., “Mass Transfer Operations”, McGraw Hill Publications, 3/e, 2003.
2. Geankoplis, Christie J., “Transport Processes and Unit Operations”, Prentice Hall of India, New Delhi, 3/e, 1997.
3. Seader, J.D.,Henley, Ernest J., “Separation Process Principles”, John Wiley & Sons, Inc,1998.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B

45-59	C
35-44	D
< 35	E

Course Outcomes

1. Recognize the basic definition, driving force, equilibrium & equipment of advanced separation processes, being used in chemical/ petrochemical industries.
2. Able to evaluate and compare the various advanced separation processes on the basis of technological differences
3. Able to design advanced separation techniques in petroleum and petrochemical industry.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H		
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M	
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			M
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**COAL CONVERSION PROCESSES**
Course Number:	**PK740**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

To understand the basic coal conversion processes

Topics Covered

Origin and Classification of Coal, Characteristics and industrial uses, Carbonization Processes Coke areas by Product recovery systems liquid fuels from coal and tar. Theory of Gasification reaction, Industrial gasification of Coal with oxygen and steam

Textbook(s)/Reference Material(s):

1. Considine, D.M. Energy Technology Hand Book/ McGraw Hill Book Company, New York.
2. Sarkar S. Fuels and Combustion Second edition Orient Longman Ltd. Kamani Marg Ballard Estate, Mumbai-400001
3. Lowenhien, F.A. and Moran, M.K. Industrial Chemicals, John Willey and Sons, New Delhi.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. getting students acquainted with the major coal gasification technologies
2. developing understanding of chemical reactions involved in coal conversion
3. enabling students to prepare the process design of coal gasification

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	L	L	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development			
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design			L
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**HETEROGENEOUS CATALYSIS**
Course Number:	**PK741**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

This course will serve as a graduate-level introduction to catalysis and surface science.

Topics Covered

Review of Chemical kinetics, Homogeneous acid catalysts heterogenic catalysts Physical and chemical, surface area pore size and determination, reaction rates and selected diffusion in catalysts polymerization in emulsions selection preparation and evaporation of catalysts.

Textbook(s)/Reference Material(s):

1. J.W. Thomas and W.J. Thomas Introduction to the principles of heterogeneous catalysts academic Press 1967.
2. C.N. sattereed and T.I. Sherwood The role of diffusion in catalysts Addition Wesley 1963.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Knowledge of the principle of heterogeneous catalysis.
2. Understand with the concept of catalyst preparation, characterization and testing.

3. Understand the relation structure-properties

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development			M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.			
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M	
e	An understanding of professional and ethical responsibilities in research and professional activities			
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning			

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**NOVEL SEPARATION PROCESS IN HYDROCARBON INDUSTRIES**
Course Number:	**PK742**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

To learn the preparation methods of synthetic membranes, which membrane materials are exactly suitable for a given separation process, the characterization of both porous and non-porous membranes, understanding adsorption and ion exchange principles for industrial applications

Topics Covered

Fundamentals of Separation Processes in Petroleum and Petrochemical Industries. Identification of novel separation processes, Membrane separation processes, External Field induced Membrane separation processes, Gas separation, Surfactant based separation, Micellar enhanced ultrafiltration, Liquid membranes, Centrifugal Separation processes, Ion Exchange processes, Chromatographic separation processes, Electrophoretic Separation Methods, Supercritical fluid extraction.

Textbook(s)/Reference Material(s):

1. Marcel Mulder, "Basic Principles of Membrane Technology", 2 Ed., Springer Publications, 2007
2. Wankat, P. C. "Rate- Controlled Separations", Springer, 1994

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A

60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

After completion of this course the student would be able to

1. To select suitable membrane materials for specific applications.
2. Select the suitable preparation technique and module for the outcome.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**	
		1	2
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.		
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		
e	An understanding of professional and ethical responsibilities in research and professional activities		
f	A capability for innovation and entrepreneurship.		
g	An ability to engage in lifelong learning		

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DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**SAFETY AND HAZARD ASSESSMENT IN HYDROCARBON INDUSTRIES**
Course Number	**PK743**
Credits	**04**
Course Category	**DE**
Pre requisites	**NIL**
Weekly Contact Hours (L-T-P)	**3-1-0**
Type of Course	**Theory**
Semester	**III**

Course Objectives

Upon completion of this course a student will understand how to identify hazards and assess risks for hydrocarbon industries. The student will also learn about safety measures to address these risks.

Topics Covered

Introduction: Industrial Safety; Major Process Hazards; Regulations for HSE in India; Occupational Health and Hygiene; Safety Culture.

Hazard Identification: What if? Analysis; Event Tree and Fault Tree Analysis; Bow-Tie Method; Preliminary Hazard Analysis (PHA); Hazard and Operability Studies (HAZOP); Process Safety Review System; Quality Assurance; Computer Aids

Hazard Assessment: Hazard Analysis; Risk Assessment; Fault/Event Trees; Dependent Failures; Expert Judgement; Presentation of Results and their Confidence; Risk Criteria; Guide Assessments; Simplified Assessment Methods; Computer Aids

Special Topics: Inherently Safer Design (Introduction; Strategies; Measuring Inherent Safety Characteristics of a Process); LNG Hazards and Safety Measures; Offshore Process Safety (Design Concerns; Emergency Planning); Case Studies (Oil Spill Risk Assessment; Investigation of Piper Alpha Explosion)

Textbook(s)/Reference Material(s):

1. Frank P. Less, Loss Prevention in the process industry, 4th Ed., Butterworth Heinemann, 2012
2. Roy E. A Saders, Chemical Process Safety learning from case History, 4th Ed., Butterworth Heinemann, 2015
3. Introduction to Oil and Gas Operational Safety: For the NEBOSH International Technical Certificate in Oil and Gas Operational Safety, Wise Global Training Ltd, Routledge, 2014
4. M Y Omar, A A Hassan, M A Algthami and E HHegazy, Chapter 92: Oil spill risk assessment (case study), Developments in Maritime Transportation and Exploitation of Sea Resources, CRC Press, 2013 , 841 -845.
5. L Wei, Z Hu, L Dong, W Zhao, A damage assessment model of oil spill accident combining historical data and satellite remote sensing information: a case study in Penglai 19-3 oil spill accident of China, Marine Pollution Bulletin, 91(1), 2015 (258-271)

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

After completing this course, a student should develop:

1. Knowledge on occupational health, safety and relevant government regulations.
2. Ability to identify and analyse hazards
3. Understanding of Risk issues and Hazard assessment
4. Knowledge of recent developments in safety and risk assessment specific to hydrocarbon industries.

PK743: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development		M	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M	M	M
e	An understanding of professional and ethical responsibilities in research and professional activities	H	H	H	H
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning				L

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**COLLOID AND INTERFACE SCIENCE AND TECHNOLOGY**
Course Number:	**PK744**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

- To understand the nature of the various interparticle forces, how they can be calculated and applied.
- To understand the origins of surface tension, how surface tension can be modified by the addition of surfactants.
- To know the nature of the different classes of surfactants, and how they modify the properties of interfaces, be they solid, liquid or gas.

Topics Covered

Capillarity, interfacial thermodynamics surfactants stability of multiphase systems foam, emulsion multiphase reactors wetting and adhesion catalyst sintering/ redispersion stability and coagulation of colloids nucleation and growth colloids in Chemical engineering in separation processes, bio science

Textbook(s)/Reference Material(s):

Principles of Colloid and Surface Chemistry, Paul C. Hiemenz, Marcel Dekker.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C

35-44	D
< 35	E

Course Outcomes

1. Knowledge of the significant forces between colloidal systems, how they can be calculated approximately and exactly and how they can be measured
2. know how to form emulsions and foams and the physical properties required for stable foams and emulsions to form
3. Understand how to manipulate the wettability of surfaces
4. know why surfactants are active at interfaces and be able to choose which type/class of surfactant would be best to use in certain situations

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		**Course Outcomes**			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H	H	H	H
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development			M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.				
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design				
e	An understanding of professional and ethical responsibilities in research and professional activities				
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning				

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**BIO-CHEMICAL ENGINEERING AND BIO-TECHNOLOGY**
Course Number:	**PK745**
Credits:	**04**
Course Category:	**DE**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**3-1--0**
Type of Course:	**Theory**
Semester	**III**

Course Objectives

This course is formulated with an objective to familiarize the students with the fundamentals of material balance, energy balance, media optimization techniques and various models of microbial growth.

Topics Covered

Computer application for instrumentation and control for on-line data acquisition and calculation of instantaneous mass and energy balance r-DNA manipulation and cell fusion approaches for hybridomas, dynamics of mixed culture and unstable recombinant microbial strains plant and animal tissue culture lines and bio transformation.

Textbook(s)/Reference Material(s):

1. Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications.
2. Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer – verlog, berlin (2000)
3. Introduction to Biochemical Engineering by D G Rao. Tata, Mc Graw Hill, New Delhi.

Course Assessment:

Component	**Marks**
Home Assignments	15
Mid Semester Examination	25
End Semester Examination	60
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. The students will gain awareness of various media optimization techniques.
2. Students will gain expertise in quantitative estimation of the biomass growth and product formation rate, which will help them to design bioreactor and product in general.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes	
		1	2
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	M
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.		
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		M
e	An understanding of professional and ethical responsibilities in research and professional activities	M	M
f	A capability for innovation and entrepreneurship.		
g	An ability to engage in lifelong learning		

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**GENERAL SEMINAR**
Course Number:	**PK780P**
Credits:	**02**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**1-1-0**
Type of Course:	**Seminar/Colloquim**
Semester	**III**

Course Objectives

To develop capabilities related to interacting intellectually in a seminar through speaking and report writing.

Topics Covered

Any topic related to Petroleum Processing, Petrochemicals and/or allied fields.

Course Assessment:

Component	**Marks**
Continuous Evaluation	60
Final Examination	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Ability to conduct literature review relevant to an advanced topic
2. Ability to present the work in a variety of formats (written, oral, formal presentation) in front of an audience and to explore topics of their own choosing in detail.
3. Ability to evaluate the reliability of sources of information and be prepared for rapidly changing technological environments with the core knowledge central to multidisciplinary development.
4. Ability to understand professional ethics by acknowledging original resource material

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes			
		1	2	3	4
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H		H	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L		L	
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	H	H	H	
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	M	M		
e	An understanding of professional and ethical responsibilities in research and professional activities				H
f	A capability for innovation and entrepreneurship.				
g	An ability to engage in lifelong learning	M	M	M	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**PRELIMINARY DISSERTATION SEMINAR**
Course Number:	**PK781P**
Credits:	**03**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**0-0-3**
Type of Course:	**Seminar/Colloquim**
Semester	**III**

Course Objective

After preliminary research, a M.Tech. student conducts oral presentation and writes a report to best represent their preliminary research while effectively meeting audience/reader expectations. In the preliminary research presentation, a student should be able to describe the research problem supported by literature review and present possible solution strategy.

Topics Covered:

Any Engineering Problem related to Petroleum Processing, Petrochemicals and/or allied fields.

Course Assessment:

Component	**Marks**
Continuous Evaluation	60
Final Examination	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Perform topic related literature survey and identify gaps in available knowledge.
2. Propose feasible solution(s) to the problems and their methodology of implementation.
3. Effectively present their work and prepare technical report.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	M	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	H	
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	H		H
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	M		M
e	An understanding of professional and ethical responsibilities in research and professional activities	M	M	M
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning	M	M	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**FINAL DISSERTATION SEMINAR**
Course Number:	**PK782P**
Credits:	**02**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**0-0-2**
Type of Course:	**Seminar/Colloquim**
Semester	**IV**

Course Objectives

After preliminary research, a M.Tech. student conducts oral presentation and writes a report to best represent their final research while effectively meeting audience/reader expectations. In the final research presentation, a student should be able to describe the research problem, present the solution strategy considered, and describe the analysis of results.

Topics Covered:

Any Engineering Problem related to Petroleum Processing, Petrochemicals and/or allied fields.

Course Assessment:

Component	**Marks**
Continuous Evaluation	60
Final Examination	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Justify and defend the research work/thesis.
2. Effectively present the research work.
3. Prepare the technical report/thesis.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes		
		1	2	3
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M		
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	H		
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.		H	H
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	M	M	H
e	An understanding of professional and ethical responsibilities in research and professional activities		M	M
f	A capability for innovation and entrepreneurship.			
g	An ability to engage in lifelong learning	L	M	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**LAB/PROJECT**
Course Number:	**PK791P**
Credits:	**03**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**0-0-3**
Type of Course:	**Project**
Semester	**III**

Course Objectives

Be able to perform analysis and/or design of any Engineering Problem

Topics Covered

Any Engineering Problem related to Petroleum Processing, Petrochemicals and/or allied fields.

Course Assessment:

Component	**Marks**
Continuous Evaluation	60
Final Examination	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Identify, formulate and solve Petroleum Processing and Petrochemical engineering problems
2. Able to conduct Literature survey
3. Have an ability to use the techniques, skills and modern engineering tools necessary for solving the selected problem.
4. Develop interpretation and process analysis skill
5. Able to communicate effectively on engineering activities and prepare technical report

PK791P: Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	H		L		
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	L	H			
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	L	M	L	H	
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design		L	H	M	
e	An understanding of professional and ethical responsibilities in research and professional activities		M		M	
f	A capability for innovation and entrepreneurship.					L
g	An ability to engage in lifelong learning					H

*H, M and L (High, Medium and Low) are qualitative degrees of matching

DEPARTMENT OF PETROLEUM STUDIES

ZAKIR HUSSAIN COLLEGE OF ENGINEERING AND TECHNOLOGY
ALIGARH MUSLIM UNIVERSITY, ALIGARH

Course Title	**DISSERTATION**
Course Number:	**PK798P**
Credits:	**10**
Course Category:	**DC**
Pre-requisite(s):	**NIL**
Weekly Contact Hours (L-T-P)	**0-3-0**
Type of Course:	**Research and Dissertation**
Semester	**III and IV**

Course Objective

After completing the M.Tech research the engineering students should demonstrate moderate skills in carrying out independent research in Petroleum Processing, Petrochemical Engineering and allied fields. The student should develop: critical thinking, interpretation and analysis of data; ability to apply knowledge of engineering and science; and ability to undertake problem identification, formulation and solution. In addition, the student should be able to compiles a dissertation to show what have been gained by the M.Tech research. This prepares the student to effectively communicate in scientific community.

Topics Covered

Petroleum Refining, Petrochemical Engineering, and Allied topics.

Course Assessment:

Component	**Marks**
Continuous Evaluation	60
Final Viva-Voce Examination	40
Total	**100**

Final Letter Grade is based on Total Marks achieved according to the following table:

Marks Range	**Grade**
75-100	A
60-74	B
45-59	C
35-44	D
< 35	E

Course Outcomes

1. Carry out literature survey and identify the needs of further research for adding new knowledge.
2. Develop, execute and manage a suitable time bound research plan, either in the core or interdisciplinary area.
3. Employ the modern tools of research and project management.

4. Derive conclusions from experimental/computational/analytical data and results.
5. Effectively communicate the research work through report & presentation and defend the same.

Mapping of Course Outcomes with Program Outcomes

Program Outcomes		Course Outcomes				
		1	2	3	4	5
a	An ability to apply acquired knowledge in the area of Petroleum Processing and Petrochemical Engineering	M	M	M	M	
b	An ability of creative thinking, critical analysis, problem solving and decision making specially in research and development	M	H	M	H	M
c	An ability to conduct literature survey, prepare technical reports and communicate effectively.	H				H
d	A knowledge of relevant research tools, skills and techniques, and, their application in analysis and design	M		M		
e	An understanding of professional and ethical responsibilities in research and professional activities	M		H	M	
f	A capability for innovation and entrepreneurship.		M		M	M
g	An ability to engage in lifelong learning	L	M	L	M	M

*H, M and L (High, Medium and Low) are qualitative degrees of matching