1. **Programme Educational Objectives (PEOs)**
   Graduates of B. Tech. Petroleum Engineering will
   I. Exhibit a professional and ethical attitude, effective communication skills, teamwork, multidisciplinary approach, and an ability to solve the problems encountered in petroleum sector.
   II. Gain knowledge in basic sciences, mathematics, reservoir engineering and onshore & offshore petroleum engineering.
   III. Have a knowledge and competency in Petrochemical Engineering complemented by the appropriate skills and attributes.
   IV. Understand the theory and applications of analytical equipment used in industries for testing the quality of petroleum and its products.
   V. Address to meet the world’s ever-increasing demand for hydrocarbon fuel, and waste management.

2. **Programme Outcomes (POs)**
   On successful completion of the programme,
   I. Graduates will be able to demonstrate their knowledge professionally and shoulder ethical responsibilities.
   II. Graduates will be able to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
   III. Graduates will be able to identify, formulate, and solve engineering problems related to petroleum industry.
   IV. Graduates will be capable to design experiments, analyze and interpret data.
   V. Graduates will be able to meet the world’s ever-increasing demand for hydrocarbon fuel, reservoir engineering and waste management.
   VI. Graduates will be able to communicate effectively and work in interdisciplinary groups.
   VII. Graduates will have knowledge to analyze petroleum products.
   VIII. Graduates will understand the characteristics of source and reservoir engineering.
   IX. Graduates will become familiar with environmentally sound exploration, evaluation and recovery of oil, gas and other fluids in the earth.
   X. Graduates will understand the prerequisites of onshore & offshore reservoir engineering.

3. **PEOs / POs Mapping**

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### SUBJECT AREAWISE DETAILS

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**SUMMARY**

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OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills.

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY & FRIENDS 12


UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading - comprehension questions (multiple choice questions and/or short questions/open-ended questions)-inductive reading - short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts). Writing - paragraph writing - topic sentence - main ideas - free writing, short narrative descriptions using some suggested vocabulary and structures. Listening - telephonic conversations. Speaking - sharing information of a personal kind - greeting - taking leave. Language development - prepositions, conjunctions. Vocabulary development - guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading - short texts and longer passages (close reading). Writing - understanding text structure-use of reference words and discourse markers-coherence-jumbled sentences. Listening - listening to longer texts and filling up the table - product description-narratives from different sources. Speaking - asking about routine actions and expressing opinions. Language development - degrees of comparison - pronouns - direct vs indirect questions. Vocabulary development - single word substitutes - adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading - comprehension-reading longer texts - reading different types of texts - magazines. Writing - letter writing, informal or personal letters - e-mails-conventions of personal email. Listening - listening to dialogues or conversations and completing exercises based on them. Speaking - speaking about oneself - speaking about one's friend. Language development - Tenses - simple present - simple past - present continuous and past continuous. Vocabulary development - synonyms - antonyms.
OBJECTIVES:

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.
UNIT I  DIFFERENTIAL CALCULUS  12
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II  FUNCTIONS OF SEVERAL VARIABLES  12

UNIT III  INTEGRAL CALCULUS  12
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV  MULTIPLE INTEGRALS  12

UNIT V  DIFFERENTIAL EQUATIONS  12

OUTCOMES :
After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS :
2. James Stewart, “Calculus: Early Transcendentals”, Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].
REFERENCES:

PH8151 ENGINEERING PHYSICS

OBJECTIVES:
- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER

UNIT II WAVES AND FIBER OPTICS

UNIT III THERMAL PHYSICS

UNIT IV QUANTUM PHYSICS

UNIT V CRYSTAL PHYSICS
- Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth
OUTCOMES:

Upon completion of this course,

- The students will gain knowledge on the basics of properties of matter and its applications,
- The students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- The students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- The students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- The students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

REFERENCES:

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT
UNIT II SURFACE CHEMISTRY AND CATALYSIS


UNIT III ALLOYS AND PHASE RULE

UNIT IV FUELS AND COMBUSTION

UNIT V ENERGY SOURCES AND STORAGE DEVICES
Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H₂-O₂ fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:
• The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

REFERENCES:

GE8151         PROBLEM SOLVING AND PYTHON PROGRAMMING     L T P C
                  3 0 0 3

COURSE OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures — lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I       ALGORITHMIC PROBLEM SOLVING                  9
Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II      DATA, EXPRESSIONS, STATEMENTS               9
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III     CONTROL FLOW, FUNCTIONS                    9
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV      LISTS, TUPLES, DICTIONARIES                 9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V       FILES, MODULES, PACKAGES                   9
Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:
Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


**REFERENCES:**


**GE8152 ENGINEERING GRAPHICS**

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<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**OBJECTIVES:**

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

**CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

**UNIT I PLANE CURVES AND FREEHAND SKETCHING** 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE** 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points.
Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12
Principles of isometric projection – isometric scale – Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method.

TOTAL: 90 PERIODS

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

- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and project isometric and perspective sections of simple solids.

TEXT BOOK:

REFERENCES:

Publication of Bureau of Indian Standards:

Special points applicable to University Examinations on Engineering Graphics:
1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.

The examination will be conducted in appropriate sessions on the same day.

GE8161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

OBJECTIVES:
- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS
1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton’s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED
Python 3 interpreter for Windows/Linux

OUTCOMES:
Upon completion of the course, students will be able to
- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.
BS8161 PHYSICS AND CHEMISTRY LABORATORY
(Common to all branches of B.E. / B.Tech Programmes) 0 0 4 2

OBJECTIVES:
- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)
1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young’s modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometry.

1. Estimation of HCl using Na₂CO₃ as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler’s method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
12. Pseudo first order kinetics-ester hydrolysis.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOMES:
- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:

HS8251 TECHNICAL ENGLISH

L T P C
4 0 0 4

OBJECTIVES: The Course prepares second semester engineering and Technology students to:
- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TECHNICAL ENGLISH

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises
Speaking –Asking for and giving directions
Reading – reading short technical texts from journals, newspapers
Writing- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations
Vocabulary Development- technical vocabulary
Language Development—subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS

Listening- Listening to longer technical talks and completing exercises based on them
Speaking – describing a process
Reading – reading longer technical texts- identifying the various transitions in a text
Paragraphing- Writing- interpreting charts, graphs
Vocabulary Development- vocabularyused in formal letters/emails and reports
Language Development- impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR

Listening- Listening to classroom lectures/ talks on engineering/technology
Speaking – introduction to technical presentations
Reading – longer texts both general and technical, practice in speed reading
Writing-Describing a process, use of sequence words
Vocabulary Development- sequence words- Misspelled words
Language Development- embedded sentences

UNIT IV REPORT WRITING

Listening- Listening to documentaries and making notes
Speaking – mechanics of presentations
Reading – reading for detailed comprehension
Writing- email etiquette
Writing- job application – cover letter –Résumé preparation (via email and hard copy)
Vocabulary Development- finding suitable synonyms-paraphrasing.
Language Development- clauses- if conditionals.

UNIT V          GROUP DISCUSSION AND JOB APPLICATIONS          12
Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- verbal analogies Language Development- reported speech

TOTAL : 60 PERIODS

OUTCOMES: At the end of the course learners will be able to:

• Read technical texts and write area- specific texts effortlessly.
• Listen and comprehend lectures and talks in their area of specialisation successfully.
• Speak appropriately and effectively in varied formal and informal contexts.
• Write reports and winning job applications.

TEXT BOOKS:

REFERENCES
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007

MA8251          ENGINEERING MATHEMATICS – II          L T P C
4 0 0 4

OBJECTIVES :
• This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I          MATRICES          12
UNIT II VECTOR CALCULUS
12
Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green’s, Gauss divergence and Stoke’s theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS
12
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c$, $cz$, $\frac{1}{z}$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION
12

UNIT V LAPLACE TRANSFORMS
12

TOTAL: 60 PERIODS

OUTCOMES:
After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green’s theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS:

REFERENCES:
PH8254  PHYSICS OF MATERIALS
(Common to courses offered in Faculty of Technology
except Fashion Technology)

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OBJECTIVES:
- To introduce the physics of various materials relevant to different branches of technology

UNIT I  PREPARATION OF MATERIALS

UNIT II  CONDUCTING MATERIALS

UNIT III  SEMICONDUCTING MATERIALS

UNIT IV  DIELECTRIC AND MAGNETIC MATERIALS

UNIT V  NEW MATERIALS AND APPLICATIONS

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course, the students will able to
- gain knowledge on phase diagrams and various material processing methods,
- acquire knowledge on basics of conducting materials, superconductors and their applications
- get knowledge on the functioning of semiconducting materials and their applications in LED and solar cells,
- understand the functioning of various dielectric and magnetic materials,
- have the necessary understanding on various advanced materials.

TEXT BOOKS:

REFERENCES

CY8291 ORGANIC CHEMISTRY

OBJECTIVE:
- To enable the students to learn the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

UNIT I ORGANIC REACTION MECHANISM
Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene CH₃ – CH = CH₂.

UNIT II CARBOHYDRATES
Introduction – mono and disaccharides – important reactions – polysaccarides – starch and cellulose – derivatives of cellulose – carboxy methyl cellulose and gun cotton – structural aspects of cellulose

UNIT III POLYNUCLEAR AROMATICS AND HETEROCYCLES
Classification of polynuclear aromatics. naphthalene preparation, properties and uses. Classification of heterocyclic compounds. Furan, thiophene, pyrrole, pyridine, quinoline, isoquinoiline - preparation, properties and uses.

UNIT IV AMINO ACIDS AND PROTEINS
Classification, preparation (Strecker, Skraup, Gabriel phthalimide) and properties of Amino acids.

UNIT V DRUGS & DYES

OUTCOMES:
• At the end of the course students will have knowledge on various reaction mechanism, preparation of organic compounds and their properties.

TEXTBOOKS:

REFERENCES:

BE8256 BASIC MECHANICAL ENGINEERING

OBJECTIVE
• To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I LAWS OF THERMODYNAMICS
Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III AIR STANDARD CYCLES
Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND TEAM
Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke
cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.

Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle. Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALNCING 12
Definition of Kinematic Links, Pairs and Kinematic Chains; Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL : 60 PERIODS

OUTCOME
- Students should learn thermodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines etc.,
- Students should be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms

TEXT BOOKS

REFERENCES

PE8201 INTRODUCTION TO PETROLEUM ENGINEERING L T P C
3 0 0 3

OBJECTIVE
- To provide an overview of petroleum industry. Petroleum exploration and exploitation techniques, oil and gas reserve identification and evaluation. Drilling and production of oil and gas. Desposal of effluents.

UNIT I
Earth science - occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism.

UNIT II
9
Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipments. Drilling fluids and cementing.

UNIT III

UNIT IV
Petroleum exploitation – well testing, production potential and well performances. Material balance, Artificial lift, Improved recovery methods.

UNIT V

TOTAL : 45 PERIODS

TEXT BOOKS / REFERENCE:
3. Introduction to Petroleum Engineering by Geltin

CY8281 ORGANIC CHEMISTRY LABORATORY L T P C
0 0 4 2

OBJECTIVE:
- To learn basic principles involved in analysis and synthesis of different organic derivatives.

LIST OF EXPERIMENTS
1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions:
   a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester,
   g) primary, secondary and tertiary amines and h) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives (Benzoic acid from Benzaldehyde, hydrolysis of ester and meta- dinitrobenzene from nitrobenzene) .
5. Analysis of proteins.
6. Methodology of filtration and recrystallization.
7. Introduction to organic synthetic procedures:
   i. Acetylation – Preparation of acetanilide from aniline.
   ii. Hydrolysis – Preparation of salicylic acid from methyl salicylate.
   iii. Substitution – Conversion of acetone to iodoform.
   iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
   v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

TOTAL: 60 PERIODS
List of Equipment for a Batch of 30 students

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description of Equipment</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>1.</td>
<td>Bunsen burners</td>
<td>30 Nos.</td>
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<tr>
<td>2.</td>
<td>LPG Cylinder in each row of the Laboratory</td>
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<tr>
<td>3.</td>
<td>Hot Air Oven</td>
<td>2 Nos.</td>
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<tr>
<td>4.</td>
<td>Hot Plate</td>
<td>6 Nos.</td>
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<tr>
<td>5.</td>
<td>Water Bath</td>
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<tr>
<td>7.</td>
<td>Magnetic Stirrers</td>
<td>6 Nos.</td>
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<tr>
<td>8.</td>
<td>Mechanical Stirrers</td>
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<tr>
<td>9.</td>
<td>Refluxion Set up</td>
<td>30 Nos.</td>
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<tr>
<td>10.</td>
<td>Sharp Knives to cut sodium</td>
<td>6 Nos.</td>
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<tr>
<td>11.</td>
<td>Balance</td>
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<tr>
<td></td>
<td>I. Rough balance</td>
<td>2 Nos.</td>
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<td></td>
<td>II. Four digit Balance</td>
<td>1 No.</td>
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<tr>
<td></td>
<td>Desirable</td>
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<tr>
<td></td>
<td>Melting Point apparatus</td>
<td>4 Nos.</td>
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OUTCOME:
- The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions. The student shows their mastery of nomenclature since ethyl bromide is not drawn out. The student analyzes a list of compounds and determines their reactivity.

REFERENCES:

GE8261 ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:
- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

Buildings:
(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.
Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:
   Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
   Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE

Welding:

(a) Preparation of butt joints, lap joints and T-joints by Shielded metal arc welding.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and V-fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
5. Measurement of energy using single phase energy meter.
1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

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

- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL
1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets.
2. Carpentry vice (fitted to work bench) 15 Nos.
4. Models of industrial trusses, door joints, furniture joints 5 each
5. Power Tools: (a) Rotary Hammer 2 Nos
   (b) Demolition Hammer 2 Nos
   (c) Circular Saw 2 Nos
   (d) Planer 2 Nos
   (e) Hand Drilling Machine 2 Nos
   (f) Jigsaw 2 Nos

MECHANICAL
1. Arc welding transformer with cables and holders 5 Nos.
2. Welding booth with exhaust facility 5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2 Nos.
5. Centre lathe 2 Nos.
6. Hearth furnace, anvil and smithy tools 2 Sets.
7. Moulding table, foundry tools 2 Sets.
8. Power Tool: Angle Grinder 2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner One each.
ELECTRICAL
1. Assorted electrical components for house wiring 15 Sets
2. Electrical measuring instruments 10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1 No.
5. Power Tools: (a) Range Finder 2 Nos
   (b) Digital Live-wire detector 2 Nos

ELECTRONICS
1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply

MA8391 PROBABILITY AND STATISTICS

OBJECTIVE:
- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 12
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 12
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 12
One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

UNIT V STATISTICAL QUALITY CONTROL 12
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.
OUTCOMES:
Upon successful completion of the course, students will be able to:

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

TEXT BOOKS:

REFERENCES:

PE8301 RESERVOIR ROCKS AND FLUID PROPERTIES L T P C
3 0 0 3

OBJECTIVES:
To enable the students to understand
- Petroleum reservoir system and fluid properties
- Basic principles and operations in upstream petroleum industry

UNIT I
9

UNIT II
9
UNIT III

UNIT IV

UNIT V

TOTAL: 45 PERIODS

OUTCOME:
- Student will learn the use of Darcy’s Law to calculate permeability of single phase; definition of interfacial tension; use of capillary pressure to determine saturation changes in reservoir; definition of effective and relative permeability; use of drainage/imbibition curves to characterize reservoir relative permeability.

TEXT BOOKS:

REFERENCE:

GE8292 ENGINEERING MECHANICS L T P C
3 2 0 4

OBJECTIVE:
- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I STATICS OF PARTICLES 9+6

UNIT II EQUILIBRIUM OF RIGID BODIES 9+6
UNIT III  PROPERTIES OF SURFACES AND SOLIDS  9+6

UNIT IV  DYNAMICS OF PARTICLES  9+6

UNIT V  FRICTION AND RIGID BODY DYNAMICS  9+6
Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 45+30=75 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- illustrate the vectorial and scalar representation of forces and moments
- analyse the rigid body in equilibrium
- evaluate the properties of surfaces and solids
- calculate dynamic forces exerted in rigid body
- determine the friction and the effects by the laws of friction

TEXT BOOKS:

REFERENCES:

PE8302  FLUIDS AND SOLID OPERATIONS  L T P C
3 2 0 4

OBJECTIVE:
• To impart to the student knowledge on fluid properties, fluid static and dynamic characteristics flow metering and transport, particle mechanics, techniques of solid – fluid separation

UNIT I PROPERTIES OF FLUID
Newtonian fluids Classification of fluid motion Fluid statics – equilibrium of fluid element – pressure variation in a static fluid – Differential analysis of fluid motion – continuity, Euler’s and Bernoulli equation

UNIT II FLOW THROUGH PIPES & BOUNDARY LAYER CONCEPTS
Reynolds number regimes, Flow through pipes – pressure drop under laminar and turbulent flow conditions; boundary layer concepts; different types of flowmeters; Valves, pumps, compressors – characteristics and sizing; Agitation and Mixing;

UNIT III SIZE ANALYSIS
General characteristics of solids, techniques of size analysis; Laws of size reduction, equipments for size reduction

UNIT IV FLOW THROUGH FLUIDIZED BEDS
Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds. Filtration – batch and continuous, filtration equipments - selection, operation

UNIT V CLASSIFIERS
Screening, gravity separation - sedimentation, thickening, elutriation, classifiers - Centrifugal separation - continuous centrifuges, cyclones and hydro cyclones, electrostatic and magnetic separators

TOTAL:75 PERIODS

OUTCOME:
• At the end of this course, the students will be able to understand the principles of fluid mechanics and applications of mechanical operations in process industries.

TEXT BOOKS:

REFERENCES:
energy balance equations for single and network of units and introduce to process simulators.

UNIT I
Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II
Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT III
Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV

UNIT V
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

TOTAL: 75 PERIODS

OUTCOMES:
- Understand the fundamentals of units and stoichiometric equations.
- Write material balance for different chemical process.
- Understand the fundamentals of ideal gas behavior and phase equilbria. Write energy balance for different chemical process.

TEXT BOOKS:

REFERENCE:

EE8352 PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Electric circuit laws, single and three phase circuits and wiring
- Working principles of Electrical Machines
- Various electronic devices and measuring instruments

UNIT I  ELECTRICAL CIRCUITS  9
Basic principles involved in power generation, transmission and distribution, Ohms Law, Kirchoff’s Law, steady state solution of DC circuits, Thevinin’s Theorem, Norton’s Theorem, Superposition Theorem.

UNIT II  AC CIRCUITS  9
Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits, housing wiring, industrial wiring, materials of wiring.

UNIT III  ELECTRICAL MACHINES  9
Principles of operation and characteristics of DC machines. Transformers (single and three phase), Synchronous machines, three phase and single phase induction motors.

UNIT IV  ELECTRONIC DEVICES AND CIRCUITS  9

UNIT V  MEASUREMENTS AND INSTRUMENTATION  9
Introduction to transducers: pressure, temperature, position, electrical measurements, classification of instruments – moving coil and moving iron Ammeter and Voltmeter – multimeters – dynamometer type Wattmeter – three-phase power measurements – energy meter – megger – instrument transformers (CT and PT)

TOTAL: 45 PERIODS

OUTCOMES:
Ability to
- Understand electric circuits and working principles of electrical machines
- Understand the concepts of various electronic devices
- Choose appropriate instruments for electrical measurement for a specific application

REFERENCES:

EE8361  ELECTRICAL ENGINEERING LABORATORY  0 0 4 2

OBJECTIVE:
- To validate the principles studied in theory by performing experiments in the laboratory
LIST OF EXPERIMENTS
1. Load test on DC Shunt & DC Series motor
2. O.C.C & Load characteristics of DC Shunt and DC Series generator
3. Speed control of DC shunt motor (Armature, Field control)
4. Load test on single phase transformer
5. O.C & S.C Test on a single phase transformer
6. Regulation of an alternator by EMF & MMF methods.
7. V curves and inverted V curves of synchronous Motor
8. Load test on three phase squirrel cage Induction motor
9. Speed control of three phase slip ring Induction Motor
10. Study of DC & AC Starters

TOTAL: 60 PERIODS

OUTCOME:
• Ability to perform speed characteristic of different electrical machine

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>NAME OF THE EQUIPMENT</th>
<th>Qty. (Nos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DC Shunt motor</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>DC Series motor</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>DC shunt motor-DC Shunt Generator set</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>DC Shunt motor-DC Series Generator set</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Single phase transformer</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Three phase alternator</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Three phase synchronous motor</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Three phase Squirrel cage Induction motor</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Three phase Slip ring Induction motor</td>
<td>1</td>
</tr>
</tbody>
</table>

ME8362  MECHANICAL ENGINEERING LABORATORY  L T P C  
0 0 4 2

OBJECTIVE:
• To impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

LIST OF EXPERIMENTS
1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test
* Minimum 10 experiments shall be offered.

OUTCOME

- Students will be able to understand Power-generating units such as engines and operate IC engines and conduct tests. They will be able to appreciate the theory behind the functioning of engines. Material properties, their behavior under different kinds of loading and testing can be visualized.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>NAME OF THE EQUIPMENT</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I.C Engine – 2 stroke and 4 stroke model</td>
<td>1 set</td>
</tr>
<tr>
<td>2.</td>
<td>4-stroke Diesel Engine with mechanical loading.</td>
<td>1 No.</td>
</tr>
<tr>
<td>3.</td>
<td>Torsion cylinder Diesel Engine</td>
<td>1 No.</td>
</tr>
<tr>
<td>4.</td>
<td>Universal Tensile Testing machine with double 1 shear attachment –</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>Torsion Testing Machine (60 NM Capacity)</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Impact Testing Machine (300 J Capacity)</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Brinell Hardness Testing Machine</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>Rockwell Hardness Testing Machine</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>Spring Testing Machine for tensile and compressive loads (2500 N)</td>
<td>1</td>
</tr>
</tbody>
</table>

PE8491 CHEMICAL ENGINEERING THERMODYNAMICS L T P C

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.

UNIT I


UNIT II


UNIT III

Refrigeration and liquefaction process, Thermodynamic Potentials, thermodynamic correlation, Maxwell relations, criteria for Equilibria and stability. Clapeyron equation

UNIT IV
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures.

UNIT V
Activity coefficient-composition models, thermodynamic consistency of phase equilibria, Chemical Reaction equilibria, Extent of reaction, equilibrium constant and standard free energy change

TOTAL: 45 PERIODS

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

TEXT BOOKS:

REFERENCES:

PE8401 GEOPHYSICS
OBJECTIVE:
• To review the basic geophysical concepts as used in the petroleum industry; Applications of seismic date in the reservoir mapping and description.

UNIT I

UNIT II

UNIT III
Land and marine geophysical methods. 2D 3D seismic methods. 3D exploration. Non conventional methods, VSP, shear waves and channel waves, seismic data processing, attribute analysis and migration techniques.

UNIT IV

UNIT V

OUTCOME:
- Student would be able to understand: Main geophysical methods; Wave propagation- P and S waves, Alteration at interfaces (reflection/refraction); Seismic method (data gathering and interpretation); Use and limits of seismic in reservoir description.

TEXT BOOKS:

CY8292 CHEMISTRY FOR TECHNOLOGISTS L T P C 3 0 0 3

UNIT I UNIT PROCESSES 9
Nitration, Sulphonation, Halogenation, Esterification, Amination, Saponification and Hydrogenation – Role of the above unit processes in such industries as petroleum, drugs, pharmaceuticals and organic synthesis.

UNIT II REACTION MECHANISMS 9
Free radical, substitutions, electrophilic, addition, aromatic electrophilic substitutions, nucleophilic additions, condensation reactions, nucleophilic substitutions in aliphatic and aromatic compounds, cyclo-additions, rearrangements-Beckmann and Fries rearrangement reactions.

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9
Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test. Solid lubricants – graphite and molybdenum disulphide.

UNIT IV CHEMICALS AND AUXILIARIES 9
Preparation, properties and uses of bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide. Estimation of available chlorine in hypochlorite bleach liquor. Determination of strength of hydrogen peroxide.

UNIT V COLORANTS 9
Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Chemistry and synthesis of azo dye (Methyl red, Methyl orange and Congo red)

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

PE8402  FUNDAMENTALS OF PETROLEUM GEOLOGY  L  T  P  C
4  0  0  4

OBJECTIVES:
To enable the students to
- Have basic understanding of broad array of tools used in the search for and production of hydrocarbon reserves
- Learn the principles of mapping a subsurface reservoir and estimating the volumetrics.

UNIT I  12

UNIT II  12
Introduction to stratigraphy - Litho – Bio- Chronostratigraphy. Geological Time Scale- Introduction to microfossils- types-Importance of Microfossils- Application of microfossil in hydrocarbon application

UNIT III  12

UNIT IV  12
Petroleum traps- definition-types- structural –stratigraphic traps- types and classification of fold, fault, joint; unconformities and pinch outs – identification of structural and stratigraphic traps in the field and in geological section (surface and subsurface)

UNIT V  12
Introduction to plate tectonics - sedimentary basins- types and classification of sedimentary basins- categorization of petroliferous basins of India.
OUTCOME:
- Students able to understand how geologists conduct the search for petroleum resources through the value chain or the life cycle of a petroleum resource.

TEXT BOOKS:

REFERENCES:

PE8403    HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT IN PETROLEUM INDUSTRIES

OBJECTIVE:
- This course would expose the students to identify and assess hazards in any stage of operation, to quantify and manage them as well in petroleum industries.

UNIT I    INTRODUCTION

UNIT II    OCCUPATIONAL HEALTH AND HYGIENE

UNIT III    WORKPLACE SAFETY AND SAFETY SYSTEMS
Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

UNIT IV    TECHNIQUES OF ENVIRONMENTAL SAFETY
UNIT V  
EDUCATION AND TRAINING

Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

TOTAL: 45 PERIODS

OUTCOME:
- Upon completing the course, the students understand the key issues for making petroleum production and processing, cleaner and safe.

REFERENCES:
1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995

CH8591  
HEAT TRANSFER  
L T P C
3 2 0 4

OBJECTIVE:
- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I
Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, - Heat conduction through a series of resistances - Thermal conductivity measurement; effect of temperature on thermal conductivity; Heat transfer in extended surfaces.

UNIT II
Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, flow through packed beds.

UNIT III
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV

UNIT V
Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit
OUTCOMES:
At the end of this course,

- The students would have knowledge in various heat transfer methodology in process engineering.
- To design heat transfer equipments such as furnace, boilers, heat exchangers evaporation

TEXT BOOKS:

REFERENCES:

EQUIPMENT REQUIRED
1. Venturi meter - 1 No.
2. Orifice meter - 1 No.
3. Rotameter - 1 No.
5. Open drum with orifice - 1 No.
6. Pipes and fittings - 1 No.
7. Helical and spiral coils - 1 No.
8. Centrifugal pump - 1 No.
9. Packed column - 1 No.
10. Fluidized bed - 1 No.
LIST OF EXPERIMENTS - Phase-II (minimum 5 Experiments to be conducted)
1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Drop weight crusher
10. Drag on Sphere
11. Effectiveness of screen

EQUIPMENT REQUIRED
1. Sieve shaker - 1 No.
2. Leaf filter - 1 No.
4. Sedimentation Jar - 1 No.
5. Jaw Crusher - 1 No.
7. Cyclone Separator - 1 No.
8. Roll Crusher - 1 No.
10. Drop Weight Crusher - 1 No.
11. Sieves. - 1 No.

TOTAL: 60 PERIODS

OUTCOMES:
• Use variable area flow meters and variable head flow meters
• Analyze the flow of fluids through closed conduits, open channels and flow past immersed bodies. Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties.
• Determine work index, average particle size through experiments by crushers, ball mill and conducting sieve analysis.
• Design size separation equipments such as cyclone separator, sedimentation, Filters etc.

CH8281 CHEMICAL ANALYSIS LABORATORY L T P C
(Minimum of 8 experiments to be conducted) 0 0 4 2

OBJECTIVE:
• To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of nitrite in water, cement, oil, coal and Phenol.

LIST OF EXPERIMENTS
1. Determination of Redwood / Saybolt numbers, kinematic viscosity and viscosity index of Lubricating oils
2. Determination of flash point, fire point, cloud and pour point of oils
3. Determination of acid value and iodine value of oils
4. Determination of COD of water samples
6. Coal Analysis  
   a. Estimation of sulphur present in coal  
   b. Ultimate analysis of coal  
   c. Proximate analysis of coal  
7. Soap Analysis  
   a. Estimation of total fatty acid  
   b. Estimation of percentage alkali content  
8. Flue gas analysis by Orsat's apparatus  
10. Determination of calorific value using bomb calorimeter  
11. Determination of nitrite in water.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description of Equipment</th>
<th>Quantity required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Silica Crucible</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Heating Mantle</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Muffle Furnace</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Hot air oven</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Desiccator</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Vacuum Pump</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Condenser</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Reflux Condenser</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Pensky martens closed cup apparatus</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Cleveland Open cup apparatus</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Cloud point apparatus</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Saybolt Viscometer</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Redwood Viscometer</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Bomb Calorimeter</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>COD reflux</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Orsat apparatus</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>UV-Vis Spectrophotometer</td>
<td>1</td>
</tr>
</tbody>
</table>

TOTAL: 60 PERIODS

OUTCOMES:
- Familiarization with equipment like viscometers, flash and fire point apparatus etc.
- Familiarization of methods for determining COD
- Familiarization of a few simple synthetic techniques for soap

REFERENCES:
1. Environmental pollution analysis, S.M.Khopkar, New age international. 2011
To know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

UNIT I INSTRUMENTATION 15
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.

UNIT II OPEN LOOP SYSTEMS 15
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.

UNIT III CLOSED LOOP SYSTEMS 15
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.

UNIT IV FREQUENCY RESPONSE 15
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.

UNIT V ADVANCED CONTROL SYSTEMS 15
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.

TOTAL: 75 PERIODS

OUTCOME:
- Upon completing the course, the student should have understood controller tuning, type of controller that can be used for specific problems in chemical industry and design of controllers for interacting multivariable systems.

TEXT BOOKS:

REFERENCES:

51
transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity.

UNIT I  ABSORPTION  15
Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II  DISTILLATION  15

UNIT III  LIQUID-LIQUID EXTRACTION  15
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction.

UNIT IV  LEACHING  15
Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank’s system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V  ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS  15
Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultra filtration.

TOTAL: 75 PERIODS

OUTCOME:
- On completion of this course, the students would learn to design absorber and stripper, distillation column, extraction and leaching equipments and adsorber.

TEXT BOOKS:

REFERENCES:
OBJECTIVES:
To enable the students to
- Understand the rock and fluid properties of a hydrocarbon reservoir
- Describe the nature of the fluid flow and pressure distribution in a reservoir
- Understand the effects of production/injection on recovery of reserves

UNIT I 12
Introduction to Reservoir Engineering, Basic principles, definitions and data – Reservoir fluids, oil, gas, Gas formation volume factor, oil formation, volume factor, water formation volume factor – oil, gas, water, rock compressibility – Resistivity index, wettability and contact angle, effective permeability characteristics, capillary pressure curves – Resistivity factors and saturation exponents. Fluid PVT analysis and oil gas phase behaviour.

UNIT II 12

UNIT III 12

UNIT IV 12

UNIT V 12
Well inflow equations for stabilized flow conditions. Constant terminal rate solution of the radial diffusivity equation and its application to oil well testing.

TOTAL: 60 PERIODS

OUTCOME:
- Students will understand the location, formation, fluid content of a hydrocarbon reservoir; understand the definitions of reserves; be aware of the role of reservoir engineering in exploration and development

TEXT BOOKS:

REFERENCES:
1. Dake, L.P. Practice of Reservoir Engineering Elsevier 2001

CH8561 HEAT TRANSFER LABORATORY

OBJECTIVE:
- To enable the students to develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS
1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in Shell and Tube Heat Exchanger
3. Heat Transfer in a Bare and Finned Tube Heat Exchanger
4. Heat transfer in composite wall
5. Heat transfer by Forced / Natural Convection
6. Heat Transfer by Radiation - Determination of Stefan Boltzmann constant
7. Heat Transfer by Radiation - Emissivity measurement
8. Heat transfer in Open Pan Evaporator
9. Heat transfer by Single effect evaporation / Multiple effect evaporation
10. Boiling Heat Transfer
11. Heat Transfer through Packed Bed
12. Heat Transfer in a Horizontal Condenser / Vertical Condenser
13. Heat Transfer in Helical Coils
14. Heat Transfer in Agitated Vessels

TOTAL: 60 PERIODS

Minimum 10 experiments to be offered

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Double Pipe Heat Exchanger 1 No.
2. Shell and Tube heat exchanger 1 No.
3. Bare and Finned Tube Heat Exchanger 1 No.
4. Composite wall set up 1 No.
5. Natural convection set up or Forced convection set up 1 No.
6. Stefan Boltzmann Apparatus 1 No.
7. Emissivity measurement set up 1 No.
8. Open Pan Evaporator 1 No.
9. Single effect evaporator or Multiple effect evaporator 1 No.
10. Boiler 1 No Compulsory equipment
11. Packed Bed 1 No.
12. Vertical Condenser or Horizontal Condenser 1 No.
13. Helical Coil 1 No.
15. Jacketed vessel 1 No.

Any 10 equipment excluding boiler

OUTCOME:
- Student would be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena.
OBJECTIVE:
- To demonstrate various methods involved in the preparation of structural maps and interpretation and calculation the thickness of the beds, studying depositional environment using grain size analysis and find out sediment types using Sand – Silt – Clay ratio.

LIST OF EXPERIMENTS
1) Calculation of True and Apparent Dip.
2) Estimation of Thickness, Distance and Depth of the ore body.
3) Estimation of Throw and Nature of the fault.
4) Interpretation of surface Geology using contour maps.
5) Sand – Silt – Clay ratio estimation.
6) Grain – Size analysis.
7) Identification of important sedimentary rocks in hand specimen.
8) Identification of important sedimentary rocks in microscopic level

TOTAL: 60 PERIODS

OUTCOME:
- Students will be able to understand the preparation of Geological maps and identify the rock specimens by Megascopicy and Microscopic, Identify the Depositional environment and Sediment types.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1) Sieve Shakers - 1 No.
2) Sieves set. - 1 No.
3) Petrological Microscopes - 1 No.
4) Hot even - 1 No.
5) 1000 ml and 50 ml beakers - 1 No.

OBJECTIVES:
The course aims to:
- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully

UNIT I
Introduction to Soft Skills— Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II
Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations
UNIT III
Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic — questioning and clarifying – GD strategies- activities to improve GD skills

UNIT IV
Interview etiquette – dress code – body language – attending job interviews— telephone/skype interview - one to one interview & panel interview – FAQs related to job interviews

UNIT V
Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

OUTCOMES:
At the end of the course Learners will be able to:
• Make effective presentations
• Participate confidently in Group Discussions.
• Attend job interviews and be successful in them.
• Develop adequate Soft Skills required for the workplace

Recommended Software
1. Open Source Software
2. Win English

REFERENCES:

PE8601 WELL DRILLING EQUIPMENT AND OPERATION L T P C
3 0 0 3

OBJECTIVE:
• To make the students learn about the Drilling Process and Drilling Equipments.

UNIT I

UNIT II
UNIT III 9
Directional Drilling, Well Planning, Two Dimensional, Horizontal, Tools, Techniques, MWD, surveying, Muds, Mud Use, Property measurements, Types, - Pneumatic (Air, Gas, Mist, Foam), Water based, Oil based, solids Control, Definitions, Equipment, Problems, Contaminations Effect.

UNIT IV 9

UNIT V 9
Origin of Overpressure, Kick Signs, shut-in Procedures, Kill sheets, Kill Procedures, Driller’s Methods – Engineer’s Method (Wait and Weight)

TOTAL: 45 PERIODS

OUTCOME:
- Students will understand the concepts and techniques used in well drilling. They will learn the design requirements of well planning and construction. Students would be able to optimize the design of a drilling program.

TEXT BOOKS:
2. D.P Helander ‘Fundamentals Of Formation Evaluation’

REFERENCE:

PE8602 WELL LOGGING L T P C
4 0 0 4

OBJECTIVE:
- To enable the students to understand the concept of formation evaluation and well logging and techniques involved in it.

UNIT I 12
Aims and objectives of well logging. Reservoir formations. Borehole conditions. Fundamental concepts in borehole geophysics physical properties of reservoir rocks. Formation parameters and their relationships: formation factor, porosity, permeability, resistivity, water and hydrocarbon saturations, and movable oil. Archie’s and Humbles equations.

UNIT II 12
Principles, instrumentation, operational procedures and applications of different geophysical logs: S.P., electrical, induction, nuclear, sonic, caliper, temperature, dip and direction. Natural gamma ray spectrometry log, nuclear magnetic log, litho density log, neutron activation technique, thermal neutron decay time log, chlorine and oxygen logs.

UNIT III 12
Recording, transmission and processing of log data. Formation evaluation for hydrocarbons. Qualitative and quantitative interpretations of well log data. Overlays and cross-plots. Determination of reservoir parameters – porosity, resistivity, permeability, water and hydrocarbon
saturation, movable oil. Lithology determination by neutron, density and sonic cross-plots, dual mineral method, triporosity method, litho porosity cross-plot (M-N plot), clean sand and shaly sand interpretations.

UNIT IV


UNIT V

Theoretical computations of normal and lateral log responses. Identification and delineation of sub-surface formations from well log data. Calculation of reservoir parameters: formation factor, porosity, permeability, resistivity, water and hydrocarbon saturations, and movable oil. Sub-surface correlation of formations and interpretation of field data.

TOTAL: 60 PERIODS

OUTCOME:

- Students able to understand the physical principles of the tools used in logging. They can characterize the formation based on interpretation of well logs

TEXT BOOKS:

2. D.P Helander ‘Fundamentals Of Formation Evaluation’

REFERENCE:


PE8603 RESERVOIR ENGINEERING II

OBJECTIVE:

- To enable the student to interpret cross plots, well characteristics, simulation and gas condensate reservoirs.

UNIT I

Fluid characteristics. Introduction to the production system. Characteristics of the reservoir rocks- Porosity, Permeability- cross plots. Fluid saturation, capillary pressure.

UNIT II

Well testing – Basic well testing theory – oil well testing: gas well testing – Practical well testing – Gas field reservoir engineering – Fluid phase behaviour – Gas in place volumes and recovery estimations. Reservoir testing and performance analysis: well test – drill stem tests (DST); production tests, pressure tests on gas wells; formation interval testing and other well testing techniques. Conning of water and gas; effects of partial penetration.

UNIT III

UNIT IV
Material balance techniques: Production forecasting – Gas condensate reservoir engineering Fluid phase behaviour development – options.

UNIT V

TOTAL: 60 PERIODS

OUTCOME:
• Student will be able to follow and understand the reservoir concepts such as reservoir simulation, rock characteristics and reservoir management.

TEXT BOOKS:

REFERENCE:

GE8076 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVE:
• To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES

UNIT II ENGINEERING ETHICS

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

UNIT V GLOBAL ISSUES

TOTAL: 45 PERIODS

OUTCOME:
- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

REFERENCES:

Web sources:
1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

PE8604 DRILLING FLUIDS AND CEMENTING TECHNIQUES L T P C
3 0 0 3

OBJECTIVE:
- To enable the students to understand the types of drilling fluids and cementing techniques

UNIT I 9
Introduction to the basic functions and properties of drilling fluids and cement slurries. Compositions and related properties of drilling fluids and cement slurries.

UNIT II 9

UNIT III 9
Types of equipment and methods used in cementing operations. Drilling fluid and cement slurry hydraulics.
UNIT IV

UNIT V

OUTCOMES:
Upon completion of this course, the students would have
- Learned the concepts and applications of drilling fluids
- Learned the equipments involved in the cementing operations

TEXT BOOKS:

REFERENCES:

CH8781 MASS TRANSFER LABORATORY

OBJECTIVE:
- To train the students to develop sound working knowledge on different types of mass transfer equipments.

LIST OF EXPERIMENTS
1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Surface evaporation
13. Adsorption studies
14. Leaching studies
15. Demonstration of Gas – Liquid absorption

*Minimum 10 experiments shall be offered.

TOTAL: 60 PERIODS
### LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Simple distillation setup 1 No.
2. Steam distillation setup 1 No.
3. Packed column 1 No.
4. Liquid-liquid extractor 1 No.
5. Vacuum Dryer 1 No.
6. Tray dryer 1 No.
7. Rotary dryer 1 No.
8. Ion exchange column 1 No.
9. Rotating disc contactor 1 No.
10. Cooling tower 1 No.
11. Absorption column 1 No.
12. Surface evaporation set up 1 No.
13. Adsorption column set up / Adsorption studies using conical flask 1 No.
14. Leaching column set up / Leaching studies using conical flask 1 No.

Any 10 equipment

**OUTCOME:**
- Students would be able to determine important data for the design and operation of the process equipments like distillation, extraction, diffusivity and drying principles which are having wide applications in various industries

PE8661 PETROLEUM TESTING LABORATORY  
L T P C 0 0 4 2

**OBJECTIVE:**
- To make the student to be conversant with the theoretical principles and experimental procedures for quantitative estimation of petroleum products.

**LIST OF EXPERIMENTS**

1. Fluid viscosity determination
2. Carbon residue determination
3. Karl-Fisher Conductometer Apparatus for water estimation
4. Fluid density
5. Aniline point
6. Corrosion testing of petroleum oils and copper
7. Freezing point of Aqueous Engine coolant solution
8. Automatic Distillation
9. Fire point- Flash point
10. Gas Colorific value determination
11. liquid or solid Colorific value determination
12. Smoke point determination
13. Cloud and pour point determination
14. Softening point determination
15. Ductility of bitumen
16. Penetration index determination

**TOTAL: 60 PERIODS**
OUTCOMES:
- Perform the various physical and chemical properties of the petroleum products in a safe manner.
- Differentiate various petroleum products by performing the specific tests.
- Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.

LIST OF EQUIPMENT
1. Redwood / Saybolt / Engler viscometer - 1 No.
2. Conradson Apparatus - 1 No.
3. Muffle furnace - 1 No.
4. Hydrometer - 1 No.
5. Aniline point apparatus - 1 No.
6. Copper corrosion Apparatus - 1 No.
7. Freezing / Cloud / Pour point apparatus - 1 No.
8. Junkers Gas Calorimeter / Bomb Calorimeter - 1 No.
9. Cleveland / PenskyMartien open and closed cup Flash and fire point Apparatus-1 No.
10. API Distillation Apparatus - 1 No.
11. Abbey Refractometer - 1 No.
12. Dean and Stark apparatus- 1 No.
15. Ductiliometer - 1 No.
16. Penetrometer - 1 No.

OBJECTIVE:
- To provide knowledge of production operations in the oil and gas wells such as artificial lifts and subsurface equipments.

UNIT I 9

UNIT II 9

UNIT III 9
Surface equipment and operations. Flow control and well heads. Gathering systems; service and cleaning systems; design and testing of flow lines. Separation and separators; separator components, stage separation; design and construction of separators. Meeting - Oil and gas metering techniques.

UNIT IV 9

UNIT V

Well completion techniques and equipment, drill stem test (DST) flowing well performance, vertical lift performance, optimum size tubing and chokes, production forecast for a pool. Design and analysis of artificial methods of petroleum production. Work over and sand exclusion technique.

OUTCOME:

- Student will be able to understand the basics of oil and gas production engineering techniques.

TEXT BOOKS:


REFERENCE:


GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING

OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth’s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes,
UNIT II       ENVIRONMENTAL POLLUTION  
Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III      NATURAL RESOURCES  
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV       SOCIAL ISSUES AND THE ENVIRONMENT  

UNIT V       HUMAN POPULATION AND THE ENVIRONMENT  

TOTAL: 45 PERIODS

OUTCOMES:
- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

REFERENCES:

PE8711 DRILLING FLUIDS AND CEMENTING TECHNIQUES LABORATORY L T P C
0 0 4 2

OBJECTIVE:
- To demonstrate the processes involved in drilling and cementing operations, introduce laboratory techniques which are used to select and optimize drilling fluids and cement slurry and to develop interest in experimentation.

LIST OF EXPERIMENTS
1) Drilling Fluid properties measurements using: Mud balance – Determination on density or weight of a drilling mud.
2) Determination of thickening time of cement slurry.
3) Determination and measurement of fluid loss of a drilling fluid and mud cake properties of a drilling fluid using atmospheric filter press.
4) Determination and measurement of fluid loss of cement slurry using atmospheric filter press.
5) Determination of rheology of drilling fluid by Fann viscometer.
6) Determination of rheology of cement slurries using Fann viscometer.
7) pH.
8) Measurement and control of the basic properties of drilling fluids (density, viscosity, filtration, lubricity and electrochemical properties) and cement slurries (density, viscosity, filtration, thickening time and mechanical properties).
9) Determination of compressive strength of cement slab.

TOTAL: 60 PERIODS

OUTCOME:
- Students able to understand the drilling fluid equipment, Principles and operation and oil well cement properties.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1) Mud balance - 1 No.
2) Picnometer and F.G.T meter - 1 No.
3) Atmospheric Filter press. - 1 No.
4) pH meter - 1 No.
5) Compact Curing chamber - 1 No.
6) Fann viscometer - 1 No.
7) cement compressive strength testing machine - 1 No.
8) Hamilton Beach Mixer - 1 No.
Students shall undergo training in R&D institutions / Academics / Industries for a minimum period of 15 days. At the end of internship students must submit a report for internal evaluation.

OBJECTIVE:
• The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.

Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

The Objective of the comprehension test is to assess the overall level of proficiency and the scholastic attainment of the student in the various subjects studied during the degree course.

OBJECTIVE:
• To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I
Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II
Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel, size comparison of reactors.

UNIT III
Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.
UNIT IV
Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V
The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

OUTCOME:
- At the end of this course, the students would gain knowledge on the selection of reactor for the required reaction.

TEXT BOOKS:

REFERENCE:

CH8075  PETROLEUM REFINING AND PETROCHEMICALS  L  T  P  C
3  0  0  3

OBJECTIVE:
- Students will gain knowledge about petroleum refining process and production of petrochemical products

UNIT I

UNIT II
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen.

UNIT III
Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance, Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining.

UNIT IV
Cracking of Naphtha and Feedstock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, Catalytic Reforming of Petroleum Feed Stocks and Extraction of Aromatics.

UNIT V
Production of Petrochemicals like Dimethyl Terephthalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate
Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black.

TOTAL: 45 PERIODS

OUTCOMES:
- Understand the classification, composition and testing methods of crude petroleum / product to develop innovative refining process and develop quality control and assurance techniques.
- Apply the knowledge of treatment processes to develop the manufacture of petroleum products.

TEXT BOOKS:

PE8092  NATURAL GAS ENGINEERING  L  T  P  C
3  0  0  3

OBJECTIVE:
- Enable the students to learn the basic concept and applications of Natural Gas Engineering.

UNIT I

UNIT II
Properties of Natural Gases: typical compositions. Equations of state: general cubic equations, specific high accuracy equations. Use of equation of state to find residual energy properties, gas measurement gas hydrates, condensate stabilization, acid gas treating, gas dehydrations, compressors, process control deliverability test, gathering and transmission, and natural gas liquefaction.

UNIT III

UNIT IV
UNIT V


OUTCOME:
- Students will be able to understand the Natural gas processing, Gas Compression, Gas Gathering and Transport Installation, Operation and trouble shooting of natural gas pipelines.

TEXT BOOK:

REFERENCE:

PE8001 PRINCIPLES OF GEOCHEMISTRY L T P C
3 0 0 3

OBJECTIVES:
Student will learn about the concepts of
- Geochemical dispersion, and the principles of trace element analysis
- Geochemical soil surveys.

UNIT I

UNIT II

UNIT III

UNIT IV
Anomalies in Natural waters: Mode of occurrence of elements – persistence of anomaly – contrast at source – Decay by dilution – Decay on precipitation – ground water, seawater and lake water anomalies

UNIT V

TOTAL: 45 PERIODS

OUTCOMES:
• Upon completion of this course, the students would
• Gain knowledge on the principles and concepts of geochemistry
• Select appropriate techniques to obtain information on the chemical composition of sedimentary rocks and fluids such as oils and gases

TEXT BOOKS:

REFERENCES:

GE8071 DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:
• To provide students an exposure to disasters, their significance and types.
• To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
• To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
• To enhance awareness of institutional processes in the country and
• To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don’ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj

Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and
Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

REFERENCES:
1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005

PE8071 ADVANCED SEPARATION TECHNIQUES LT PC 3 0 0 3

OBJECTIVE:
- To learn the principle and technical concept of advanced separation processes.

UNIT I BASICS OF SEPARATION PROCESS 9
Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process
concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9
Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9
Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV INORGANIC SEPARATIONS 9
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9
Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL: 45 PERIODS

OUTCOME:
- Fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.

TEXT BOOKS:

REFERENCES:

PE8002 WELL COMPLETION TESTING AND WORK OVER L T P C
3 0 0 3

OBJECTIVE:
- To provide insights into the Well Operation during the hydrocarbon Explorations.

UNIT I 9

UNIT II 9
Drilling methods and equipment for directional, horizontal and multilateral wells. Selection of casing shoes, material properties and design of casing program, perforation, skin effect, activation.
UNIT III
Well Completion and Stimulations: Well completion design, types of completion, completion selection and design criteria. Interval selection and productivity considerations: effects of producing mechanisms. Inflow performance and multiple tubing performance analyses using commercial software. well stimulation.

UNIT IV
Well stimulation and work over planning. Tubing-packer movement and forces. Tubing design: graphical tubing design and simplified tensitional strength design. Selection of down hole equipment, tubing accessories and wellhead equipment.

UNIT V

TOTAL: 45 PERIODS

OUTCOME:
- Student will be able to understand the basics and operations of Well Completion techniques.

TEXT BOOKS:
1. Wellsite Geological Techniques for Petroleum exploration by Sahay .B. et al
2. Petroleum Exploration Hand Book by Moody, G.B.

REFERENCE:

PE8072 CATALYTIC REACTION ENGINEERING

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

UNIT I CATALYST AND ITS CHARACTERIZATION
General definition of catalysts, Solid catalysts, Components of catalyst, Industrial catalysts, Preparation of solid catalysts, Precipitation and co-precipitation methods, Sol gel method, Supported catalysts, Impregnation and ion exchange method, Catalyst drying calcination and formulations, Catalyst Characterization techniques, Structural analysis, Chemisorption technique, Thermal analysis, Spectroscopic techniques, Microscopic technique.

UNIT II KINETICS OF HETEROGENEOUS CATALYTIC REACTIONS

UNIT III TRANSPORT PROCESSES WITH REACTIONS CATALYZED BY SOLIDS
Effect of external transport on catalytic reaction rate, Effect of external mass transfer resistance on order of reaction, Effect of external transport on selectivity, Effect of internal mass transport on
catalytic reaction rate, Bulk diffusion, Knudsen diffusion, Surface diffusion, Effectiveness factor at isothermal conditions, Significance of intrapellet diffusion, Effect of intrapellet mass transfer on activation energy

UNIT IV CATALYST DEACTIVATION 9

UNIT V INDUSTRIAL CATALYTIC PROCESSES 9
Steam reforming, Catalytic cracking, Three Lumped kinetic model for catalytic cracking of gas oil Hydrocracking, Hydrogenation and Dehydrogenation Catalytic Reactions

TOTAL: 45 PERIODS

OUTCOME:
- At the end of this course, the students would gain knowledge on the selection of catalyst and multiphase reactor for the heterogeneous reaction.

TEXT BOOKS:

REFERENCES:

PE8003 NUMERICAL RESERVOIR SIMULATION 3 0 0 3

OBJECTIVE:
- To enable the student to understand the basic concept and applications of Numerical Methods in Reservoirs.

UNIT I 9
Introduction, fracturing, Stress Distribution, Vertical Versus Horizontal Fractures, Pressure Related to Fracturing, Closure Pressure, Fracturing Pressure – Decline analysis, Pressure Interpretation After Closure, Properties of Fracturing Fluids.

UNIT II 9

UNIT III 9
Acid Fracturing, Acid Systems and Placement Techniques, Fracturing of Deviated and Horizontal Wells, Matrix Stimulations, Matrix Acidizing Design, Rate and Pressure Limits for Matrix Treatment, Fluid Volume Requirements,
UNIT IV
Design and implementation of a multiphase flow reservoir simulator, including interphase mass transfer and variable fluid saturation pressure. Design of compositional reservoir simulators using generalized equation of state. Recent advances in reservoir simulation.

UNIT V

OUTCOME:
- Student will be able to understand the basics of Mathematics in Reservoir applications

TEXT BOOK:

REFERENCE:
1. Petroleum Exploration Hand Book by Moody, G.B.

GE8075 INTELLECTUAL PROPERTY RIGHTS

OBJECTIVE:
- To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS

UNIT IV DIGITAL PRODUCTS AND LAW

UNIT V ENFORCEMENT OF IPRs
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

OUTCOME:
- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS

REFERENCES

PE8004 ONSHORE AND OFFSHORE ENGINEERING AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To enable the students to
- Learn the concepts of petroleum site exploration, analysis of offshore structure
- Understand the offshore soil mechanics.

UNIT I
Introduction to offshore oil and gas operations. Sea States and Weather, Offshore Fixed and mobile Units, Offshore Drilling, Difference in drilling from land, from fixed platform, jack up, ships and semi submersibles. Offshore Well Completion, Offshore Production systems, Deep-water technology, Divers and Safety, Offshore Environment.

UNIT II
Introduction; classification, properties of marine sediments. Consolidation and shear strength characteristics of marine sediments. Planning and site exploration.

UNIT III
Drilling. Sampling techniques. Laboratory testing, In situ testing methods and geophysical methods. Current design practices of pile supported and gravity offshore structures.

UNIT IV

UNIT V
Offshore drilling systems and types of platforms; Ocean mining and energy systems. ROV. Onshore drilling-on shore oil rigs. onshore drilling equipments onshore rig structures-hydraulics applied in onshore rigs. construction methods of wet & dry completion.

OUTCOME:
- Students will learn the basics of onshore and offshore oil and gas operations. They will learn the Laboratory testing methods, In situ testing methods and geophysical methods

TEXT BOOKS:

REFERENCE:
1. Petroleum Exploration Hand Book by Moody, G.B.

PE8005 PETROLEUM EQUIPMENT DESIGN

OBJECTIVE:
- To study and analyze suitable equipment for particular reservoir conditions.

UNIT I
Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating, hydraulic fracturing. DRILL BIT DESIGN. ROLLER CONE BITS. PDC DRILL BITS. NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP (Electrical submersible pumps). SRP (Sucker rod pumping) unit design.

UNIT II
Design of Surface Facilities - Design of production and processing equipment, including deparation problems, treating, and transmission systems.

UNIT III
Capstone design Student teams apply knowledge in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.

UNIT IV

UNIT V
Refinery Equipment Design-atmospheric distillation column Design and construction of on/offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation.

TOTAL: 45 PERIODS

OUTCOME:
- Students will be able to understand the concept of designing Equipments for Petroleum Exploration

TEXT BOOKS:
1. Petroleum Exploration Hand Book by Moody, G.B.
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

REFERENCE:

PE8073 ENHANCED OIL RECOVERY

OBJECTIVE:
To impart knowledge on how residual oil is recovered and the problems associated with Enhanced Oil Recovery.

UNIT I  FUNDAMENTALS OF ENHANCED OIL RECOVERY  9

UNIT II  WATER FLOODING  9
Properties, sampling and analysis of oil field water; Injection waters; Water flooding - Sweep efficiency, Predictive techniques, Improved water flood processes, Performance of some important water floods.

UNIT III  ENHANCED OIL RECOVERY OPERATIONS - 1  9
Flooding – miscible, CO₂, polymer, alkaline, surfactants, steam;

UNIT IV  ENHANCED OIL RECOVERY OPERATIONS - 2  9
Gas injection, in-situ combustion technology, microbial method.

UNIT V  PROBLEMS IN ENHANCED OIL RECOVERY  9
Precipitation and deposition of Asphaltenes and Paraffin’s, Scaling problems, Formation of damage due to migration of fines, Environmental factors.

TOTAL: 45 PERIODS

OUTCOME:
- Students would gain knowledge on residual oil recovery, operations and problems of Enhanced Oil Recovery.

REFERENCE:

Objective:
- To sensitize the Engineering students to various aspects of Human Rights.

GE8074  HUMAN RIGHTS  L T P C
3 0 0 3

UNIT I

UNIT II

UNIT III
Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.
UNIT IV
Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V

OUTCOME:
- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

GE8072 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT

OBJECTIVES:
- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT

UNIT II REQUIREMENTS AND SYSTEM DESIGN

UNIT III DESIGN AND TESTING
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design
of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component
design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and
Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV  SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT  9
Introduction to Product verification processes and stages - Introduction to Product Validation
processes and stages - Product Testing Standards and Certification - Product Documentation
- Sustenance - Maintenance and Repair – Enhancements - Product EoL - Obsolescence
Management – Configuration Management - EoL Disposal

UNIT V  BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY  9
The Industry - Engineering Services Industry - Product Development in Industry versus
Academia – The IPD Essentials - Introduction to Vertical Specific Product Development
processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical,
Embedded and Software Systems – Product Development Trade-offs - Intellectual Property

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:
- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business
  Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:
1. Book specially prepared by NASSCOM as per the MoU.

REFERENCES:
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford,
   2004.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design",

PE8006  WATER FLOODING AND ENHANCED OIL RECOVERY  L T P C
3  0  0  3

OBJECTIVE:
- To enable the students to understand the basics of oil recovery methods in oil & gas
  Industry.

UNIT I  9
Introduction to Enhanced oil recovery methods – Schematic representation of enhanced oil
Recovery – Techniques involved in EOR – Factors affecting EOR methods
UNIT II
Chemical recovery methods – Polymer flooding – Surfactant flooding - Alkaline flooding – Hydrocarbon or Gas injection - Carbon dioxide (CO₂) flooding – Nitrogen and flue gas flooding - Thermal recovery methods – fire flooding – steam flooding

UNIT III

UNIT IV

UNIT V
Laboratory design for EOR – Preliminary test – Water analysis – Oil analysis – Core testing – Viscosity testing.

TOTAL: 45 PERIODS

OUTCOME:
- Students will be able to get the clear idea, better understanding and can get introduced with different types of recovery methods which are employed in the oil and gas Engineering.

TEXT BOOKS:

REFERENCE:
Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

UNIT IV SAFETY PROCEDURES

UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS
Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

TOTAL: 45 PERIODS

OUTCOME:
• At the end of this course, the students will be able to analyze the risk in the process industries.

TEXT BOOKS:

REFERENCES:

PE8074 MULTICOMPONENT DISTILLATION

OBJECTIVE:
• To understand the concepts of Multicomponent distillation systems.

UNIT I THERMODYNAMIC PRINCIPLES

UNIT II THERMODYNAMIC PROPERTY EVALUATION
Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM
General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of \( \text{R}_m \) for multi component distillation – Underwood method – Colburn method.
UNIT IV VARIOUS METHODS OF MCD COLUMN DESIGN
Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.

UNIT V VARIOUS TYPES OF MCD COLUMNS
Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

TOTAL: 45 PERIODS

OUTCOME:
- Students able to design multicomponent distillation unit. They learn about various types of MCD column.

TEXT BOOKS:

REFERENCES:

CH8076 PIPING AND INSTRUMENTATION

OBJECTIVE:
- To impart knowledge on piping technology and instrumentation on pipelines.

UNIT I FUNDAMENTALS OF PIPING ENGINEERING
Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping.

UNIT II PIPE HYDRAULICS AND SIZING
Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.

UNIT III PLOT PLAN
Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis -Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.

UNIT IV PIPING SUPPORT
Different types of support based on requirement and its calculation.

UNIT V INSTRUMENTATION
Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID).

TOTAL: 45 PERIODS
OUTCOME:
- Students gain knowledge on fundamentals of piping engineering, pipe hydraulics, piping supports and instrumentation.

TEXT BOOKS:

GE8077 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:
- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

UNIT II TQM PRINCIPLES 9
Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM 9

TOTAL: 45 PERIODS

OUTCOME:
- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.
TEXT BOOK:

REFERENCES:
4. ISO9001-2015 standards

PE8007 PETROLEUM TRANSPORTATION AND DESIGN L T P C
3 0 0 3

OBJECTIVE:
- To enable the students to understand the fundamental concepts of transportation equipment and machinery design. To make student aware of different equipment and machineries used in petroleum industry.

UNIT I FUNDAMENTALS OF DESIGN
Steps in design activity. Selection of material. Theories of failure. Stress concentration and factor of safety. Creativity in design activity. Use of standards and codes in design activity. design of shaft, keys and coupling.

UNIT II DESIGN OF MECHANICAL DRIVE COMPONENTS APPLIED TO PETROLEUM EQUIPMENTS

UNIT III PUMPS & COMPRESSOR
Selection of pumps and valves. Specification of pumps, valves, performance curve, system pump interaction, two pumps in parallel & series (flow sheet) and compressors – reciprocating, rotary, centrifugal, reciprocating cylinder sizing. Cooling & lubricating system. Introduction to hydraulic and pneumatic circuit and their components. Introduction to mud circulation system & equipments, Types of springs (compression helical – shale shaker), Design consideration for pipeline used in oil and gas transportation.

UNIT IV DESIGN OF PRESSURE VESSEL

UNIT V DESIGN OF STORAGE SYSTEM
Storage of hydrocarbon fluids, Introduction to oil and gas storage facility. Types of storage tank and their design considerations. Design of fixed roof cylindrical storage tank. Liquids, liquefied gases, highly volatile HC, solids, and sulphur containing fluids.
OUTCOME:
- Students would be able to understand the concepts of designing petroleum transportation equipments

TEXT BOOKS:

REFERENCES:

PE8075 PETROLEUM CORROSION TECHNOLOGY

OBJECTIVE:
- To understand the types of corrosion found in the petroleum industries. This course will provide the student with knowledge of the analytical methods needed to diagnose, treat, and monitor corrosion to reduce costs, protect the environment, and increase safety.

UNIT I

UNIT II

UNIT III
Role of oxygen in oil filed corrosion- down hole and surface equipment - water flood. Removal of oxygen, analysis and criteria for control. Role of carbon dioxide (CO₂) in corrosion-Effect of temperature and pressure - Corrosion of well tubing and other equipments. Role of hydrogen sulphide (H₂S)-Corrosion in downhole, surface, storage and pipelines.

UNIT IV

UNIT V
Inspection and corrosion monitoring. Oil treatment corrosion - crude oil properties - desalting-sweetening processes. Corrosion in oil storage tank corrosion- oilfield and oil treating facilities-oil/ gas pipelines -offshore platforms- subsea systems.

TOTAL: 45 PERIODS
OUTCOME:
- Students will identify and define the various types of petroleum corrosion and prevention technologies.

TEXT BOOKS:

REFERENCE:

PE8008 WELL COMPLETION AND SIMULATION L T P C 3 0 0 3

OBJECTIVE:
- Students will learn the designing of well and its completion concepts. They will also learn the well simulation technologies.

UNIT I

UNIT II
Design of drill string including bottom hole (BHA) assembly. Drilling methods and equipment for directional, horizontal and multilateral wells. Selection of casing shoes, material properties and design of casing program.

UNIT III
Well Completion and Stimulation: Well completion design, types of completion, completion selection and design criteria. Interval selection and productivity Considerations: effects of producing mechanisms. Inflows performance and multiple tubing performance analyses using commercial software.

UNIT IV
Well stimulation and work over planning. Tubing-packer movement and forces. Tubing design: graphical tubing design and simplified tensional strength design. Selection of down hole equipment, tubing accessories and wellhead equipment.

UNIT V

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to understand the
- Designing, well completion and to develop functional understanding of various equipment, processes and systems involved in drilling and completion operations
- Develop design capabilities for major engineering components and materials for safe operations and maximum production.
TEXT BOOKS:

REFERENCE:
1. Petroleum Exploration Hand Book by Moody, G.B.

PE8079 STORAGE TRANSPORTATION OF CRUDE OIL AND NATURAL GAS

OBJECTIVE:
- To understand the natural gas regasification technology, crude oil transportation and to learn the concepts of storage.

UNIT I INTRODUCTION
Crude oil Trade, Selection of Port Location, Ship Building/Shipyards.

UNIT II NATURAL GAS REGASIFICATION TECHNOLOGY
Commercial Sourcing of Natural Gas, Different Kinds of Regasification Techniques, Regasification Process & Cold Utilization, Synchronization of Degasified gas and Pipelines, Current Status in India

UNIT III CRUDE OIL TRANSPORTATION
Transportation techniques of crude oil, Pipeline specification, Corrosion Prevention techniques, Pressure drop, Pumps and Booster station, Wax deposition and prevention, Chemical treatment

UNIT IV DESIGN
Basic Engineering Aspects of Terminal Design, Design of Liquefaction Train, Ship Building/Shipyards, Storage Facilities

UNIT V CHARTERTICS OF STORAGE

OUTCOME:
- Students would be able to design various terminal design. They will be familiarize with the storage systems.

TEXT BOOKS:
OBJECTIVE:

- To enable the students to follow and utilize different concepts of reservoir modeling and characteristics and their usage.

UNIT I
Overview of reservoir characterization and modeling problems. Reservoir mapping. 3D modeling. Univariate, bivariate and multivariate statistics for geological data analysis.

UNIT II

UNIT III

UNIT IV
Reservoir simulation – Investigation of petroleum reservoir characteristics and behavior, including: pore volume, fluid distribution and movement, and recovery. Optimized field development and management plans.

UNIT V

TOTAL: 45 PERIODS

OUTCOME:

- Students gain the knowledge of reservoir characterization, modeling and simulation methods used in oil industry.

TEXT BOOKS:

2. Wellsite Geological Techniques for petroleum Exploration by Shay’s et al.

REFERENCE:


OBJECTIVE:

- To train the students in designing of the following equipments as per IADC, API, ISME, TEMA, ISI codes and drawing according to scale.

LIST OF EXPERIMENTS

1. Drawing and design of Offshore platform TLP (TENSION LEG PLATFORM) - Fixed
2. Platform design,
3. Drawing and design of offshore Jack ups
4. Drawing and design of well equipments]
5. Drawing and design of ROV (remotely operated vehicle)
6. Drawing and design of natural gas storage tank(Horton sphere)
7. Drawing and Designing of Mud tank
8. Drawing and design of on/offshore pipeline.
9. Drawing and design of rotary system in drilling

TOTAL: 45 PERIODS

OUTCOME:
- On completion of this practical course, the students would be able draw and design offshore jackups, pipeline well equipments, ROV, natural gas storage tank

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS
1. Intel Dual Core computer or better hardware with suitable graphics facility – 30 nos.
2. Licensed software for Drafting and Modeling – 30 Licenses.
3. Laser Printer or Plotter to print / Plot drawings – 2 Nos.

PE8077                               PROCESS ECONOMICS          L  T  P  C
                                          3  0  0  3

OBJECTIVE:
- The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

UNIT I  PRINCIPLES OF MANAGEMENT AND ORGANISATION  9
Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II  INVESTMENT COSTS AND COST ESTIMATION  9
Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

UNIT III  PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT  9
Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV  ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE  9
Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V  ECONOMIC BALANCE  9

TOTAL: 45 PERIODS
OUTCOME:
- At the end of this course, the students will have knowledge on cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk analysis.

TEXT BOOKS:

REFERENCES:

PE8076 PETROLEUM ECONOMICS

OBJECTIVE:
- To understand the basic quantitative theories and methodologist in oil sector.

UNIT I
Supply and demand curves, the elasticity of supply and demand, public finance concepts such as consumer surplus, excise and export taxes. Forecasting techniques for the energy industry, including energy prices. Demand and supply for natural gas, cured oil and pipeline transportation, determinants of energy demand, energy markets, energy pricing, stability and performance of energy markets.

UNIT II
The economics of investment, Discounted cash flow analysis, Cost Benefit Analyses, Internal Rate of Return, NPV, Profitability Index, Natural Monopoly theory, National competition Policy, Gas Market Regulation, taxation of the oil and gas industry, government policy and trade permits, Monte Carlo analysis, Net Back Pricing, Transfer Pricing and regulatory aspects.

UNIT III
Application of petroleum engineering principles and economics to the evaluation of oil and gas projects, evaluation principles, time value of money concepts, investment measures, cost estimation, price and production forecasting, risk and uncertainty, project selection and capital budgeting inflation, escalation, operating costs, depreciation, cost recovery.

UNIT IV
Petroleum exploration and production contracts. Sharing of the economic rent, portfolio management. Value creation, Corporate finance & return on capital, economic appraisal methods for oil filed development, reservoir model costs and calculations.
UNIT V
Case studies: Economic study of an oil filed development project, petrochemical plant project, natural gas break even price, natural gas liquefaction cost, LGN transport cost, investment profitability study for a gas pipeline.

OUTCOME:
- Students will be able to understand the concept and fundamentals of engineering economics of energy industry

TEXT BOOKS:

REFERENCES:

PE8010 INTEGRATED OIL/GAS FIELD EVALUATION L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge on different oil/gas field evaluations in order to maximize the production and improvement of facilities.

UNIT I

UNIT II
Petroleum project evaluation-mineral project evaluation case studies. The design and evaluation of well drilling systems-Economic appraisal methods for oil field developmental project evaluation including risk analysis, probability and statistics in decision-making and evaluations. case studies.

UNIT III
An integrated reservoir description in petroleum engineering-usage of geophysical, geological, petro physical and engineering data-emphasis on reservoir and well data analysis and interpretation, reservoir modeling (simulation), reservoir management (production optimization of oil and gas fields) and economic analysis (property evaluation)

UNIT IV
An integrated reservoir development in petroleum engineering-reservoir and well evaluation production optimization-nodal analysis, stimulation, artificial lift facilities-surveillance.
UNIT V

TOTAL: 45 PERIODS

OUTCOME:
- Students will be able to understand the different evaluation methods of oil/gas fields and reserves.

TEXT BOOKS:

GE8073 FUNDAMENTALS OF NANOSCIENCE

OBJECTIVE:
- To learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS

UNIT IV CHARACTERIZATION TECHNIQUES

UNIT V APPLICATIONS

TOTAL: 45 PERIODS

OUTCOMES:
- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

REFERENCES: