Semester V

Unit Operations - IV

1.1 Course Number: CE301
1.2 Contact Hours: 3-1-0 Credits:11
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Mathematics, Physics, Chemistry & Unit Operation-III
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To teach the different mass transfer operations and separation processes such as distillation, liquid-liquid extraction, solid-liquid extraction, adsorption Chromatography and Ion-exchange, membrane separation, supercritical fluid extraction.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Distillation**	Vapour-liquid equilibrium: Constant pressure equilibria, Constant temperature equilibria, Relative Volatility, Methods of distillation: Flash distillation, Differential distillation. Continuous distillation of binary mixtures, multistage contact operations, McCabe-Thiele methods, Total, Minimum and Optimum reflux ratios, Tray efficiency, Introduction to Azeotropic and Extractive distillation.	12
2	**Extraction & Leaching**	Liquid-liquid extraction, Choice of solvent, Extraction equipments and their application. Solid-Liquid Extraction (Leaching), Industrial application of leaching, Factor affecting the rate of leaching, Leaching equipments and their application.	6
3	**Adsorption, Chromatography and Ion-exchange**	Adsorption: Types; Parameters affecting the adsorption rate, Types of adsorbents and their industrial application. Chromatography: Types of equipment and commercial processes, Chromatographic separation processes. Ion-exchange: Mechanism, Industrial application.	8
4	**Membrane Separation**	Basic principle of membrane separation, Classification of membrane processes: Osmosis, Reverse Osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Dialysis, Electrodialysis, Pervaporation, Advantages and	8

		disadvantages of membrane separation processes, Industrial applications, Types and selection of membranes.	
5	**Supercritical Fluid Extraction**	Supercritical Fluid Extraction: Supercritical fluids, Industrial applications; Important supercritical processes: Decaffination of coffee, Extraction of oil from seeds, Residuum oil supercritical extraction (ROSE), Supercritical fluid chromatography, Supercritical fluid reactions etc.	6
TOTAL			**40**

4. Readings:

4.1 Textbooks:

1. R. E. Treybal, Mass Transfer Operations, McGraw -Hill International Edition.
2. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill, International Edition.
3. H. M. Schoew, New Chemical Engineering Separation Techniques, Interscience Publishers
4. C.J. King, Separation Processes, Tata McGraw - Hill Publishing Co. Ltd

4.2 Reference Books:

1. C. J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall, India.
2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall of India.

5. Outcome of the Course:

After the completion of the course, students will be able to

1) Learn the basic concepts, principles and classification of distillation operation, learn graphical solutions and able to formulate, solve and analyze continuous distillation problems, concept of azeotropic and extractive distillation, Basic understanding of various equipments to carryout distillation.
2) Understand the basic concept, principles and applications of liquid-liquid extraction and solid-liquid extraction, basic understanding of various equipments to carryout liquid-liquid extraction and solid-liquid extraction.
3) Understand the fundamental concepts, equilibrium, operation and analysis of adsorption operation, chromatography and ion-exchange separation processes,
4) Understand the concept of membrane separation processes and their industrial applications.
5) Understand the fundamentals of supercritical fluid extraction and their industrial applications.

Industrial Pollution and Control

1.1 Course Number: CE302
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Chemistry and Chemical Technology
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To learn the essential principles used in industrial pollution control and also understand the important issues in industrial pollution control and importance of different environmental acts and legislations.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Types of environments and their pollutants**	Classification of pollutants, Legislative aspects including water act. 1974, Air Act 1981 and effluent standards, EPA Air pollution: Sources and effects of different air pollutants, Sampling and analysis of air pollutants, Air pollution control methods and equipment, Cyclone separator, Baghouse, ESP, Venturi scrubber.	10
2	**Water pollution**	Sources, sampling and classification of water pollutants, determination of basic parameters and computations associated with: BOD, COD, TS, TDS, SS; Waste water treatment: primary, secondary, tertiary and advanced; aerobic treatment with special reference to activated sludge, trickling filter, RBDC and RBRC, EA, Non-conventional: WSP, anaerobic treatment with special reference to AFFR, UASB.	10
3	**Solid waste management**	Sources and classification, Public health aspects, Methods of collection and disposal methods: Open dumping, Landfill, Incineration, Composting, Vermiculture; Solid waste management using bioremediation for specific pollutants like chromium. Mercury, Ammonia/ urea, Phenolic sludges. Management and handling of Bio-medical waste; E-waste-classification and re-use and disposal, Hazardous waste management- Electro-chemical and photo-chemical oxidation - dye waste, chrome slag – case studies.	10
4	**Pollution control in selected process**	Fertilizer industries, Petroleum refineries and petrochemical units, Pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, Ranking of	10

	industries	wastewater treatment alternatives. Case Studies.	
TOTAL			**40**

4. Readings:

4.1 Textbooks:

1. C. S. Rao Environmental Pollution Control Engineering, New age Publishing.
2. Connwell and Devis, Introduction to Environmental Engineering, Tata McGraw - Hill Publishing Co. Ltd.

4.2 Reference Books:

1. Metcalf and Eddy, Wastewater Engg, Tata McGraw - Hill Publishing Co Ltd.
2. S.P. Mahajon Pollution Control in process industries, Tata McGraw - Hill Publishing Co Ltd.
3. S.J. Arceivala, Wastewater treatment for pollution control, Tata McGraw - Hill Publishing Co Ltd.

5. Outcome of the Course:

Students completing the course will be able to:

1) Demonstrate comprehensive understanding of various types of pollution from chemical industries and various regulations pertinent to air, solid and water pollutions.
2) Suggest process modifications in order to reduce pollution and waste from a chemical industry.
3) Design gravity settling chamber, cyclones, electrostatic precipitator, fabric filters and absorbers for air pollution control.

Process Instrumentation and Control

1.1 Course Number: CE303
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Physics & Mathematics
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

i) To learn about different process instruments widely used in chemical industries.
ii) To introduce the fundamentals of process control using mathematical models based on transfer function approach and the different components in a control system loop.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Process Instrumentation**	Instruments: Static and dynamic characteristics of instruments. Temperature Measuring Instruments: Expansion Thermometers, Electrical Temperature Measurements- RTD, Thermocouple, Thermistor, Pyrometers. Pressure Measuring Instruments: Barometer, Manometers, Bourdon tube, Pirani Gauge.	10
2	**Introduction to Process Control**	Process Control with examples; Control system classification; Modeling tools for process dynamics: Laplace Transform: Transforms of simple function, Transforms of Derivative, Initial value theorem and Final value theorem, Transform of Integral.	8
3	**Process Dynamics**	Response of First Order process, Second order process, Interacting and non-interacting system.	8
4	**Closed Loop Systems**	Components of control system; Block diagram and its development; Piping and instrumentation design; Instrumentation symbols; Closed loop transfer function.	6
5	**Controllers and Final Control Elements**	Proportional, Proportional Integral, Proportional Integral Derivative controllers; Responses to Set point and Load change; Control valve; valve sizing and its characteristics; Types of valve.	8
TOTAL			**40**

4. Readings:

4.1 Textbook:

1. D. R. Coughanowr and L. B. Koppel, Process systems Analysis and Control, Mc-Graw-Hill.

4.2 Reference Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, Publishing Ltd, New Delhi.
2. G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey.

5. Outcome of the Course:

Students completing the course will be able to:

1) Identify and understand the principles involved in measurements and application of different pressure and temperature measurement devices used in chemical industries.
2) Understand different control system loops having different components and its function.

Humanities

1.1 Course Number: HU301
1.2 Contact Hours: 2-0-0 Credits: 6
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level English
1.5 Syllabus Committee Members: DUGC

2. Objective:

i) Foster intellectual curiosity, global knowledge, critical thinking, personal responsibility, and ethical and cultural awareness.
ii) Prepare students to use language effectively.
iii) Establish a framework for students to develop an aesthetic appreciation for fine arts.
iv) Prepare students to be responsible citizens, lifelong learners, and world-ready leaders in their chosen fields.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Sociology**	Definition of sociology, some sociological concepts: social structure, status, role, norms, values etc. Socialization, and culture and change. Social stratification - various approaches and concept of social mobility. Population and society - Trends of demographic change in India and the world, Human Ecology, Trends of Urbanization in the developing countries and the world. Major social institutions - Family and marriage, caste and tribe and organizations: (i) formal organization (bureaucracy) (ii) informal organization. Processes of social change - Modernization (including Sanskritization), industrialization, environmental/ecological changes and development. Social movements - protest movements, reformist movement and radical movements in India.	9
2	**Introduction to Literature**	Nature of Literature: Literature as a Humanistic Experience. Definitions: (i) Humanities: concern with culture, values, ideologies; (ii) Literature: concepts of imitation, expression, intuition & imagination. Major Themes of Literature: Nature, Science, Selfhood, Love, Rebellion. The Language of Literature: Modes of literary and non-literary expression. The concepts of Figurative language, imagery,	7

		symbolism, style. The Forms of Literature: Prose Narratives (short stories & novels) Poetry, Drama and Essays (Suitable texts are to be chosen by the instructors), Use of a Learner Dictionary.	
3	**Introduction to Philosophy**	Philosophy and History of Science: Growth of scientific knowledge: factors leading to the emergence of modern science. Conceptual evolution: internal and external history. Methodology of science: induction, falsifications, confirmation and probability. Nature of scientific laws and theories: realism, instrumentalism, and under-determination. Relationship between scientific observation, experiment and scientific theory. Nature of scientific explanation: teleological explanations and the covering law model. Selected case studies on scientific theories. Logic and the nature of mathematical reasoning: Inductive and deductive forms of reasoning. Nature of axioms: formal axiomatic systems. Concept of consistency, independence, and completeness. Nature of rules of inference and proof. Selected examples of axiomatic systems and proof procedures. Cognition: Current approaches to the understanding of mind and mental processes: empiricist, rationalist, behaviorist and cognitivist. Ethics: Impact of science and technology on man and society: elements of environmental and professional ethics	7
Total			**23**

4. Readings:

4.1 Textbook/Reference Books:

(A) Introduction to Sociology:

(a) L. Broom, P. Selznick and D. Dorrock, Sociology, 11th Edn. 1990 (Harper International).
(b) M. Haralambos, Sociology: Themes and Perspectives, Oxford University Press, 980.
(c) M.S.A. Rao (ed) Social movements in India, vols. 1-2, 1984, Manohar.
(d) David Mandelbaum, Society in India, 1990, Popular.
(e) M.N. Srinivas, Social change in modern India, 1991, Orient Longman.
(f) Guy Rocher, A. General Introduction to Sociology, MacMillan, 1982.

(B) Introduction to Literature:

(a) David Murdoch (ed.). The Siren's Song: An Anthology of British and American Verse, Orient Longman, 1988.
(b) S. Alter & W. Dissanayake (eds.) The Penguin Book of Modern Indian Short Stories. Penguin Books (India), 1989.
(c) Bertrand Russell, Impact of Science on Society. Allen &Unwin, 1952.
(d) Henrik Ibsen, A Doll's House, Macmillan India, 1982.
(e) George Orwell, Animal Farm, Penguin, 1951.
(f) J. Bronowski. The Ascent of Man, BBC, 1973.

(C) Introduction to Philosophy:

(a) A.C. Grayling (ed.) Philosophy: A Guide through the Courses/Subjects, Oxford Univ. Press, London, 1995.
(b) Marx W. Wartofsky, Conceptual Foundations of Scientific Thought: An Introduction to the Philosophy of Science, Macmillan, London, 1968.
(c) I.B. Cohen, The Birth of a New Physics, Vakils, Feffer and Simons Pvt. Ltd., Bombay, 1968.
(d) H. Eves and C.V. Newsom, Foundations and Fundamental Concepts of Mathematics, Boston, PWS-Kart Pub. Co., 1990.
(e) K.E. Goodpaster and K.M. Sayre (eds.) Ethics and Problems of 21st Century, Univ. of Notre Dame Press, London, 1979.
(f) S.D. Agashe, A. Gupta & K. Valicha (eds.) Scientific Method, Science, Technology and Society: A Book of Readings, Univ. of Bombay Press, 1963.

5. Outcome of the Course:

Students will demonstrate:

Knowledge of the conventions and methods of at least one of the humanities in addition to those encompassed by other knowledge areas required by the General Education program.

Engineering Economics

1.1 Course Number: MT301
1.2 Contact Hours: 2-1-0 Credits: 8
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Mathematics
1.5 Syllabus Committee Members: DUGC

2. Objective:

i) To make fundamentally strong base for decision making skills by applying the concepts of economics.
ii) Educate the students on how to systematically evaluate the various cost elements of a typical manufactured product, an engineering project or service, with a view to determining the price offer.
iii) Prepare engineering students to analyze profit/revenue data and carry out make economic analysis in the decision-making process to justify or reject alternatives/projects.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Economics**	Introduction to economics – Flow in an economy – Law of supply and demand – Concept of engineering economics – Engineering efficiency – Economic efficiency – Scope of engineering economics – Element of costs – Marginal cost – Marginal revenue – Sunk cost – Opportunity cost – Break-even analysis – V ratio – Elementary economic analysis – Material selection for product design selection for a product – Process planning.	10
2	**Value Engineering**	Make or buy decision – Value engineering – Function – Aims – Value engineering procedure – Interest formulae and their applications –Time value of money – Single payment compound amount factor – Single payment present worth factor – Equal payment series sinking fund factor – Equal payment series payment Present worth factor – Equal payment series capital recovery factor – Uniform gradient series annual equivalent factor – Effective interest rate – Examples all methods.	8
3	**Cash Flow**	Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram) – Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Rate of return method – Examples all methods.	8
	Total		**26**

4. Readings:

4.1 Textbooks:

1. Panneer Selvam, R., “Engineering Economics”, Prentice Hall of India Ltd, 2001.
2. Smith, G.W., “Engineering Economy”, Lowa State Press, 1973.

4.2 Reference books:

1. Park, C.S., “Contemporary Engineering Economics”, Prentice Hall of India, 2002.
2. Newman, D.G. and Lavelle, J.P., “Engineering Economics and Analysis”, Engineering Press, 2002.
3. Degarmo, E.P., Sullivan, W.G. and Canada, J.R, “Engineering Economy”, Macmillan, 1984.
4. Grant, E.L., Ireson, W.G. and Leavenworth, R.S., “Principles of Engineering Economy”, Ronald Press, 1976.

5. Outcome of the Course:

Upon completing the course, students will be able to:

1) Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2) Apply economic principles to prices and quantities in competitive supply and demand for goods and for money.
3) Solve economic problems involving comparison and selection of alternatives by using analytical techniques including benefit-cost ratio and breakeven analysis.

Industrial Pollution and Control Laboratory

1.1 Course Number: CE302L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Mathematics and Chemistry
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To study the physical, chemical and biological water quality parameters. The course includes experimental execution, data analysis and error analysis, skills development in oral presentation, technical report writing, and team-building.

3. Course Content:

Sl. No.	List of Experiments
1	To determine the Total Solids of a given sample
2	To find out Total Dissolved Solids of a given sample
3	To find out Fixed and Volatile solids of the given sample
4	To determine the Acidity of the given sample
5	To determine the Alkalinity of the given sample
6	To determine the Total Hardness of the given sample
7	To find out amount of Sulphates in a given sample
8	To estimate the content of Chlorides in the given water sample
9	To find the quantity of the Dissolved Oxygen present in the given sample
10	To determine the BOD of a given wastewater sample
11	To determine the COD of a given wastewater sample

4. Outcome of the Course:

The lab will give the student a thorough understanding to analyze different wastewater samples.

Process Instrumentation and Control Laboratory

1.1 Course Number: CE303L
1.2 Contact Hours: 0-0-2 Credits: 2
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Mathematics and Physics
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To understand the fundamentals of process control with applications using P, PI, and PID controllers in different control trainers, control valve and first order processes. The course includes experimental execution, data analysis and error analysis, skills development in oral presentation, technical report writing, and team-building.

3. Course Content:

Sl. No.	List of Experiments
1	To study the Control Valve Characteristics
2	To study the basic principles of level control using Level Control Trainer
3	To study the basic principles of flow control using Flow Control Trainer
4	To study the basic principles of Temperature control using Temperature Control Trainer
5	To study the characteristics of thermometer & thermocouple
6	To study the step response of the first order system using Thermometer and U-Tube Manometer

4. Outcome of the Course:

Students completing the course will be able to:

1) Identify and operate the commonly used pressure and temperature measuring instruments in chemical plant.
2) Identify the dynamics and further use different controllers to control the different process responses.

Department Elective/ Open Elective

Corrosion Engineering and Materials Selection

1.1 Course Number: CE304
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year – Odd
1.4 Prerequisite: Diploma level Chemistry and Material Science
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

The objective of this course is to enable the students to understand the industrial corrosion scenarios and to develop understanding on microscopic and electrochemical origins of the corrosion phenomena. This course will also help students to understand the factors responsible for industrial corrosion and to design corrosion mitigation strategies by using appropriate engineering methods.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	Introduction and Corrosion Principles	General Introduction, corrosion rate expression, electrochemical reactions, polarization, passivity	4
2	Types of Corrosion	Galvanic (two-metal corrosion), Pitting, selective leaching, crevice corrosion, stress corrosion, hydrogen damage, erosion corrosion, intergranular corrosion, microbial corrosion, high temperature corrosion	8
3	Corrosion in Petroleum Industries (upstream and downstream)	Corrosion problems in (a) production, (b) transportation and storage and (c) refinery operations	6
4	Important Engineering Alloys for Industrial Application	Carbon steels, stainless steels, Al and its alloys, Cu and its alloys, Ni and its alloys), Non metallics	6
5	Materials Selection (Corrosion Resistant Materials) for Chemical Industries	Materials (metallic/nonmetallic) for sulfuric acid, nitric acid & hydrochloric acid	6
6	Corrosion Prevention in Petroleum Industries	Alteration of environment (changing medium, inhibitors) Cathodic and Anodic Protection Coatings (metallic and inorganic)	6
7	High Temperature Corrosion and Materials Selection	Mechanism and Kinetics, High Temperature Materials (Hot corrosion of alloys)	4
Total			**40**

4. Readings:

4.1 Text books:

1. Corrosion Engineering (third edition) by Mars G. Fontana, Tata McGraw-Hill.

4.2 Reference books:

1. J.F. Shackelford and W. Alexander, Material Science and Engineering Handbook, CRC
2. V. Saini, Corrosion and Corrosion Control, Scitus Publisher.

5. Outcome of the course:

Upon completion of this course, students will be able to rationally arrive at the solutions for corrosion mitigation. They will also be able to select the materials for corrosion control and to analyze the failures caused by corrosion.

Energy Resources and Utilization

1.1 Course Number: CE305
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Chemistry
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

Main purpose of this course is to introduce various conventional (coal and petroleum) and non-conventional energy resources (solar, nuclear, wind, tidal, geothermal), ways of harnessing energy from these sources, its distribution and utilization.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Energy Scenario**	Energy Scenario: Indian and global, Energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Remedial measures to some energy crisis, Biomass and its conversion routes to solid, gaseous and liquid fuels.	8
2	**Solid Fuel**	Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas and recovery of chemical from coal tar, Coal gasification, Liquid fuel synthesis from coal, CBM.	8
3	**Liquid and Gaseous Fuels**	Petroleum crude, Types of crude, Emergence of petroleum products as energy source, Gaseous Fuels: Natural gas, Water gas, Producer gas, LPG, Bio-gas, Coke oven gas, Blast furnace gas, LNG, CNG, Gas hydrates, GTL Technology (gas to liquid), Biodiesel.	8
4	**Non-conventional Energy Sources**	Solar energy:Photo thermal and photovoltaic conversion, Solar water heating, cooking, drying and its use for other industrial processes, Solar cells their material and mode of operation, direct and indirect methods, Solar energy storage, Sensible heat and latent heat storage materials, Solar ponds, Bio energy, Biogas plants and their operation, Wind energy - its potential and generation by wind mills. Hydroelectric potential, its utilization & production, Geothermal energy its potential status and production, Energy from Tidal and Ocean thermal sources, MHD systems.	10
5	**Nuclear Energy**	Status, Raw materials, Nuclear reactors and their classification, Generation of nuclear power, Nuclear installations in India and their capacity, Limitations of nuclear energy, Cogeneration of fuel and power.	6
Total			**40**

4. Readings:

4.1 Textbooks:

1. Brame J.S.S. and King J.G., Edward Arnold “Fuel Solid, Liquid and Gases” Edward Arnold (1967).
2. Rao S. & Parulckar B.B. “Energy technology” Khanna Publisher

4.2 Reference Book:

1. Sukhatme S.P, "Solar Energy - Principles of Thermal Collection and Storage", 3rd Edition, Tata McGraw- Hill., (2008).

5. Outcome of the Course:

Students completing the course will be able to

1) Understand the energy scenario, energy crisis, classification of various energy sources.
2) Understand the origin, properties and applications of solid, liquid and gaseous fuels.
3) Demonstrate understanding of the different types of renewable and non-renewable energy sources that are currently available and how they are used to provide energy.
4) Realize the sustainability of natural resources, primary global energy resource profile.
5) Identify the strengths and limitations associated with different energy sources.

Natural Gas Engineering

1.1 Course Number: CE306
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Petroleum Refinery Operations, Chemistry, Unit operation-I & Engineering Thermodynamic
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

Main purpose of this course is to introduce the basic knowledge of natural gas processing, their properties, storage, transportation and utilization.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Gas from condensate and oilfields**	Scope of Natural gas industry. Basic thermodynamic and system energy concepts in Natural Gas Engineering. Review of physical and chemical properties of natural gas and associate hydrocarbons.	8
2	**Flow of fluids**	Compression calculations. Heat Transfer and Mass Transfer principles and applications in Natural Gas Engineering. Gas flow measurement. Process control and instrumentation in natural gas processing plants.	8
3	**Natural Gas Processing**	Field separation and oil absorption process. Refrigeration and low temperature processing. Liquification process. Dehydration of Natural Gas sweetening of Natural gas and sulphur recovery, Processing for LPG, LNG, CNG system.	8
4	**Transmission of Natural Gas**	Specifications. Utilization of Natural Gas. Underground storage and conservation of Natural Gas	8
5	**Unconventional Gases**	Coal Bed Methane, Natural Gas Hydrate. Conversion of gas to liquid. Economic consideration for development of gas fields.	8
Total			**40**

4. Readings:

4.1 Textbooks:

1. Kumar S., “Gas Production Engineering”, Gulf Publishing Co., (1987).
2. Beggs H. D., “Gas Production Operations”, OGCI Publication, (1984).
3. Ikoku C. K., “Natural Gas Engineering”, John Wiley, (1984).

4.2 Reference Books:

1. Alexandre R., “Natural Gas: Production, Processing and Transport”, Hyperion Books, (1995).
2. Katz D. L., “Hand Book of Natural Gas Engineering”, McGraw Hill.

5. Outcome of the Course:

Students completing the course will be able to

1) Understand the sources of natural gas, their processing, properties, transportation and uses.

2) Understand the importance of unconventional gases such as coal bed methane, Natural Gas Hydrate and their economy aspects in present energy scenario.

Polymer Technology

1.1 Course Number: CE307
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Chemistry and Chemical Technology
1.5 Syllabus Committee Members: Dr. Bhaskar Jyoti Medhi, Dr. Anil Kumar Varma, Dr. Arun Kumar

2. Objective:

To provide a broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behavior. Emphasis is on the processing techniques, along with the production of polymers and their uses.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Polymerization Chemistry**	Introduction to polymers, Classification of polymers - Plastics, elastomers, fibres & resins, Polymerization: Chain, step and miscellaneous polymerization reactions and polymerization technique, Polymerization kinetics: Free radical, cationic and anionic polymerization, Polycondensation and polymerization. Degree of polymerization, Glass Transition temperature,	8
2	**Mechanism of Polymerization**	Addition polymerization, Free radical polymerization (Initiation, propagation, termination), Ionic polymerization, Co-ordination polymerization such as polymerization with Ziegler-Natta catalyst, chain transfer Reaction, condensation polymerization- polycondensation, ring opening polymerization, co poly condensation.	8
3	**Polymerization Techniques**	Bulk polymerization, Solution polymerization, Suspension polymerization, Emulsion polymerization, Melt polycondensation, Solution Polycondensation, Interfacial polymerization	6
4	**Polymer Processing**	Extrusion, injection molding, compression molding, blow molding, film extrusion, spinning, extrusion film blowing, etc.	6
5	**Manufacture of Polymers & their uses**	Manufacturing processes and uses of important polymers: Plastics - Polyethylene, Polystyrene, PVC, PP, Teflon, Polyacrylonitrile, Polyamide, Natural rubber, Resins, Fibers.	12
Total			**40**

4. Readings:

4.1 Textbooks:

1. V. R. Gowariker, N. V. Viswanathan and J. Sreedhar, Polymer science, New Age.

4.2 Reference Books:

1. J. R. Fried, Polymer Science & Technology, Prentice Hall of India.
2. P. Bahadur and N. V. Sastry, Principles of Polymer Science, Narosa Publishing House.

5. Outcome of the Course:

Students completing the course will be able to:

1) Demonstrate the understanding of different polymers and its uses.
2) Analyze the different polymer processing techniques and along with its kinetics