NEP- Third Semester B.Tech.(Chem.Engg.) Syllabi Details

3CH200PC/ 3CT200PC: **Chemical Engineering Thermodynamics (**PCC**)**

Subject Code	**Title**	**Credits- 03**		
3CH200PC/3CT200PC	Chemical Engineering Thermodynamics	L	T	P
Semester: III	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives:

1. To introduce the basic principles and terminologies of thermodynamics; including systems, processes and energy classifications for understanding heat and work interactions.
2. To explain the laws of thermodynamics emphasizing; entropy, irreversibility, spontaneous processes and the limitations of energy transformations.
3. To analyze real and ideal gas behaviours using equations of state, critical properties and compressibility factors.
4. To apply thermodynamic principles to flow processes including; control volume analysis and evaluate the performance of devices like turbines, nozzles and compressors.
5. To understand solution thermodynamics including; phase equilibria, chemical potential, fugacity, Raoult's law and deviations in ideal and non-ideal systems.
6. To explore the concept of chemical equilibrium emphasizing; free energy changes, equilibrium constants and their dependence on temperature and pressure while analyzing factors affecting yield and conversion efficiency.

Course Outcomes: After successful completion of the course the students will be able:

1. Students will be able to classify thermodynamic systems and processes, calculate energy changes and apply the first law of thermodynamics to various systems.
2. Students will gain a thorough understanding of the second law of thermodynamics, entropy changes and the working principles of heat engines, pumps and refrigerators.
3. Students will be equipped to model real and ideal gases using equations of state, analyze deviations from ideal gas behaviour and study critical phenomena near phase transitions.
4. Students will demonstrate the ability to perform control volume analysis for flow processes and analyze the operation of flow devices such as nozzles, condensers and turbines.
5. Students will comprehend solution thermodynamics concepts including; vapour-liquid equilibrium, phase diagrams and the determination of molecular weights in ideal and non-ideal systems.
6. Students will evaluate chemical equilibrium systems, calculate free energy changes and apply Le Chatelier’s principle to predict and optimize reaction outcomes under varying conditions.

SECTION- A

Unit- I: Basic Concepts and first law of thermodynamics: The terminologies of thermodynamics. Categorization of systems and processes. Energy classifications; point and path Function, heat and work, reversible and irreversible processes. First law of thermodynamics – heat and energy changes, enthalpy and heat capacity limitations of the first law, application of first law to different processes. (7Hrs)

Unit- II: Second law of thermodynamics: Introduction to the Second Law: Concepts of entropy, irreversibility, and spontaneous processes, Entropy changes in systems and surroundings, entropy change in mixing. Heat Engines and Efficiency: Carnot cycle, heat pumps, and refrigerators. The Third Law of Thermodynamics. (7Hrs)

Unit- III: Equation of State (EOS): Ideal gas law and real gas behavior. Van der Waals equation, Redlich-Kwong, and Peng-Robinson equations. Compressibility Factor (Z): Definition, significance, and deviations from ideal gas behavior. Z for Real Gases: Use of charts and equations of state for calculation.

Critical Properties: Definition of critical temperature, pressure, and volume. Behavior Near Critical Point: Phase transitions and compressibility factor. (8Hrs)

SECTION- B

Unit- IV: Basics of Flow Processes: Control volume analysis and the first law for flow systems flow of compressible fluids through ducts, compression processes. Applications of Flow Processes: Nozzles, condensers, compressors, and turbines. (7Hrs)

Unit- V: Solution thermodynamics: The Chemical Potential and Equilibrium, Partial Properties, Fugacity and Fugacity Coefficient of pure species and Species in Solution. Generalized Correlations for the Fugacity Coefficient . Vapour liquid equilibrium, phase rule , T-X-Y diagrams and X-Y diagram for ideal and non ideal system . Raoult's law and Henry's law, Deviations from Raoult's law. Comparison of ideal and non- ideal systems. Colligative properties, ebullioscopic constant. Determination of molecular weight of unknown chemical substances. (8Hrs)

Unit- VI: Chemical Equilibrium : Concept of equilibrium and dynamic nature of reversible reactions. Free energy change and its role in determining reaction spontaneity. Equilibrium Constant: Definition, expression, and its relation to reaction quotient. Le Chatelier's Principle. Temperature and Pressure Effects: Impact on equilibrium constant and equilibrium position. Relation Between Kp, Kc, and Kv Endothermic and Exothermic Reactions: Energy changes and their influence on equilibrium. Heterogeneous Equilibria Free Energy Change Calculations, Various methods to determine ΔG for reactions., Factors affecting yield and conversion efficiency. (8Hrs)

Text Books:

1. J.M. Smith & H.C. Van Ness, "Intro. to Chem. Engg Thermodynamics", McGraw Hill, 1998.
2. K.V.Narayanan, ."A textbook of Chem. Engg Thermodynamics", Prentice Hall of India Ltd., 2001.
3. An Introduction to Chemical Thermodynamics, R.P.Rastogi, R.R.Mishra. Vikas Publishing

Reference Books:

1. Sadler S. I., J, "Chem & Engg Thermodynamics" John Wiley & Sons, Inc. NY, 3rd Ed., 1999.
2. Elliot J. R. and Lira C.T., "Introductory Chemical Engg Thermodynamics", Prentice Hall, 1999.
3. Eastop T. D. and McConkey A. "Applied Thermodynamics for Engineering Technologists", Addison Wesley Longman Ltd., England, 5th Ed., 1999.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH201PC: PROCESS INSTRUMENTAION (PCC)

Subject Code	Title	Credits- 03		
3CH201PC	Process Instrumentation	L	T	P
Semester: III	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives:

1. Learn the essentials of process control and instrumentation for a successful career in process industries
2. Understand process control's main terms and parameters (Process variable PV, Set point SP, Operating point OP, Error, Offset)
3. Identify the different control loops and describe their main tasks.
4. Describe the basic mechanism, advantages, and disadvantages of the following mode of controller action: Proportional, Integral, and Derivative.
5. Identify the basic implementation of P, PI, and PID control in the following types of loops: Pressure, Flow, Level, and Temperature loops.
6. Differentiate feedback and feed forward control loops.

Course Outcomes: After successful completion of the course the students will be able:

1. To learn the operating principles, construction and working of temperature, pressure, level and flow measuring devices.
2. To select the most suitable measuring device based on its performance characteristics for specific measuring task.
3. To test, calibrate, maintain measuring devices elements.
4. Students learn the different control loops and their main tasks.
5. Students learn the basic mechanism, advantages, and disadvantages of proportional, integral, and derivative controller action
6. Students learn how to implement P, PI, and PID control in pressure, flow, level, and temperature loops.

SECTION- A

UNIT-I : Basic method of measurements –Errors in measurements – Types of Errors. Transducers – definition, classification – Static characteristics of instruments Dynamic characteristic. Transmitter –definition different types. (8Hrs)

UNIT-II : Temperature measurements: Introduction – Temperature scale Conventional methods of temperature sensing. Resistance Thermometer Detector (RTD) – Unbalanced Wheatstone Bridge Direct conversion. Thermistors- Temperature sensing using thermistor – Semiconductor temperature sensor. Thermocouple – Basics of thermocouple – Thermocouple types – Cold junction compensation. Infrared thermometry – Basics of radiation – Emissivity – Methods of sensing –Direct detection – Indirect detection. (8Hrs)

UNIT-III: Pressure measurements: Introduction – Units of pressure – Types of pressure measurement- –Bourdon tube and bellows – SG based pressure sensors – Capacitance type pressure transducers. Low pressure measurements -pirani gauge – Thermocouple gauge – Ionization gauge. (8Hrs)

SECTION- B

UNIT-IV: Basics of fluid flow – Flow meters – Quantum flow measurements, Differential pressure measurement
– Principle of the differential pressure flow meter, Orifice plate, Venturimeter, Flow nozzle, Dall

tube, Pitot tube. Variable area flow meter,Magnet Flowmeters – DC Magnetic Flow meter, Pulsed Magnetic Flow meter, Permanent Magnet Type Magnetic Flow meter, AC Magnetic Flow meter. Positive displacement Flowmeters – Different type of ultrasonic Flow meter. (7Hrs)

UNIT-V : Level Measurements – Level transducer with differential pressure sensing– Capacitance based level sensors – Capacitance sensors for conducting liquids – Capacitance sensors for Non – conducting liquids, other liquid sensors – Displacement type level sensor – Ultrasonic type level sensor, Gamma ray level sensor. (7Hrs)

UNIT-VI : pH measurements – Basic ideas of pH value – Measurement of electrode potentials – Glass electrode – Reference electrode – Calomel electrode – Silver- Silver chloride electrode, Humidity Sensing – Basic ideas of humidity sensing – Humidity measurement by dew point sensing – Humidity measurement using Lithium Chloride. **Measurement for Concentration**: Obtaining concentration of solution by conductivity and conductivity titration, determination of concentration by density meter, hydrometer, refractometer, measurement of concentration of ion and coloured solution. (7Hrs)

Text Books:

1. Tattamangalam R. Padmanaban "Industrial Instrumentation Principles and Design" Springer, 2000.
2. Donald P. Eckman, " Industrial Instrumentation", CBS Publishers, New Delhi,2002.

Reference Books:

1. R.K.Jain, "Mechanical and Industrial Measurements" Khanna Publishers, New Delhi, 1999
2. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill Publishing Ltd, New Delhi, 1999
3. C.D. Johnsons, "Process Control Instrumentation Technology", Prentice Hall Inc,
4. A.K.Sawhney, "A Course In Electrical and Electronics Measurement and Instrumentation", Dhanpat Rai and Sons, New Delhi, 1999

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH203PC: PROCESS INSTRUMENTAION LAB. (PCC Lab.)

Subject Code	Title	Credits-01		
3CH203PC	Process Instrumentation Lab.	L	T	P
Semester: III	Total Contact Hours: 2 Hrs / Week	0	0	2

List of experiments:

1. Measurement of temperature using thermocouple or RTD or Thermistor and to find their characteristics.
2. Measurement of high temperature using radiation or Optical pyrometer.
3. Measurement of pressure using LVDT or Strain gauge transducer.
4. Calibration of pressure gauge using Dead Weight Tester.
5. Measurement of level using air purge or capacitance type level detector.
6. Measurement of flow using magnetic flow meter or Ultrasonic flow meter.
7. Calibration of thermocouple/Bimetallic thermocouple/Resistance thermocouple.
8. Calibration of Pressure gauge/ Pnuematic pressure recorder/ Differential pressure recorder.
9. Calibration of Orificemeter/ Venturimeter / Rotameter/ Gas flow meter.
10. Estimation of viscosity by Redwood/ Saybolt/ Ostwald viscometer.
11. Calibration of pH meter.
12. Calibration of Conductivity meter.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

3CH202PC/3CT202PC: CHEMICAL ENGINEERING ANALYSIS (PCC)

Subject Code	Title	Credits- 03		
3CH202PC/3CT202PC	Chemical Engineering Analysis	L	T	P
Semester: III	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives:

1. To understand the transport phenomenon, internal forces and molecular speed in gases.
2. To understand the electrical properties of fluid.
3. To know the rate, order, energy of activation of chemical reactions and their determination.
4. To know the use of kinetics and thermodynamics to elucidate mechanisms of reactions.
5. To understand the basic concepts, the Ist and IInd Laws of Thermodynamics, Thermodynamic functions and their applications.
6. To predict the high and low quantum yield photochemical reactions and to know about advanced spectroscopic analysis techniques.

Course Outcomes: After completion of the course the students will be able:

1. Evaluate the properties of non-ideal gases, Intermolecular forces in gas, critical phenomenon & probability consideration of molecular speed.
2. Solve problems involving root mean square, average and most probable speeds & critical constants.
3. Evaluate the specific rate, order and energy of activation of chemical reactions.
4. Know the fundamental concepts related to homogeneous and heterogeneous catalysis, mechanisms of industrially important reactions, surface phenomenon and adsorption isotherms.
5. Apply mass and energy balances to closed and open systems, Rationalize bulk properties and processes using thermodynamic considerations
6. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques and spectroscopic methods for identification of compounds.

SECTION-A

UNIT I: Surface, interfacial chemistry, and catalysis: (08Hrs)

Adsorption, types of adsorptions, Adsorption isotherms, Langmuir theory of adsorption, BET adsorption isotherm and its application for determination of surface area of fine powder. Homogeneous and heterogeneous catalysis, criteria of catalyst. Theory of heterogeneous and Homogeneous catalysis, Lewis acid-base catalysts, organometallic catalysts and industrial examples, Auto and enzyme catalysis.

UNIT II: Electro analytical Methods: (08Hrs)

Introduction, Application of standard electrode potential, Application of Oxidation/Reduction potential, electrochemical cells, Types of electroanalytical methods; Potentiometry, pH metry, Conductometry

UNIT III: Thermal Analysis techniques: (07Hrs)

Introduction, Principles, Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA)

SECTION-B

UNIT IV: Kinetics and Separations: (07 Hrs)
Introduction, Rate of chemical reaction, Introduction to Chromatographic separations, Principles and application of Gas Chromatography (GC), High performance liquid chromatography (HPLC)

UNIT V: Photochemistry and Modern Analytical techniques: (07Hrs)
Photochemical Reaction, Lambert and Beer' Law, Laws of photochemical equivalence, quantum efficiency and its determination, low & high quantum yield reactions, Photosensitization

UNIT VI: **Spectroscopic techniques and applications:** (08Hrs)
Principles and applications of UV-VI Sspectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Principle and applications of Infrared (IR), Nuclear Magnetic Resonance (NMR) Spectroscopy.

Text Books/ Reference Books Recommended:

- Principles of Instrumental Analysis, Skoog Douglas A, F James Holler, Stanley R , Cengage 7th Ed
- Fundamentals of Analytical Chemistry, Douglas A, Donald M, James F, Stanley R, Cengage 10th Ed
- Physical Chemistry, P.W. Atkins and J.D. Paula, Oxford University Press.
- Physical Chemistry , K.J. Laidler and J.M. Meiser, CBS Publisher
- Chemical kinetics and catalysis , R. J. Masel, John Wiley publications
- Handbook of conducting polymers, Skotheim, Elsenbaumer and Reynolds, Marce Dekker.
- Fundamentals of spectroscopy ,Banwell, Tata McGraw-Hill
- Physical chemistry of surfaces, Arthur W. Adamsons, Alice P. Gast, John Wiley publications
- Principle of Heterogeneous catalysis, J.M.Thomas, W.J. Thomas, John Wiley publications

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH204PC/3CT204PC: CHEMICAL ENGINEERING ANALYSIS LAB. (PCC Lab.)

Subject Code	Title	Credits-01		
3CH204PC/3CT204PC	Chemical Engineering Analysis Lab.	L	T	P
Semester: III	Total Contact Hours: 2 Hrs / Week	0	0	2

List of experiments:

Objective: To provide the practical knowledge of analysis techniques by classical and instrumental methods for developing experimental skill to built technical competence.

1. Determination of critical temperature of phenol-water system
2. Determination of order of reaction and specific rate constant of hydrolysis of methyl acetate.
3. Study of kinetics of second order reaction.
4. Determination of relative strength of two acids by kinetic study of reaction
5. Determination of energy of activation of reaction
6. Determination of equivalent conductivity of strong electrolytes at infinite dilution.
7. Determination of transport number
8. Determination of equivalence point of titration by conductance measurement.
9. Potentiometric titration between strong acid and strong base.
10. Verification of Beer- Lambert's law and determination of concentration of unknown solution.
11. Verification of Freundlich and Langmuir isotherm.
12. Determination of refractive index.
13. Determination of solubility of sparingly soluble salts by EMF measurement.
14. Determination of heat of neutralization & ionization of acetic acid
15. Determination of ΔH and ΔS of monobasic acid by measuring its solubility at different temperatures.
16. Determination of specific rotation of cane sugar by polarimetry.
17. **Any advance methods of chemical analysis available in all labs of the department.**

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

Evaluation Scheme:

- **Internal Assessment** : **25 Marks**
  - ✓ Teaching Evaluation Components : 20Marks
  - ✓ Class Attendance : 05Marks
- **External University Practical Examination** : **25 Marks**

3CH205M: Environmental Pollution: Policies and Regulations. (MDM –I)

Subject Code	Title	Credits- 02		
3CH205M	Environmental Pollution: Policies and Regulations	L	T	P
Semester: III	Total contact hours: 2 hrs / week	2	-	-

Course Objectives:

1. Understanding the fundamentals of pollution
2. Analyzing the impacts of pollution
3. Studying pollution control methods
4. Evaluating environmental regulations and policies
5. Developing critical thinking skills
6. Promoting environmental awareness and sustainability

Course Outcomes: After successful completion of this course student will be able to:

1. Classify different types of environmental pollutants (air, water, soil) and their sources.
2. Explain the mechanisms and pathways of pollutant dispersion in the environment.
3. Analyze the impacts of pollution on ecosystems, human health, and biodiversity.
4. Discuss the principles of environmental toxicology and the effects of hazardous substances.
5. Identify relevant environmental regulations and policies related to pollution control.
6. Design and implement pollution mitigation strategies for different industries and sectors.

SECTION-A

UNIT-I: Environmental Pollution: (9Hrs)

- Definition, Causes, effects and control measures of: a) Air pollution b) Water pollution c) Soil pollution d) Noise pollution e) Nuclear hazards.
- Solid waste Management: Principles, methods and significance
- Disaster management: Floods, Earthquake, Cyclone and Landslides.

UNIT-II: Social issues and the Environment: (9Hrs)

- From unsustainable to sustainable development
- Urban problems related to energy
- Water conservation: rainwater harvesting, watershed management
- Environmental ethics: issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion and nuclear accidents
- Wasteland reclamation
- **Environmental Legislation:** Environment protection Act (1986); Air (prevention and control of pollution) Act (1981-82); Water (prevention and control of pollution) Act (1974); Wildlife protection act (1972); Forest conservation act (1980), Issues involved in enforcement of environmental legislation.

UNIT-III: Human population and the environment: (9Hrs)

- Population growth and variation among nations
- Population explosion-family welfare program
- Environment and human health
- Human rights
- Value education
- HIV/AIDS/ COVID
- Women and child welfare
- Role of information technology in environment and human health.

Reference Books:

- Text Book of Environmental studies, Erach Bharucha, UGC.
- Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd.
- Ecology and Environment, P. D. Sharma.
- Ecology, M. P. Arora, Himalaya Publishing House.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH206OE: De carbonization Technologies (OE-I)

Subject Code	**Title**	**Credits- 03**		
3CH206OE	De carbonization Technologies	L	T	P
Semester: III	Total Contact Hours: 3 Hrs. / Week	3	0	0

Course Objectives:

1. To introduce & understand the concepts of climate change and de carbonization.
2. To examine the significance of energy efficiency and process optimization for reducing carbon emissions.
3. To analyse the economic and environmental impacts of de carbonization.
4. To explore advancements in carbon capture, storage, and utilization.
5. To Study Renewable and Low-Carbon Energy Alternatives.
6. To Evaluate the Economic and Environmental Implications of De carbonization.

Course Outcomes: Upon successful completion, students will be able to:

1. Explain the fundamentals of de carbonization and its importance in global sustainability.
2. Apply Energy Efficiency and Process Optimization Strategies in de carbonization Technologies.
3. Analyse and Select Appropriate Carbon Capture Technologies for carbon reduction in general.
4. Design & Evaluate strategies for implementing de carbonization using Carbon Storage.
5. Explore Renewable and Low-Carbon Energy Solutions.
6. Assess & Analyse the techno-economic feasibility and Environmental Impact Assessments of de carbonization methods.

SECTION- A

Unit-I: Introduction to De carbonization: (7Hrs)

- What is climate change and why it matters.

- Definition and importance of de carbonization.
- How industries contribute to global green house gas emissions and climate crisis.
- Importance of de carbonization in the industries & Role of Chemical Engineering.
- International policies and agreements.(e.g., Paris /Kyoto Agreement, and net-zero targets)
- Sources of Carbon Emissions in the Chemical Industry.

Unit-II: Energy Efficiency and Process Optimization: (8Hrs)

- What is energy efficiency and why it is important.
- Carbon foot print analysis and life cycle assessment.
- Energy management in chemical processes. (Using waste heat to save energy)
- Process intensification and optimization. (Improving processes to use less energy)
- Integration of renewable energy sources. (How renewable energy can help industries)

Unit-III: Carbon Capture Technologies: (8Hrs)

- Simple explanation of carbon capture. (trapping carbon before it goes into the air)
- Post-combustion capture: capturing carbon after burning fuels.
- Pre-combustion capture: cleaning fuel before burning.
- Oxy-fuel combustion: burning fuel with oxygen to make capturing carbon easier.
- Direct air capture (DAC): removing carbon directly from the air.
- Advanced reactors for de carbonization. (e.g., plasma, catalytic and modular reactors)

SECTION- B

Unit-IV: Carbon Storage and Utilization: (7Hrs)

- Geological and ocean storage of CO2. (Where & how captured carbon is stored)
- Mineral carbonation turning captured carbon into useful products. (fuels, chemicals)
- Bio-sequestration. (How nature stores carbon (trees, plants))
- Carbon-to-value technologies. (New ways to make use of carbon)
- Challenges and advancements in carbon capture and Storage.

Unit-V: Renewable and Low-Carbon Energy Sources: (8Hrs)

- Basics of Hydrogen energy, green hydrogen and fuel cells.
- Bio energy and waste-to-energy/ materials conversion. (Using waste &biomass to make energy & waste to materials reducing carbon footprint)
- Introduction to solar, wind and geothermal energy.
- Nuclear energy as a low carbon source. (How nuclear energy can help reduce carbon emissions)
- Innovations and Emerging Technologies: bio plastics, sustainable polymers &Carbon-neutral fuels. (e.g., e-fuels, methanol, ammonia)

Unit-VI: Economic and Environmental Impact Analysis: (7Hrs)

- Techno-economic analysis of de carbonization technologies. (How much de carbonization technologies cost & How these technologies impact the environment)
- Government policies, rules and market-based approaches. (carbon trading, carbon tax)
- Environmental impact assessment. (EIA)
- Simple case studies on how industries cut carbon emissions.

Textbooks:

1. Bhattacharya, S.C., *Energy Economics: Concepts, Issues, Markets, &Governance*, Springer.
2. MacKay,D. J.C., *Sustainable Energy: Without the Hot Air*, UIT Cambridge.
3. *Global Energy Assessment Writing Team*, Global Energy Assessment, Toward a Sustainable Future, UIT Cambridge

Reference Books:

1. Kakaras,E., *De carbonization of Fossil Fuels*, Springer.
2. Rubin,E. S.,etal., *Carbon Capture and Storage*, Cambridge University Press.
3. Rao,S., *Environmental Pollution Control Engineering*, New Age International Publishers.
4. Garg,S. K., *Environmental Engineering*, Khanna Publishers.
5. Ghosh,T.K., *Introduction to Chemical Engineering*, Tata McGraw-Hill.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH207EM/3CT207EM: ENGINEERING ECONOMICS (HSSMC) [ENTREPRENEURSHIP DEVELOPMENT]

Subject Code	**Title**	**Credits-02**		
3CH207EM/3CT207EM	Engineering Economics	L	T	P
Semester: III	Total Contact Hours: 2 Hrs / Week	2	0	0

Course Objectives:

1. **Understanding economics concepts**: Learning the basics of economics, like demand and supply, costing factors, and market structures
2. **Evaluating problems**: Using economic theories to analyze problems
3. **Analyzing costs and benefits**: Using time value of money concepts to evaluate the costs and benefits of engineering projects over time
4. **Formulating economic outcomes**: Estimating and evaluating the economic outcomes of different alternatives
5. **Applying cost analysis methods**: Learning how to use cost analysis methods like equivalence, value measurement, and interest relationships
6. **Using problem-solving methods**: Learning how to use problem-solving methods to make decisions in the face of Privatization and Globalization.

Course Outcomes:

1. **Economic analysis**: Students can perform economic analysis to evaluate the impact of financial factors on projects.
2. **Investment planning**: Students can analyze investment planning and cost controls.
3. **Cost-benefit analysis**: Students can perform cost-benefit analysis to evaluate the economic outcomes of engineering alternatives.
4. **Time value of money**: Students can account for the time value of money in economic analyses.
5. **Economic decision-making**: Students can make economic decisions using present worth, annual worth, future worth, and capitalized cost.

6. **Scope of Indian Economy in Privatization & Globalization**: Students can make decisions to evaluate the scope of business in global scenario.

SECTION A

UNIT-I: Nature and scope of economics, Demand and Supply, Demand: concepts, specification, types of demand. Demand Analysis: significance of demand analysis, law of diminishing utility, consumer surplus. Demand Forecasting: concept of forecasting, types of forecast, steps in demand forecasting, techniques of demand forecasting. (9Hrs)

UNIT-II: Market: Meaning, types of market – Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition. Inflation: Causes, measurement, effects, controlling of inflation. (9Hrs)

UNIT-III: Nature and characteristics of Indian economy, Privatization – meaning, merits and demerits.
Globalisation of Indian economy – merits and demerits. Concepts of VAT, WTO. Banking, Foreign exchange. (9Hrs)

BOOKS RECOMMENDED:

- ManagerialEconomics :K. K. Seo, RichardD. Irwin Inc.
- EngineeringEconomics : J. L. Riggs,McGrawHill,NewYork,Latest Edition.
- ManagerialEconomics :AdhikaryM.,KhoslaPub.House,NewDelhi.
- Small BusinessManagement Fundamentals:Dan Strenhoff andJ.F.Burgess,McGrawHillBookCompany.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

3CH208VE/3CT208VE: Environmental Studies (VEC- Environmental Science)

Subject Code	**Title**	**Credits- 02**		
3CH208VE/3CT208VE	Environmental Studies	L	T	P
Semester: III	Total contact hours: 2 hrs / week	2	-	-

Course Objectives:

1. To introduce & understand the concepts of climate changes in environment
2. To examine the significance of environmental degradation.
3. To analyse the economic and environmental impacts on natural recourses.
4. To explore advancements in environment protection.

5. To Study Renewable and Non Renewable Energy Alternatives.
6. To Evaluate the Economic and Environmental Implications on living beings.

Course Outcomes: Upon successful completion, students will be able to:

1. Explain the fundamentals of climate change and its importance in global sustainability.
2. Apply Energy Efficiency and Process Optimization Strategies in environmental protection Technologies.
3. Analyse and Select Appropriate Technologies for environment protection in general.
4. Design & Evaluate strategies for implementing bio-diversity in ecosystem.
5. Explore Renewable Energy Solutions.
6. Assess & Analyse the techno-economic feasibility and Environmental Impact Assessments of ecosystem, biodiversity and it's conversation methods.

SECTION-A

UNIT-I:
(a) The Multidisciplinary nature of environmental studies: (9Hrs)
Definition, Principles, Scope and importance, Need for public awareness.

(b) Natural Resources: Renewable and non-renewable resources:
Availability, uses, over exploitation and associated environmental problems related to following Natural resources:

- Mineral Resources: Use and Over exploitation, environmental effects of extraction.
- Food Resources: Use and Over exploitation, deforestation, case study.
- Energy Resources: Growing energy needs, renewable and nonrenewable energy sources, case study.
- Role of individual in conservation of natural resources.

UNIT-II: Ecosystems: (9Hrs)

- Concept and components of an ecosystem.
- Types of ecosystems.
- Structure and function of forest and pond ecosystem.
- Energy flow in the ecosystems.
- Food chains, food webs and ecological pyramids.
- Ecological succession: General mechanism.

UNIT-III: **Biodiversity and its Conservation:** (9Hrs)

- Introduction, definition, and types of biodiversity.
- Bio-geographical classification of India.
- India as a mega-diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts.
- Endangered and endemic species of India.
- Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Reference Books:

- Text Book of Environmental studies, Erach Bharucha, UGC.
- Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd.
- Ecology and Environment, P. D. Sharma.
- Ecology, M. P. Arora, Himalaya Publishing House.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **20 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 05Marks
- ✓ Teaching Evaluation Components : 05Marks
  (Viva Voce / Assignments / Report Writing etc.)
- ✓ Class Attendance : 05Marks
- **End-Semester Examination** : **30 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

B.Tech.(Chemical Engineering) Double Minor-I: Chemical Process Safety

3CH260DM1: **Industrial Hygiene and Occupational Health (PCC)**

Subject Code	**Title**	**Credits-03**		
3CH260DM1	Industrial Hygiene and Occupational Health	L	T	P
Semester:III	Total Contact Hours	3	0	0

Course Objectives: The course aims to:

1. Provide a comprehensive understanding of health, hygiene, and occupational hazards in various workplaces.
2. Identify and classify different types of chemical hazards, their sources, and their effects on human health.
3. Educate on the importance of personal protective equipment (PPE) and effective housekeeping practices for workplace safety.
4. Explain occupational diseases, their causes, prevention methods, and workplace health management strategies.
5. Analyze occupational hazards, including chemical, physical, biological, ergonomic, and psychosocial risks, and their adverse health effects.
6. Equip learners with fundamental first aid skills to handle workplace injuries and medical emergencies.

Course Outcomes: Upon successful completion of this course, students will be able to:

1. Define and explain key concepts related to health, hygiene, hazards, and occupational diseases.
2. Identify chemical hazards, interpret safety labels and pictograms, and understand exposure risks and toxicity indicators.
3. Select and use appropriate PPE for different workplace hazards and implement good housekeeping practices.
4. Recognize common occupational diseases, evaluate workplace injuries, and recommend preventive measures.
5. Assess various occupational hazards and their impact on worker health, implementing suitable control measures.
6. Demonstrate basic first aid techniques, including CPR, burn treatment, fracture management, and wound care.

SECTION-A

Unit I: Definition: (7Hrs)

Definition of Health, Hygiene, Hazards, and Occupational Diseases. Control measures for occupational hazards. Importance of personal hygiene.

Unit II: Chemical Hazards: (8Hrs)

Definition and classification of chemical hazards. Methods of identifying chemical hazards. Chemical labels and pictograms. National Fire Protection Association (NFPA) codes. Sources of chemical hazards in industries and daily life. Routes of exposure (inhalation, ingestion, dermal contact). Short-term and long-term health effects. Dose-response relationship, LD50, and other toxicity indicators. Occupational exposure limits (OELs, PELs, TLVs).

Unit III: Personal Protective Equipment (PPE) & Housekeeping: (7Hrs)

Types of PPE: Head, ears, eyes, hands, feet, and body protection. Respiratory PPE, types, and maintenance. Importance of housekeeping. Elements of an effective housekeeping system. Benefits of good housekeeping. Costs of poor housekeeping.

SECTION-B

Unit IV: Occupational Health (7Hrs)

Definition of occupational health. Common occupational diseases. Methods of preventing occupational diseases. Evaluation of injuries. Occupational health management services at the workplace.

Unit V: Occupational Hazards (8Hrs)

- **Adverse health effects from noise:** Hearing loss, tinnitus, stress, and reduced productivity.
- **Adverse health effects from chemicals:** Poisoning, respiratory diseases, skin disorders, and cancer.
- **Adverse health effects from biological hazards:** Infections, allergic reactions, and toxin-related illnesses.
- **Adverse health effects from physical hazards:** Burns, radiation sickness, heat stress, and frostbite.
- **Adverse health effects from ergonomic hazards:** Musculoskeletal disorders, repetitive strain injuries, and posture-related pain.
- **Adverse health effects from psychosocial hazards:** Stress, anxiety, depression, and workplace violence-related trauma.

Unit VI: Fundamentals of First Aid (8Hrs)

Introduction to first aid. Treatment for burns, fractures, suffocation, toxic ingestion, and bleeding wounds. Cardiopulmonary resuscitation (CPR) and artificial respiration.

Text Book :

1) Occupational Health and Hygiene in IndustriesBy Raja Sekhar Mamillapalli, Visweswara Rao Pasumarthi.

Reference Book :

1) Cheremisinoff, N. p., Cheremisinoff P. N., “Hazardous Materials and Waste Management: A Guide for the Professional Hazards Manager”, Noyes Publications, 1995.

2) Hunter’s Diseases of occupations – Baxter, Adams, Aw, Cockcroft & Harrington – 9th Edition

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**
- ✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
- ✓ Teaching Evaluation Components : 10Marks
  (Viva Voce / Assignments / Report Writing/ Field Work etc.)
- ✓ Class Attendance : 10Marks
- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

B.Tech.(Chemical Engineering) Double Minor-II: Biofuels Technology

3CH264DM2: **Biofuels - Types and Applications (PCC)**

Subject Code	**Title**	**Credits- 03**		
3CH264DM2	Biofuels- Types and Applications	L	T	P
Semester: III	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives:

7. To provide the knowledge about properties, composition, features of bio fuels and uses of biomass.
8. To provide the students a substantial knowledge of bio fuel production technologies.
9. To provide knowledge about the process of biogas production and methods of production of biodiesel and comparison of the standards to the conventional diesel.
10. To provide knowledge about the production of lipids, bio hydrogen from different bacteria and algae.
11. To provide knowledge about the fuel cell technology.
12. To explore the concept of Biofuels and their environmental impacts.

Course Outcomes: After successful completion of the course the students will be able:

7. Describe the functional principle of biofuel technologies in small and large scale.
8. Describe the main steps and components in bioethanol, biodiesel and biogas production.
9. Participate actively in teamwork and work with case related problem solving.
10. Work with professional problem solving in an industrial environment.
11. Work in other fields of engineering.
12. Will create the awareness of environmental protection among society.

SECTION- A

Unit- I: Types and Composition of Biomass: Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemi cellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; trichodermacellulases; bacterial cellulases; and comparison with degradation of high starch crops. (7Hrs)

Unit- II: Introduction of biofuels: Sources of energy,, availability of bio mass, composition of biomass, terrestrial biomass, aquatic biomass.Physical and chemical properties of biomass. Useful and undesirable features of biofuels. (7Hrs)

Unit- III: Biogas: The substrate, the digester, the microorganisms, the process of bio gas production, factors affecting bio gas yields, advantages, disadvantages. Bioethanol : Bioethanol vs. Petrol, production of bio ethanol, ethanol recovery. Bio butanol.Properties and standards of bioethanol. Lignocellulosic biomass composition and characterizations. (8Hrs)

SECTION- B

Unit- IV: Sources and processing of biodiesel (fatty acid methyl ester): nature of lipids, especially fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). (7Hrs)

Unit- V: Hydrogen Production: - Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production - Storage of Hydrogen - Gaseous, Cryogenic and Metal hydride. Bio hydrogen : Production of bio hydrogen from anaerobic bacteria, photosynthetic algae, photosynthetic - hydrogenase system. Pyrolysis, bio-oil upgradation. (8Hrs)

Unit- VI: Engineering, economics and environmental issues of biodiesel: major policies and regulations pertaining to the production, distribution, and use of biodiesel. Comparison of bio diesel with conventional diesel. Standards of bio diesel, current technologies and challenges. (8Hrs)

Text Books:

1. Robert C. Brown - Biorenewable Resources: Engineering,
2. New Products from Agriculture, Wiley - Blackwell Publishing, 2003

Reference Books:

1. Samir K. Khanal-Anaerobic Biotechnology for Bioenergy Production: Principles and Applications, Wiley - Blackwell Publishing 2008
2. Martin Kaltschmitt, Hermann Hofbauer - Biomass Conversion and Biorefinery, Springer Publishing,

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
✓ Teaching Evaluation Components : 10Marks
2. (Viva Voce / Assignments / Report Writing/ Field Work etc.)
✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

B.Tech.(Chemical Engineering) Double Minor-III: Petrochemical Technology

3CH268DM3: Petroleum Exploration and Recovery Techniques (PCC)

Subject Code	Title	Credits- 03		
3CH268DM3	Biofuels- Types and Applications	L	T	P
Semester: III	Total Contact Hours: 3 Hrs / Week	3	0	0

Course Objectives:

13. To enable the students to understand basic principles of petroleum geology.
14. To enable the students to get acquainted with geological exploration methods.
15. To enable the students to understand various well Drilling Equipments & Drilling operations.
16. To enable the students to understand and follow the concepts of oil and gas production & processing techniques.
17. To provide knowledge about the petroleum exploration technology.
18. To explore the concept of petroleum recovery.

Course Outcomes: After successful completion of the course the students will be able:

13. Understand & apply the knowledge of petroleum geology.
14. Understand the various rocks along with migration of oil & gas from source rock to reservoir rock.
15. Get the knowledge about the accumulation of oil and gas.
16. Analyze and compare various drilling operations and associated equipments.
17. Recognize information about the basic concepts of Crude Oil Recovery.
18. Will create the awareness of fossil fuels among society.

SECTION- A

Unit- I: Origin and Occurrence of Petroleum Origin of oil–Rock Cycle-Important factors that control petroleum occurrence – Source, cap and reservoir rocks-traps for oils and gas and their structural details. (7Hrs)

Unit- II: Methods of Surface and Subsurface Exploration Geological exploration methods, Geophysical exploration methods. (7Hrs)

Unit- III: Theories and Accumulation of Oil and Gas Kerogen composition, classification, isolation, Properties of petroleum and gas in rocks, porosity, permeability, connate water, electrical resistivity, compressibility of rocks, phase behavior, shrinkage, viscosity, compressibility, permeability, mobility, interfacial tension, wetting capillary pressure and forces of oil and flows. (8Hrs)

SECTION- B

Unit- IV: Drilling and Drilling Fluids Cable tool and Rotary Drilling. (7Hrs)

Unit- V: Turbo drilling, drilling of wells (vertical, deviated and horizontal). Fluids, composition and functions, rates, coring, cementing, acidization, fracturing, completion and testing of well logging. (8Hrs)

Unit- VI: Recovery Techniques Primary recovery, Secondary and Tertiary enhanced oil recovery.

(8Hrs)

Reference Books:

3. An introduction to Physics and Chemistry of Petroleum: R R F Kinghorn
4. Composition and properties of Petroleum: H J Neumann, B P Lahme and B Severin
5. Fundamental Aspects of Petroleum geochemistry: Negi and Colombo
6. Modern Petroleum Technology: G D Hobson and W Pohl

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
✓ Teaching Evaluation Components : 10Marks
3. (Viva Voce / Assignments / Report Writing/ Field Work etc.)
✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)

B.Tech.(Chemical Engineering) Double Minor-IV: Polymer Technology

3CH272DM4: Polymer Science & Technology (PCC)

Subject Code	**Title**	**Credits- 03**		
3CH272DM4	Polymer Science & Technology	L	T	P
Semester: III	Total contact hours: 3hrs/week	3	0	0

Course Objectives:

1. To Understand Polymer Fundamentals and Gain the knowledge of polymer structures, classifications, and synthesis methods
2. Explore Polymer material and their Properties and Study the relationship between polymer structure, processing techniques, and material properties
3. Develop Practical Skills and learn characterization techniques
4. Apply Polymer Science in Industry and understand real word application
5. Promote Ethical and Sustainable Practices like Environmental Impact, recycling
6. Foster Innovation in Polymer Design in polymer composite and sustainable materials

Course Outcomes:

1. Demonstrate the ability to understand , analyse perform polymerization reactions.
2. Students will acquire proficiency in Polymer Properties and Conduct experiments to measure mechanical strength
3. Students will demonstrate the ability to perform Design Polymer-Based Solutions – Develop new materials or improve existing ones for industrial applications
4. Students will be able to Operate Processing Equipment – Gain hands-on experience with extrusion, injection molding, and compounding techniques
5. Students will Evaluate Polymer Performance – Assess material suitability for specific applications.
6. Students will gain expertise in Technical Findings in Present research, reports, and project outcomes effectively to peers and industry professionals .

SECTION- A

Unit- I: History of Polymer, Introduction to polymers, classification & types of polymers. Nomenclature. Thermoplastics and thermosets. Linear, branches an cross linked polymer Block and graft copolymer. Avg. Mol. wt, Number Avg. Mol. Wt., degree of polymerization, poly dispersity, and mol. Wt. distribution, size of polymer molecules, (8Hrs)

Unit- II: History and development of polymer materials. Basic raw & materials for polymer and their availability, Production, Properties and application of Polyolefin's, Vinyl halides, PVC. (8Hrs)

Unit- III: Polymer processing techniques: Injection moulding, compression moulding, transfer moulding. (7Hrs)

SECTION-B

Unit- IV: Polymer Processing Techniques: Extrusion molding, Blow molding, Thermoforming. Etc. (8Hrs)

Unit- V: Polymer Degradation and recycling: Types of degradation, Thermal degradation, Mechanical Degradation, Degradation by ultrasonic waves, photo degradation, Biodegradation. (7Hrs)

Unit- VI: Polymers in agricultural applications: green houses, mulches, control release of agricultural chemicals, seed coatings, etc., polymers in construction and building applications, polymers in cosmetics and food applications. (7Hrs)

Text Books:

1. Plastic Materials : J.A.Brydson
2. Polymer Science: V.R. Gowariker
3. Polymer Science & Technology of Plastics & Rubbers : P.Ghosh**.**

Reference Book:

1) Manufacture of Plastics: Maya Smith.
2) Fibers Fillers Plastics & Rubbers: W.J.Roff.
3) Plastics Materials Proof & Application (1, 2, 3) : Birley.
4) Hand Book of Plastics & Elastomers : Harmansen.
5) Plastic Materials Handbook: Athalye.
6) Handbook of Plastics Materials & Technology : Rubin.

Evaluation Scheme: Each Unit is Weighed 10 Marks

- **Internal Assessment** : **40 Marks**

✓ Class Test-I (MCQ/ Subjective/ Objective) : 10Marks
✓ Class Test–II (MCQ/ Subjective/ Objective) : 10Marks
✓ Teaching Evaluation Components : 10Marks
4. (Viva Voce / Assignments / Report Writing/ Field Work etc.)
✓ Class Attendance : 10Marks

- **End-Semester Examination** : **60 Marks**

(Records of Internal Assessment must be kept with the department / institute at least till 5 years from the admission academic year of the student.)