APPENDIX - I

COURSES OF STUDY

Master of Technology

in

Petroleum Processing and Petrochemical Engineering

Department of Petroleum Studies

Aligarh Muslim University, Aligarh

CURRICULUM STRUCTURE

DEPARTMENT OF PETROLEUM STUDIES

Zakir Husain College of Engineering & Technology

Aligarh Muslim University, Aligarh

Master of Technology in Petroleum Processing and Petrochemical Engineering

I Semester

S. No.	Course Category	Course No.	Course Title	Contact Periods per week			Credits	Marks			
				L	G	P		Course Work	Mid Semester	End Semester	Total
1.	ES	AMS 6**0	Advance Mathematics	3	1	0	4	15	25	60	100
2.	PC	PKC 6010	Advance Transport Processes	3	1	0	4	15	25	60	100
3.	PC	PKC 6020	Petroleum Processing - I	2	1	0	3	15	25	60	100
4	PC	PKC 6030	Petroleum Processing - II	2	1	0	3	15	25	60	100
4.	PE	PKE 6**0	Elective-1	3	1	0	4	15	25	60	100
5.	PE	PKE 6**0	Elective-2	3	1	0	4	15	25	60	100
6.	PC	PKC 6910	Petroleum Laboratory	0	1	2	2	60		40	100

Total Credits: 24

II Semester

S. No.	Course Category	Course No.	Course Title	Contact Periods per week			Credits	Marks			
				L	G	P		Course Work	Mid Semester	End Semester	Total
1.	OE	*****	Open Elective	3	1	0	4	15	25	60	100
	PC	PKC 6040	Reactor Analysis & Design	3	1	0	4	15	25	60	100
2.	PC	PKC 6050	Petrochemical Processes	3	1	0	4	15	25	60	100
3.	PE	PKE 6 ***	Elective-3	3	1	0	4	15	25	60	100
4.	PE	PKE 6***	Elective-4	3	1	0	4	15	25	60	100
5.	PC	PKC 6920	Petrochemical Laboratory	0	1	2	2	60		40	100
6.	PC	PKC 6930	Project	0	3	0	4	60		40	100

Total Credits: 26

III Semester

S. No.	Course Category	Course No.	Course Title	Contact Periods per week			Credits	Marks			
				L	G	P		Course Work	Mid Semester	End Semester	Total
2.	AU	PKA 7**0	MOOCS courses/ Language/ Ethics etc	0	2	0	0	-	-	-	-
3.	PC	PKC 7990	Dissertation (Phase-I)	0	3	0	6	60		40	100

Total Credits: 6

IV Semester

S. No.	Course Category	Course No.	Course Title	Contact Periods per week			Credits	Marks			
				L	G	P		Course Work	Mid Semester	End Semester	Total
2.	PC	PKC 7810	Pre-Dissertation Seminar	0	0	0	2			100	100
3.	PC	PKC 7990	Dissertation (Phase-II)	0	3	0	14	60		40	100

Total Credits: 16

NOTE:

1. The audit course has two General contact periods assigned to it, which is the minimum requirement for the course. However, the actual contact periods may be more, depending on the course registered by the student.
2. The audit course in III Semester will have no marks assigned to any component of evaluation as it is a non-credit course. Fulfilment of the requirement(s) of this course will be governed by the guidelines approved the Board of Studies/Faculty
3. Course no. PKC 7810- Pre Dissertation Seminar will have the only evaluation component as End Semester Examination since this pre submission Seminar will be based entirely on the Dissertation work of the student.
4. The Chairman, in consultation with the Coordinator, is authorized to take necessary actions, such as alternate and filler courses, etc. in order to wind up the previous curriculum structure.

List of possible electives to be offered by the Department

S. No.	Course Category	Course No.	Course Title	Contact Periods per week			Credits	Marks			
				L	G	P		Course Work	Mid Semester	End Semester	Total
	PE	PKE 6110	Advance Separation Processes	3	1	0	4	15	25	60	100
	PE	PKE 6120	Distillation and Extraction	3	1	0	4	15	25	60	100
	PE	PKE 6130	Advance Process Control	3	1	0	4	15	25	60	100
	PE	PKE 6140	Process Dynamics and Control	3	1	0	4	15	25	60	100
	PE	PKE 6150	Natural Gas Processing	3	1	0	4	15	25	60	100
	PE	PKE 6160	Natural Gas Production and Utilisation	3	1	0	4	15	25	60	100
	PE	PKE 6170	Polymers and Composites	3	1	0	4	15	25	60	100
	PE	PKE 6180	Polymer Structure Property Relationship	3	1	0	4	15	25	60	100
	PE	PKE 6190	Process Modeling and Simulation	3	1	0	4	15	25	60	100
.	PE	PKE 6200	Waste Management in Oil and Gas Industries	3	1	0	4	15	25	60	100
.	PE	PKE 6210	Selected Topics in Refining and Petrochemicals	3	1	0	4	15	25	60	100
.	PE	PKE 6220	Downstream Safety and Loss Prevention	3	1	0	4	15	25	60	100
.	PE	PKE 6230	Advance Thermodynamics	3	1	0	4	15	25	60	100
.	OE	PKO 6310	Design of Experiments	3	1	0	4	15	25	60	100
.	OE	PKO 6320	Robust Design	3	1	0	4	15	25	60	100

SYLLABI OF THE COURSES

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**AMS 6**0: Advanced Mathematics**
Credits	04
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

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

Course Outcomes

At the completion of this course, students should be able:

1. To understand vector spaces and linear transformations.
2. To understand matrices and its application to chemical engineering problems.
3. To solve ordinary and partial differential equations numerically.
4. To use Fourier transformations.

Course Content

Unit I: Vectors and vector spaces, Vector norms, Inner products and orthogonality, linear transformation, unitary transformation, Similarity transformation.

Unit II: Eigen values and eigenvectors especially for real symmetric matrices, Fredholm alternatives, Rayleighs' quotient, applications to chemical engineering systems

Unit III: Numerical solutions of a system of ordinary differential equations by Runge-Kutta method of order four, numerical solution of partial differential equations: parabolic equations: Schimidt and Crank Nicholson schemes, Elliptic equations: five point scheme, Hyperbolic equations: explicit and implicit schemes.

Unit IV: Fourier transforms, important properties and applications.

Text Books / Reference Materials

1. Kreyszig, E., 1979. Answer Booklet to Advanced Engineering Mathematics. John Wiley & Sons.).
2. Pushpavanam, S., 1998. Mathematical methods in chemical engineering. PHI Learning Pvt. Ltd..
3. Stephanopolous, G., "Chemical Process Control", Prentice Hall of India, New Delhi, 1985.
4. Chandrika Prasad, Advanced Mathematics for Engineers, Prasad Mudralay.
5. Jain, M.K., 2003. Numerical methods for scientific and engineering computation. New Age International.
6. S.S. Sastry, Introductory Numerical Methods, Wiley Eastern.

Course Assessment

Course Work (Quiz/Assignments, etc)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

NOTE: This course is being offered by the Department of Applied Mathematics, therefore, the syllabus passed by its Board of Studies, from time to time, shall prevail.

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKC 6010: Advance Transport Phenomena**
Credits	04
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

Apply scientific and engineering principles to analyse and design single and two phase Momentum, Heat Transfer and Mass transfer systems using appropriate analytical and computational tools to investigate Momentum, Heat and Mass Transport Phenomena; both competent and confident in interpreting results of investigations related to Transport Phenomena and its application in the Design of Process equipment especially related to Petroleum Processing Industries.

Course Outcomes

At the completion of this course, students should be able:

1. 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. Ability to calculate pressure drop for single and two phase flow systems.
2. 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.
3. 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.
4. To understand the fundamentals of molecular diffusion and development of differential equations

Course Content

Unit I: Momentum Transport Overview, Shell momentum balance and velocity profile in laminar flow, General equations of momentum transfer under isothermal condition, Momentum transfer in turbulent flow, (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).

Unit II: Heat transfer Overview, Steady State conduction, Transient conduction, Free convection, Convective heat transfer, Heat transfer with phase change, Introduction to compact heat exchanger employing extended surfaces, heat transfer by conduction, heat transfer to solids in packed and moving / fluidized beds, Pinch Technology and its application, concepts of energy conservation and its application in process equipment.

Unit III: Definition of Non-Newtonian fluid, Mathematical Model, Fluid properties, Pressure drop and velocity profile in pipes for Non- Newtonian fluids, Flow regimes, Flow Models, Homogeneous Models in two phase flow and pressure drop calculations.

Unit IV: Mass Transfer Overview, Mass transfer properties, Convective mass transport, Steady state molecular diffusion, Momentum, heat and mass transfer analogies and similitude analysis, Solve and physically interpret simultaneous interaction of thermal or concentration boundary layers .

Text Books / Reference Materials

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.
3. WM Deen, Analysis of Transport Phenomena, Oxford University Press, UK.
4. RS Brodkey, and HC Hershey, Transport Phenomena – A Unified Approach, McGraw Hill, USA

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKC 6020: Petroleum Processing - I
Credits	03
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	2-1-0

Course Objectives

To understand and know origin, occurrence, exploration, drilling and production of crude oil and be aware of the challenges involved in crude refining from viewpoint of product specifications, economic considerations and environmental regulations.

Course Outcomes

At the completion of this course, students should be able:

1. To know Origin, occurrence, Exploration, Drilling and Production of Crude Oil.
2. To explain the composition of crude oil and its products, along with its properties and characterization methods together with the process of fractionation of crude oil
3. To Identify different types of petroleum products ,their specifications and different quality control test with their significance

Course Content

Unit I: Origin, Occurrence, Exploration, Drilling and Production of Crude Oil: Formation, Migration and Traps of oil and gas, Sedimentary rocks, Conventional and advance exploration techniques, Types of Rigs, Drilling techniques, Drill string components, Drill Bits, Blowout preventer valve, Well completion, Enhanced oil recovery methods.

Unit II: Crude oil Evaluation, Composition and Distillation: Properties of crude oil, Crude oil classification and selection, Pre-treatment, Preheating, Atmospheric and Vacuum Distillation, other Processes.

Unit II: Petroleum Products and their Quality assessment: Important Petroleum Products like LPG, Motor Gasoline, Kerosene, ATF, Diesel Oil, Lubricating oil etc. Quality Control Test like API gravity, RVP, ASTM distillation, Flash and Fire point, Viscosity, Octane No, Cetane No., Copper Corrosion Test, FIA method, Calorific Value etc., Working of Gasoline and diesel engines.

Text Books / Reference Materials

1. Robert A. Meyers, Handbook of Petroleum Refining Processes, Third Edition, McGraw-Hill Education,2004, ISBN: 9780071391092
2. Speight, J.C.; The Chemistry and Technology of Petroleum, Marcel Dekkar, New York, 1991.
3. Ram Prasad , Petroleum Refining Technology , Khanna Publishers , Delhi 2000
4. Rao, B.K.B; Modern Petroleum Refining Processes, 4/e, 2002, Oxford and IBH Company Pvt. Ltd.
5. G.D. Hobson, W. Pohl, Modern Petroleum Technology (Part I &II), John Wiley & Sons, N.Y., 1986.

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKC 6030: Petroleum Processing - II
Credits	03
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	2-1-0

Course Objectives

This course reviews the fundamentals of secondary and finishing refining processes as well as covers advanced concepts of these processes, for both fuel and lube refineries.

Course Outcomes

At the completion of this course, students should be able:

1. To understand secondary refining processes for light and middle distillates and to analyse the application of these for different refining scenarios
2. To understand and evaluate various residue processing schemes.
3. To apply the finishing processes to petroleum products for meeting the market specifications in view of fuel quality and environmental regulations.

Course Content

Unit I: Secondary processing of light and middle distillates - Catalytic reforming, Fluid catalytic cracking, Hydrocraking, Hyrdoprocessing

Unit II: Residue upgradation processes – Visbreaking, Delayed Coking, Fluid and Flexi Coking, Solvent Deasphalting, Gasification

Unit III: Finishing processes – Sweetening, Alkylation, Polymerisation, Isomerisation; Production of lubes and waxes.

Text Books / Reference Materials

1. Mark J. Kaiser, Arno de Klerk , James H. Gary, Glenn E. Handwerk; Petroleum Refining: Technology, Economics, and Markets, 6/e, CRC Press, Boca Raton (USA), 2019.
2. Editions Technip, Petroleum Refining, Vol. I - V, Institute Francais Du Petrol, France, 1995
3. Speight, J.C.; The Chemistry and Technology of Petroleum, Marcel Dekkar, New York, 1991.
4. Ram Prasad , Petroleum Refining Technology , Khanna Publishers , Delhi 2000
5. Rao, B.K.B; Modern Petroleum Refining Processes, 4/e, 2002, Oxford and IBH Company Pvt. Ltd.
6. G.D. Hobson, W. Pohl, Modern Petroleum Technology (Part. I &II), John Wiley & Sons, N.Y., 1986.

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKC 6910: Petroleum Laboratory
Credits	02
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Laboratory
Contact Hours (L-G-P)	0-1-2

Course Objectives

This course covers experimental and computational aspects related to petroleum processing and testing as well as allied operations, including those related to alternate fuels.

Course Outcomes

At the completion of this course, students should be able:

1. To analyse the quality of fuels based on the results of experimental tests performed in accordance with international standard test procedures.
2. To undertake experimental studies on petroleum refinery operations as well as on alternate fuels.
3. To apply modern computational tools and techniques for simulating different petroleum processes.

Course Content

Experimental and computational studies related to testing & processing of petroleum and biofuels, from amongst the following:

- Product quality tests for Gasoline, Diesel, Kerosene, Wax, etc. such as Flash point, ASTM Distillation, Diesel Index, Cloud and Pour point, Smoke Point, Copper strip corrosion test, Conradson carbon residue test, Reid vapor pressure test, API gravity, Aniline point, Specific gravity, Kinematic viscosity, TBP distillation, Melting point of wax etc.
- Thermal/Catalytic cracking of hydrocarbons
- Pyrolysis of biomass to biofuels
- Algae culture and/or harvesting for the production of algal biofuel
- Production of biodiesel by transesterification process
- Analysis of Oil-Water Phase Separation for Refinery wastewater treatment using Optical Microscope
- Separation of hydrocarbons from soil by surfactant washing
- Simulation of petroleum refinery operation(s)

Text Books / Reference Materials

1. ASTM Standard Test Manuals
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, 6/e, 2017.
4. Prasad, R., “Petroleum Refining Technology”, Khanna Publishers, New Delhi, 2002.
5. IP Standard Methods for Analysis and Testing of Petroleum and Related Products

Course Assessment

Course Work	-	60%
End Semester Examination	-	40%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKC 6040: Reactor Analysis and Design
Credits	04
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

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

Course Outcomes

At the completion of this course, students should be able:

1. To distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
2. To understand various aspects associated with the design and operation of steady and unsteady state non isothermal reactors.
3. To apply mass transfer effects associated with the heterogeneous reactions while designing multiphase reactors.
4. To analyze and interpret deactivation kinetic data and use it for the design and sizing of industrial reactors.

Course Content

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 multiphase reactors.

Text Books / Reference Materials

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.
4. Fundamentals of Chemical Reaction Engineering, Charles D. Holland and Rayford G. Anthony, Prentice-Hall International Series.

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKC 6050: Petrochemical Processes
Credits	04
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To know the current scenario of petrochemical industry in India, together its present and future feed stocks and learn the production techniques and challenges of various intermediate and value added petrochemicals

Course Outcomes

At the completion of this course, students should be able:

1. To describe the status of petrochemical industry in India together its present and future feed stocks and their production.
2. To identify various Petrochemicals from C1, C2, C3, C4 and learn their production techniques and examine various associated challenges
3. To discuss various petrochemicals from aromatics and select and explain their appropriate production techniques in present day scenario.
4. To list various thermosetting and thermoplastic value added petrochemicals and learn their production techniques and examine various advancement in their production

Course Content

Unit I: Overview & Current Scenario of Petrochemical Industry in India, Primary raw materials for petrochemicals, Feed stocks and its production by cracking and reforming, Various unit processes and unit operations involved in petrochemical production.

Unit II: Petrochemicals from C1, C2, C3, C4:Methanol,Formaldehyde,Ethylene oxide, Ethylene Glycol, Isopropanol ,Acetone, Butadiene, Maleic Anhydride etc

Unit III: Petrochemicals from Aromatics: Cumene, Styrene, LAB, Bisphenol A, Terephthalic Acid, Phthalic Anhydride etc.

Unit IV: Thermoset and thermoplastic polymers: polyethylene, polypropylene, polystyrene, PVC, ABS plastic, nylon, polycarbonate, rubber etc.

Text Books / Reference Materials

1. Groogins, Unit Process in Organic Synthesis McGraw Hill Book Company, New York.
2. Robert A. Meyers,Handbook of Petrochemicals Production Processes, Second Edition, 2019,McGraw-Hill Education: New York, ISBN: 9781259643132.
3. Hatch L.F. and Matar Sarri From Hydrocarbons to Petrochemicals, Gulf Publishing Co., Houston, London.
4. Chawvel, A & Lefebvre G. Petrochemical Process, Vol. I & II, Gulf Publishing Co., Houston, London.
5. Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 2007.
6. Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.
7. B.K. Bhaskara Rao, A Text on Petrochemicals, 2/e, Khanna Publishers, Delhi, 1998.

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKC 6920: Petrochemical Laboratory**
Credits	02
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Laboratory
Contact Hours (L-G-P)	0-1-2

Course Objectives

This course covers experimental and computational aspects related to petrochemical and polymer processing and testing as well as allied operations, including those related to Natural Gas.

Course Outcomes

At the completion of this course, students should be able:

1. To apply the basic and advanced techniques of petrochemical and/or polymer processing.
2. To understand and apply the analytical techniques employed petrochemical characterisation and degradation studies
3. To apply modern computational tools and techniques for simulating different petrochemical processes.

Course Content

Experimental and computational studies related to testing & processing of petrochemicals and polymers, from amongst the following:

- Processing of polymers such as Bulk polymerisation and/or Emulsion polymerisation, micro injection moulding, etc.
- Identification/testing of polymers such Universal Testing Machine, Heat Deflection Temperature, Vicat softening point, Melt Flow Index, etc.
- Studies on Polymer - Surfactant interactions
- Use of Electrochemical Impedance Spectroscopy (EIS) for material characterisation
- Synthesis of composite polymeric membrane
- Analysis of petrochemicals/hydrocarbons using Gas Chromatography
- Simulation of basic degradation and stabilization of polymers using MATLAB
- Simulation of petrochemical process employing both the Crude oil and Natural Gas.

Text Books / Reference Materials

1. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International, 1986.
2. Mall, I.D., “Petrochemical Process Technology”, Macmillan India Limited, Delhi, 2007.

Course Assessment

Course Work	-	60%
End Semester Examination	-	40%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKC 6910: Project**
Credits	04
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Laboratory
Contact Hours (L-G-P)	0-3-0

Course Objectives

This course aims to impart instructions through minor projects related analysis, design, modeling, simulation, etc. using modern computational tools and techniques.

Course Outcomes

At the completion of this course, students should be able:

1. To identify, formulate and solve Petroleum Processing and Petrochemical engineering problems
2. To use the techniques, skills and modern engineering tools necessary for solving the selected problem.
3. To communicate effectively on engineering activities and prepare technical report

Course Content

Relevant engineering problem regarding Petroleum Processing, Petrochemicals and/or allied fields.

Text Books / Reference Materials

Relevant study materials will be provided by the course instructors depending on the problems assigned to the concerned student(s)

Course Assessment

Course Work	-	60%
End Semester Examination	-	40%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKE 6110: Advance Separation Processes
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To enable the students to understand the principle and technical concept and applications of advanced separation processes.

Course Outcomes

At the completion of this course, students should be able:

1. To understand the applications of advanced separation Techniques.
2. To understand and apply advanced concepts of separation processes carried out in petroleum and chemical industries.
3. To utilize the innovative technological methods in problem solving of separation in industries.

Course Content

Unit I: Introduction to separation processes, mechanism of separation, separation by phase addition or creation, separation by barrier, separation by solid agent, separation by external field or gradient, component recoveries and product purities, separation power, selection of feasible separation processes.

Unit II: Advances in Distillation and Supercritical fluid Extraction

Unit III: Advances in Adsorption, Absorption and crystallization

Unit IV: Membrane Separation Processes

Text Books / Reference Materials

1. King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.
2. Handbook of separation Techniques for Chemical Engineers, Schweitzer P. A. (Ed.), Mc Graw-Hill, New York, 1997.
3. Separation Processes by C. J. King3rd Edition, , Tata McGraw Hill, New delhi, 1982.
4. Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.
5. Ronald W.Roussel - " Handbook of Separation Process Technology ", John Wiley, New York, 1987.
6. Lacey, R.E. and S.Loaeb - " Industrial Processing with Membranes ", Wiley -Inter Science, New York, 1972.
7. New Chemical Engineering separation Techniques by H. M. Schoen, Wiley Interscience, New York, 1972.

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6120: Distillation and Extraction**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To learn conceptual design of Distillation and Extraction and Design of equipment involved.

Course Outcomes

At the completion of this course, students should be able:

1. To understand the governing mechanisms and driving forces for Distillation and Extraction.
2. To perform process and design calculations for multicomponent systems in distillation and extraction by approximate methods as well as by rigorous methods.
3. To design equipment for distillation and extraction.
4. To understand and apply Advances in distillation and Extraction

Course Content

Unit I: Separation factors and its dependence on different variables, mechanism of separation for distillation and extraction, separation by phase addition or creation, component recoveries and product purities, separation power and selection of feasible separation processes.

Unit II: Distillation: Vapor-liquid equilibrium, T-x-y diagram, key components, bubble and dew point calculations, Flash calculations, analytical and graphical methods of calculations in distillation.

Unit III: Ternary liquid-liquid equilibrium, triangular coordinates, single-stage extraction, Multi-stage cross-current extraction, continuous counter current multistage extraction, analytical and graphical methods of calculation in extraction, selection and design of extractors.

Unit IV: advances in distillation and extraction: Azeotropic and extractive distillation, pressure swing distillation, salt distillation, supercritical fluid extraction etc.

Text Books / Reference Materials

1. Henley E. L., J. D. Seader, Equilibrium Stage Separation operations in Chemical Engineering, John Wiley.
2. King C.J., Separation Process, TMH New Delhi (1962).
3. Gean koplis
4. Mass-Transfer Operations: R. E. Treybal, McGraw-Hill International Editions, 3rd Ed.1981.
5. Principles of Mass Transfer and Separation Processes: B. K. Dutta, Prentice-Hall of India Private Ltd., 2007.
6. Separations in Chemical Engineering: Equilibrium Staged Separations: P. C. Wankat, Prentice Hall, NJ, US, 1988.

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6130: Advance Process Control**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To impart students the knowledge of advanced control schemes and computer control methods used in petroleum and chemical industries and prepares the student to take up such challenges in his/her profession.

Course Outcomes

At the completion of this course, students should be able:

1. To understand advanced control schemes
2. To understand computer control techniques
3. To apply and analyse advanced control and computer control schemes that need to be used for specific problems in chemical/Petroleum process industries.

Course Content

Unit – I: Analysis and Design of Advanced control systems: Feed Forward Control and ratio control, Feedback control of systems with large dead time and inverse response.

Unit – II: cascade control, selective control, split range control, adaptive and inferential control, internal model control, model based control systems etc.

Unit – III: Multiloop and Multivariable Control: Synthesis of alternative control configurations for multiple-input, multiple-output Processes, Interaction and decoupling of control loops

Unit – IV: Process Control using digital computers: Basic scheme of computer control, Computer based process control: Direct Digital Control, Supervisory Control, Distributed Control Systems, Hybrid Distributed Control, PLC.

Text Books / Reference Materials

1. D.E. Seborg, T.F. Edger, and D.A. Millichamp, 'Process Dynamics and Control', John Wiley and Sons, 2nd Edition, 2004.
2. Stephanopolous, G., "Chemical Process Control", Prentice Hall of India, New Delhi, 1985.
3. Donald R. Coughnowr and L.B. Koppel, Process System Anaysis and control, McGraw Hill
4. Prabir kumar Sarkar, Advanced process Dynamics and Control, PHI Learning Private Limited, New Delhi-110092, 2015.

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6140: Process Dynamics and Control**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To impart the students knowledge on development and analysis of models for physical systems, to design feedback controllers and to understand and apply advanced control schemes and computer control in petroleum and chemical industries.

Course Outcomes

At the completion of this course, students should be able:

1. To understand and analyse the continuous and discrete-time response of dynamic systems.
2. To select and design feedback controllers
3. To understand and apply advanced control schemes and computer control in industrial systems.

Course Content

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

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

Unit III: Advanced Process control Techniques

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

Text Books / Reference Materials

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, McGraw Hill Book Co. (1993)
6. John & Fredly, Dynamic Behavior of Process, Prentice Hall**.**

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6150: Natural Gas Processing**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

The course objective gives 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.

Course Outcomes

At the completion of this course, students should be able:

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.

Course Content

Unit I: Natural gas industry. Global & Indian scenario of natural gas. Natural gas property and its evaluation. Introduction to Natural gas processing

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

Unit III: Gas-water system & Dehydration processing: water content of natural gas, gas hydrates, absorption dehydration, adsorption dehydration. Advanced dehydration processes

Unit IV: Desulfurization processing: removal processes, solid bed sweetening processes and physical and chemical absorption processes. Advanced desulfurization process

Text Books / Reference Materials

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

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKE 6160: Natural Gas Production and Utilisation
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

This course gives an opportunity to highlight about natural gas production & its processing operations. The course covers the utilization aspect of natural gas as a fuel also as a basic raw material for petrochemical industries.

Course Outcomes

At the completion of this course, students should be able:

1. To familiarize with the basic concept of natural gas phase behaviour, processing & utilization.
2. To understand the various types and parts of natural gas processing & utilization.
3. To identify the parameters and selection criteria for different parts of gas processing & utilization

Course Content

Unit I: Properties of natural gas; equation of state; critical pressure & temperature determination, Phase behaviour of natural gas.

Unit II: Gas processing; gas liquid separation, natural gas dehydration; sweetening & desulfurization processes.

Unit III: Natural Gas compression, Natural gas flow measurement, Gas transportation: pipeline transport, LNG.

Unit IV: Natural gas utilization as fuel; compressed natural gas, Natural gas utilization as chemicals; chemicals based on methane, synthesis gas production

Text Books / Reference Materials

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

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6170: Polymers and Composites**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

1. Building fundamental concepts of polymers.
2. To impart knowledge about various properties of polymers such as mechanical, rheological, thermal properties.
3. To impart knowledge about polymeric composites, their fabrication methods and micro-mechanics of a lamina.
4. To impart knowledge about macro-mechanics of a lamina, failure theories

Course Outcomes

At the completion of this course, students should be able:

1. To understand the fundamental concepts about the polymers, its types, structure, and properties.
2. To have detailed knowledge of various properties of the polymer and their characterization such as mechanical, rheological, thermal properties.
3. To know polymer composites, and they will be conversant with quantitative aspects of micromechanical behavior of various types of composite laminas.
4. To have the ability to solve the design problems on macro-mechanical behavior of lamina and failure theories.

Course Content

Unit I: the 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: the Rheological and viscoelastic properties, mechanical properties, thermal properties and electrical properties of polymers.

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

Unit IV: Macro-mechanical Behaviour of a lamina, the strength of orthotropic lamina, Failure theories. Manufacturing techniques and applications of polymer composites.

Text Books / Reference Materials

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. Robert M. Jones, Mechanics Of Composite Materials, CRC Press, 1998.
4. P.K. Mallick, Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Second Edition, CRC Press, 1993.

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6180: Polymer Structure Property Relationship**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

1. Building fundamental concepts of polymer structure.
2. To impart detailed knowledge about the influence of polymer structure on mechanical, rheological, thermal and electrical properties of the polymer.

Course Outcomes

At the completion of this course, students should be able:

1. To understand fundamental concepts about the polymers, its types, structure, and properties.
2. To have detailed knowledge about the effect of polymer structure on its mechanical properties.
3. To have detailed knowledge about the effect of polymer structure on its Rheological properties.
4. To have detailed knowledge about the effect of polymer structure on its Thermal properties.
5. To have detailed knowledge about the effect of polymer structure on its electrical properties.

Course Content

Unit I: Linear, branched, cross-linked and other polymer structures, Homo-chain and hetero-chain polymers, random, alternate, block and graft copolymers. Pressure-volume temperature (PVT) relationship. Prediction of polymer properties.

Unit II: Mechanical Properties - Stress-strain relationship in the polymer. Introduction to modulus, tensile strength, yield strength, percentage elongation, toughness, creep, fatigue and stress relaxation — the effect of additives on mechanical properties of polymers.

Unit III: Rheological Properties: Flow Behaviour of non-Newtonian fluids. Rheological models like power law, truncated power law, Bird – Carreau model, etc. Effect of structure on the viscometric plot (shear rate vs. true viscosity). Introduction to Rheometer.

Unit IV: Thermal Properties – Transition temperature in polymers, glass transition (Tg), melt transition (Tm), the relationship between Tg and Tm. Heat Deflection Temperature (HDT) and its significance. Thermal characterization techniques like DSC, TGA, etc. Effect of polymer structure on thermal properties of the polymer.

Unit V: Electrical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - the effect of frequency of voltage and temperature on dielectric properties. Effect of additives on electrical properties of polymers.

Text Books / Reference Materials

1. Norbert M. Bikales, “Mechanical Properties of Polymers” Encyclopaedia Reprints, Wiley Interscience, New York, ISBN: 0-471-07234-6.
2. Johan J. Aklonis, William J. Macknight, M. Shen, “Introduction to Polymer Viscoelasticity” Wiley Interscience, New York, ISBN: 0-471-01860-0.
3. W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific PublishingCompany Amsterdam - Oxford - Newyork. 1990.
4. D.A. Seanor, ed., Electrical properties of polymers, Academic Press, Newyork, 1982.

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6190: Process Modeling and Simulation**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

This course introduces the methods and techniques of model building skills and the use of software package to simulate chemical processes.

Course Outcomes

At the completion of this course, students should be able:

1. To understand basics of chemical process modelling and simulation.
2. To develop mathematical models for various chemical engineering processes.
3. To analyse mathematical models qualitatively and quantitatively and analyse stability.
4. To simulate chemical processes with help of some computer program.

Course Content

Unit I: Introduction to Process Modelling and Process Simulation. Fundamental relations: Mass Balance; Momentum Balance; Energy Balance; Equations of Change. Constitutive Relations: Diffusion; Viscous Motion; Thermal Conduction; Chemical Reaction; Thermodynamic Relations.

Unit II: Model Formulation: Lumped Parameter Systems; Distributed Parameter Systems; Other Types of Model. Model Development Case studies.

Unit III: Theoretical Analysis of Models: Qualitative Analysis; Quantitative Analysis; Stability Analysis

Unit IV: Process Simulation: Review of Mathematics. Few Case Studies.

Text Books / Reference Materials

1. Simant R. Upreti, Process Modeling and Simulation for Chemical Engineers: Theory and Practice, Wiley, 2017
2. Christo Boyadjiev, Theoretical Chemical Engineering: Modeling and Simulation, Springer, 2010
3. Jana, Amiya k., Chemical process modelling and computer simulation, 3rd Ed., PHI Learning Pvt Ltd, 2018
4. M. Chidambaram, Mathematical Modelling and Simulation in Chemical Engineering, Cambridge University Press, 2018
5. Nishanth Chemmangattuvalappil, Chien Chon, Denny Ng, Kok Sum, Rafil Elyas, Cheng-Liang, Chen I Lung, Chien Hao-Yeh, Lee Rene Elms, Chemical Engineering Process Simulation, Ed Dominic Foo, Elsevier 2017
6. Nayef Ghasem, Modeling and Simulation of Chemical Process Systems, CRC Press, 2018
7. Tanase Gh. Dobre, Jose G. Sanchez Marcano, Chemical Engineering: Modelling, Simulation and Similitude, Wiley, 2007

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6200: Waste Management in Oil and Gas Industries**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

This course is designed to provide students with the necessary background and knowledge pertaining to industrial waste management systems, especially, in Oil and Gas Industries.

Course Outcomes

At the completion of this course, the students are expected to develop:

1. Understanding of the problems of industrial wastes and their environmental impact.
2. Knowledge of legal and institutional aspects of management of wastes.
3. Understanding of the components of oil spill response and control of air emissions.
4. Become aware of the components of oily wastewater management.
5. Become aware of the components of solid waste management

Course Content

Unit I: Pollutions and Wastes from Petroleum Industry: Waste from Exploration and Production; Waste from Hydrocarbon Processing; Waste from Storage and Handling; Oil Spills; Environmental Impacts.

Unit II: Waste Prevention Options and Regulations, Oil Spill Response, Air Emissions: Control and Treatment

Unit III: Treatment of Oily Wastewater

Unit IV: Solid Waste Management

Text Books / Reference Materials

1. Shahryar Jafarinejad, Petroleum Waste Treatment and Pollution Control, Elsevier, 2017
2. Alireza Bahadori, Waste Management in the Chemical and Petroleum Industries, Wiley, 2014
3. Environmental Management in Oil and Gas Exploration and Production: *An* Overview of Issues and Management Approaches, Oil Industry, International Exploration and Production Forum, UNEP/Earthprint, 1997
4. Alireza Bahadori, Pollution Control in Oil, Gas and Chemical Plants, Springer, 2014
5. Environmental Technology in the Oil Industry, Editor: Stefan T. Orszulik, Springer, 1997

Course Assessment

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKE 6210: Selected Topics in Refining & Petrochemicals**
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

To know some selective and important topics of petroleum and petrochemicals and learn various advance techniques of these processes.

Course Outcomes

At the completion of this course, students should be able:

1. To discuss lube oil, waxes and bitumen production processes by some latest techniques.
2. To describe some of the important processes of petroleum processing and discuss some of the advance methods used for these processes.
3. To discuss the various techniques for treating and sweetening processes together with GTL technology.
4. To know some important topics related to future techniques of petrochemicals and explain techniques of effluent treatment from petrochemical wastewater.

Course Content

Unit I: Lube oil production by advance de-asphalting, solvent extraction and de-waxing of lube oil stocks, Manufacturing of specialty products bitumen and waxes.

Unit II: Advance catalytic cracking, catalytic reforming, hydrocracking and separation processes like RFCC process, Deep catalytic cracking process, Platforming process, Unicracking process, Isocracking process, Molex and Olex process etc

Unit III: Advance treating and sweetening processes like unionfining technology, LC fining, MEROX process etc, Gas to liquid technologies

Unit IV: Some advance technologies for the production of Petrochemical feed stocks, intermediates and end products ,Petrochemicals from cellulosic wastes, Removal of effluent from petrochemical wastewater

Text Books / Reference Materials

1. Robert A. Meyers, Handbook of Petrochemicals Production Processes, Second Ed 2019,McGraw-Hill Education: New York, ISBN: 9781259643132.
2. Robert A. Meyers, Handbook of Petroleum Refining Processes, Third Edition, Mc Hill Education,2004, ISBN: 9780071391092.
3. Groogins, Unit Process in Organic Synthesis McGraw Hill Book Company, New Yor
4. Hatch L.F. and Matar Sami; From Hydrocarbons to Petrochemicals, Gulf Publishin Houston, London.
5. Chawvel, A & Lefebvre G. Petrochemical Process, Vol. I & II, Gulf Publishing Houston, London.
6. Mall, I.D., "Petrochemical Process Technology", Macmillan India Limited, Delhi, 20
7. Waddams, A.L., 'Chemicals from Petroleum', 4th edition, Gulf Publishing Company, London, 1980.
8. W.L. Nelson Petroleum Refining Engineering. 4th edition McGraw Hill(1961).

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKE 6220: Downstream Safety and Loss Prevention
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

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

Course Outcomes

At the completion of this course, the students 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 downstream hydrocarbon industries.

Course Content

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

Unit II: 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

Unit III: 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

Unit IV: 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)

Text Books / Reference Materials

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 H Hegazy, 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		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKE 6230: Advance Thermodynamics
Credits	04
Course Category	Programme Elective (PE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

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.

Course Outcomes

At the completion of this course, the students are expected to:

1. Acquire a deeper understanding of equations of state for pure fluids and mixtures.
2. Acquire knowledge of recently 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

Course Content

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

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

Unit III: 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

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

Text Books / Reference Materials

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

Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	PKO 6310: Design of Experiments
Credits	04
Course Category	Open Elective (OE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

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

Course Outcomes

At the completion of this course, students should be able to:

1. Explain the fundamentals of "Design of Experiments (DOEs)" and importance of its use in process optimization.
2. Perform critical analysis of data using statistical methods.
3. Apply different techniques of DOE (Factorial, RSM, and Taguchi method) to optimize the engineering processes/product and correlate the advantages and limitations of these techniques.

Course Content

Unit I: 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 II: 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 III: 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.

Unit IV: 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).

Text Books / Reference Materials

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		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKO 6320: Robust Design**
Credits	04
Course Category	Open Elective (OE)
Pre-requisite(s)	Nil
Type of Course	Theory
Contact Hours (L-G-P)	3-1-0

Course Objectives

Explain the relevance and importance of robust design in quality engineering. This course deals the approach of Taguchi Method for the robust design to improve the quality of a product by minimizing the effects of variation without eliminating the causes of variations (since they are too difficult or too expensive to control).

Course Outcomes

At the completion of this course, students should be able to:

1. Explain the fundamentals of robust design and its importance in quality engineering for both static and dynamic systems.
2. Apply different Taguchi techniques to various engineering problems to achieve robust design.
3. Perform critical analysis of data using relevant statistical tools and Taguchi's signal-to-noise ratio.

Course Content

Unit I: Principles of Quality Engineering: Robust design and its benefits; Historical perspective; Quality and loss-function; Noise factors; Classification of parameters and their interactions; Analysis of non-linearity; Some basic concepts of statistics; Analysis of mean (ANOM) and Analysis of variance (ANOVA).

Unit II: Engineering Design: Concept, parameter, and tolerance design; Various quality control activities; Orthogonal arrays and their properties; Quality characteristics & signal-to-noise ratio for static problems; Estimation of factors effects and additive model; Model-adequacy check Steps in robust design; Case studies.

Unit III: Achieving Additivity: Guidelines for selecting quality characteristics, control factors and orthogonal arrays; construction of orthogonal arrays (standard, dummy level, compound factor, column merging method, etc.); linear graph and interactions table; Case studies; Comparison with classical design of experiments.

Unit IV: Design of Dynamic Systems: Quality characteristics and signal-to-noise ratio for dynamic problems (continuous-continuous, continuous-digital, digital-continuous, digital-digital); Optimization of the design; Iterative optimization; Case studies.

Text Books / Reference Materials

1. Madhav S. Phadke, *Quality Engineering using Robust Design*, Low price edition - Pearson Education, Dorling Kindersley Publishing, New Delhi, 2008.
2. Philip J. Ross, *Taguchi Techniques for Quality Engineering*, McGraw Hill, USA, 1988.
3. Douglas C. Montgomery, *Design and Analysis of Experiments*, 8th edition, John Wiley & Sons.
4. Jacques Goupy, Lee Creighton, *Introduction to Design of Experiments*, 3rd edition, SAS Publishing, NC, 2013.

Course Assessment		
Course Work (Quiz/Assignments, etc.)	-	15%
Mid Semester Examination (1 hour)	-	25%
End Semester Examination (2 hours)	-	60%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKC 7810: Pre Dissertation Seminar**
Credits	02
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Seminar
Contact Hours (L-G-P)	0-0-0

Course Objectives

Effective technical and professional communication that develops skills in Oral presentations.

Course Outcomes

At the completion of this course, students should be able to:

1. To develop effectual technical presentation dexterity by amalgamating technical facts and communication skills.
2. To demonstrate effective writing skills by employing the rhetorical techniques of academic writing.
3. To develop audience-centered presentations meeting professional objectives by delivering well-rehearsed presentation meeting time and content requirements followed by discussions and oral arguments.
4. To develop the comprehension of accessing information by locating and using library collections and services and other search tools and databases.

Course Content

The content of this course is based entirely on the Dissertation work.

Text Books / Reference Materials

R. C. Sharma and Krishnamohan, Business correspondence and Report writing, Tata McGraw Hill.

Course Assessment

End Semester Examination - 100%

DEPARTMENT OF PETROLEUM STUDIES

M.Tech. (Petroleum Processing & Petrochemical Engineering)

Course Number and Title	**PKC 7990: Dissertation**
Credits	20 (6+14)
Course Category	Program Core (PC)
Pre-requisite(s)	Nil
Type of Course	Dissertation
Contact Hours (L-G-P)	0-3-0

Course Objectives

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.

Course Outcomes

At the completion of this course, students should be able to:

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.

Course Assessment

Course Work	-	60%
End Semester Examination	-	40%

APPENDIX - II

GENERAL GUIDELINES

for the implementation of revised curriculum

to be effective from session 2019-20

Master of Technology

in

Petroleum Processing and Petrochemical Engineering

GENERAL GUIDELINES

for the implementation of revised curriculum, to be effective from session 2019-20

M.Tech. in Petroleum Processing & Petrochemical Engineering

1. Students will be allowed to register for a particular audit course, only after the approval of the Course Advisor/Departmental Coordinator of M.Tech. program, based on the based on the suitability/relevance of the course content.

2. Students may register for the Open Elective courses offered by other departments as well. However, this will be subject to the approval of the Course Advisor/Departmental Coordinator of M.Tech. program.

3. Dissertation is split into two phases - I & II. Phase - I will be undertaken by the student in III Semester and Phase - II in the IV Semester. Since the work will not be completed in the Phase - I, therefore, the End Semester Examination of Dissertation Phase - I will be conducted in a manner similar to that of Pre Dissertation Seminar.

4. Although the Dissertation work is given in the III and IV semesters in the curriculum structure, the Department may assign the supervisor and topic of Dissertation to the students in I or II semester as well, for timely completion of the program by the student. The same procedure may also be adopted for the Project course as well.