Petro - Chemical Engineering

Course Code	*Course Title*	*Course Type*	*Credits*	*Prerequisite*
CCCM0401	*Process Heat Transfer*	*Theory + Practice*	*5*	
CCCM0402	*Chemical Reaction Engineering*	*Theory + Practice*	*5*	
CCCM0403	*Instrumentation & Process Control*	*Theory + Practice*	*5*	
CCCM0404	*Petroleum Refinery Engineering*	*Theory + Practice*	*5*	
CCCM0405	*Mass Transfer operations*	*Theory + Practice*	*5*	
CCCM0406	*Petroleum Reservoir Engineering*	*Theory + Practice*	*5*	
CCCM0407	*Petroleum Production Engineering & Design*	*Theory + Practice*	*5*	
CCCM0408	*Petroleum Exploration and Exploitation Techniques*	*Theory + Practice*	*5*	
CCCM0101	*Thermodynamics for Petroleum Engineers*	*Theory*	*5*	

SYLLABUS

CCCM 0401 Process Heat Transfer

Pre – requisites	*Course Type*	*Credits*
Nil	***Theory + Practice***	***5***

OBJECTIVE:

To learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

OUTCOME:

Students gain knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments such as furnace, boilers, heat exchangers evaporation

MODULE I CONDUCTION

Modes of heat transfer – Steady and unsteady state heat transfer – Concept of heat conduction – Fourier's law of heat conduction – General heat conduction equation in spherical coordinates – Onedimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere – Analogy between flow of heat and flow of electricity – Effect of 41temperature on thermal conductivity – Critical insulation thickness– Transient heat conduction – Lumped heat parameter model.

MODULE II

CONVECTION

Concept of heat transfer by convection – Natural and forced convection – Concept of LMTD – Local and overall heat transfer coefficient – Application of dimensional analysis for convection – Empirical Equations for forced convection under laminar, transient and turbulent conditions –

Empirical equations for natural convection –Influence of boundary layer on heat transfer – Heat transfer through packed and fluidized beds – Heat transfer with phase change: boiling, vaporization and condensation.

MODULE III

RADIATION

Concept of thermal radiations – Black body concept – Stefan Boltzman's law –Emissive power – Black body radiation – Emissivity – Planck's law – Radiation between black surfaces – Gray Surfaces – Radiation shields – Radiation applications– Pipe still heaters.

HEAT EXCHANGERS

Heat exchanger types – Parallel and counter flow heat exchangers – Overall heat transfer Coefficient – Log mean temperature difference for single pass – Correction factor for multi pass heat exchangers – Heat exchanger effectiveness – Number of transfer units – Chart for Different configurations – Dirt factor.

EVAPORATORS

Evaporation – Single effect and multiple effect evaporation – Boiling point elevation –Effect of liquid head – Capacity and economy of multiple effect evaporators –Evaporation equipments.

TEXT BOOKS:

1. Kumar, D.S., "Heat and Mass Transfer", 5th Edition, S.K. Kataria and Sons, 2000. 2.

McCabe,W.L. and Smith, J.C., "Unit Operations in Chemical Engineering", 5 th

Edition. McGraw Hill Publishing Co., 2001.

REFERENCES:

1. Kern, D.Q., "Process Heat Transfer", Tata McGraw Hill Publishing Co., 1990.

2. Hollman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.

3. Kreith, F., "Principles of Heat Transfer", 4th Edition, Harper and Row, 1976.

CCCM0402 CHEMICAL REACTION ENGINEERING

Pre – requisites	***Course Type***	***Credits***
Nil	***Theory + Practice***	***5***

OBJECTIVE:

To gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

OUTCOME:

Students gain knowledge on the selection of the reactor for the reaction and its design.

MODULE I

NON – IDEAL REACTORS

Residence time distribution function and its measurement – Characteristics of tracer – Mean residence time – Conversion in non-ideal flow reactors.

HETROGENEOUS PROCESS AND SOLID CATALYSIS

Rate equation for heterogeneous reactions – Nature of catalysis –Adsorption isothermal and rates of adsorption – Desorption and surface reaction analysis of rate equation – Rate controlling steps.

MODULE II

GAS – SOLID CATALYTIC REACTORS

Characteristics of catalyzed reactions – Mechanism of solid catalyzed reactions – Pore diffusion resistance combined with surface kinetics – Performance equations for reactors containing porous catalysts.

GAS – SOLID NON – CATALYTIC REACTORS

Selection of the kinetic model – Progressive – conversion model, shrinking – core model – Shrinkingcore model for spherical particles of unchanging size – Shrinking-core model for cylindrical particles of unchanging size.

MODULE III

GAS – LIQUID REACTIONS

Various ways of carrying out gas – liquid reactions catalyzed by solids – General rate equation – Resistances in series in the gas – liquid reaction on catalyst surface.

TEXT BOOKS:

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, Wiley Asian Edition, 1990.

2. Smith, J.M., "Chemical Engineering Kinetics", 2nd Edition, McGraw Hill, 1984.

REFERENCES:

1. Scott Fogler, H., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India.2009

2. Gavanhe, K.A., "Chemical Reaction Engineering I", Nirali Prakashan Publishers, 2007.

3. Dawande, D., "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.

CCCM0403 PROCESS DYNAMICS AND CONTROL

Pre – requisites	***Course Type***	***Credits***
Nil	***Theory + Practice***	***5***

OBJECTIVE:

To introduce of open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

OUTCOME:

Students will understand and discuss the importance of process control in process operation and the role of process control engineers. They also understand and design the modern hardware and instrumentation needed to implement process control.

MODULE I

INSTRUMENTATION

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

OPEN LOOP SYSTEMS

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

MODULE II

CLOSED LOOP SYSTEMS

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

FREQUENCY RESPONSE

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

MODULE III

ADVANCED CONTROL SYSTEMS

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TEXT BOOKS:

1. *Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.*
2. *Coughnowr, D., " Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.*

REFERENCES:

1. *Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000.*
2. *Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997.*
3. *Jason L. Speyer, Walter H.Chung, "Stochastic Processes, Estimation, and Control",PHI Ltd*

CCCM0404 PETROLEUM CRUDE PROCESSING TECHNOLOGY

Pre – requisites	*Course Type*	*Credits*
Nil	***Theory + Practice***	***5***

OBJECTIVE:

To learn the testing of petroleum products, crude processing and treatment techniques

OUTCOME:

Students able to understand the principles of crude processing and various treatment techniques.

MODULE I

GENERAL

Origin – Exploration and production of petroleum – Types of crudes, crude composition – Characteristics and classification – Crude oil properties – Indigenous and imported crudes – Crude availability Vs demands.

TESTING OF PETROLEUM PRODUCTS

IS 1448: Standard – Testing of Petroleum crude – Products: Specifications and their Significance.

MODULE II

CRUDE PROCESSING

Pretreatment of crude for Refining – Dehydration and desalting – Atmospheric distillation, Vacuum distillation of residue products – Types of trays, flow pattern in the trays – Reflux types and its significance.

LUBE DISTILLATE TREATMENT TECHNIQUES

Treatment techniques for vacuum distillates with different processes like solvent extraction – Deasphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process – Production of lubricating oils.

MODULE III

BITUMEN PROCESSING and FINAL TREATMENT TECHNIQUES

Catalytic dewaxing and clay contact process – Production of lubricating oils.

Asphalt manufacture, Air blowing technology, Bitumen Types and their properties, Acid gas removal and sulphur removal techniques.

TEXT BOOKS:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers. .

2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 3rd edition, Oxford and IBH Publishing Company Pvt. Ltd. REFERENCES:

1. James H. Gary and Glenn E. Handwerk., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc., 2001.

2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill 1985.

3. Hobson, G.D., "Modern Petroleum Refining Technology ", 5th Edition, John Wiley 1984

CCCM0405 MASS TRANSFER Operations

Pre – requisites	***Course Type***	***Credits***
Nil	***Theory + Practice***	***5***

OBJECTIVE:

Students will learn to determine mass transfer rates under laminar and turbulent conditions.

OUTCOME:

Students apply the mass transfer concepts in the design of humidification columns, dryers and crystallisers.

MODULE I

DIFFUSION

Diffusion in fluids – Molecular and eddy diffusion – Measurement and calculation of diffusivities

– Ordinary diffusion in multi component gaseous mixtures – Diffusion in solids – Molecular and Knudsen diffusion in solids – Theories of mass Transfer –Film theory, penetration theory and surface renewal theories of mass transfer.

Interphase Mass Transfer – Local and overall mass transfer coefficients – Steady state co current and counter current mass transfer process – Stage and stage efficiencies – Concept of NTU and HTU – Equilibrium and operating lines – JD Factor– Equipments for gas-liquid contact operations – Bubble columns – Tray towers and packed towers.

MODULE II

ABSORPTION

Gas Absorption: Principles of absorption and desorption – Selection of solvents for absorption – Tray tower absorber – Absorption factor – Calculation of number of theoretical stages – Murphree efficiency – Point efficiency – Tray efficiency and overall tray efficiency – Calculation of actual number of trays. Packed tower absorber – Tower packing and characteristics – Calculation of NTU, HTU,HETP and height of absorption towers – Absorption with chemical reactions.

DRYING

Drying – Principle and definitions – Estimation of drying rates, drying rate curve – Critical and equilibrium moisture content – Calculation of drying time under constant drying conditions – Different types of dryers.

MODULE III

HUMIDIFICATION AND CRYSTALLIZATION

Humidification – Definitions, psychometric charts – Wet bulb temperature – Methods of humidification – Types of cooling towers, spray chambers and spray ponds. Crystallization – Factors governing nucleation and crystal growth – Theory of Crystallization – Classification of crystallizer and their applications – Product size distribution.

DISTILLATION

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

TEXTBOOKS:

1. *McCabe,W.L., Smith, J.C. and Harriot,P., "Unit Operations of Chemical Engineering", 6th Edition, McGraw – Hill Book Co., 2001.*
2. *Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw – Hill Book Co.,1980.*

REFERENCES:

1. *Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol.I, II and III,Pergamon Press, 1977.*
2. *Bennett, C.O. and Myers, J.E., "Momentum, Heat and Mass Transfer", McGraw Hill Book Company, 3rd Edition, 1983.*
3. *Christie J. Geankoplis, "Transport Processes and Unit Operations", 3rd Edition,Prentice Hall of India Pvt. Ltd, 2000.*
4. *Binay K.Dutta,"Principles of Mass Transfer and Seperation Processes",PHI Learning Ltd,2013.*

CCCM0406 PETROLEUM EXPLORATION AND EXPLOITATION TECHNIQUES

Pre – requisites	*Course Type*	*Credits*
Nil	***Theory***	***5***

OBJECTIVE:

To understand the stages of oil and gas exploration and production

OUTCOME:

The student will get exposed to different geological and geophysical methods for exploration

MODULE I

ORIGIN AND OCCURRENCE OF PETROLEUM AND SEDIMENTRARY ENVIRONMENT

Origin of oil – Important factors that control petroleum occurrence – Migration and accumulation – Source and reservoir rocks – Oil bearing rocks – Continental environment – Transitional environment – Marine environment.

EXPLORATION METHODS, WELL PROGNOSIS AND ECONOMIC ANALYSIS

Geological exploration methods – Geophysical exploration methods – Geochemical methods prognostication – Classification of drilling locations – Economic analysis – Well programme – Geotechnical order.

MODULE II

GEOLOGICAL STRUCTURE AND GEOLOGGING

Various traps – Anticline – Fracturing – Well logging – Geological control – Gas logging– Drilling control important formation evaluation using wireline logging data.

DRILLING FLUIDS AND WORK COMPLETION

Drilling Fluids:Function, composition, and classification – Packer fluid – Casing packs –Solids removal – Completion methods – Various stimulation methods.

MODULE III

OFF – SHORE TECHNOLOGY

Seismic technology – Sniffer survey – Drilling technology – Off-share rigs – Primary and secondary enhanced oil recovery techniques and methods – Major well complication and Remedies.

and exploitation of oil and gas *TEXT*

BOOKS:

1. Bhagwan Sahay "Petroleum Exploration and Exploitation Practices" Allied Publishers Ltd., Chennai, 1994.

2. Richard Dawe, "Modern Petroleum Technology", Vol.I, Upstream, 6th Edition, John and Wiley Sons Ltd, 2000.

REFERENCES:

1. Howard B. Bradley, "Petroleum Engineering Handbook", Society of Petroleum Engineers,1987.

2. Norman J. Hyne., "Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production", 2nd Edition, Pennwell Books, 2001.

3. Shay B., "Wellsite Geological Techniques for Petroleum Exploration" Allied Publishers Ltd., 1991.

CCCM0407PETROLEUM PRODUCTION ENGINEERING & DESIGN

Pre – requisites	*Course Type*	*Credits*
Nil	***Theory***	***5***

OBJECTIVE:

To develop skill to design and install process equipments used widely in a chemical industry.

OUTCOME:

Students would develop skill to design and install process equipments used widely in a chemical industry.

MODULE I

DESIGN OF PIPE FITTINGS AND JOINTS

Design and schematic of simple bolts and screws – Riveted joints – Design and drawing of shafts and couplings.

DESIGN OF REACTION VESSEL AND STORAGE TANK

Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.

DESIGN OF HIGH PRESSURE SYSTEMS

Design of high pressure vessels and reactors.

MODULE II

DESIGN OF PHASE SEPARATION EQUIPMENT

Design of physical separation equipments such as cyclones, centrifuges, thickeners, filtration equipment

DRAWING OF HEAT EXCHANGERS AND COLUMNS

Drawing of physical process equipments such as double pipe heat exchangers – Shell and tube heat exchangers – Plate and frame heat exchangers – Distillation columns and reactors.

MODULE III

EVAPORATOR DESIGN

Steam – Uses of steam – Outstanding qualities of steam – BPE – Duhring's rule – Principle of multiple effect evaporation – Temperature driving force – Evaporators types and its selection – Design of single and multiple effect evaporators.

COLUMN DESIGN

Design of distillation columns and Absorption columns.

PUMPS, FANS AND COMPRESSORS

Pumps, fans and compressors – Types and its applications – Characteristics – Piping and pressure drop calculations – Performance analysis of pumps, fans and compressors.

OUTCOME:

Students would develop skill to design and install process equipments used widely in a chemical industry.

TEXT BOOKS:

1. *R.S. Khurmi, "Textbook of Machine design". S. Chand & Company , XXV Edition , 2005.*
2. *M.V. Joshi and V.V. Mahajan, "Design of Process Equipment Design", McMillan India III Edition 1994.*

REFERENCES:

1. *S.D. Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.*
2. *Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.*
3. *R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.*
4. *W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operation of Chemical Engineering", McGraw-Hill, 2001.*
5. *Robert Treybal, "Mass Transfer Operations", McGraw-Hill.*
6. *J.M. Coulson and J.Richardson, "Chemical Engineering", Vol. 6, Asian Books Printers Ltd.*
7. *Suresh C.Maidargi ,"Chemical Process Equipment Design & Drawing, Vol 1,PHI Learning Ltd (2012).*

CCCM0408 PETROLEUM REFINERY ENGINEERING

COURSE OBJECTIVES

1. *To understand the importance of crude oil as source of fuel and the size of refining industry*
2. *Get acquainted with the various refinery processes and the products along with their specifications*
3. *Be aware of the challenges involved in refining from viewpoint of product specifications, economic considerations and environmental regulations*

COURSE OUTCOMES:

1. *Know the composition of crude oil and its products, along with its properties and characterization methods*
2. *Get conversant the basic separation and conversion processes used in refining crude oil*
3. *Apply chemical engineering principles to the analysis of safe and efficient refinery operations*
4. *Identify the specifications required for good quality petroleum product*
5. *Understand the process of purification and fractionation of crude oil*
6. *Decide the proper conversion route to upgrade the products from ATU and VDU*
7. *Understand in detail the manufacturing process of lube oil.*

MODULE – I: Overview of Production and Refining of Crude Oil

Origin, formation, exploration and production of crude oil, Reserves and deposits in the world, Petroleum industry in India, Overall Refinery flow, Petroleum Products, Nelson complexity factor

Composition and evaluation of Crude oil and its Products

Classification of crude oil, Composition of crude oil, Crude Assay, ASTM/TBP/EFV curves, Specifications and Test methods for: LPG, Naphtha, Gasoline, Kerosene, Diesel, Lube oil, Waxes, Bitumen and Coke.

MODULE – II

Crude Oil Distillation

Desalting of Crude, Preheating Train, Atmospheric distillation of Crude oil, Vacuum distillation

Conversion Processes

Catalytic cracking, Catalytic reforming, Hydrocracking, Alkylation, Isomerization, Coking, Bitumen Blowing

MODULE – III: Lube Oil Manufacturing

Lube oil processing, Propane deasphalting, Solvent extraction, Dewaxing, finishing Processes, Lube oil additives

Supporting Processes and Pollution Control in Refineries

Product blending, Hydrogen production, Sulphur Recovery, Control of air and water pollution, solid waste management ***Text Books***

1. Bhaskararao, B.K, 'Modern Petroleum Refining Processes', Fifth Edition, Oxford and IBH Publishing Co. Pvt. Ltd, 2007

2. Gary, J.H and Handework, G.E., 'Petroleum Refining Technology and Economics', Fourth Edition, Marcel Dekker, Inc. , 2001

3. Ram Prasad, 'Petroleum Refining Technology', First Edition, Khanna Publishers, 2013

Reference Books

1. Fahim, M.A., Alsahhaf, T.A. and Elkilani, A., 'Fundamentals of Petroleum Refining', Elsevier, 2010

2. Nelson, N.L. , 'Petroleum Refinery Engineering', McGraw Hill Book Co., 1985

3. Speight, J.G., ' Handbook of Petroleum Product Analysis', Wiley Interscience, 2002

4. Myers, R.A.,Ed., 'Handbook of Petroleum Refining Processes', Third Edition, McGraw Hill Book Co., 2004

5. Ottinger, G., 'Refining Expertise: How Responsible Engineers Subvert Environmental Justice Challenges' 1st Edition. New York University Press, 2013

CCCM0101 THERMODYNAMICS FOR PETROLEUM ENGINEERS

Pre – requisites	***Course Type***	***Credits***
Nil	***Theory***	***5***

COURSE OBJECTIVES:

To make the student understand OBJECTIVE:

Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

OUTCOME:

The course will help the students to know about engineering thermodynamics and understand the practical implications of thermodynamic law in engineering design.

MODULE I

ZEROTH AND FIRST LAWS, PROPERTIES OF PURE SUBSTANCES

Definitions and Concepts. Property, Thermodynamic State. Equilibrium, Energy, Work. Zeroth Law of thermodynamics, Temperature Scale. Pure substance, Phase, Simple compressible substance, Ideal gas Equation of State, Law of corresponding states, Compressibility chart, Pressure –Volume and Temperature-volume Phase diagrams. Mollier diagram. First Law of Thermodynamics and its consequences.

APPLICATION OF I LAW TO STEADY - STATE PROCESSES, II LAW

Application of I Law of Thermodynamics for Flow Process. Steady-state processes. II Law of Thermodynamics and its Applications: Limitations of the I Law of Thermodynamics, Heat Engine, Heat Pump/Refrigerator. II Law of Thermodynamics – Kelvin Planck and Clausius statements. Reversible and irreversible processes, Criterion of reversibility, Carnot cycle and Carnot principles, Thermodynamic Temperature scale, Clausius inequality, Entropy.

MODULE II

POWER CYCLES, THERMODYNAMIC POTENTIALS, EQUILIBRIA AND STABILITY

Power and Refrigeration Cycles. Thermodynamic Potentials. Maxwell relations. Thermodynamic relations. Equilibria and stability. Maxwell construction, Gibbs Phase Rule. Clapeyron equation and vapor pressure correlations.

PROPERTIES OF PURE COMPONENTS AND MIXTURES

Pure component properties: Equation of state. Ideal gas heat capacities, fundamental equations from experimental data, fugacity and corresponding states. Mixture Properties: Mixing function. GibbsDuhem relation for mixtures, partial molar quantities. Ideal gas mixtures and fugacities, ideal mixtures and activities, excess functions. Gibbs free energy models, infinite dilution properties.

Henry's Law

MODULE III

PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA

Phase Equilibira of Mixtures. Osmotic pressure and Osmotic coefficients. Boiling point elevation and freezing point depression. Chemical Reaction Equilibria. Reaction extent and Independent reactions. Equilibrium criteria and equilibrium constant. Standard enthalpies and Gibbs free energy, temperature and pressure effects on reactions, heterogeneous reaction, multiple chemical reactions

TEXT BOOKS:

1. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7 th Edition, Wiley India, New Delhi, 2009.

2. Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7 th Edition, McGraw Hill, New York, 2005