

# **COURSE STRUCTURE AND SYLLABUS**

**For**

## **PETROLEUM ENGINEERING**

*(Applicable for batches admitted from 2016-2017)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**  
**KAKINADA - 533 003, Andhra Pradesh, India**

## I Year - I Semester

S. No.	Subjects	L	T	P	Credits
1-HS	English – I	4	--	--	3
2-BS	Mathematics - I	4	--	--	3
3-ES	Engineering Chemistry	4	--	--	3
4- ES	Engineering Mechanics	4	--	--	3
5-BS	Computer Programming	4	--	--	3
6-ES	Environmental Studies	4	--	--	3
7-HS	Engineering/Applied Chemistry Laboratory	--	--	3	2
8-BS	English - Communication Skills Lab – I	--	--	3	2
9-ES	Computer Programming Lab	--	--	3	2
<b>Total Credits</b>					<b>24</b>

## I Year - II Semester

S. No.	Subjects	L	T	P	Credits
1-HS	English – II	4	--	--	3
2-BS	Mathematics – II (Mathematical Methods)	4	--	--	3
3-BS	Mathematics – III	4	--	--	3
4- BS	Engineering Physics	4	--	--	3
5-HS	Elements of Mechanical Engineering	4	--	--	3
6-ES	Engineering Drawing	4	--	--	3
7-BS	English - Communication Skills Lab - II	--	--	3	2
8-HS	Engineering /AppliedPhysics Lab	--	--	3	2
9-ES	Engineering /Applied Physics – Virtual Labs - Assignments	--	--	2	--
10	Engineering Workshop & IT Workshop	--	--	3	2
<b>Total Credits</b>					<b>24</b>

## II Year - I Semester

S. No.	Subjects	L	T	P	Credits
1	Complex Variables	4	--	--	3
2	Basic Electrical & Electronics Engineering	4	--	--	3
3	General Geology	4	--	--	3
4	Surveying & Offshore Structures	4	--	--	3
5	Chemical Process Calculations	4	--	--	3
6	Materials Science & Engineering	4	--	--	3
7	Basic Engineering (Mech. + Elec.) Lab	--	--	3	2
8	Geology & Surveying Lab	--	--	3	2
MC	Managerial Economics & Financial Analysis	2	--	--	--
<b>Total Credits</b>					<b>22</b>

## II Year - II Semester

S. No.	Subjects	L	T	P	Credits
1	Probability & Statistics	4	--	--	3
2	Momentum Transfer	4	--	--	3
3	Petroleum Geology	4	--	--	3
4	Thermodynamics for Petroleum Engineers	4	--	--	3
5	Process Heat Transfer	4	--	--	3
6	Petroleum Exploration	4	--	--	3
7	Momentum Transfer Lab	--	--	3	2
8	Process Heat Transfer Lab	--	--	3	2
MC	Professional Ethics & Human Values	2	--	--	--
<b>Total Credits</b>					<b>22</b>

### III Year - I Semester

S. No.	Subjects	L	T	P	Credits
1	Management Science	4	--	--	3
2	Process Dynamics & Control	4	--	--	3
3	Process Instrumentation	4	--	--	3
4	Well Logging & Formation Evaluation	4	--	--	3
5	Drilling Technology	4	--	--	3
6	Mathematical Methods Lab	--	--	3	2
7	Instrumentation, Process Dynamics & Control Lab	--	--	3	2
8	Drilling Fluids Lab	--	--	3	2
9	Industrial Visits	--	--	-	-
MC	Mini Project-I	--	--	--	--
<b>Total Credits</b>					<b>21</b>

### III Year - II Semester

S. No.	Subjects	L	T	P	Credits
1	Well Completions, Testing & Servicing	4	--	--	3
2	Petroleum Production Engineering	4	--	--	3
3	Petroleum Reservoir Engineering-I	4	--	--	3
4	Petroleum Refinery & Petrochemical Engineering	4	--	--	3
5	<b>OPEN ELECTIVE</b>	4	--	--	3
	i. Electronic Instrumentation				
	ii. Big Data Analytics				
	iii. Alternative Energy Sources for Automobiles				
	iv. Waste Water Management				
	v. Fundamentals of Liquefied Natural Gas				
vi. Computational Fluid Dynamics					
6	Drilling Simulation Lab	--	--	3	2
7	Petroleum Analysis Lab	--	--	3	2
8	Petroleum Reservoir Engineering Lab	--	--	3	2
9	Summer Internship ( 4-6 weeks)	--	--	--	--
MC	Mini Project-II	--	--	--	--
<b>Total Credits</b>					<b>21</b>

## IV Year - I Semester

S. No.	Subjects	L	T	P	Credits
1	Integrated Asset Management	4	--	--	3
2	Petroleum Reservoir Engineering - II	4	--	--	3
3	Surface Production Operations	4	--	--	3
4	Oil & Gas Processing Plant Design	4	--	--	3
5	<b>Elective I</b> i. Natural Gas Hydrates ii. Pipeline Engineering iii. Horizontal Well Technology	4	--	--	3
6	<b>Elective II</b> i. Coal Bed Methane Engineering ii. Offshore Engineering iii. Reservoir Stimulation	4	--	--	3
7	IPR & Patents	--	2	--	--
8	Petroleum Equipment Design & Simulation Lab	--	--	2	2
9	Petroleum Reservoir Simulation Lab	--	--	2	2
<b>Total Credits</b>					<b>22</b>

## IV Year - II Semester

S. No.	Subjects	L	T	P	Credits
1	EOR Techniques	4	--	--	3
2	HSE & FE in Petroleum Industry	4	--	--	3
3	Petroleum Economics, Policies & Regulations	4	--	--	3
4	<b>Elective III</b> i. Shale Gas Reservoir Engineering ii. Subsea Engineering iii. Reservoir Modelling & Simulation	4	--	--	3
5	Seminar ( SIP Report Presentation)	--	--	--	2
6	Project	--	--	--	10
<b>Total Credits</b>					<b>24</b>

**Total Course Credits = 48+44 + 42 + 46 = 180**

## SYLLABUS

**I Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

### **ENGLISH-I**

#### **Introduction:**

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training the students to acquire communicative competence, the syllabus has been designed to develop linguistic and communicative competence of the students of Engineering.

As far as the detailed Textbooks are concerned, the focus should be on the skills of listening, speaking, reading and writing. The non-detailed Textbooks are meant for extensive reading for pleasure and profit.

Thus the stress in the syllabus is primarily on the development of communicative skills and fostering of ideas.

#### **Objectives:**

- To improve the language proficiency of the students in English with emphasis on LSRW skills.
- To enable the students to study and comprehend the prescribed lessons and subjects more effectively relating to their theoretical and practical components.
- To develop the communication skills of the students in both formal and informal situations.

#### **LISTENING SKILLS:**

##### **Objectives:**

- To enable the students to appreciate the role of listening skill and improve their pronunciation.
- To enable the students to comprehend the speech of people belonging to different backgrounds and regions.
- To enable the students to listen for general content, to fill up information and for specific information.

#### **SPEAKING SKILLS:**

##### **Objectives:**

- To make the students aware of the importance of speaking for their personal and professional communication.
- To enable the students to express themselves fluently and accurately in social and professional success.
- To help the students describe objects, situations and people.
- To make the students participate in group activities like roleplays, discussions and debates.
- To make the students participate in Just a Minute talks.

## **READING SKILLS:**

### **Objectives:**

- To enable the students to comprehend a text through silent reading.
- To enable the students to guess the meanings of words, messages and inferences of texts in given contexts.
- To enable the students to skim and scan a text.
- To enable the students to identify the topic sentence.
- To enable the students to identify discourse features.
- To enable the students to make intensive and extensive reading.

## **WRITING SKILLS:**

### **Objectives:**

- To make the students understand that writing is an exact formal skill.
- To enable the students to write sentences and paragraphs.
- To make the students identify and use appropriate vocabulary.
- To enable the students to narrate and describe.
- To enable the students capable of note-making.
- To enable the students to write coherently and cohesively.
- To make the students to write formal and informal letters.
- To enable the students to describe graphs using expressions of comparison.
- To enable the students to write technical reports.

### **Methodology:**

- The classes are to be learner-centered where the learners are to read the texts to get a comprehensive idea of those texts on their own with the help of the peer group and the teacher.
- Integrated skill development methodology has to be adopted with focus on individual language skills as per the tasks/exercise.
- The tasks/exercises at the end of each unit should be completed by the learners only and the teacher intervention is permitted as per the complexity of the task/exercise.
- The teacher is expected to use supplementary material wherever necessary and also generate activities/tasks as per the requirement.
- The teacher is permitted to use lecture method when a completely new concept is introduced in the class.

### **Assessment Procedure:**

#### **Theory**

- The formative and summative assessment procedures are to be adopted (mid exams and end semester examination).
- Neither the formative nor summative assessment procedures should test the memory of the content of the texts given in the textbook. The themes and global comprehension of the units in the present day context with application of the language skills learnt in the unit are to be tested.
- Only new unseen passages are to be given to test reading skills of the learners. Written skills are to be tested from sentence level to essay level. The communication formats— emails, letters and reports-- are to be tested along with appropriate language and expressions.

- Examinations:
  1. I mid exam + II mid exam (15% for descriptive tests+10% for online tests)= 25%
  2. (80% for the best of two and 20% for the other)
    1. Assignments= 5%
  3. End semester exams=70%
- Three take home assignments are to be given to the learners where they will have to read texts from the reference books list or other sources and write their gist in their own words.

The following text books are recommended for study in I B.Tech I Semester (Common for all branches)and I B.Pharm. I Sem. of JNTU Kakinada from the academic year 2016-17. (R-16 Regulations)

**Detailed Textbook:**

1. **English for Engineers and Technologists**, Published by **Orient BlackswanPvt Ltd.**

**Non-detailed Textbook:**

1. **PANORAMA: A COURSE ON READING**, Published by **Oxford University Press India.**

The course content along with the study material is divided into six units.

**UNIT-I:**

1. 'Human Resources' from English for Engineers and Technologists.

**Objective:**

To develop human resources to serve the society in different ways.

**Outcome:**

The lesson motivates the readers to develop their knowledge different fields and serve the society accordingly.

2. 'An Ideal Family' from Panorama: A Course on Reading

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills

**UNIT-II:**

1. ' Transport: Problems and Solutions' from English for Engineers and Technologists.

**Objective:**

To highlight road safety measures whatever be the mode of transport.

**Outcome:**

The lesson motivates the public to adopt road safety measures.

- 2.'War' from 'Panorama: A Course on Reading'

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills

**UNIT-III:**

1. 'Evaluating Technology' from English for Engineers and Technologists.

**Objective:**

To highlight the advantages and disadvantages of technology.



**Outcome:**

The lesson creates an awareness in the readers that mass production is ultimately detrimental to biological survival.

2. 'The Verger' from 'Panorama: A Course on Reading'

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills

**UNIT-IV:**

1. 'Alternative Sources of Energy' from English for Engineers and Technologists.

**Objective:**

To bring into focus different sources of energy as alternatives to the depleting sources.

**Outcome:**

The lesson helps to choose a source of energy suitable for rural India.

2. 'The Scarecrow' from Panorama: A Course on Reading

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills

**UNIT-V:**

1. 'Our Living Environment' from English for Engineers and Technologists.

**Objective:**

To highlight the fact that animals must be preserved because animal life is precious.

**Outcome:**

The lesson creates an awareness in the reader as to the usefulness of animals for the human society.

2. 'A Village Host to Nation' from Panorama: A Course on Reading.

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills.

**UNIT-VI:**

1. 'Safety and Training' from English for Engineers and Technologists.

**Objective:**

To highlight the possibility of accidents in laboratories, industries and other places and to follow safety measures.

**Outcome:**

The lesson helps in identifying safety measures against different varieties of accidents at home and in the workplace.

2. 'Martin Luther King and Africa' from Panorama: A Course on Reading.

**Objective:**

To develop extensive reading skill and comprehension for pleasure and profit.

**Outcome:**

Acquisition of writing skills.

**Note:**

All the exercises given in the prescribed lessons in both detailed and non-detailed textbooks relating to the theme and language skills must be covered.

**Overall course Outcomes:**

- Using English languages, both written and spoken, competently and correctly.
- Improving comprehension and fluency of speech.
- Gaining confidence in using English in verbal situations.

**MODEL QUESTION PAPER FOR THEORY****PART- I**

Six short answer questions on 6 unit themes

One question on eliciting student's response to any of the themes

**PART-II**

Each question should be from one unit and the last question can be a combination of two or more units.

Each question should have 3 sub questions: A,B& C

A will be from the main text: 5 marks

B from non-detailed text: 3 marks

C on grammar and Vocabulary: 6 marks

I Year - I Semester

MATHEMATICS-I

L	T	P	C
4	0	0	3

(Common to ALL branches of First Year B.Tech.)

**Learning Objectives:**

- The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
- The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.

**UNIT-I:**

**Differential equations of first order and first degree:** Linear-Bernoulli-Exact-Reducible to exact.

Applications: Newton's Law of cooling-Law of natural growth and decay-Orthogonal trajectories- Electrical circuits- Chemical reactions.

**UNIT-II:**

**Linear differential equations of higher order:** Non-homogeneous equations of higher order with constant coefficients with RHS term of the type  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ , polynomials in  $x$ ,  $e^{ax}V(x)$ ,  $xV(x)$ - Method of Variation of parameters.

Applications: LCR circuit, Simple Harmonic motion.

**UNIT-III:**

**Laplace transforms:**Laplace transforms of standard functions-Shifting theorems - Transforms of derivatives and integrals – Unit step function –Dirac's delta function- Inverse Laplace transforms– Convolution theorem (without proof).

Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

**UNIT-IV:**

**Partial differentiation:**Introduction- Homogeneous function-Euler's theorem-Total derivative-Chain rule-Generalized Mean value theorem for single variable (without proof)-Taylor's and Mc Laurent's series expansion of functions of two variables– Functional dependence- Jacobian.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

**UNIT-V:**

**First order Partial differential equations:**Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions –solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

**UNIT-VI:**

**Higher order Partial differential equations:**Solutions of Linear Partial differential equations with constant coefficients. RHS term of the type  $e^{ax+by}$ ,  $\sin(ax+by)$ ,  $\cos(ax+by)$ ,  $x^m y^n$ . Classification of second order partial differential equations.

**Outcomes:**

At the end of the course, student will be able to:

- Solve linear differential equations of first, second and higher order.
- Determine Laplace transform and inverse Laplace transform of various functions and use Laplace transforms to determine general solution to linear ODE.
- Calculate total derivative, Jacobian and minima of functions of two variables.

**Text Books:**

1. Higher Engineering Mathematics, B.S.Grewal, 43<sup>rd</sup> Edition, Khanna Publishers.
2. Engineering Mathematics, N.P.Bali, Lakshmi Publications.

**Reference Books:**

1. Advanced Engineering Mathematics, Erwin Kreyszig, 10<sup>th</sup> Edition, Wiley-India.
2. Advanced Engineering Mathematics, Micheael Greenberg, 9<sup>th</sup> Edition, Pearson Edn.
3. Advanced Engineering Mathematics with MATLAB, Dean G. Duffy, CRC Press.
4. Advanced Engineering Mathematics, Peter O'neil, Cengage Learning.
5. Engineering Mathematics, Srimanta Pal, SubodhC.Bhunia, Oxford University Press.
6. Higher Engineering Mathematics, Dass H.K., RajnishVerma. Er.,S. Chand Co. Pvt. Ltd, Delhi.

I Year - I Semester

L	T	P	C
4	0	0	3

**ENGINEERING CHEMISTRY**  
(CE, ME, PCE, PE, Met.E, Mining, Automobile, Aeronautical, Chemical, Bio.tech.)

Knowledge of basic concepts of chemistry for engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

**Learning Objectives:**

- Plastics are nowadays used in household appliances; also they are used as composites (FRP) in aerospace and automotive industries.
- Fuels as a source of energy are a basic need of any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence they are introduced.
- The basics for the construction of galvanic cells are introduced. Also if corrosion is to be controlled, one has to understand the mechanism of corrosion which itself is explained by electrochemical theory.
- With the increase in demand, a wide variety of materials are coming up; some of them have excellent engineering properties and a few of these materials are introduced.
- Water is a basic material in almost all the industries, more so where steam is generated and also where it is supplied for drinking purposes.
- Materials used in major industries like steel industry, metallurgical industries and construction industries and electrical equipment manufacturing industries are introduced. Also lubrication is introduced.

**UNIT-I: HIGH POLYMERS AND PLASTICS:**

**Polymerisation:-** Introduction- Mechanism of polymerization - Stereo regular polymers – Methods of polymerization (emulsion and suspension) -Physical and mechanical properties – Plastics as engineering materials:advantages and limitations – Thermoplastics and Thermosetting plastics – Compounding and fabrication (4/5 techniques)- Preparation, properties and applications of polyethene, PVC, Bakelite Teflon and Polycarbonates

**Elastomers:**Natural rubber- compounding and vulcanization – Synthetic rubbers: Buna S, Buna N, Thiokol and polyurethanes – Applications of elastomers.

**Composite materials&** Fiber reinforced plastics – Biodegradable polymers – Conducting polymers.

**UNIT-II: FUEL TECHNOLOGY**

**Fuels** – Introduction – Classification – Calorific value - HCV and LCV – Dulong’s formula – Bomb calorimeter – Numerical problems – Coal — Proximate and ultimate analysis – Significance of the analyses – Liquid fuels – Petroleum- Refining – Cracking – Synthetic petrol –Petrol knocking – Diesel knocking - Octane and Cetane ratings – Anti-knock agents – Power alcohol – Bio-diesel – Gaseous fuels – Natural gas, LPG and CNG – Combustion – Calculation of air for the combustion of a fuel – Flue gas analysis – Orsat apparatus – Numerical problems on combustion.

**Explosives:**Rocket fuels

### **UNIT-III: ELECTROCHEMICAL CELLS AND CORROSION**

Galvanic cells - Reversible and irreversible cells – Single electrode potential – Electro chemical series and uses of this series- Standard electrodes (Hydrogen and Calomel electrodes) - Concentration Cells – Batteries: Dry Cell - Ni-Cd cells - Ni-Metal hydride cells - Li cells - Zinc – air cells.

**Corrosion :-** Definition – Theories of Corrosion (chemical & electrochemical) – Formation of galvanic cells by different metals, by concentration cells, by differential aeration and waterline corrosion – Passivity of metals – Pitting corrosion - Galvanic series – Factors which influence the rate of corrosion - Protection from corrosion – Design and material selection – Cathodic protection - Protective coatings: – Surface preparation – Metallic (cathodic and anodic) coatings - Methods of application on metals (Galvanizing, Tinning, Electroplating, Electroless plating).

### **UNIT-IV: CHEMISTRY OF ADVANCED MATERIALS**

**Nano materials:-** Introduction – Sol-gel method & chemical reduction method of preparation – Characterization by BET method and TEM methods - Carbon nano tubes and fullerenes: Types, preparation, properties and applications

**Liquid crystals:-** Introduction – Types – Applications

**Super conductors:-**Type –I, Type II – Characteristics and applications

**Green synthesis:-** Principles - 3or 4 methods of synthesis with examples –  $R_4M_4$  principles

### **UNIT-V: WATER TECHNOLOGY**

**Hard water:-** Reasons for hardness – Units of hardness - Determination of hardness and alkalinity - Water for steam generation - Boiler troubles – Priming and Foaming, Scale formation, Boiler corrosion, Caustic embrittlement - Internal treatments - Softening of Hard water : Lime – Soda process, Zeolite process and numerical problems based on these processes and Ion Exchange process - Water for drinking purposes- Purification – Sterilization and disinfection : Chlorination, Break point chlorination and other methods – Reverse Osmosis and Electro Dialysis.

### **UNIT-VI: CHEMISTRY OF ENGINEERING MATERIALS AND FUEL CELLS**

**Refractories:** - Definition, Characteristics, Classification, Properties, Failure of refractories.

**Lubricants:** - Definition, function, Theory and mechanism of lubricants, Properties (Definition and importance).

**Cement:** - Constituents, Manufacturing, Hardening and setting, Deterioration of cement.

**Insulators:** - Thermal and electrical insulators.

**Fuel cells:** - Hydrogen Oxygen fuel cells – Methanol Oxygen fuel cells.

#### **Outcome:**

- The advantages and limitations of plastic materials and their use in design would be understood. Fuels which are used commonly and their economics, advantages and limitations are discussed. Reasons for corrosion and some methods of corrosion control would be understood. The students would be now aware of materials like nano materials and fullerenes and their uses. Similarly liquid crystals and superconductors are understood. The importance of green synthesis is well understood and how they are different from conventional methods is also explained. The impurities present in raw water, problems associated with them and how to avoid them are understood. The advantages and limitations of plastic materials and their use in design would be understood. The commonly used industrial materials are introduced.

**Standard Text Books:**

1. Engineering Chemistry, Jain and Jain; Dhanpat Rai Publishing Co.
2. Engineering Chemistry, Shikha Agarwal; Cambridge University Press, 2015 Edition.

**Reference Books:**

1. Engineering Chemistry of Wiley India Pvt. Ltd., Vairam and others, 2<sup>nd</sup> Edition, 2014.
2. Engineering Chemistry, Prasanth Rath, Cengage Learning, 2015 Edition.
3. A Text Book of Engineering Chemistry, S. S. Dara; S. Chand & Co Ltd., Latest Edition
4. Applied Chemistry, H.D. Gesser, Springer Publishers
5. Text book of Nano-science and Nanotechnology, B.S. Murthy, P. Shankar and others, University Press, IIM.

I Year - I Semester

L	T	P	C
4	0	0	3

## ENIGINEERING MECHANICS

### Learning Objectives:

- The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods.
- They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

### UNIT-I:

**Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.**

Introduction to Engg. Mechanics – Basic Concepts.

**Systems of Forces:** Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.

**Friction:** Introduction, Limiting friction and impending motion, Coulomb's laws of dry friction, Coefficient of friction, Cone of friction.

### UNIT-II:

**Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle of forces.**

**Equilibrium of Systems of Forces:** Free body diagrams, Equations of equilibrium of coplanar systems, Spatial systems for concurrent forces, Lamis Theorem, Graphical method for the equilibrium of coplanar forces, Converse of the law of triangle of forces, Converse of the law of polygon of forces condition of equilibrium, Analysis of plane trusses.

### UNIT-III:

**Objectives: The students are to be exposed to concepts of centre of gravity.**

**Centroid:** Centroids of simple figures (from basic principles) – Centroids of composite figures

**Centre of Gravity:** Centre of gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappus theorems.

### UNIT-IV:

**Objective: The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.**

**Area moments of Inertia:** Definition – Polar moment of inertia, Transfer theorem, Moments of inertia of composite figures, Products of inertia, Transfer formula for product of inertia.

**Mass Moment of Inertia:** Moment of inertia of masses, Transfer formula for mass moments of Inertia, Mass moment of inertia of composite bodies.

### UNIT-V:

**Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.**



**Kinematics:** Rectilinear and Curvilinear motions – Velocity and Acceleration – Motion of rigid body – Types and their analysis in planar motion.

**Kinetics:** Analysis as a particle and analysis as a rigid body in translation – Central force motion – Equations of plane motion – Fixed axis rotation – Rolling bodies.

#### **UNIT-VI:**

**Objectives: The students are to be exposed to concepts of work, energy and particle motion**

**Work-Energy Method:** Equations for translation, Work-Energy applications to particle Motion, Connected system-Fixed axis rotation and plane motion, Impulse momentum method.

#### **Text Books:**

1. Engg. Mechanics, S.Timoshenko&D.H.Young., 4<sup>th</sup>Edn, McGraw Hill Publications.

#### **References Books:**

1. Engineering Mechanics Statics and Dynamics, R.C.Hibbeler, 11<sup>th</sup>Edn.,Pearson Publ.
2. Engineering Mechanics, Statics, J.L.Meriam, 6<sup>th</sup>Edn.,Wiley India Pvt. Ltd.
3. Engineering Mechanics, Statics and Dynamics, I.H.Shames, Pearson Publ.
4. Mechanics For Engineers, Statics, F.P.Beer&E.R.Johnston, 5<sup>th</sup>Edn.,McGraw Hill Publ.
5. Mechanics For Engineers, Dynamics, F.P.Beer&E.R.Johnston, 5<sup>th</sup>Edn.,McGraw Hill Publ.
6. Theory & Problems of Engineering Mechanics, Statics & Dynamics, E.W.Nelson, C.L.Best& W.G. McLean, 5<sup>th</sup>Edn., Schaum's Outline Series, McGraw Hill Publ.
7. Singer's Engineering Mechanics: Statics And Dynamics, K. Vijay Kumar Reddy, J. Suresh Kumar, Bs Publications.
8. Engineering Mechanics, Ferdinand. L. Singer, Harper – Collins.
9. Engineering Mechanics Statics and Dynamics , A Nelson , McGraw Hill Publications.

I Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## COMPUTER PROGRAMMING

### Learning objectives:

Formulating algorithmic solutions to problems and implementing algorithms in C.

- Notion of operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.
- Understanding branching, iteration and data representation using arrays.
- Modular programming and recursive solution formulation.
- Understanding pointers and dynamic memory allocation.
- Understanding miscellaneous aspects of C.
- Comprehension of file operations.

### UNIT-I:

**History and Hardware** - Computer Hardware, Bits and Bytes, Components, Programming Languages - Machine Language, Assembly Language, Low- and High-Level Languages, Procedural and Object-Oriented Languages, Application and System Software, The Development of C Algorithms The Software Development Process.

### UNIT-II:

**Introduction to C Programming**- Identifiers, The main () Function, The printf () Function.

**Programming Style** - Indentation, Comments, Data types, Arithmetic Operations, Expression Types, Variables and Declarations, Negation, Operator Precedence and Associativity, Declaration Statements, Initialization.

**Assignment** - Implicit Type Conversions, Explicit Type Conversions (Casts), Assignment Variations, Mathematical Library Functions, Interactive Input, Formatted Output, Format Modifiers.

### UNIT -III:

**Control Flow-Relational Expressions - Logical Operators:**

**Selection:** if-else Statement, nested if, examples, Multi-way selection: switch, else-if, examples.

**Repetition:** Basic Loop Structures, Pretest and Posttest Loops, Counter-Controlled and Condition-Controlled Loops, The while Statement, The for Statement, Nested Loops, The do-while Statement.

#### **UNIT-IV:**

**Modular Programming:** Function and Parameter Declarations, Returning a Value, Functions with Empty Parameter Lists, Variable Scope, Variable Storage Class, Local Variable Storage Classes, Global Variable Storage Classes, Pass by Reference, Passing Addresses to a Function, Storing Addresses, Using Addresses, Declaring and Using Pointers, Passing Addresses to a Function.

Case Study: Swapping Values, Recursion - Mathematical Recursion, Recursion versus Iteration.

#### **UNIT-V:**

##### **Arrays & Strings:**

**Arrays:** One-Dimensional Arrays, Input and output of Array Values, Array Initialization, Arrays as Function Arguments, Two-Dimensional Arrays, Larger Dimensional Arrays- Matrices

**Strings:** String Fundamentals, String Input and Output, String Processing, Library Functions

#### **UNIT-VI:**

##### **Pointers, Structures, Files:**

**Pointers:** Concept of a Pointer, Initialisation of Pointer Variables, Pointers as function arguments, Passing by Address, Dangling Memory, Address Arithmetic, Character pointers and Functions, Pointers to Pointers, Dynamic Memory Management Functions, Command line arguments.

**Structures:** Derived types, Structures declaration, Initialization of structures, Accessing structures, Nested structures, Arrays of structures, Structures and functions, Pointers to structures, Self Referential Structures, Unions, Typedef, Bit-fields.

**Data Files:** Declaring, Opening, and Closing File Streams, Reading from and Writing to Text Files, Random File Access.

#### **Outcomes:**

- Understand the basic terminology used in computer programming.
- Write, compile and debug programs in C language.
- Use different data types in a computer program.
- Design programs involving decision structures, loops and functions.
- Explain the difference between call by value and call by reference.
- Understand the dynamics of memory by the use of pointers.
- Use different data structures and create/update basic data files.

#### **Text Books:**

1. ANSI C Programming, Gary J. Bronson, Cengage Learning.
2. Programming in C, BI Juneja Anita Seth, Cengage Learning.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.

#### **Reference Books:**

1. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
2. Programming with C, Bichkar, Universities Press.
3. Programming in C, ReemaThareja, OXFORD.
4. C by Example, Noel Kalicharan, Cambridge.

## ENVIRONMENTAL STUDIES

### Learning Objectives:

The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

### UNIT-I:

**Multidisciplinary nature of Environmental Studies:** Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.

**Ecosystems:** 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 Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

### UNIT-II:

**Natural Resources:** Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest 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.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

### UNIT-III:

**Biodiversity and its conservation:** Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

**UNIT – IV Environmental Pollution:** Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

**Solid Waste Management:** Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

**UNIT – V Social Issues and the Environment:** Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act - Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

**UNIT – VI Environmental Management:** Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

**Text Books:**

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2<sup>nd</sup> Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

**Reference:**

1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2014

I Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

### **ENGINEERING /APPLIED CHEMISTRY LABORATORY**

1. Introduction to Chemistry laboratory – Molarity, Normality, Primary, secondary standard solutions, Volumetric titrations, Quantitative analysis, Qualitative analysis, etc.
2. Trial experiment - Determination of HCl using standard  $\text{Na}_2\text{CO}_3$  solution.
3. Determination of alkalinity of a sample containing  $\text{Na}_2\text{CO}_3$  and  $\text{NaOH}$ .
4. Determination of  $\text{KMnO}_4$  using standard Oxalic acid solution.
5. Determination of Ferrous iron using standard  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.
6. Determination of Copper using standard  $\text{K}_2\text{Cr}_2\text{O}_7$  solution.
7. Determination of temporary and permanent hardness of water using standard EDTA solution.
8. Determination of Copper using standard EDTA solution.
9. Determination of Iron by a Colorimetric method using thiocyanate as reagent.
10. Determination of pH of the given sample solution using pH meter.
11. Conductometric titration between strong acid and strong base.
12. Conductometric titration between strong acid and weak base.
13. Potentiometric titration between strong acid and strong base.
14. Potentiometric titration between strong acid and weak base.
15. Determination of Zinc using standard EDTA solution.
16. Determination of Vitamin – C.

#### **Outcomes:**

- The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

#### **Reference Books**

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.
2. Laboratory Manual of Engineering Chemistry-II, Dr. JyotsnaCherukuris, VGS Techno Series, 2012.

3. Chemistry Practical Manual, Lorven Publications.
4. Practical Engineering Chemistry, K. Mukkanti, B.S. Publication, 2009.

<b>I Year - I Semester</b>	<b>ENGLISH - COMMUNICATION SKILLS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>LAB- I</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

**PRESCRIBED LAB MANUAL FOR SEMESTER I:**

**'INTERACT: English Lab Manual for Undergraduate Students'** Published by **Orient BlackswanPvt Ltd.**

**Objectives:**

- To enable the students to learn through practice the communication skills of listening, speaking, reading and writing.

**Outcome:**

- A study of the communicative items in the laboratory will help the students become successful in the competitive world.
- The course content along with the study material is divided into six units.

**UNIT-I:**

1. WHY study Spoken English?
2. Making Inquiries on the phone, thanking and responding to Thanks  
Practice work.

**UNIT-II:**

1. Responding to Requests and asking for Directions  
Practice work.

**UNIT-III:**

1. Asking for Clarifications, Inviting, Expressing Sympathy, Congratulating
2. Apologising, Advising, Suggesting, Agreeing and Disagreeing  
Practice work.

**UNIT-IV:**

1. Letters and Sounds  
Practice work.

**UNIT-V:**

1. The Sounds of English  
Practice work.

**UNIT-VI:**

1. Pronunciation
2. Stress and Intonation  
Practice work.

## Assessment Procedure: Laboratory

1. Every lab session (150 minutes) should be handled by not less than two teachers (three would be ideal) where each faculty has to conduct a speaking activity for 20/30 students.
2. The teachers are to assess each learner in the class for not less than 10 speaking activities, each one to be assessed for 10 marks or 10%. The average of 10 day-to-day activity assessments is to be calculated for 10 marks for internal assessment.

The rubric given below has to be filled in for all the students for all activities.

### The rubric to assess the learners:

Body language		Fluency & Audibility	Clarity in Speech	Neutralization of accent	Appropriate Language		Total 10 marks	Remarks
Gestures & Postures	Eye Contact				Grammar	Vocabulary & expressions		

- **Lab Assessment: Internal (25 marks)**
  1. Day-to-Day activities: 10 marks
  2. Completing the exercises in the lab manual: 5 marks
  3. Internal test (5 marks written and 5 marks oral)
- **Lab Assessment: External (50 marks)**
  1. Written test: 20 marks (writing a dialogue, note-taking and answering questions on listening to an audio recording.
  2. Oral: Reading aloud a text or a dialogue- 10 marks
  3. Viva-Voce by the external examiner: 20 marks

### Reference Books:

1. Strengthen your communication skills by Dr M Hari Prasad, DrSalivendraRaju and Dr G Suvarna Lakshmi, Maruti Publications.
2. English for Professionals by Prof Eliah, B.S Publications, Hyderabad.
3. Unlock, Listening and speaking skills 2, Cambridge University Press
4. Spring Board to Success, Orient BlackSwan
5. A Practical Course in effective english speaking skills, PHI
6. Word power made handy, Drshaliniverma, Schand Company
7. Let us hear them speak, JayashreeMohanraj, Sage texts
8. Professional Communication, ArunaKoneru, McGrawhill Education
9. Cornerstone, Developing soft skills, Pearson Education



## COMPUTER PROGRAMMING LAB

### Learning Objectives:

- Understand the basic concept of C Programming, and its different modules that includes conditional and looping expressions, Arrays, Strings, Functions, Pointers, Structures and File programming.
- Acquire knowledge about the basic concept of writing a program.
- Role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language.
- Use of conditional expressions and looping statements to solve problems associated with conditions and repetitions.
- Role of Functions involving the idea of modularity.

### Programming:

#### Exercise – 1: Basics

- a) What is an OS Command, Familiarization of Editors - vi, Emacs
- b) Using commands like mkdir, ls, cp, mv, cat, pwd, and man
- c) C Program to Perform Adding, Subtraction, Multiplication and Division of two numbers From Command line

#### Exercise – 2: Basic Math

- a) Write a C Program to Simulate 3 Laws at Motion
- b) Write a C Program to convert Celsius to Fahrenheit and vice versa

#### Exercise – 3: Control Flow - I

- a) Write a C Program to Find Whether the Given Year is a Leap Year or not.
- b) Write a C Program to Add Digits & Multiplication of a number

#### Exercise – 4: Control Flow - II

- a) Write a C Program to Find Whether the Given Number is
  - i) Prime Number
  - ii) Armstrong Number
- b) Write a C program to print Floyd Triangle
- c) Write a C Program to print Pascal Triangle

#### Exercise – 5: Functions

- a) Write a C Program demonstrating of parameter passing in Functions and returning values.
- b) Write a C Program illustrating Fibonacci, Factorial with Recursion without Recursion

#### Exercise – 6: Control Flow - III

- a) Write a C Program to make a simple Calculator to Add, Subtract, Multiply or Divide Using switch...case
- b) Write a C Program to convert decimal to binary and hex (using switch call function the function)

**Exercise – 7: Functions – Continued..**

Write a C Program to compute the values of  $\sin x$  and  $\cos x$  and  $e^x$  values using Series expansion. (use factorial function)

**Exercise – 8: Arrays**

Demonstration of arrays

- a) Search-Linear.
- b) Sorting-Bubble, Selection.
- c) Operations on Matrix.

**Exercises – 9: Structures**

- a) Write a C Program to Store Information of a Movie Using Structure
- b) Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
- c) Write a C Program to Add Two Complex Numbers by Passing Structure to a Function

**Exercise – 10: Arrays and Pointers**

- a) Write a C Program to Access Elements of an Array Using Pointer
- b) Write a C Program to find the sum of numbers with arrays and pointers.

**Exercise – 11: Dynamic Memory Allocations**

- a) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc () function.
- b) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

Understand the difference between the above two programs

**Exercise – 12: Strings**

- a) Implementation of string manipulation operations **with** library function.
  - i) copy
  - ii) concatenate
  - iii) length
  - iv) compare
- b) Implementation of string manipulation operations **without** library function.
  - i) copy
  - ii) concatenate
  - iii) length
  - iv) compare

**Exercise -13: Files**

- a) Write a C programming code to open a file and to print its contents on screen.
- b) Write a C program to copy files

**Exercise – 14: Files Continued**

- a) Write a C program merges two files and stores their contents in another file.
- b) Write a C program to delete a file.

**Outcomes:**

- Apply and practice logical ability to solve the problems.
- Understand C programming development environment, compiling, debugging, and linking and executing a program using the development environment
- Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs
- Understand and apply the in-built functions and customized functions for solving the problems.
- Understand and apply the pointers, memory allocation techniques and use of files for dealing with variety of problems.
- Document and present the algorithms, flowcharts and programs in form of user-manuals
- Identification of various computer components, Installation of software

**Note:**

- a) All the Programs must be executed in the Linux Environment. (Mandatory)**
- b) The Lab record must be a print of the LATEX (.tex) Format.**

<b>I Year - II Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## **ENGLISH-II**

### **Introduction:**

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training the students to acquire communicative competence, the syllabus has been designed to develop linguistic and communicative competence of the students of Engineering.

As far as the detailed Textbooks are concerned, the focus should be on the skills of listening, speaking, reading and writing. The non-detailed Textbooks are meant for extensive reading for pleasure and profit.

Thus the stress in the syllabus is primarily on the development of communicative skills and fostering of ideas.

### **Learning Objectives:**

- To improve the language proficiency of the students in English with emphasis on LSRW skills.
- To enable the students to study and comprehend the prescribed lessons and subjects more effectively relating to their theoretical and practical components.
- To develop the communication skills of the students in both formal and informal situations.

### **LISTENING SKILLS:**

#### **Objectives:**

- To enable the students to appreciate the role of listening skill and improve their pronunciation.
- To enable the students to comprehend the speech of people belonging to different backgrounds and regions.
- To enable the students to listen for general content, to fill up information and for specific information.

### **SPEAKING SKILLS:**

#### **Objectives:**

- To make the students aware of the importance of speaking for their personal and professional communication.
- To enable the students to express themselves fluently and accurately in social and professional success.
- To help the students describe objects, situations and people.
- To make the students participate in group activities like role-plays, discussions and debates.
- To make the students participate in Just a Minute talks.

## **READING SKILLS:**

### **Objectives:**

- To enable the students to comprehend a text through silent reading.
- To enable the students to guess the meanings of words, messages and inferences of texts in given contexts.
- To enable the students to skim and scan a text.
- To enable the students to identify the topic sentence.
- To enable the students to identify discourse features.
- To enable the students to make intensive and extensive reading.

## **WRITING SKILLS:**

### **Objectives:**

- To make the students understand that writing is an exact formal skills.
- To enable the students to write sentences and paragraphs.
- To make the students identify and use appropriate vocabulary.
- To enable the students to narrate and describe.
- To enable the students capable of note-making.
- To enable the students to write coherently and cohesively.
- To make the students to write formal and informal letters.
- To enable the students to describe graphs using expressions of comparison.
- To enable the students to write technical reports.

### **Methodology:**

- The classes are to be learner-centered where the learners are to read the texts to get a comprehensive idea of those texts on their own with the help of the peer group and the teacher.
- Integrated skill development methodology has to be adopted with focus on individual language skills as per the tasks/exercise.
- The tasks/exercises at the end of each unit should be completed by the learners only and the teacher intervention is permitted as per the complexity of the task/exercise.
- The teacher is expected to use supplementary material wherever necessary and also generate activities/tasks as per the requirement.
- The teacher is permitted to use lecture method when a completely new concept is introduced in the class.

### **Assessment Procedure:**

#### **Theory**

1. The formative and summative assessment procedures are to be adopted (mid exams and end semester examination).
2. Neither the formative nor summative assessment procedures should test the memory of the content of the texts given in the textbook. The themes and global comprehension of the units in the present day context with application of the language skills learnt in the unit are to be tested.
3. Only new unseen passages are to be given to test reading skills of the learners. Written skills are to be tested from sentence level to essay level. The communication formats— emails, letters and reports-- are to be tested along with appropriate language and expressions.
4. Examinations:  
I mid exam + II mid exam (15% for descriptive tests+10% for online tests)= 25%

(80% for the best of two and 20% for the other)

Assignments= 5%

End semester exams=70%

5. Three take home assignments are to be given to the learners where they will have to read texts from the reference books list or other sources and write their gist in their own words.

The following text books are recommended for study in I B.Tech II Semester (Common for all branches) and I B.Pharm. II Sem of JNTU Kakinada from the academic year 2016-17 (**R-16 Regulations**)

1. **DETAILED TEXTBOOK:ENGLISH ENCOUNTERS**Published by**Maruthi Publishers.**
2. **DETAILED NON-DETAIL:THE GREAT INDIAN SCIENTISTS** Published by **Cengage learning.**

The course content along with the study material is divided into six units.

#### **UNIT-I:**

1. ' The Greatest Resource- Education' from English Encounters

**Objective:**Schumacher describes the education system by saying that it was mere training, something more than mere knowledge of facts.

**Outcome:**The lesson underscores that the ultimate aim of Education is to enhance wisdom.

2. ' A P J Abdul Kalam' from The Great Indian Scientists.

**Objective:**The lesson highlights Abdul Kalam's contributions to Indian science and the awards he received.

**Outcome:**Abdul Kalam's simple life and service to the nation inspires the readers to follow in his footsteps.

#### **UNIT-II:**

1. ' A Dilemma' from English Encounters

**Objective:** The lesson centres on the pros and cons of the development of science and technology.

**Outcome:** The lesson enables the students to promote peaceful co-existence and universal harmony among people and society.

2. 'C V Raman' from The Great Indian Scientists.

**Objective:** The lesson highlights the dedicated research work of C V Raman and his achievements in Physics.

**Outcome:**

The Achievements of C V Raman are inspiring and exemplary to the readers and all scientists.

#### **UNIT-III:**

1. 'Cultural Shock': Adjustments to new Cultural Environments from English Encounters.

**Objective:**The lesson depicts of the symptoms of Cultural Shock and the aftermath consequences.

**Outcome:**The lesson imparts the students to manage different cultural shocks due to globalization.

2. 'HomiJehangirBhabha' from The Great Indian Scientists.

**Objective:** The lesson highlights HomiJehangirBhabha's contributions to Indian nuclear programme as architect.

**Outcome:**The seminal contributions of HomiJehangirBhabha to Indian nuclear programme provide an aspiration to the readers to serve the nation and strengthen it.

#### **UNIT-IV:**

1. 'The Lottery' from English Encounters.

**Objective:** The lesson highlights insightful commentary on cultural traditions.

**Outcome:**The theme projects society's need to re examine its traditions when they are outdated.

2. 'Jagadish Chandra Bose' from The Great Indian Scientists.

**Objective:** The lesson gives an account of the unique discoveries and inventions of Jagadish Chandra Bose in Science.

**Outcome:** The Scientific discoveries and inventions of Jagadish Chandra Bose provide inspiration to the readers to make their own contributions to science and technology, and strengthen the nation.

#### **UNIT-V:**

1. 'The Health Threats of Climate Change' from English Encounters.

**Objective:**The essay presents several health disorders that spring out due to environmental changes.

**Outcome:**The lesson offers several inputs to protect environment for the sustainability of the future generations.

2. 'Prafulla Chandra Ray' from The Great Indian Scientists.

**Objective:** The lesson gives an account of the experiments and discoveries in Pharmaceuticals of Prafulla Chandra Ray.

**Outcome:**Prafulla Chandra Ray's scientific achievements and patriotic fervour provide inspiration to the reader.

#### **UNIT-VI:**

1. 'The Chief Software Architect' from English Encounters

**Objective:**

The lesson supports the developments of technology for the betterment of human life.

**Outcome:**

Pupil get inspired by eminent personalities who toiled for the present day advancement of software development.

2. 'SrinivasaRamanujan' from The Great Indian Scientists.

**Objective:**The lesson highlights the extraordinary achievements of SrinivasaRamanujan, a great mathematician and the most romantic figure in mathematics.

**Outcome:** The lesson provides inspiration to the readers to think and tap their innate talents.

#### **NOTE:**

All the exercises given in the prescribed lessons in both detailed and non-detailed textbooks relating to the theme and language skills must be covered.

## **MODEL QUESTION PAPER FOR THEORY**

### **PART- I**

Six short answer questions on 6 unit themes

One question on eliciting student's response to any of the themes

### **PART-II**

Each question should be from one unit and the last question can be a combination of two or more units.

Each question should have 3 sub questions: A,B& C

A will be from the main text: 5 marks

B from non-detailed text: 3 marks

C on grammar and Vocabulary: 6 marks



I Year - II Semester

L	T	P	C
4	0	0	3

**MATHEMATICS-II (Mathematical Methods)**  
**(Common to ALL branches of First Year B.Tech.)**

**Learning Objectives:**

- The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
- The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.
- Understand the most basic numerical methods to solve simultaneous linear equations.

**UNIT-I:**

**Solution of Algebraic and Transcendental Equations:**

Introduction- Bisection method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations).

**UNIT-II:**

**Interpolation:**

Introduction- Errors in polynomial interpolation – Finite differences- Forward differences- Backward differences – Central differences – Symbolic relations and separation of symbols - Differences of a polynomial-Newton's formulae for interpolation – Interpolation with unequal intervals - Lagrange's interpolation formula.

**UNIT-III:**

**Numerical Integration and solution of Ordinary Differential equations:**

Trapezoidal rule- Simpson's  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rule-Solution of ordinary differential equations by Taylor's series-Picard's method of successive approximations-Euler's method - Runge-Kutta method (second and fourth order).

**UNIT-IV:**

**Fourier Series:**

Introduction- Periodic functions – Fourier series of  $\pi$ -periodic function - Dirichlet's conditions – Even and odd functions – Change of interval– Half-range sine and cosine series.

**UNIT-V:**

**Applications of PDE:**

Method of separation of Variables- Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

**UNIT-VI:**

**Fourier Transforms:**

Fourier integral theorem (without proof) – Fourier sine and cosine integrals - sine and cosine transforms – properties – inverse transforms – Finite Fourier transforms.

**Outcomes:**

At the end of the course, student will be able to:

- Calculate a root of algebraic and transcendental equations. Explain relation between the finite difference operators.
- Compute interpolating polynomial for the given data.
- Solve ordinary differential equations numerically using Euler's and RK method.
- Find Fourier series and Fourier transforms for certain functions.
- Identify/classify and solve the different types of partial differential equations.

**Text Books:**

1. Higher Engineering Mathematics, B.S.Grewal, 43<sup>rd</sup> Edition, Khanna Publishers.
2. Engineering Mathematics, N.P.Bali, Lakshmi Publications.

**Reference Books:**

1. Advanced engineering mathematics with MATLAB, Dean G. Duffy, CRC Press
2. Mathematical Methods, V.Ravindranath and P.Vijayalakshmi, Himalaya Publishing House.
3. Advanced Engineering Mathematics, Erwin Kreyszig, 10<sup>th</sup> Edition, Wiley-India
4. Numerical Analysis-Mathematics of Scientific Computing, David Kincaid, Ward Cheney, 3<sup>rd</sup> Edition, Universities Press.
5. Engineering Mathematics, Srimanta Pal, Subodh C. Bhunia, Oxford University Press.
6. Higher Engineering Mathematics, Dass H.K., Rajnish Verma. Er., S. Chand Co. Pvt. Ltd, Delhi.

I Year - II Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

**MATHEMATICS-III**  
(Common to ALL branches of First Year B.Tech.)

**Learning Objectives:**

- The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
- The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.
- Understand the most basic numerical methods to solve simultaneous linear equations.

**UNIT-I:**

**Linear systems of equations:** Rank-Echelon form-Normal form – Solution of linear systems – Gauss elimination - Gauss Jordan- Gauss Jacobi and Gauss Seidal methods.

Applications: Finding the current in electrical circuits.

**UNIT-II:**

**Eigen values - Eigen vectors and Quadratic forms:** Eigen values - Eigen vectors– Properties – Cayley-Hamilton theorem - Inverse and powers of a matrix by using Cayley-Hamilton theorem- Diagonalization- Quadratic forms- Reduction of quadratic form to canonical form – Rank - Positive, negative and semi definite - Index – Signature.

Applications: Free vibration of a two-mass system.

**UNIT-III:**

**Multiple integrals:** Curve tracing: Cartesian, Polar and Parametric forms.

Multiple integrals: Double and triple integrals – Change of variables – Change of order of integration.

Applications: Finding Areas and Volumes.

**UNIT-IV:**

**Special functions:** Beta and Gamma functions- Properties - Relation between Beta and Gamma functions- Evaluation of improper integrals.

Applications: Evaluation of integrals.

**UNIT-V:**

**Vector Differentiation:** Gradient- Divergence- Curl - Laplacian and second order operators - Vector identities.

Applications: Equation of continuity, potential surfaces

**UNIT-VI:**

**Vector Integration:** Line integral – Work done – Potential function – Area- Surface and volume integrals Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and related problems.

Applications: Work done, Force.

**Outcomes:**

At the end of the Course, Student will be able to:

- Determine rank, Eigenvalues and Eigen vectors of a given matrix and solve simultaneous linear equations.
- Solve simultaneous linear equations numerically using various matrix methods.
- Determine double integral over a region and triple integral over a volume.
- Calculate gradient of a scalar function, divergence and curl of a vector function. Determine line, surface and volume integrals. Apply Green, Stokes and Gauss divergence theorems to calculate line, surface and volume integrals.

**Text Books:**

1. Higher Engineering Mathematics, B.S.Grewal, 43<sup>rd</sup> Edition, Khanna Publishers.
2. Engineering Mathematics, N.P.Bali, Lakshmi Publications.

**Reference Books:**

1. Advanced Engineering Mathematics, Greenberg, 2<sup>nd</sup> edition, Pearson edn
2. Advanced Engineering Mathematics, Erwin Kreyszig, 10<sup>th</sup> Edition, Wiley-India
3. Advanced Engineering Mathematics, Peter O'Neil, 7<sup>th</sup> edition, Cengage Learning.
4. Mathematical Techniques, D.W. Jordan and T.Smith, Oxford University Press.
5. Engineering Mathematics, Srimanta Pal, SubodhC.Bhunia, Oxford University Press.
6. Higher Engineering Mathematics, Dass H.K., RajnishVerma. Er.,S. Chand Co. Pvt. Ltd, Delhi.

I Year - II Semester

L	T	P	C
4	0	0	3

**ENGINEERING PHYSICS**

(ME, CE, PE, PCE, MET.E, MINING, AUTOMOBILE, CHEMICAL, AERONAUTICAL, BIO.TECH)

**Learning Objectives:**

Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by JNTUK That serves as a transit to understand the branch specific advanced topics. The courses are designed to:

- Impart concepts of Optical Interference, Diffraction and Polarization required to design instruments with higher resolution- Concepts of coherent sources, its realization and utility optical instrumentation.
- Study the Structure-property relationship exhibited by solid crystal materials for their utility.
- Tap the Simple harmonic motion and its adaptability for improved acoustic quality of concert halls.
- To explore the Nuclear Power as a reliable source required to run industries
- To impart the knowledge of materials with characteristic utility in appliances.

**UNIT-I:**

**INTERFERENCE:** Principle of Superposition – Coherent Sources – Interference in thin films (reflection geometry) – Newton’s rings – construction and basic principle of Interferometers.

**UNIT-II:**

**DIFFRACTION:** Fraunhofer diffraction at single slit cases of double slit, N-slits & Circular Aperture (Qualitative treatment only)-Grating equation - Resolving power of a grating, Telescope and Microscopes.

**UNIT-III:**

**POLARIZATION:** Types of Polarization-production - Nicol Prism -Quarter wave plate and Half Wave plate – Working principle of Polarimeter (Sacharimeter)

**LASERS:** Characteristics– Stimulated emission – Einstein’s Transition Probabilities- Pumping schemes - Ruby laser – Helium Neon laser.

**UNIT-IV:**

**ACOUSTICS:** Reverberation time - Sabine’s formula – Acoustics of concert-hall.

**ULTRASONICS:** Production - Ultrasonic transducers- Non-Destructive Testing – Applications.

**UNIT-V:**

**CRYSTALLOGRAPHY & X-RAY DIFFRACTION:** Basis and lattice – Bravais systems- Symmetry elements- Unit cell- packing fraction – coordination number- Miller indices – Separation between successive (h k l) planes – Bragg’s law.

**NUCLEAR ENERGY – SOURCE OF POWER:** Mass defect & Binding Energy – Fusion and Fission as sources – Fast breeder Reactors.

**UNIT-VI:**

**MAGNETISM:** Classification based on Field, Temperature and order/disorder –atomic origin – Ferromagnetism- Hysteresis- applications of magnetic materials (Para & Ferro)..

**DIELECTRICS:** Electric Polarization – Dielectrics in DC and AC fields – Internal field – ClausiusMossoti Equation - Loss, Breakdown and strength of dielectric materials – Ferroelectric Hysteresis and applications.

**Outcome:**

- Construction and working details of instruments, ie., Interferometer, Diffractometer and Polarimeter are learnt. Study Acoustics, crystallography magnetic and dielectric materials enhances the utility aspects of materials.

**Text Books:**

1. A Text book of Engineering Physics, Dr. M.N.Avadhanulu and Dr.P.G.Kshirasagar, S.Chand& Company Ltd., 2014.
2. Physics for Engineers, M.R.Srinasan, New Age International Publishers, 2009.
3. Engineering Physics, D.K.Bhattacharya and PoonamTandon , Oxford Press, 2015.

**Reference books:**

1. Applied Physics, P.K.Palanisamy, Scitech Publications, 2014.
2. Lasers and Non-Linear Optics, B.B.Laud, Newage International Publishers, 2008.

I Year - II Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## **ELEMENTS OF MECHANICAL ENGINEERING**

### **Learning Objectives:**

- The content of this course shall provide the student the basic concepts of various mechanical systems and exposes the student to a wide range of equipment and their utility in a practical situation. It shall provide the fundamental principles of materials, fuels, Steam, I.C. Engines, compressors, hydraulic machines and transmission systems that usually exist in any process plant.

### **UNIT –I:**

Stresses and strains: kinds of – stress-strains, elasticity and plasticity, Hooks law, stress –strain diagrams, modules of elasticity, Poisson’s ratio, linear and volumetric strain, relation between E, N, and K, bars of uniform strength, compound bars and temperature stresses.

### **UNIT–II:**

Types of supports – loads – Shear force and bending moment for cantilever and simply supported beams without overhanging for all types of loads.

Theory of simple bending, simple bending formula, Distribution of Flexural and Shear stress in Beam section – Shear stress formula – Shear stress distribution for some standard sections

### **UNIT-III:**

Thin cylindrical shells: stress in cylindrical shells due to internal pressures, circumferential stress, longitudinal stress, design of thin cylindrical shells, spherical shells, change in dimension of the shell due to internal pressure, change in volume of the shell due to internal pressure.

Thick Cylinders: Lamé’s equation- cylinders subjected to inside and outside pressures columns and Struts.

### **UNIT-IV:**

Steam boilers and Reciprocating air compressors: Classification of boilers, essentialities of boilers, selection of different types of boilers, study of boilers, boiler mountings and accessories.

Reciprocating air compressors: uses of compressed air, work done in single stage and two-stage compression, inter cooling and simple problems.

### **UNIT-V:**

Internal combustion engines: classification of IC engines, basic engine components and nomenclature, working principle of engines, Four strokes and two stroke petrol and diesel engines, comparison of CI and SI engines, comparison of four stroke and two stroke engines, simple problems such as indicated power, brake power, friction power, specific fuel consumption, brake thermal efficiency, indicated thermal efficiency and mechanical efficiency.

**UNIT-VI:**

Transmission systems:Belts –Ropes and chain: belt and rope drives, velocity ratio, slip, length of belt , open belt and cross belt drives, ratio of friction tensions, centrifugal tension in a belt, power transmitted by belts and ropes, initial tensions in the belt, simple problems.

Gear trains: classification of gears, gear trains velocity ratio, simple, compound –reverted and epicyclic gear trains.

**Outcomes:**

After completing the course, the student shall be able to determine:

- The stress/strain of a mechanical component subjected to loading.
- The performance of components like Boiler, I.C. Engine, Compressor, Steam/Hydraulic turbine, Belt, Rope and Gear.
- The type of mechanical component suitable for the required power transmission.

**Text Books:**

1. Strength of Materials and Mechanics of Structures, B.C.Punmia, Standard Publications and distributions, 9<sup>th</sup> Edition, 1991.
2. Thermal Engineering, Ballaney,P.L., Khanna Publishers, 2003.
3. Elements of Mechanical Engineering, A.R.Asrani, S.M.Bhatt and P.K.Shah, B.S. Publs.
4. Elements of Mechanical Engineering, M.L.Mathur, F.S.Metha&R.P.Tiwari Jain Brothers Publs., 2009.

**Reference Book:**

1. Theory of Machines, S.S. Rattan, Tata McGraw Hil., 2004 & 2009.



I Year - II Semester

L	T	P	C
4	0	0	3

## ENGINEERING DRAWING

### Learning Objectives:

- Engineering drawing being the principle method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

### UNIT-I:

**Objective:** To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

**Polygons:** Constructing regular polygons by general methods, inscribing and describing polygons on circles.

**Curves:** Parabola, Ellipse and Hyperbola by general methods, cycloids, involutes, tangents & normals for the curves.

### UNIT-II:

**Objective:** To introduce the students to use scales and orthographic projections, projections of points & simple lines.

**Scales:** Plain scales, diagonal scales and vernier scales

**Orthographic Projections:** Horizontal plane, vertical plane, profile plane, importance of reference lines, projections of points in various quadrants, projections of lines, lines parallel either to of the reference planes (HP, VP or PP)

### UNIT-III:

**Objective:** The objective is to make the students draw the projections of the lines inclined to both the planes.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces- HT, VT

### UNIT-IV:

**Objective:** The objective is to make the students draw the projections of the plane inclined to both the planes.

Projections of planes: regular planes perpendicular/parallel to one plane and inclined to the other reference plane; inclined to both the reference planes.

### UNIT-V:

**Objective:** The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to one of the planes.

**UNIT-VI:**

**Objective:** The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

**Text Books:**

1. Engineering Drawing, N.D. Butt, Chariot Publications.
2. Engineering Drawing, Agarwal & Agarwal, Tata McGraw Hill Publishers.

**Reference Books:**

1. Engineering Drawing, K.L.Narayana& P. Kannaiah, Scitech Publishers.
2. Engineering Graphics for Degree, K.C. John, PHI Publishers.
3. Engineering Graphics, PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCAD, K Venugopal, V. Prabhu Raja, New Age.

**I Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

## **ENGLISH-COMMUNICATION SKILLS LAB-II**

### **PRESCRIBED LAB MANUAL FOR SEMESTER-II:**

**'INTERACT: English Lab Manual for Undergraduate Students'** Published by **Orient BlackswanPvt Ltd.**

#### **Objectives:**

- To enable the students to learn demonstratively the communication skills of listening, speaking, reading and writing.

#### **Outcome:**

- A study of the communicative items in the laboratory will help the students become successful in the competitive world.
- The course content along with the study material is divided into six units.

#### **UNIT-I:**

1. Debating  
Practice work

#### **UNIT-II:**

1. Group Discussions  
Practice work

#### **UNIT-III:**

1. Presentation Skills  
Practice work

#### **UNIT-IV:**

1. Interview Skills  
Practice work

#### **UNIT-V:**

1. Email,
  2. Curriculum Vitae
- Practice work

#### **UNIT-VI:**

1. Idiomatic Expressions
  2. Common Errors in English
- Practice work

**Reference Books:**

1. Strengthen your communication skills by Dr M Hari Prasad, DrSalivendraRaju and Dr G Suvarna Lakshmi, Maruti Publications.
2. English for Professionals by Prof Eliah, B.S Publications, Hyderabad.
3. Unlock, Listening and speaking skills 2, Cambridge University Press.
4. Spring Board to Success, Orient BlackSwan.
5. A Practical Course in effective english speaking skills, PHI.
6. Word power made handy, Drshaliniverma, Schand Company.
7. Let us hear them speak, JayashreeMohanraj, Sage texts.
8. Professional Communication, ArunaKoneru, McGrawhill Education.
9. Cornerstone, Developing soft skills, Pearson Education.

**I Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

**ENGINEERING/APPLIED PHYSICS LAB**  
**(Any Ten of the following)**

**Learning Objective:**

- Training field oriented Engineering graduates to handle instruments and their design methods to improve the accuracy of measurements.

**LIST OF EXPERIMENTS:**

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Determination of Rigidity modulus of a material- Torsional Pendulum.
5. Determination of Acceleration due to Gravity and Radius of Gyration- Compound Pendulum.
6. Melde's experiment – Transverse and Longitudinal modes.
7. Verification of laws of vibrations in stretched strings – Sonometer.
8. Determination of velocity of sound – Volume Resonator.
9. L- C- R Series Resonance Circuit.
10. Study of I/V Characteristics of Semiconductor diode.
11. I/V characteristics of Zener diode.
12. Characteristics of Thermistor – Temperature Coefficients.
13. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
14. Energy Band gap of a Semiconductor p - n junction.
15. Hall Effect in semiconductors.
16. Time constant of CR circuit.
17. Determination of wavelength of laser source using diffraction grating.
18. Determination of Young's modulus by method of single cantilever oscillations.
19. Determination of lattice constant – lattice dimensions kit.
20. Determination of Planck's constant using photocell.
21. Determination of surface tension of liquid by capillary rise method.

**Outcome:**

- Physics lab curriculum gives fundamental understanding of design of an instrument with targeted accuracy for physical measurements.

I Year - II Semester

L	T	P	C
0	0	2	0

### ENGINEERING /APPLIED PHYSICS- VIRTUAL LAB-ASSIGNMENTS

**(Constitutes 5% marks of 30marks of Internal-component)**

#### **Learning Objective:**

- Training Engineering students to prepare a technical document and improving their writing skills.

#### **LIST OF EXPERIMENTS**

1. Hall Effect
2. Crystal Structure
3. Hysteresis
4. Brewster's angle
5. Magnetic Levitation / SQUID
6. Numerical Aperture of Optical fiber
7. Photoelectric Effect
8. Simple Harmonic Motion
9. Damped Harmonic Motion
10. LASER – Beam Divergence and Spot size
11. B-H curve
12. Michelson's interferometer
13. Black body radiation

**URL:** [www.vlab.co.in](http://www.vlab.co.in)

#### **Outcome:**

- Physics Virtual laboratory curriculum in the form of assignment ensures an engineering graduate to prepare a /technical/mini-project/ experimental report with scientific temper.

I Year - II Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

## ENGINEERING WORKSHOP & IT WORKSHOP

### ENGINEERING WORKSHOP:

**Learning Objective:** To impart hands-on practice on basic engineering trades and skills.

**Note:** At least two exercises to be done from each trade.

**Trade:**

<b>Carpentry</b>	1. T-Lap Joint 2. Cross Lap Joint 3. Dovetail Joint 4. Mortise and Tenon Joint
<b>Fitting</b>	1. Vee Fit 2. Square Fit 3. Half Round Fit 4. Dovetail Fit
<b>Black Smithy</b>	1. Round rod to Square 2. S-Hook 3. Round Rod to Flat Ring 4. Round Rod to Square headed bolt
<b>House Wiring</b>	1. Parallel / Series Connection of three bulbs 2. Stair Case wiring 3. Florescent Lamp Fitting 4. Measurement of Earth Resistance
<b>Tin Smithy</b>	1. Taper Tray 2. Square Box without lid 3. Open Scoop 4. Funnel

### IT WORKSHOP:

#### OBJECTIVES:

- Understand the basic components and peripherals of a computer.
- To become familiar in configuring a system.
- Learn the usage of productivity tools.
- Acquire knowledge about the netiquette and cyber hygiene.
- Get hands on experience in trouble shooting a system?

#### 1. System Assembling, Disassembling and identification of Parts / Peripherals

2. **Operating System Installation**-Install Operating Systems like Windows, Linux along with necessary Device

Drivers.

#### 3. MS-Office / Open Office

- a. **Word** - Formatting, Page Borders, Reviewing, Equations, symbols.
- b. **Spread Sheet** - organize data, usage of formula, graphs, charts.

- c. **Power point** - features of power point, guidelines for preparing an effective presentation.
  - d. **Access**- creation of database, validate data.
4. **Network Configuration & Software Installation**-Configuring TCP/IP, proxy and firewall settings. Installing application software, system software & tools.
  5. **Internet and World Wide Web**-Search Engines, Types of search engines, netiquette, cyber hygiene.
  6. **Trouble Shooting**-Hardware trouble shooting, Software trouble shooting.
  7. **MATLAB**- basic commands, subroutines, graph plotting.
  8. **LATEX**-basic formatting, handling equations and images.

#### **OUTCOMES:**

- Common understanding of concepts, patterns of decentralization implementation in Africa †
- Identified opportunities for coordinated policy responses, capacity building and implementation of best practices †
- Identified instruments for improved decentralization to the local level †
- Identified strategies for overcoming constraints to effective decentralization and sustainable management at different levels

#### **TEXT BOOKS:**

1. Computer Hardware, Installation, Interfacing, Troubleshooting and Maintenance, K.L. James, Eastern Economy Edition.
2. Microsoft Office 2007: Introductory Concepts and Techniques, Windows XP Edition By Gary B. Shelly, Misty E. Vermaat and Thomas J. Cashman (2007, Paperback).
3. LATEX- User's Guide and Reference manual, Leslie Lamport, Pearson, LPE, 2/e.
4. Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers, Rudraprathap, Oxford University Press, 2002.
5. Scott Mueller's Upgrading and Repairing PCs, 18/e, Scott. Mueller, QUE, Pearson, 2008
6. The Complete Computer upgrade and repair book, 3/e, Cheryl A Schmidt, Dreamtech.
7. Comdex Information Technology course tool kit Vikas Gupta, WILEY Dreamtech.
8. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education..



## COMPLEX VARIABLES

### Learning Objectives:

- The aim of this course is to introduce the special functions, their generating functions and the algebra, geometry and calculus of functions of a complex variable. The emphasis will be on gaining a geometric understanding of complex analytic functions as well as developing computational skills in employing the powerful tools of complex analysis for solving theoretical and applied problems.

### UNIT-I:

#### Functions of a complex variable:

Introduction -Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates. Harmonic and conjugate harmonic functions – Milne – Thompson method.

Applications: Potential between parallel plates, coaxial cylinders, potential in angular regions.

### UNIT-II:

#### Elementary functions and Mapping:

Exponential, trigonometric, hyperbolic functions and their properties – General power  $Z$  ( $c$  is complex), principal value.

Applications: Polar plots of sinusoidal transfer function. (Section 7.3 of reference book 5)

### UNIT-III:

#### Complex integration:

Line integral – Cauchy’s integral theorem – Cauchy’s integral formula – Generalized integral formula -Liouville Theorem - Morera’s Theorem.

Applications: Circulation along closed curve, conservative fields.

### UNIT-IV:

#### Power series:

Radius of convergence – Taylor’s series,-Maclaurin’s series -Laurent series- Singular point – Isolated singular point – pole of order  $m$  – essential singularity.

### UNIT-V:

#### Evaluation of Integrals:

Residue – Residue theorem

Application: Types of real integrals:

(a) Improper real integrals  $\int_{-\infty}^{\infty} f(x)dx$                       (b)  $\int_c^{c+2\pi} f(\cos \theta, \sin \theta)d\theta$

(c)  $\int_{-\infty}^{\infty} e^{imx} f(x)dx$       (d) Integrals by indentation

**UNIT -VI:**

Transformation by  $\exp z$ ,  $\ln z$ ,  $z^2$ ,  $z^n$  ( $n$  positive integer),  $\sin z$ ,  $\cos z$ ,  $z+a/z$ , Translation, rotation, inversion and bilinear transformation –fixed point- cross ratio – properties-invariance of circles.

Applications: Mapping theorem (without proof) with application to stability analysis of closed loop systems, Nyquist stability criterion and its Remarks.(Section 7.5 of reference book 5)

**Outcomes:**

At the end of the course, student will be able to:

- Solve linear differential equations of first, second and higher order.
- Determine Laplace transform and inverse Laplace transform of various functions and use Laplace transforms to determine general solution to linear ODE.
- Calculate total derivative, Jacobian and minima of functions of two variables.

**Text Books:**

1. Higher Engineering Mathematics, B.S.Grewal, 43<sup>rd</sup> Edition, Khanna Publishers.
2. Advanced Engineering Mathematics, Micheael Greenberg, 2<sup>nd</sup> Edition, Pearson Edn.

**Reference Books:**

1. Advanced Engineering Mathematics, Erwin Kreyszig, 10<sup>th</sup> Edition, Wiley-India.
2. Complex Analysis for Mathematics and Engineering, John H Mathews, Russell W. Howell, 5<sup>th</sup> Edition, Jones and Bartlett Publishers, 2006.
3. Fundamentals of Complex Analysis, Saff, E.B and A.D Snider, 3<sup>rd</sup> Edition, Pearson, 2003.
4. A First course in Complex Analysis with Application, Dennis G. Zill and Patrick Shanahan, Jones and Bartlett Publishers, 2011.
5. Modern Control Engineering, Katsuhiko Ogata, 5<sup>th</sup> Edition, Pearson Publishers.

II Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## BASIC ELECTRICAL & ELECTRONICS ENGINEERING

### Learning Objectives:

This is a basic course designed to make the student:

- Learn the basic principles of electrical laws and analysis of networks.
- Understand the principle of operation and construction details of DC machines.
- Understand the principle of operation and construction details of transformer.
- Understand the principle of operation and construction details of alternator and 3-Phase induction motor.
- Study the operation of PN junction diode, half wave, full wave rectifiers and OP-AMPs.
- Learn the operation of PNP and NPN transistors and various amplifiers.

### UNIT-I:

**Electrical Circuits:** Basic definitions, Types of network elements, Ohm's Law, Kirchhoff's Laws, inductive networks, capacitive networks, series, parallel circuits and star-delta and delta-star transformations.

### UNIT-II:

**DC Machines:** Principle of operation of DC generator – emf equation - types – DC motor types –torque equation – applications – three point starter, swinburn's Test, speed control methods.

### UNIT-III:

**Transformers:** Principle of operation of single phase transformers, emf equation, losses, efficiency and regulation.

### UNIT-IV:

**AC Machines:** Principle of operation of alternators – regulation by synchronous impedance method, Principle of operation of 3-Phase induction motor–slip–torque characteristics - efficiency – applications.

### UNIT-V:

**Rectifiers & Linear ICs:** PN junction diodes, diode applications(Half wave and bridge rectifiers), Characteristics of operation amplifiers (OP-AMP), Application of OP-AMPs(inverting, non -inverting,integrator and differentiator).

### UNIT-VI:

**TRANSISTORS:** PNP and NPN junction transistor, transistor as an amplifier, single stage CE Amplifier, frequency response of CE amplifier, concepts of feedback amplifier.

**Outcomes:**

At the end of the course, the student will be able to:

- Analyze the various electrical networks.
- Understand the operation of DC generators, 3-point starter and conduct the Swinburn's Test.
- Analyze the performance of transformer.
- Explain the operation of 3-phase alternator and 3-phase induction motors.
- Analyze the operation of half wave, full wave rectifiers and OP-AMPs.
- Explain the single stage CE amplifier and concept of feedback amplifier.

**Text Books:**

1. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, 9<sup>th</sup> Edition, PEI/PHI, 2006.
2. Electrical Technology: Vol – I, Electrical Fundamentals & Vol – II Machines and Measurement, Surinder Pal Bali, Pearson, 2013.
3. Electrical Circuit Theory and Technology, John Bird, 4<sup>th</sup> Edition, Elsevier, 2010.

**Reference Books:**

1. Electrical Technology, Naidu, M. and S. Kamakshaiah, Tata McGraw-Hill, 2006.
2. Fundamentals of Electrical Engineering, Rajendra Prasad, 2<sup>nd</sup> Edition, PHI Learning, 2009.
3. Basic Electrical Engineering, Nagasarkar, T. K. and M. S. Sukhya, 2<sup>nd</sup> Edition, Oxford Publications, 2009.
4. Industrial Electronics, Mithal, G. K., 9<sup>th</sup> Edition, Khanna Publishers, 2000.

**II Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## **GENERAL GEOLOGY**

### **Learning Objectives:**

- This basic course in general geology is designed to train the studentstounderstand the basics of geology, viz: formation of earth, layers of earth, different types of rocks, formation of sedimentary basins and the micro fossils and their relationship to oil and gas.
- It exposes the students to different geological environments relates to petroleum industry.

### **UNIT-I:**

Dimensions of earth, structure, composition and origin of earth-envelops of the Earth- crust, mantle, core. Internal dynamic process- Plate tectonics- Continental drift, Earthquake and Volcanoes, External dynamic process- weathering, erosionand deposition.

### **UNIT-II:**

Fundamental concepts in Geomorphology-geomorphic processes distribution of landforms-drainage patterns –development, Landforms in relation to rocks types, paleochannels, buried channels.

### **UNIT-III:**

Geological work of rivers, wind, ocean, glaciers and the landforms created by them. Identification of different structural features encountered in oil exploration viz: joints, faults, folds, unconformities.

### **UNIT-IV:**

Origin of igneous,sedimentary and metamorphic rocks. Sedimentary structures-petrographic character of conglomerate, sandstone, shale, limestones.

### **UNIT-V:**

Introduction to sedimentary basins and deltaic systems; Topographic maps, Thematic maps, Topographic and Thematic profiles.

### **UNIT-VI:**

Paleontology: Introduction to Paleontology, Fossils and Fossilization.

Micropaleontology - Palynology: Distribution of microfossils-Foraminifera, Radiolaria, Conodonts, Ostracodes, Diatoms; Importance of micro fossils in oil exploration.

**Outcomes:**

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

- Discern the dimension of earth structure, composition, origin of earth, formation of earth. It deals essence of scientific studies dealing with the origin, age, structure of the earth and with the evolution, modification, and extinction of various surface and subsurface physical features.
- Understand the land forms as geomorphology, physiography and to gain a better perspective conforming to the present day thinking on the aspects of geology.
- Be impressed by the fact that the subject is not static and will more likely keep his mind open to new ideas.
- Understand the origin of different kinds of igneous, sedimentary, metamorphic rocks that can be understood in terms of their tectonic setting.
- Gain the knowledge on fundamentals of sedimentary basins and paleontology and their significance to the petroleum industry.

**Text Books:**

1. Engineering Geology, Bell, F.G., 2<sup>nd</sup> Edition, ButterworthHeimann, 2007.
2. Text book of Geology, Mukharjee, P.K., The World Press Pvt. Ltd., 2005.

**Reference Books:**

1. Elements of Mineralogy, Gribble, C. D., Rutley's, 27<sup>th</sup> Edition. CBS Publishers, 2005.
2. Principles of Physical Geology, David Duff, Homes, Nelson Thornes Ltd; 4<sup>th</sup> Revised edition, 1992.
3. Text Book of Physical Geology, Mahapatra, G.B., CBS Publishers, 2002.
4. Principles of Engineering Geology, Bangar, K.M., 2<sup>nd</sup> Edition, Standard Publishers, 2009.

## SURVEYING AND OFFSHORE STRUCTURES

### Learning Objectives:

The students will be trained to:

- Demonstrate the principles of surveying for the measurement of distance and angles.
- Explain the concepts of leveling and contouring.
- Introduce the concepts of advanced surveying and implementation in shoreline surveying.
- Demonstrate the principles of sea surveying.
- Introduce the concepts of wave and current data collection.
- Explain various stages of fixed offshore structure in view of the operation.
- Introduce the concept and types of compliant structures.
- Demonstrate the basic terminology and floatation principles of floating structures.

### UNIT-I:

**Distance and Direction:** Objectives, Principles and classifications of Surveying, chain, tape, Electronic distance measurements, Meridians Azimuths and Bearings, declination, computation of angle.

**Theodolite:** Theodolite, description, uses and adjustments – temporary, Measurement of horizontal and vertical angles, Principles of Electronic Theodolite.

### UNIT-II:

**Leveling and Contouring:** Concept and Terminology, Temporary- Method of leveling. Characteristics and Uses of contours- Methods of conducting contour surveys and their plotting.

### UNIT-III:

**Introduction to Advanced Surveying:** Total Station and Global positioning system and Differential GPS.

**Hydrographic surveying:** Introduction- Shoreline Surveys- Sounding Methods (Bathymetry).

### UNIT-IV:

Subsea surveying and Geomatics, Introduction to the principles of subsea surveying and geomatics is including bathymetry and seismic survey, positioning systems (surface positioning, visual positioning techniques) distance from shore & water depth, Generation of surface waves in oceans, Wave data collection and current data collection.

### UNIT-V:

Functions of offshore structures, Fixed offshore structures, Types of fixed structures, fabrication, transportation, installation and operation of offshore structures, construction of offshore concrete structures, Definition of compliant structures, Types of compliant structures.

### UNIT-VI:

Floating structures, basic hydrostatics, centre of gravity, center of buoyancy, displacement, law of floatation, draft, keel, Simpson's rule for areas and centroids, second moments of area,

moments of inertia, mass moment of inertia, calculation of metacentric height, Stability of floating structures, Definition of neutrally and positively buoyant structures.

### **Outcomes:**

After successful completion of the course, the student can understand:

- The basic principles and significance of measurement of distance and direction.
- Horizontal and vertical angles.
- Principles, importance and measurement of angles using Theodolite.
- Concepts and terminology in contour mapping.
- Measurement and to plotting the contour maps.
- Basics of total station and GPS.
- Shore line survey and basics of acoustics, application in the field.
- Basics of sea surveying and bathymetry, importance of bathymetry survey, seismic survey, positioning and wave and current data collection and significance of data collection.
- Types and functions of fixed offshore structures, methodology of fabrication transportation, installation and operation of fixed offshore structures, Significance and types of compliant structures.
- The basic principles of floatation and stability of floating structures.
- Stability criteria of neutrally and positively buoyant structures.

### **Text Books for Units I-III:**

1. Surveying (Vol – 1, 2) ; Higher Surveying, Punmia, B.C., Ashok Kumar Jain and Arun Kumar Jain , Vol 3, Laxmi Publications, 2005.
2. Surveying (Vol – 1 & 2), Duggal S K, Tata McGraw Hill, 2004.
3. Text book of Surveying, Venkataramaiah, C., Universities Press, 1996.

### **Text Books for Units IV-VI:**

1. Handbook of Offshore Engineering, Subrata K. Chakrabarti, Volume 1, Elsevier, 2005.
2. Ship Stability for Masters and Mates, Barrass, C. B. and D. R. Derret, 7<sup>th</sup> Edition, Butterworth-Heinemann, 2012.
3. Construction of Marine and Offshore Structure, Gerwick, Jr., C., 3<sup>rd</sup> Edition, CRC Press, 2007.



II Year - I Semester

L	T	P	C
4	0	0	3

## CHEMICAL PROCESS CALCULATIONS

### Learning Objectives:

The subject of chemical process calculations is intended to make the students understand mainly the calculations involved in material and energy balances of process units. The students will be trained to:

- Understand and correctly implement unit conversions in process calculations.
- Understand and apply theoretical knowledge towards problem solving.
- Analyze and solve elementary material balances in physical and chemical processes.
- Analyze and solve elementary energy balances in reactive and non-reactive processes.
- Formulate and solve combined material and energy balances.
- Realize the relevance of thermodynamics in process calculations.
- Carry out complex process calculations using MS Excel.

### UNIT-I:

**Stoichiometric relation:** Basis of calculations, Methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

**Behavior of Ideal gases:** Kinetic theory of gases, Application of ideal gas law, Gaseous mixtures, Gases in chemical reactions.

### UNIT-II:

**Vapor pressure:** Liquefaction and liquid state, vaporization, boiling point, Effect of temperature on vapor pressure, Antoine equation, Vapor pressure plots, Estimation of critical properties, Vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes.

### UNIT-III:

**Humidity and Saturation:** Relative and percentage saturation or dew point, wet bulb and dry bulb temperature, Use of humidity charts for engineering calculations.

### UNIT-IV:

**Material balances:** Tie substance, Yield, Conversion, Processes involving chemical reactions. Material balance calculation involving drying, dissolution and crystallization; Processes involving recycles, bypass and purge.

### UNIT-V:

**Thermo-physics:** Energy, energy balances, Heat capacity of gases, liquid and mixture solutions. Kopp's rule, Latent heats, Heat of fusion and Heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids enthalpy and its evaluation.

**Thermo-chemistry:** Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change, calculation of theoretical and actual flame temperatures.

## **UNIT-VI:**

**Combustion Calculations:** Introduction to fuels, Calorific value of fuels, coal, liquid fuels, Gaseous fuels, air requirement and flue gases, Combustion calculations, Incomplete combustion, Material and energy balances, Thermal efficiency calculations.

### **Outcomes:**

A student who successfully completes this course will be able to:

- Learn all background information/charts/datasheets required to carry out process calculations. Some of these are vapor pressure correlations, latent heat correlation, steam tables, psychrometric charts, enthalpy-concentration diagrams etc.,
- Formulate and solve simple and moderately complex process calculations associated to industrially prominent chemical processes and technologies.
- Conceptualize an integrated methodology that encompasses the knowledge in other subjects (Physical Chemistry, Thermodynamics and Mathematics) and MS Excel for a systematic and structured approach towards chemical process calculations.
- Analyze chemical processes through the power of modeling and computation. These include back-calculation methods, inventory losses and revenue related assessment etc.

### **Text Books:**

1. Chemical Process Principles, Part -I, Material and Energy Balances, Hougen O A, Watson K.M. and Ragatz R.A., 2<sup>nd</sup> Edition, CBS Publishers & distributors, New Delhi, 2010.
2. Basic Principles and Calculations in Chemical Engineering, D.H. Himmelblau, 7<sup>th</sup> Edition. PHI, New Delhi, 2009.

### **Reference Books:**

1. Elementary Principles of Chemical Processes, R. M. Felder and R. W. Rousseau, 3<sup>rd</sup> Ed., Wiley, 1999.
2. Handbook Chemical Engineering Calculations, N. Chohey, 3<sup>rd</sup> Edition, Mc-Graw Hill, 2004.
3. Stoichiometry, Bhatt, B. I., Thakore S. B., 5<sup>th</sup> Ed., Tata Mc-Graw Hill Education 2010.

II Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

## MATERIALS SCIENCE & ENGINEERING

### Learning objectives:

This subject is intended to:

- Provide all the technical/engineering inputs to the learner to choose or select suitable materials of construction of chemical/petrochemical process equipment, piping and internals.
- Impart expertise to the material so that it meets the specific life expectancy, by reducing the shutdown frequency.
- Learn the techniques in minimizing equipment breakdown and increasing the on-stream factor.
- To gain knowledge in choosing/selecting the material such that it withstands the severe process operating conditions such as cryogenic, high temperature, high pressure, acidic, basic, stress induced chemical/petrochemical environments keeping view the reliability and safety of the process equipment.

### UNIT-I:

Classification of engineering materials, Levels of Structure, Structure-Property relationships in materials, Crystal Geometry and non-crystalline (amorphous) states; Lattice – Bravais lattices, Crystal systems with examples; Lattice co-ordinates, Miller and Miller- Bravais Indices for directions and planes: ionic, covalent and metallic solids; Packing factors and packing efficiency, Ligancy and coordination number; Structure determination by Brag's X-ray diffraction method.

### UNIT-II:

Crystal Imperfections-Classification-point defects-Estimation of point defects-Dislocations-classification(edge and screw)-Surface defects-Dislocation motion and its relevance to mechanical and chemical properties – Stress & Strain relationship and diagrams for different materials (metals, non-metals, rubbers and plastics and polymers)-Elastic and plastic deformation-Slip -stress required to move a dislocation; Multiplication of dislocations – Dislocation reactions, Effect on mechanical behavior of materials, Strain hardening/work hardening – Dynamic recovery and recrystallization.

### UNIT-III:

Fracture and failure of materials: Ductile fracture analysis-Brittle fracture analysis-Fracture toughness-Ductile-Brittle transition-Fatigue fracture-theory, creep and mechanism – Methods to postpone the failure and fracture of materials and increase the life of the engineering components /structures.

### UNIT-IV:

Solid – liquid and solid-solid equilibria for metals and alloys, Phase rule, Phase diagram for pure metals (single component system), alloys (binary systems), Micro structural changes during cooling, Lever rule and its applications, Typical phase diagrams Homogeneous and

heterogeneous systems, formation of Eutectic, Eutectoid mixtures, Non-equilibrium cooling, Binary Systems(phase diagrams) for study: Cu-Ni/Bi-Cd/Pb-Sn/ Fe-C /Al-Cu.

#### **UNIT-V:**

Materials for chemical and petrochemical industrial process equipment, Effect of alloying on mechanical and chemical behavior of materials, Applicationsof heat treatment methods for strengthening of engineering materials.

Composite structures and their advantages over conventional materials, Matrix-reinforcement properties and evaluation of strength properties with different orientation of reinforcement, Applications, Nano materials, Synthesis and characterization.

#### **UNIT-VI:**

Stability criteria of materials in chemical/petrochemical industrial environments; Corrosion and Oxidation of materials; Basic mechanisms-types of corrosion; Corrosion testing and evaluation; Prevailing methods to combat corrosion; Coatings –metallic non-metallic, passivity, cathodic protection.

#### **Outcomes:**

After the course, the students will be to:

- Equipped with knowledge to prepare material selection diagram, evaluation of equipment life and prediction of life of the equipment.
- Acquiring the abilities to carryout reliability studies.
- Ready to carryout equipment failure analysis and propose the remedial measures.

#### **Text Books:**

1. Materials Science and Engineering,Raghavan, V., 5<sup>th</sup> Edition, PHI, New Delhi, 2009.
2. Material Science and Engineering, Ravi Prakash, William F. Smith and JavedHashemi, 4<sup>th</sup> Edition, Tata-McGraw Hill, 2008.

#### **Reference Books:**

- 1 Elements of Material Science and Engineering, Lawrence H. Van Vlack, 6<sup>th</sup> Edition, Pearson, 2002.
- 2 Materials Science and Engineering, Balasubramaniam,R., Callister's, Wiley, 2010.
3. Corrosion Engineering, Mars G. Fontana, Tata-McGraw Hill, 2005.

**II Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

### **BASIC ENGINEERING (Mech + Elec) LABORATORY**

**Any SIX experiments from each section**

#### **Section A: Mechanical Engineering Laboratory:**

##### **Learning Objectives:**

- To impart practical exposure on the performance evaluation methods of various mechanical components like, I.C. Engine, Hydraulic turbine, Hydraulic pump, Air compressor etc. and also understand the various processes that can be performed on a lathe machine.

##### **List of Experiments:**

1. Draw the valve timing diagram of a 4-stroke diesel engine and port timing diagram of a 2-stroke petrol engine.
2. Perform load test on a 4-stroke I.C. Engine and draw the performance curves.
3. Pattern design and making – for one casting drawing.
4. Taper turning and thread cutting on a Lathe machine.
5. Performance on an Impulse/Reaction Hydraulic Turbine.
6. Performance of Centrifugal/Reciprocating Pump.
7. Find the volumetric efficiency, isothermal efficiency of an Air compressor.

##### **Outcomes:**

- The student will be able to predict the performance of several mechanical components and operate a lathe machine to produce the required job work.

#### **Section B: Electrical Engineering Laboratory:**

##### **Learning Objectives:**

This course imparts knowledge to the students to:

- Learn the estimation of efficiency of a DC machine as motor & generator.
- Learn the estimation of efficiency of transformer at different load conditions & power factors.
- Study the performance of a 3-Phase induction motor by conducting direct test.
- Pre-determine the regulation of an alternator by Synchronous impedance method.
- Understand the speed control of a DC shunts motor.
- Study the performance of a DC shunts motor by conducting direct test.

**The following experiments are required to be conducted as compulsory experiments:**

1. Swinburne's test on D.C. Shunt machine. (Predetermination of efficiency of a given D.C. Shunt machine working as motor and generator).
2. OC and SC tests on single phase transformer (Predetermination of efficiency and regulation at given power factors)
3. Brake test on 3-phase Induction motor (Determination of performance characteristics)
4. Regulation of alternator by Synchronous impedance method.
5. Speed control of D.C. Shunt motor by
  - a) Armature Voltage control
  - b) Field flux control method
6. Brake test on D.C Shunt Motor

**Outcomes:**

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

- Estimate the efficiency of a DC machine as motor & generator.
- Estimate the efficiency of transformer at different load conditions & power factors.
- Understand the performance of a 3-Phase induction motor by conducting direct test.
- Pre-determine the regulation of an alternator by Synchronous impedance method.
- Control the speed of a DC shunt motor by Field flux control method & Armature Voltage control method.
- Understand the performance characteristics of a DC shunt motor by conducting direct test.

**GEOLOGY LAB & SURVEYING LAB**

**GEOLOGY LAB**

<b>Experiments</b>	<b>Objective</b>	<b>Outcome: Student can understand</b>
1. Location of observed outcrops on the Top sheet. Geological mapping and Traversing.	To identify location of outcrops on the topo sheet, geological mapping.	Plotting geological mapping.
2. Measurement of the strike, dip and apparent and true thickness of the outcrops.	To measure strike and dip. To learn representation of strike and dip in different locations such as hills beach etc.	Plotting strike and dip in different geological locations such as hills, river banks, beaches etc.
3. Carrying out sampling of the outcrops for petrological, palynological and palentological studies.	To collect samples for petrological, palynological and palentological studies.	Collection of samples of outcrops for different studies and the importance of such studies.
4. Preparation of the geological map of the area, structure contour maps and isopach maps for different stratigraphic levels.	To train for drawing area geological map, structure contour and isopach maps.	How to use the maps to estimate reservoir area and thickness.
5. Preparation of litho stratigraphic columns, litho stratigraphic correlation, geological cross sections.	To find importance of litho stratigraphic columns, plotting geological cross sections.	Plotting litho strati-graphic column and geological cross sections.
6. Preparation of structural contour map and location of Oil Water Contact (OWC)	To determine the location of oil-water contact in the reservoir.	Confirmation of the height of the oil bearing sand.
7. Interpretation of isopach map and depositional model.	To train reading of isopach map and depositional model.	Reading of isopach map and depositional model.
8. Field trips to the different deltaic environments of Godavari delta	To make students to do geology survey in Godavari delt using above mentioned methods	Student can be in a position to plot geological map, strike, dip and litho stratigraphic column etc. at any chosen location.

## SURVEYING LAB

Experiments	Objective	Outcome: Student can understand
1. Study of linear measuring instruments and chain surveying.	To teach linear measurement system and chain surveying.	Student can learn the meaning of linear measuring instrument. Chain surveying and measuring horizontal distances.
2. Study of theodolite and traversing with theodolite.	To teach measurement of angles.	Using theodolite, precision and its applications in various fields. Measuring angles in horizontal and vertical planes.
3. Study of levels and ordinary leveling with tilting level, Profile leveling.	To teach measurement of leveling.	Student can learn meaning of bench mark, fixing up bench mark, Importance of leveling, leveling in a horizontal plane. Measurement of vertical distances. Representation of vertical distances. Using tilting level, accuracy in measurement of angles, its advantages and disadvantages. Meaning of profile leveling and plotting a profile level diagram.
4. Study of total station and measurement with total station.	To teach measuring of distances and angles at a time.	Using total station, its advantages with conventional measuring instruments. Measuring angles and distances using total station and data processing after the measurements. Applications of total station in various fields such as mining, construction etc.
5. Study of Global Positioning System (GPS) and measurement with GPS.	To teach dynamic data acquisition.	Importance of GPS and its applications in various fields. Measurement of and any dynamic data with respect to time for example wave height.
6. Measurement and errors	To teach sources of errors and minimizing measurement errors.	Minimizing of measurement errors.



II Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>

**MC**  
**MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS**

**Learning Objectives:**

- The Learning objectives of this paper is to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting, Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation. Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

**UNIT-I:**

**Introduction to Managerial Economics and Demand Analysis:**

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

**UNIT-II:**

**Production and Cost Analyses:**

Concept of Production function- Cobb-Douglas Production function- Leontief production function - Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable Costs and Total costs –Cost – Volume-Profit analysis-Determination of Breakeven point(simple problems)-Managerial significance and limitations of Breakeven point.

**UNIT-III:**

**Introduction to Markets, Theories of the Firm & Pricing Policies:**Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson’s models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing.

**UNIT-IV:**

**Types of Business Organization and Business Cycles:** Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms – Business Cycles : Meaning and Features – Phases of a Business Cycle.

**UNIT-V:**

**Introduction to Accounting & Financing Analysis:** Introduction to Double Entry Systems – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow statements (Simple Problems).

## **UNIT-VI:**

**Capital and Capital Budgeting:** Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(payback period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index).

### **Outcomes:**

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product and the knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- One is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis and to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

### **Text books:**

1. Managerial Economics and Financial Analysis, Dr. N. AppaRao, Dr. P. Vijay Kumar, Cengage Publications, New Delhi – 2011.
2. Managerial Economics and Financial Analysis, Dr. A. R. Aryasri, TMH 2011.
3. Managerial Economics and Financial Analysis, Prof. J.V.Prabhakararao, Prof. P. Venkatarao. Ravindra Publication.

### **Reference books:**

1. Managerial Economics & Financial Analysis, Dr. B. Kuberudu and Dr. T. V. Ramana: Himalaya Publishing House, 2014.
2. Managerial Economics, V. Maheswari, Sultan Chand.2014.
3. Managerial Economics, Suma Damodaran, Oxford 2011.
4. Managerial Economics, VanithaAgarwal, Pearson Publications 2011.
5. Financial Accounting for Managers, Sanjay Dhameja, Pearson.
6. Financial Accounting, Maheswari, Vikas Publications.
7. Managerial Economics and Financial Analysis, S. A. Siddiqui& A. S. Siddiqui, New Age International Publishers, 2012.
8. Indian Economy, Ramesh Singh, 7<sup>th</sup>Edn., TMH2015.
9. A Text Book of Microeconomic Theory, PankajTandon, Sage Publishers, 2015.
10. Univerties press, ShailajaGajjala and UshaMunipalle, 2015.

## PROBABILITY & STATISTICS

**Course Objectives:** To acquaint students with the fundamental concepts of probability and statistics and to develop an understanding of the role of statistics in engineering. Also to introduce numerical techniques to solve the real world applications.

**Course Outcomes: At the end of the Course, Student will be able to:**

1. Examine, analyze, and compare various Probability distributions for both discrete and continuous random variables.
2. Describe and compute confidence intervals for the mean of a population.
3. Describe and compute confidence intervals for the proportion and the variance of a population and test the hypothesis concerning mean, proportion and variance and perform ANOVA test.
4. Fit a curve to the numerical data.

### **UNIT I: Discrete Random variables and Distributions:**

Introduction-Random variables- Discrete Random variable-Distribution function- Expectation-Moment Generating function-Moments and properties.

Discrete distributions: Binomial, Poisson and Geometric distributions and their fitting to data.

### **UNIT II: Continuous Random variable and distributions:**

Introduction-Continuous Random variable-Distribution function- Expectation-Moment Generating function-Moments and properties.

Continuous distribution: Uniform, Exponential and Normal distributions, Normal approximation to Binomial distribution -Weibull, Gamma distribution.

### **UNIT III: Sampling Theory:**

Introduction - Population and samples- Sampling distribution of means ( $\sigma$  known)-Central limit theorem- t-distribution- Sampling distribution of means ( $\sigma$  unknown)- Sampling distribution of variances -  $\chi^2$  and F-distributions- Point estimation- Maximum error of estimate - Interval estimation.

### **UNIT IV: Tests of Hypothesis:**

Introduction –Hypothesis-Null and Alternative Hypothesis- Type I and Type II errors –Level of significance - One tail and two-tail tests- Tests concerning one mean and proportion, two means- Proportions and their differences- ANOVA for one-way and two-way classified data.

### **UNIT V: Curve fitting and Correlation:**

Introduction - Fitting a straight line –Second degree curve-exponential curve-power curve by method of least squares-Goodness of fit.

Correlation and Regression – Properties.

## **UNIT VI: Statistical Quality Control Methods:**

Introduction - Methods for preparing control charts – Problems using x-bar, p, R charts and attribute charts.

### **Text Books:**

1. **Jay I. Devore**, Probability and Statistics for Engineering and the Sciences. 8<sup>th</sup> edition, Cengage.
2. **Richards A Johnson, Irvin Miller and Johnson E Freund**. Probability and Statistics for Engineering, 9<sup>th</sup> Edition, PHI.

### **Reference Books:**

1. **Shron L. Myers, Keying Ye, Ronald E Walpole**, Probability and Statistics Engineers and the Scientists, 8<sup>th</sup> Edition, Pearson 2007.
2. **William Menden Hall, Robert J. Bever and Barbara Bever**, Introduction to probability and statistics, Cengage learning, 2009
3. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4<sup>th</sup> edition, Academic Foundation, 2011
4. **Johannes Ledolter and Robert V. Hogg**, Applied statistics for Engineers and Physical Scientists, 3<sup>rd</sup> Edition, Pearson, 2010.



## **MOMENTUM TRANSFER**

### **Learning Objectives:**

This course involves the fundamentals of fluid flow by including both theory and the applications of fluid flow in chemical engineering. Basic concepts of fluid mechanics will be taught to make the students to:

- Understand basic concepts associated to fluid flow such as viscosity, shear, Newtonian and non-Newtonian fluids etc.
- Learn and apply continuity and Navier Stokes equations as fundamental equations for the analysis of chemical processes.
- Learn and apply the concept of boundary layer theory and governing mathematical equations for Newtonian and non-Newtonian fluid flows.
- Learn and apply Bernoulli's equation for various simple and complex cases of fluid flow.
- Understand the basic differences between compressible and incompressible fluid flows and suitably adapt, modify and apply suitable correlations for compressible fluid flows.
- Have sound knowledge with respect to various important fluid flows related machinery and equipment. Emphasis shall be towards various types of pumps, compressors and blowers.
- Master the relevant theory for the application of fluid flow past solid surfaces. Emphasis is towards drag and pressure drop correlations for packed and fluidized beds.
- Understand various accessories required for fluid flow such as fittings and valves and their relevance towards variation in pressure drop correlations.
- Understand the knowledge related to various fluid flow measuring devices (Venturi, Orifice, Rotameter and PitotTube).

### **UNIT-I:**

Basic concepts of dimensional analysis, Nature of fluids, Hydrostatic equilibrium, Applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

### **UNIT-II:**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity, differential momentum balance; Equations of motion, macroscopic momentum balances, Mechanical energy equations, Inviscid flow: concepts of Source, sink, vortex, flow over a solid sphere/cylinder, Superposition of flows: Concept of flow separation.

### **UNIT-III:**

Incompressible Newtonian/Non-Newtonian flow in pipes and channels- Shear stress and skin friction in pipes, laminar flow in pipes and channels, Turbulent flow in pipes and channels, Friction from changes in velocity or direction, Losses in pipes.

**UNIT-IV:**

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, Adiabatic frictional flow and Isothermal frictional flow.

**UNIT-V:**

Flow past immersed bodies, Drag and Drag coefficient, Flow through beds of solids, Motion of particles through fluids.

Fluidization, Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized bed, Applications of fluidization, Continuous fluidization, Slurry and pneumatic transport.

**UNIT-VI:**

Transportation and Metering of fluids- Pipes, fittings and valves, Pumps: positive displacement pumps, and centrifugal pumps, fans, blowers, and compressors;, Measurement of flowing fluids: full bore meters, insertion meters.

**Outcomes:**

By mastering the fluid mechanics course, the student shall be able to:

- Analyze fluid flow in circular and non-circular conduits.
- Do calculations associated to the estimation of friction factor and pressure drop in circular conduits.
- Do calculations involving Bernoulli's equation for the transport of acidic, alkaline, hydrocarbon and miscellaneous incompressible fluids in pipelines.
- Calculate the pressure drops and energy requirements associated to compressible fluid flow in circular and rectangular ducts.
- Estimate pressure drop in packed and fluidized beds.
- Rigorously carry out various calculations associated to fluid flow in various types of pumps, fans and blowers.
- Calculate, analyze and calibrate various flow measuring devices.

**Text Books:**

1. Unit Operations of Chemical Engineering, McCabe,W.L., J.C.Smith& Peter HarriotMcGraw-Hill, 7<sup>th</sup> Edition, 2001.
2. Transport Processes and Unit Operations,Christie J. Geankoplis, PHI, 2003.

**Reference Books:**

1. Introduction to Fluid Mechanics, Fox, R.W. and A.T.Mc.Donald, 5<sup>th</sup> Edition, John Wiley& Sons, 1998.
2. Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, J.M.Coulson and J.F.Richardson,Pergamon Press, 4<sup>th</sup> Edition,1990.
3. Fluid Mechanics for Chemical Engineers, Noel De Nevers, Tata McGraw-Hill, 2011.
4. Fluid Flow for Chemical and Process Engineers, Bragg R and F. A. Holland, 2<sup>nd</sup> Edition, Hodder Stoughton Educational, 1995.
5. Fluid Flow for the Practicing Chemical Engineer, Patrick Abulencia, J and Louis Theodore, John wiley and Sons, 2009.



## PETROLEUM GEOLOGY

### Learning Objectives:

- This is a basic course in petroleum geology. The students will be exposed to different source, reservoir and cap-rocks, characterization of reservoir rocks, classification of reservoir porespace, permeability, migration and entrapment, temperature-pressure conditions for the generation of oil and gas from sediments.

### UNIT-I:

**Source Rocks:** Definition of source rock, Organic rich sediments as source rocks, Nature and type of source rocks - Claystone / shale, The process of diagenesis, catagenesis and metagenesis in the formation of source rocks, Evaluation of petroleum source rock potential, Limestone as source rocks, Subsurface pressure temperature conditions for the generation of oil and gas from the source sediments, Oil window.

### UNIT-II:

**Reservoir Rocks:** Characteristics of Reservoir rocks, Classification and nomenclature: Clastic Reservoir Rocks, Carbonate Reservoir Rocks, Unconventional, Fractured and Miscellaneous reservoir rocks, Marine and non-marine reservoir rocks, Concept of Shale oil.

### UNIT-III:

**Reservoir Properties and Cap Rocks:** Reservoir pore space, porosity- primary and secondary porosity, effective porosity, fracture porosity - permeability – effective and relative permeability relationship between porosity, permeability and texture. Cap rocks: Definition and characteristics of cap rocks.

### UNIT-IV:

**Hydrocarbon migration:** Geological framework of migration and accumulation, The concept of hydrocarbon migration from source beds to the carrier beds, Carrier beds to the reservoir, Free-path ways for migration, Short distance and long distance migration, Evidence for migration, Oil and gas seepages.

### UNIT-V:

**Entrapment of hydrocarbons:** Entrapment and accumulation of hydrocarbons, Classification and types of traps: Structural, stratigraphic and combination type of traps, Traps associated with salt domes.

### UNIT-VI:

**Sedimentary Basins:** Sedimentary basins -origin and classification, Types of basins and their relationship to hydrocarbon prospects, Tectonic classification, stratigraphic evolution and hydrocarbon accumulations of the following basins: Krishna-Godavari basin, Cambay basin and Mumbai off-shore.

**Outcomes:**

After successful completion of the course, the students are expected to:

- Identify different source rocks from which hydrocarbons are generated.
- Discern about origin of source rocks, formation of good source rocks, different characterization of reservoir rocks, classification, nomenclature and different source of reservoir rocks, pore space, porosity and its types.
- Gain knowledge of how and why fluid hydrocarbons migrate from a source rock to reservoir rock, entrapment and accumulation of hydrocarbons.
- Do tectonic classification, stratigraphy evaluation and hydrocarbon accumulation of KG basin, Cambay basin and Mumbai off-shore.

**Text Book:**

1. Geology of Petroleum, A.I. Levorsen, 2<sup>nd</sup> Edition. CBS, Publishers, 2006.

**Reference Books:**

1. Elements of Petroleum Geology, Richard, C. Selley, Elsevier, 1997.
2. Sedimentary basins of India- ONGC bulleting.
3. Unconventional Petroleum Geology, Caineng Zou et al., Elsevier, 2013.

## THERMODYNAMICS FOR PETROLEUM ENGINEERS

### Learning Objectives:

This course is designed to make the students:

- Understand zeroth, first and second laws of thermodynamics.
- Discern various thermodynamic properties such as internal energy, specific volume, enthalpy, entropy, specific heat etc. from fundamental correlations.
- Learn the application of various thermodynamic laws for the analysis of chemical processes.
- Understand the concept and models of residual and excess Gibbs energy and the associated calculations for VLE, VLLE, SVE and SLE.
- Learn the application of the laws of thermodynamics for hydrocarbon (both liquid and gas) characterization, handling, storage and transport.

### UNIT-I:

**Introduction:** The scope of thermodynamics, defined quantities; temperature, volume, pressure, work, energy, heat, Joules Experiments, SI units.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, The steady-state steady flow process, Equilibrium, The reversible process, constant-V and constant- P processes, heat capacity.

### UNIT-II:

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, Cubic equations of state, generalized correlations for gases.

### UNIT-III:

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and the ideal-gas scale, Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics. Mollier diagram and steam tables.

### UNIT-IV:

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, Residual properties, Generalized property correlations for gases.

**Thermodynamics of flow processes;** Principles of conservation of mass and energy for flow systems, Analysis of expansion processes; turbines, throttling; compression processes – compressors and pumps; Calculation of ideal work and last work, Examples on hydrocarbons and natural gas.

### UNIT-V:

**Solution thermodynamics:** Basic concepts of chemical potential, Phase equilibria, partial properties, fugacity coefficient, residual and excess Gibbs free energy, Correlations for the estimation of fugacity coefficient, Residual and excess Gibbs energy in vapor liquid equilibria.

## **UNIT-VI:**

**Phase Equilibria:** Gamma/Phi formulation of VLE, VLE from Virial equations of state and cubic equations of state, Introduction to Vapor- Liquid-Liquid equilibrium (VLLE), Solid-Liquid equilibrium (SLE) and Solid-Vapor equilibrium (SVE), Equilibrium adsorption of gases on solids.

### **Outcomes:**

After completion of the course, the students shall be able to:

- Become conversant with all the basic concepts of thermodynamics and gain working knowledge in open, closed, isothermal, isobaric and isoentropic processes.
- Use thermodynamic tables and diagrams for the estimation of internal energy, specific volume, enthalpy and entropy.
- Apply equations such as ideal gas law, Vander Waal's equation and other cubic equations of state for the characterization of chemical process parameters.
- Determine efficiencies of turbines, pumps, compressors, blowers and nozzles.
- Rigorously use residual and excess Gibbs free energy models for design of oil and natural gas processing systems.

### **Text Book:**

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., H.C. Van Ness and M.M. Abbott, 6<sup>th</sup> Edition, 8<sup>th</sup> reprint, McGraw Hill, 2006.

### **Reference Books:**

1. Characterization and Properties of Petroleum Fractions, M. R. Riaze, ASTM, International, 2005.
2. Equation of State and PVT analysis, Tarek Ahmed, Gulf publishing company, 2007.
3. Engineering and Chemical Thermodynamics, Koretsky, M.D., John Wiley & Sons, 2004.
4. Introductory Chemical Engineering Thermodynamics, Richard Elliott, J. and Carl T. Lira, 2<sup>nd</sup> Edition, Prentice Hall, 2012.
5. Chemical, Biochemical and Engineering Thermodynamics, Stanley Sandler, 4<sup>th</sup> Edition, Wiley India Pvt Ltd, 2006.
6. Thermodynamics: Applications in Chemical Engineering and the Petroleum Industry, Vidal, J., Edition Technip, 2003.
7. Chemical and Process Thermodynamics, Kyle, B.G., 3<sup>rd</sup> Edition, PHI Learning, 2008.
8. Chemical Engineering Thermodynamics, Thomas E. Dauber, McGraw Hill, 1985.

## PROCESS HEAT TRANSFER

### Learning Objectives:

- This course is designed to introduce a basic study of the phenomena of heat transfer to carry out thermal design/ heat transfer process design for heat exchange systems such as process heat exchangers, reboilers, air/utility coolers/condensers, furnaces, boilers, super-heaters, evaporators, driers, cooling towers etc. The principles involve the estimation of overall heat transfer coefficients, heat transfer surface area, pressure drop involved in single-phase and multi-phase flow regimes.
- The students will be trained to acquire skills to carry out the detailed mechanical design of heat exchangers such as number tubes, selection of shell and tube material, estimate number of baffles and also provide necessary information regarding TEMA classification.

### UNIT-I:

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, and radiation.

**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres, thermal contact resistance, plane wall: variable conductivity.

**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid, finite solid.

### UNIT-II:

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

### UNIT-III:

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

### UNIT-IV:

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar flow heat transfer.

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

### UNIT-V:

**Radiation:** Emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, combined heat transfer by conduction, convection and radiation.

**Evaporators:** Types of Evaporators, performance of tubular evaporators, vapor recompression.

## **UNIT-VI:**

**Heat Exchange Equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calorifiers, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method).

### **Outcomes:**

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

- Understand the basic laws of heat transfer.
- Account for the consequence of heat transfer in thermal analyses of engineering systems.
- Analyze problems involving steady state heat conduction in simple geometries.
- Develop solutions for transient heat conduction in simple geometries.
- Obtain numerical solutions for conduction and radiation heat transfer problems.
- Understand the fundamentals of convective heat transfer process.
- Evaluate heat transfer coefficients for natural convection.
- Evaluate heat transfer coefficients for forced convection inside ducts.
- Evaluate heat transfer coefficients for forced convection over exterior surfaces.
- Analyze heat exchanger performance by using the method of log mean temperature difference.
- Analyze heat exchanger performance by using the method of heat exchanger effectiveness.
- Calculate radiation heat transfer between black body surfaces as well as grey body surfaces.

### **Text Books:**

1. Unit Operations of Chemical Engineering, McCabe, W.L., J.C Smith and Peter Harriott, 7<sup>th</sup> Edition, McGraw-Hill, 2005.
2. Heat Transfer, Y.V.C. Rao, Universities Press (India) Pvt. Ltd., 2001.

### **Reference Books:**

1. Process Heat Transfer, D.Q. Kern, Tata- McGraw-Hill, 1997.
2. Heat Transfer, Holman, J.P., 9<sup>th</sup> Edition, Tata McGraw-Hill, 2008.
3. Schaum's Outline of Heat Transfer, Donald Pitts and L.E.Sisson, 2<sup>nd</sup> Edition, McGraw-Hill, 1998.
4. A Text Book on Heat Transfer, Sukhatme, P., 5<sup>th</sup> Edition, Universities Press (India) Pvt. Ltd., 2005.
5. Heat Transfer: Principles and Applications, Binay Dutta, K., PHI Learning, 2009.
6. Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer, Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H., Vol.1, 6<sup>th</sup> Edition, Reed Elsevier India, 2006.

## PETROLEUM EXPLORATION

### Learning Objectives:

- The syllabus for petroleum exploration should be aimed at the students to have a broad knowledge of exploration history in India. The students should know what are the basic methods; which are used in petroleum exploration with special emphasis on gravity/magnetic and more importantly the students should understand in detail about the Seismic methods which are the back bone of the whole gamut of oil exploration.
- At the same time sedimentology and biostratigraphy are also important to understand the sedimentary sequences holding hydrocarbons as the knowledge of these will help in the log interpretation also.

### UNIT-I:

**Introduction:** Overview of petroleum exploration in India, Introduction to Geophysical/Geological methods used in petroleum exploration.

### UNIT-II:

Sedimentological and biostratigraphic approaches in hydrocarbon exploration.

### UNIT-III:

**Basic concepts of Gravity/Magnetic methods:** Newton's gravitational law- Units of gravity- Gravity measuring instruments- Gravity survey- Gravity anomalies- Gravity data reduction- Drift- latitude- Elevation and free air correction- Free air & bouguer anomalies- Gravity response of simple shapes- Interpretation of gravity anomalies- Application of gravity methods. The geomagnetic field- Magnetic anomalies- Magnetic survey-instruments- Field method of magnetic surveys- Reduction of magnetic data-Diurnal correction and geomagnetic correction- Interpretation of magnetic anomaly- Response of magnetic method for different type of bodies and geological structure- Application of magnetic surveys both overland and from air.

### UNIT-IV:

**Basic Concepts of seismic methods:** Seismic refraction surveys- Geometry of refracted path, planar interface- Two layer case with horizontal interface- Methodology of refraction profiling- Recording instruments & energy sources- Corrections applied to refraction data Interpretation of refraction data- Application of seismic refraction method.

### UNIT-V:

**Geometry of reflected ray path:** Single horizontal reflector- The reflection seismogram and seismogram (Seismic traces)- Importance of seismic reflection survey over seismic refraction survey technique- Common depth point (CDP) profiling & stacking- 2D, 3D, & 4D seismic surveys- Field procedures & principles- Time corrections applied to seismic data- Data processing - Introduction to 2D & 3D data acquisition & interpretation of reflection data for identification of drillable structures.

### UNIT-VI:

Well seismic shooting for velocity determination and Vertical Seismic Profiling (VSP).

**Outcomes:**

- It gives insight to the students to have a broad based understanding of the seismic exploration, viz its acquisition methods, processing and interpretation, as they have already had geology in II<sup>nd</sup> year course. The knowledge of these methods will go a long way along with the other subject i.e, well logging and formation evaluation for them to opt for upstream industry jobs if they so desire.

**Text Books:**

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4<sup>th</sup> Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4<sup>th</sup> Edition, John Wiley, 2011.

**Reference Books:**

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Hydrocarbon Well Logging Recommended Practice, Society of Professional Well Log Analysts.
3. Open – Hole Log Analysis and Formation Evaluation, Richard M. Batemans, International Human Resources Development Corporation, Boston, 1985.
4. Well Logging for Earth Scientists, Darwin V. Ellis, Julian M. Singer, Springer, 2007.
5. Fundamentals of Well Log Interpretation: The Acquisition of Data, Oberto Serra, Elsevier, 1984.
6. Well Logging Handbook, Oberto Serra, Editions Technip, 2008.



### **MOMENTUM TRANSFER LAB**

#### **Learning Objectives:**

- Fundamentals of momentum transfer will be demonstrated in a series of laboratory exercises like determination of discharge coefficient of orifice, venturi, notches, friction factors in pipes, pressure drop in packed and fluidized beds, fluid viscosity, characteristics of centrifugal pump, characterization of fluid flow, verification of Bernoulli's theorem, and measurement of point velocities. Hands-on experience and communication skills will be achieved.

#### **List of Experiments:**

1. Identification of laminar and turbulent flows; Major equipment - Reynolds apparatus.
2. Measurement of point velocities; Major equipment - Pitot tube setup.
3. Verification of Bernoulli's equation; Major equipment – Bernoulli's Apparatus.
4. Calibration of Rotameter; Major equipment – Rotameter Assembly.
5. Variation of Orifice coefficient with Reynolds Number; Major equipment - Orifice meter Assembly.
6. Determination of Venturi coefficient; Major equipment – Venturi meter Assembly.
7. Friction losses in Fluid flow in pipes; Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities; Major equipment - Packed bed with Pressure drop measurement.
9. Pressure drop and void fraction in a fluidized bed; Major equipment - Fluidized bed with Pressure drop measurement.
10. Studying the coefficient of contraction for a given open orifice; Major equipment - Open Orifice Assembly.
11. Studying the coefficient of discharge in a V-notch; Major equipment - V-notch Assembly.
12. Studying the Characteristics of a centrifugal pump; Major equipment - Centrifugal Pump.
13. Viscositydetermination using Stoke's law; Major equipment–Terminal Velocity determination column.

#### **Outcomes:**

After completion of the course, students will be able to do the following:

- Operate fluid flow equipment and instrumentation.
- Collect and analyze data using momentum transfer principles and experimentation methods.
- Prepare reports following accepted writing and graphical techniques.
- Perform exercises in small teams.
- Demonstrate principles discussed in momentum transfer lecture course.
- Demonstrate appropriate work habits consistent with industry standards.

### PROCESS HEAT TRANSFER LAB

#### Learning Objectives:

- Fundamentals of process heat transfer will be demonstrated in a series of laboratory exercises like determination of thermal conductivities of composite wall and metal rod, natural convective and forced convective heat transfer coefficients, both film and overall coefficients, Stefan-Boltzmann constant, emissivity of a metal plate etc. Students will achieve hands-on experience and acquire communication skills while conducting experiments in a team.

#### List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of thermal conductivity of a metal rod.
3. Determination of natural convective heat transfer coefficient for a vertical tube.
4. Determination of critical heat flux point for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
8. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
9. Determination of Stefan – Boltzmann constant.
10. Determination of emissivity of a given plate at various temperatures.

#### Outcomes:

Upon successful completion of this lab course, the students will be able to:

- Understand the basics of experimental techniques for heat transfer measurements.
- Operate the heat transfer equipment like heat exchangers
- Process experimental data and obtain correlations to predict heat transfer coefficients for design of heat transfer systems.
- Conduct the experiments at R & D level in the industry
- Understand the professional and ethical responsibilities in the field of heat transfer.
- Produce a written laboratory report.

II Year - II Semester

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**MC**  
**PROFESSIONAL ETHICS AND HUMAN VALUES**

**Learning Objectives:**

- To give basic insights and inputs to the student to inculcate Human values to grow as a responsible human beings with proper personality.
- Professional Ethics instills the student to maintain ethical conduct and discharge their professional duties.

**UNIT-I:**

**Human Values:** Morals, Values and Ethics – Integrity – Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self-confidence – Spirituality- Character.

**UNIT-II:**

**Principles for Harmony:** Truthfulness – Customs and Traditions - Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

**UNIT-III:**

**Engineering Ethics and Social Experimentation:** History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg’s Theory - Gilligan’s Argument –Heinz’s Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering.

**UNIT-IV:**

**Engineers’ Responsibilities towards Safety and Risk:** Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/s Involuntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects - Threshold Levels of Risk - Delayed v/s immediate Risk - Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis- Accidents.

**UNIT-V:**

**Engineers’ Duties and Rights:** Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights –Confidential and Proprietary Information - Conflict of Interest-Ethical egoism - Collective Bargaining – Confidentiality - Gifts and Bribes - Problem solving-Occupational Crimes- Industrial Espionage- Price Fixing-Whistle Blowing.

## **UNIT-VI:**

### **Global Issues:**

Globalization and MNCs –Cross Culture Issues - Business Ethics – Media Ethics- Environmental Ethics – Endangering Lives - Bio Ethics - Computer Ethics - War Ethics – Research Ethics - Intellectual Property Rights.

- Related Cases Shall be dealt where ever necessary.

### **Outcomes:**

- It gives a comprehensive understanding of a variety issues that are encountered by every professional in discharging professional duties.
- It provides the student the sensitivity and global outlook in the contemporary world to fulfill the professional obligations effectively.

### **Reference Books:**

1. Professional Ethics, R. Subramaniam – Oxford Publications, New Delhi.
2. Ethics in Engineering Mike W. Martin and Roland Schinzinger - Tata McGraw-Hill – 2003.
3. Professional Ethics and Morals, Prof.A.R.Aryasri, DharanikotaSuyodhana - Maruthi Publications.
4. Engineering Ethics, Harris, Pritchard and Rabins, Cengage Learning, New Delhi.
5. Human Values & Professional Ethics, S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
6. Engineering Ethics & Human Values, M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd – 2009.
7. Professional Ethics and Human Values, A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press.
8. Professional Ethics and Human Values, Prof.D.R.Kiran-Tata McGraw-Hill – 2013.
9. Human Values and Professional Ethics, Jayshree Suresh and B. S. Raghavan, S.Chand Publications.

III Year - I Semester

L	T	P	C
4	0	0	3

## MANAGEMENT SCIENCE

### Learning Objectives:

- To familiarize with the process of management and to provide basic insight into select contemporary management practices
- To provide conceptual knowledge on functional management and strategic management.

### UNIT-I:

**Introduction to Management:** Concept, nature and importance of Management –Generic Functions of Management – Evaluation of Management thought- Theories of Motivation – Decision making process-Designing organization structure- Principles of organization – Organizational typology- International Management: Global Leadership and Organizational behavior Effectiveness(GLOBE) structure

### UNIT-II:

**Operations Management:** Principles and Types of Management – Workstudy- Statistical Quality Control- Control charts (P-chart, R-chart, and C-chart)Simple problems- Material Management: Need for Inventory control-EOQ, ABC analysis (simple problems) and Types of ABC analysis (HML,SDE, VED, and FSN analysis).

### UNIT-III:

**Functional Management:** Concept of HRM, HRD and PMIR- Functions ofHR Manager- Wage payment plans(Simple Problems) – Job Evaluation and Merit Rating - Marketing Management- Functions of marketing – Marketing strategies based on product Life Cycle, Channels of distributions, Operationalizing change through performance management.

### UNIT-IV:

**Project Management:** (PERT/CPM): Development of Network – Differencebetween PERT and CPM Identifying Critical Path- Probability- ProjectCrashing (Simple Problems).

### UNIT-V:

**Strategic Management:** Vision, Mission, Goals, Strategy – Elements of corporate planning Process – Environmental Scanning – SWOT analysis-Steps in Strategy Formulation and Implementation, Generic StrategyAlternatives, Global strategies, Theories of Multinational Companies.

### UNIT-VI:

**Contemporary Management Practice:** Basic concepts of MIS, MRP, Justin-Time(JIT) system, Total Quality Management(TQM), Six sigma and Capability Maturity Model(CMM) Levies, Supply Chain Management ,Enterprise Resource Planning (ERP), Business Process outsourcing (BPO), Business process Re-engineering and Bench Marking, Balanced Score Card.

**Outcomes:**

After completion of the Course the student:

- Will acquire the knowledge on management functions, global leadership and organizational behavior.
- Will familiarize with the concepts of functional management project management and strategic management.

**Text Books:**

1. Management Science, Dr. P. Vijaya Kumar & Dr. N. Appa Rao, Cengage, Delhi, 2012.
2. Management Science, Dr. A. R. Aryasri, TMH 2011.

**Reference Books:**

1. Essentials of Management, Koontz & Wehrich, TMH 2011.
2. Global Management Systems, Seth & Rastogi, Cengage learning, Delhi, 2011.
3. Organizational Behavior, Robbins, Pearson publications, 2011.
4. Production & Operations Management, Kanishka Bedi, Oxford Publications, 2011.
5. Principles of Marketing, Philip Kotler & Armstrong, Pearson publications.
6. Human Resource Management, Biswajit Patnaik, PHI, 2011.
7. Strategic Management, Hitt and Vijaya Kumar, Cengage learning.
8. Performance Management, Prem Chadha, Trinity Press (An imprint of Laxmi Publications Pvt. Ltd.) Delhi 2015.

## PROCESS DYNAMICS & CONTROL

### Learning objectives:

- To understand and be able to describe quantitatively the dynamic behavior of process systems.
- To learn the fundamental principles of control theory including different types of controllers and control strategies.
- To estimate the stability limits for a system, with or without control.
- To calculate and use the frequency response of a system.
- To describe quantitatively the behavior of simple control systems and to design control systems.
- To get exposure to advanced control strategies.
- To design and tune a control loop and to apply this knowledge in the industry/laboratory.
- To design different types of control valves.

### UNIT-I:

Introduction to process dynamics and control, Response of first order systems - Physical examples of first order systems.

Response of first order systems in series, higher order systems: Second order and transportation lag.

### UNIT-II:

Control systems controllers and final control elements, Block diagram of a Petrochemical reactor control system.

### UNIT-III:

Closed loop transfer functions, Transient response of simple control systems.

### UNIT-IV:

Stability Criterion, Routh Test, Root locus, Transient response from root locus, Application of root locus to control systems Introduction to frequency response, Control systems design by frequency response.

### UNIT-V:

Advanced control strategies, Cascade control, Feed forward control, Ratio control, Smith predictor, Dead time compensation, Internal model control.

### UNIT -VI:

Controller tuning and process identification, Control valves.

### Outcomes:

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

- Describe a process, how it works and what the control objectives are.
- Describe processes with appropriate block diagrams.
- Numerically model a process.
- Identify the stability limits of a system.
- Apply the advanced control strategies.
- Tune process controllers.

- Experimentally determine the dynamic behavior of a process.
- Design and operate control valves.

**Text Book:**

1. Process Systems Analysis and Control, D.R. Coughanowr, 2<sup>nd</sup> Ed. McGraw Hill, 1991.

**Reference Books:**

1. Chemical Process Control, G. Stephanopolous, Prentice Hall, 1984.
2. Coulson and Richardson's Chemical Engineering, Volume-3, 3<sup>rd</sup> Edition: Chemical and Biochemical Reactors and Process Control, Richardson J. F. et.al, Elsevier India, 2006.
3. Automatic Process Control, Donald P. Eckman, John wiley, Reprint 2011.
4. Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
5. Process Dynamics and Control, Dale Seaborg, Thomas F. Edgar, Duncan Mellichamp, 2<sup>nd</sup> Edition, Wiley India Pvt. Ltd., 2006.
6. Principles of Process Control. Patranabis, 3<sup>rd</sup> Edition McGraw-Hill Education Pvt. Ltd., 2012.
7. Industrial Process Control Systems, 2<sup>nd</sup> Edition, Dale R. Patrick, Stephon, W. Fardo, CRC Press, 2009.
8. Modern Control Systems, 11<sup>th</sup> Edition Dorf, Pearson, 2008.
9. Modern Control Engineering, Katsuhiko Ogata, 5<sup>th</sup> Edition, Prentice Hall, 2010.
10. Principles and Practices of Automatic Process Control, Carlos A. Smith, Armando B. Corripio, 3<sup>rd</sup> International Edition, John Wiley and Sons, 2005.
11. Process control: Concepts, Dynamics & Control, S. K. Single, PHI Learning, 2009.
12. Process control, Peter Harriott, Tata McGraw-Hill 1964. (10th reprint 2008).
13. Computer-Aided Process Control, S. K. Singh, PHE Learning, 2004.
14. Essentials of Process Control, William L. Luyben, Michael L. Luyben, McGraw-Hill, 1997.



## PROCESS INSTRUMENTATION

### Learning Objectives:

- To learn the basic elements of an instrument and its static and dynamic characteristics.
- To study various types of industrial thermometers.
- To learn basic concepts of various types of composition analysis.
- To learn various types of instruments for measurement of pressure, vacuum, head, density, level and flow measurement.
- To get an overview of various recording, indicating and signaling instruments, transmission of instrument readings, instrumentation diagrams, control center, process analysis and digital instrumentation.

### UNIT-I:

**Fundamentals:** Elements of instruments, static and dynamic characteristics-Basic concepts of response of first order type instruments.

**Industrial Thermometers-1:** Mercury in glass thermometer-Bimetallic thermometer-Pressure spring thermometer, Static accuracy and response of thermometry.

### UNIT-II:

**Industrial Thermometers-2:** Thermo electricity-Industrial thermocouples-Thermo couple wires-Thermo couple wells and response of thermo couples; Thermal coefficient of resistance-Industrial resistance-thermometer bulbs and circuits-Radiation receiving elements-Radiation photo electric and optical pyrometers.

### UNIT-III:

**Composition analysis:** Spectroscopic analysis by absorption, emission, mass and color measurement spectrometers-Gas analysis by thermal conductivity, analysis of moisture.

**Pressure, vacuum and head:** Liquid column manometers-Measuring elements for gauge pressure and vacuum-indicating elements for pressure gauges-Measurement of absolute pressure-Measuring pressure in corrosive liquids-Static accuracy and response of pressure gauges.

### UNIT-IV:

**Density and specific gravity measurements-** Direct measurement of liquid level-Pressure measurement in open vessels-Level measurements in pressure vessels-Measurement of interface level-Density measurement and level of dry materials.

### UNIT-V:

**Flow Meters:** Head flow meters-Area flow meters-Open channel meters-Viscosity meters-Quantity meters-Flow of dry materials-Viscosity measurements.

## **UNIT-VI:**

**Recording instruments**-Indicating and signaling instruments-Transmission of instrument readings-Controls center-Instrumentation diagram-Process analysis-Digital instrumentation, SCADA systems.

### **Outcomes:**

The students will be able to:

- Understand the basic elements of an instrument and its characteristics.
- Become familiar with various types of instruments for the measurement of various process variables like temperature, pressure, vacuum, head, level, composition, flow and density.
- Get a clear perspective of various recording, indicating, signaling instruments and transmission of instrument readings.
- Get an understanding of instrumentation diagrams, control center, process analysis and digital instrumentation.

### **Text Books:**

1. Industrial Instrumentation, Donald P.Eckman, CBS, 2004.
2. Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.

### **Reference Books:**

1. Principles of Industrial Instrumentation, Patranabis, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 1996.
2. Process Control and Instrumentation Technology, Curtis D. Johnson, 3<sup>rd</sup> Edition, Prentice Hall, 1988.
3. Process Instrumentation Applications Manual, Bob Connell, 2<sup>nd</sup> Edition, McGraw-Hill, 1995.

## WELL LOGGING & FORMATION EVALUATION

### Learning objectives:

- To know the logging terminology.
- To delineate hydrocarbons through direct and indirect means/methods.
- To determine formation lithology through logs like S.P, G.R etc. and also depositional environment with the help of Gamma rays spectroscopy and Dip-meter tools.
- To determine physical properties of the subsurface, strata like resistivity, porosity, thickness etc. through tools like latero, induction, density, neutron, etc.
- To estimate hydrocarbon saturation using the data acquired by the logging tools.
- To estimate hydrocarbons reserves in a particular block.
- To refine the log interpretation data with the help of advanced technology tools namely, Scanner, NMR, Modular formation tester etc.

### UNIT-I:

**Direct Methods:** Mud logging- coring – conventional and sidewall coring - Core analysis.

**Concepts of well logging:** What is well logging? - Logging terminology-Borehole environment-Borehole temperature and pressure-Log header and depth scale-Major components of well logging unit and logging setup- Classification of well logging methods-Log presentation- Log quality control.

### UNIT-II:

**Open hole logging:** SP Logging- Origin of SP, uses of SP log-Calculation of salinity of formation water- Shaliness-Factors influence SP log.

**Resistivity log:** Single point resistance log (SPR)- Conventional resistivity logs- Response of potential and gradient logs over thin and thick conductive and resistive formations-Limitations of conventional resistivity tools. Focused resistivity log- Advantages of focused resistivity tools over conventional resistivity tools.

**Micro resistivity log:** Conventional and focused micro resistivity logs and their application.

**Induction log:** Principle of induction tool and the advantages, Criteria for selection of induction and lateral logging tool, Determination of true resistivity ( $R_t$ ) of the formation-Resistivity index-Archie's equation.

### UNIT-III:

**Gamma ray log:** principle of radioactivity-Uses of gamma ray log- Determination of Shaliness of formation-API counts- Calibration of Gamma ray tool-Statistical fluctuation- Time constant.

**Natural Spectral Gamma ray log:** Principle and application.

**Caliper log:** Principle and application of caliper tool.

**Density log:** Principle of density tool- Environmental corrections-Porosity determination-Tool calibration, Litho density log.

**Neutron log:** Principle and application of neutron tool, Porosity determination.

**Sonic log:** Principle and application of sonic log-Bore hole compensation-Determination of primary and secondary porosity, determination of mechanical properties of rock, elastic constants, fractures etc.

**UNIT-IV:**

**Cased hole logging:** Gamma ray spectral log-Neutron decay time log-Determination of fluid saturation behind casing-Cement bond log- Casing collar log-Depth control- Perforation technique- Free point locator and Plug setting-Casing inspection logs.

**Production logging:** Solving production problems with the help of Fluid Density log-Temperature log and Flow meter logs.

**UNIT-V:**

**Advances in Well logging:** Dip meter log-Formation tester-Cased hole resistivity logs -Nuclear magnetic resonance log & Scanner logs (Sonic scanner, MR scanner Rt scanner).

Calculating the dip of the formations, collection of fluid samples from wells for confirmation of log interpretation, and also recording resistivity in cased holes.

**UNIT-VI:**

**Interpretation:** Quick look interpretation- Cross plots. Neutron- Density, Sonic- Density, Sonic-Neutron cross plots-Hingle plot-Mid plot –Correlation- Hydrocarbon reserve estimate.

**Outcomes:**

From the well logs the students:

- Will be able to identify the lithology, depositional environment of subsurface strata.
- Will be able to calculate the porosity, permeability, thickness of different interesting layers in a well.
- Calculate finally, the hydrocarbon saturation in different reservoir rocks at the well site itself.

**Text Books:**

1. Formation Evaluation, Edward J. Lynch, Harper & Row, 1962.
2. Well Logging and Formation Evaluation, Toby Darling, Elsevier, New York, 2005.
3. Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip, 2007.

## DRILLING TECHNOLOGY

### Learning Objectives:

- To understand various aspects involved in drilling a well including completion.
- To understand the plan of drilling a well, the process of drilling and various equipment used for drilling and design of the drill string.
- To know the drilling fluid importance and its properties and hydraulics.
- To understand different types of casings lowered in a well, the requirement of cementation in a well and cement slurry design.
- To understand different tools used for directional drilling and various techniques, fishing, stuck pipe and well control concepts.

### UNIT-I:

**Overview of drilling:** Drilling plan- GTO -Types of drilling, Rotary bit technology- Drilling string basics. Drilling fluid properties- Drilling fluid hydraulics calculations- Bit Hydraulics- Optimization- Swab & Surge-pressures- Mud hydraulics analysis report- Lost circulation. Disposing of the drilling fluids waste and drill cuttings waste.

### UNIT-II:

Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation- Mud logging methods - Measurement while drilling & logging while drilling data- Direct measurements of pore pressure -Formation integrity tests – Fracture gradient determination – Theory of wellbore – FIT procedural Guidelines – Predicting fracture gradient HPHT well design.

### UNIT-III:

Wellbore stability–Determination of the magnitude and direction of the in situ stress Determination of rock properties, Failure criteria – Stress distribution around a wellbore Procedure for determining safe mud weights to prevent hole collapse, Preventing borehole instability Gas behavior in a well – Kick tolerance, How to calculate kick tolerance – Influence of FG on kick tolerance – Kick tolerance while drilling – Kick tolerance graph – Modifying the calculate kick tolerance – Use of kick tolerance to calculate wellbore pressures.

### UNIT-IV:

**Casing** Functions of casing – Types of casing – Casing properties Casing specifications – Casing connections – Factors influencing casing design – Collapse criterion – Burst criterion – Combination strings – Tension criterion Compression loads – Biaxial effects – Triaxial analysis – Triaxial load capacity diagram, Casing seat selection method.

**Cementation:** Introduction cement slurries-Typical field calculations- Cementing nomenclature- Cement additives – Cementation of liners.

### UNIT-V:

**Directional drilling:** Applications- Well planning- Down-hole motors- Deflection tools and techniques- Face orientation- Direction control with rotary assemblies- Navigation drilling systems; Horizontal wells–Well profile design considerations – Torque and drag – Horizontal borehole stability – Extended reach well design – Multilateral wells.

## **UNIT-VI:**

**Stuck pipe, well control:** Kicks- Kick control- Pressure control theory- BOP-Special kick problems and procedures to free the pipes and Fishing operations. Types of fishing tools, Case studies of blow out control.

### **Outcomes:**

The students will be able to:

- Apply drilling concepts of a well from planning to rig mobilization to the location.
- Apply the concept of a drill string design for drilling.
- Select the suitable drilling fluids during drilling.
- Do casing and cementation design.
- Carry out directional drilling.
- Troubles shoot well control, stuck pipe and fishing problems.
- Select the proper drilling equipment.

### **Text Books:**

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Drilling Engineering, J.J. Azar and G. Robello Samuel, Pennwell Books, 2007.
3. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.

### **Reference Books:**

1. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
2. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
3. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.
4. Primer of Oil Well Service, Workover and Completion, Petroleum Extension Service, University of Texas at Austin, 1997.
5. Formulas and Calculation for Drilling, Production and Workover, Norton J. Lapeyrouse, 2<sup>nd</sup> Edition, Gulf Publishing, 2002.
6. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, 1991.
7. Well Engineering and Construction, Hussain Rabia, Entrac Consulting, 2002.
8. Drilling Fluids Processing Handbook, ASME Shale Shaker Committee, Gulf Professional Publishing, 2005.
9. Fundamentals of Drilling Engineering, Robert F. Mitchell, Stefan Z. Miska, Society of Petroleum Engineers, 2011.

**MATHEMATICAL METHODS LAB****Learning Objective:**

To train the students in writing MATLAB code, executing and doing what if analysis of the variations in the parameters for various problems using mathematical methods.

1. Determination of Molar volume and Compressibility from Redlich-Kwong Equation
2. Calculation of Flow rate in a pipeline
3. Correlation of the Physical properties
4. Compressibility factor variation from Vanderwaals Equation
5. Isothermal compression of gas using RK/SRK/PREquation of State.
6. Thermodynamic properties of steam from RK/SRK/PREquation of State.
7. Solution of Stiff Ordinary Differential Equations
8. Iterative Solution of ODE boundary value problem
9. Shooting method for solving two-point boundary value problems
10. Expediting the solution of systems of nonlinear algebraic equations
11. Solving differential algebraic equations –DAEs
12. Method of lines for Partial Differential Equations

**Outcome:**

The students will be able to write MATLAB code and solve typical problems encountered in petroleum engineering subjects.

**Textbook:**

1. Problem solving in Chemical and Biochemical Engineering with POLYMATH, Excel and MATLAB, Michael B. Cutlip and Mordechai Shacham, Prentice Hall, 2008.

### INSTRUMENTATION, PROCESS DYNAMICS & CONTROL LAB

#### Learning Objectives:

- To calibrate and determine the time lag of various first and second order instruments.
- To determine the response in single and two capacity systems with and without interaction.
- To understand the advanced control methods used for complex processes in the industries. Different experiments like Flow, Level and Cascade control can be configured and studied.
- To study the open loop (Manual control) and the ON/OFF controller, Proportional controller, PI controller, PD controller, PID controller, Tuning of controller (Open loop and close loop methods) and to study the stability of the system (Bode plot).
- To understand the control valve operation and its flow characteristics.
- To determine the damping coefficient and response of U-tube manometer.

#### List of Experiments:

1. Calibration and determination of time lag of various first and second order instruments.  
Major equipment - First order instrument like Mercury-in-Glass thermometer and overall second order instrument like Mercury-in-Glass thermometer in a thermal well.
2. Experiments with single and two capacity systems with and without interaction.  
Major equipment- Single tank system, Two-tank systems (Interacting and Non-Interacting).
3. Level control trainer  
Major equipment - Level control trainer set up with computer.
4. Temperature control trainer  
Major equipment -Temperature control trainer with computer.
5. Cascade control  
Major equipment -Cascade control apparatus with computer.
6. Experiments on proportional, reset, rate mode of control etc.  
Major equipment – PID control apparatus
7. Control valve characteristics  
Major equipment – Control valve set up.
8. Estimation of damping coefficient for U-tube manometer  
Major equipment - U-tube manometer.

#### Outcomes:

The student will be able to:

- Estimate the dynamic characteristics of first and second order systems.
- Apply the advanced control methods used for complex processes in the industries.
- Screen and suggest controllers like ON/OFF, P, PI, PD and PID for process systems.
- Identify the stability of the system.
- Screen and suggest the types of control valves.



### DRILLING FLUIDS LAB

#### Learning Objective:

- The students will be given hands on training in the determination of the properties of different drilling fluids.

#### List of Experiments:

1. Measurement of drilling fluid weight.  
Equipment: The Baroid mud balance
2. Measurement of mud viscosity.  
Equipment: Marsh funnel
3. Measurement of pH of mud.  
Equipment: pH meter and hydrion pH dispensers
4. Determination of mud rheology (Viscosity, Gel strength, and Yield point).  
Equipment: The Baroidrheometer
5. Determination of the loss of liquid from a mud.  
Equipment: Standard API filter press
6. Measurement of a drilling mud cake and evaluate resistivity.  
Equipment: Baroid digital resistivity meter
7. Measurement of the effect of adding bentonite on mud properties.
8. Drilling fluid contamination test (Salt, Gypsum & Cement contamination) and their effect on the drilling fluid properties.
9. Measurement of solid and liquid content and emulsification characteristics of drilling fluid.  
Equipment: Sand content set, fann emulsion and electrical stability testers
10. Measurement of Oil, water, solid and clay content.  
Equipment: Oil/ water retort kit
11. Measurement of water ratios for Portland cement slurry.  
(Effect of water ratio on free water separation normal and minimum water content and thickening time)  
Equipment: The atmospheric consistometer
12. Measurement of compressive strength of cement test moulds and effect of temperature and pressure on setting of the slurry.  
Equipment: Compressive strength testing machine
13. Measurement of compressive strength of cement test moulds and effect of chemicals on flash setting and retardation  
Equipment: Compressive strength testing machine

#### Outcomes:

- The students will be able to understand and assess quality of various muds and their applications in drilling. With this knowledge, well control issues will be better understood.
- The training in the laboratory provides the students to carry out good conversation jobs for healthy construction of open oil / gas wells.

**III Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

### **INDUSTRIAL VISITS**

#### **Learning Objective:**

- To make the students aware of industrial environment, culture, requirements, nature of jobs and to develop accordingly.

During the semester, all the students are required to visit minimum 6 major petroleum industries like ONGC, RIL, GAIL, Oil India Ltd, GSPC and Petroleum Refineries like, HPCL, IOCL and BPCL accompanied by two faculty members. After each visit, every student should submit a very brief report on the industry with flow diagrams and salient features of the processes that include safety and environmental aspects.

#### **Outcomes:**

The students will be able to:

- Differentiate between the academic training and its relevance to industry.
- Understand the industrial safety measures.

**III Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**MC  
MINI PROJECT-I**

**Learning Objectives:**

- To develop innovative and original ideas
- To promote team work

Three / four member teams will be formed to carry out the mini project which is a mandatory course. Under the guidance of an instructor / faculty, each team is given a project in the following subjects at the beginning of I Semester of III year of the 4 – year B. Tech. Program.

Fluid flow (Momentum Transfer), Heat Transfer, Petroleum geology, Petroleum Exploration, Process Instrumentation and Process Dynamics and Control.

The project involves process and mechanical design calculations of an equipment / system / instrument and constructing a working model based on the above calculations. Finally a report will be submitted in a standard format along with the model. The model and report will be assessed by the concerned instructor / faculty for the completion of the mini project – I.

**Outcomes:**

After successful completion of the mini project, students will be able to:

- Practice acquired knowledge within the chosen area of technology for project/product development.
- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Work as an individual or in a team in development of technical projects.
- Communicate and report effectively project related activities and findings.

## WELL COMPLETIONS, TESTING & SERVICING

### Learning Objectives:

- Knowledge of subsurface equipment below well head.
- Planning and designing of well completion after testing of the hydrocarbon zones available.
- Knowledge of subsurface circulating equipment and packers.
- Testing of multi zones in a well with DST/RFT with logging tools as well as surface testing equipment.

### UNIT-I:

Well completion:Types of wells- Completion functions- Types of completion.

### UNIT-II:

Mechanical aspects of well testing- Cased hole logging equipment and application and perforation methods and perforation equipment.

### UNIT-III:

Packers:Function- Application- Proper selection- Packer setting – Packer loads - water / gas shut off, horizon separation etc.

### UNIT-IV:

Completion equipment (SSD, SSSV, mandrels, locks etc.)- Data acquisition in wells- Fiber optics- Permanent gauges- Memory gauges- Intelligent completion equipment.

### UNIT-V:

Tubing string design (dimension, materials and connections etc.) based on pressure, temperature, operating conditions- Media- Safety requirements.

Drill Stem Testing: General Procedure and considerations- Test tool components and arrangement-Analysis of Test data.

### UNIT-VI:

HPHT and horizontal well completions- Workover equipment wireline- Scrubbing unit- Coil tubing completion and work over design and execution.

### Outcomes:

The student will be able to:

- Have the knowledge of various equipment used in & on wells.
- Have the knowledge of DST/RFT to know the initial potential of the wells.
- Plan and design the well completion depending of the casing policy and the number of objectives available in the well.
- Plan for suitable safety valves in sub surface as well as on well head for the safe operation of the high pressure and high temperature wells.
- Become a good work over engineer to repair and maintenance of a sick well.
- Be a good CTU (Coil Tubing unit) operator whenever rigs less operation are required to be taken up.

**Text Books:**

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.
3. Well Testing, John Lee, Society of Petroleum Engineers, 1982.

**Reference Books:**

1. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
3. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.

## PETROLEUM PRODUCTION ENGINEERING

### Learning Objectives:

The students will be made to learn:

- Fundamental concepts in petroleum production engineering.
- Reservoir fluids, efficient flow to the surface without damaging the reservoir dynamics/drive mechanisms.
- Various surface equipment's for process oil and gas after flow from wells.
- Sick well identification and remedial stimulation operations.
- Application of suitable artificial lifts on reservoir energy depletion.
- Crisis management.

### UNIT-I:

**Petroleum production system over all view:** Production from various types of reservoir based on drive mechanisms field development method, Properties of Oil GOR, density, viscosity, pour point, properties of gas specific gravity, compressibility, molecular weight, calorific value, formation volume factor.

### UNIT-II:

**Reservoir deliverability:** Flow regimes- transient, steady state, pseudo steady state IPR for various types of wells, Well bore performance – single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells; Choke performance – sonic & subsonic flow, single & multiphase flow in oil & gas wells; Well deliverability nodal analysis, Well decline analysis.

### UNIT-III:

**Artificial lift methods-I:** Sucker rod pumping system- Selection of unit and types of unit, Load & power requirements, Performance analysis, dynagraph; Other lift systems- electrical submersible pumps principle design & operation, hydraulic piston pumping, progressive cavity pumping, plunger lift, hydraulic jet pumping.

### UNIT-IV:

**Artificial Lift Methods-II:** Gas lift system evaluation of potential compression requirements, study of flow characteristics, principles of compression, types of compressors, selection of gas lift valves, types of valves, principles of valve operation, setting & testing, design installations.

### UNIT-V:

**Production Stimulation:** Well problem identification- sick well analysis; Matrix acidizing- Design for sandstone & carbonate reservoirs, Hydraulic fracturing – formation fracture pressure, geometry, productivity of fractured wells, hydro-fracture design, selection of fracturing fluid, proppant, post frac evaluation.

### UNIT-VI:

**Production Optimization:** Self flowing wells, wells on gas lift, wells on sucker rod, separator, pipeline network, gas lift facilities, producing fields.

**Outcomes:**

After the course, the students will be able to:

- Determine the well head pressure, down-hole pressure and operating oil/ gas flow rates of the reservoir.
- Identify formation damage and find remedial methods to bring the well back into production.
- Screen, design and operate artificial lifts on reservoir pressure depletions.
- Handle in case of any crisis at drilling/production installations.
- Process oil and gas before supply to refinery/consumers.
- Contribute to reservoir management as production engineers to prolong the reservoir life with optimum production.

**Text Books:**

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M.J. Economides, A.Daniel Hill &C.E.Economides, Prentice Hall, 1994.

**Reference Books:**

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

## PETROLEUM RESERVOIR ENGINEERING-I

### Learning Objectives:

- To impart knowledge in the basic concepts like PVT analysis for oil, Material balance applied to oil reservoir, Darcy's law and applications, well inflow estimation for stabilized flow conditions.
- To make them suitable as reservoir engineers for petroleum industry.

### UNIT-I:

**Some basic concepts in reservoir engineering:** Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor-Volumetric gas reservoir engineering- Application of the real gas equation of state - Gas material balance and recovery factor- Hydrocarbon phase behavior.

### UNIT-II:

**PVT analysis for oil:** Definition of the basic PVT parameters – Collection of fluid samples - Determination of the basic parameters in the laboratory and conversion for field operating conditions - Alternative manner of expressing PVT lab analysis results - Complete PVT analysis.

### UNIT-III:

**Material balance applied to oil reservoirs:** General form -The material balance expressed as a linear equation- Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water drive- Compaction drive under related pore compressibility phenomena.

### UNIT-IV:

**Darcy's law and applications:** Darcy's law and field potential- Sign convention- Units and units conversion- Real gas potential – Datum pressures- Radial steady state flow and well stimulation- Two phase flow- Effective and relative permeabilities.

### UNIT-V:

The basic differential equation for radial flow in a porous medium- Derivation of the basic radial differential equation – Conditions of solution – The linearization of the equation for fluids of small and constant compressibility.

### UNIT-VI:

**Well inflow estimation for stabilized flow conditions:** Semi steady state solution – Steady state solution – Example of the application of the stabilized inflow equations – Generalized form of inflow equation under semi steady state conditions.

### Outcomes:

The students will be able to:

- Do calculations on basic PVT analysis of the specific reservoir of various sands.
- Estimate the reserves of various sands of the reservoir from well data.
- Calculate the formation damage and can recommend suitable stimulation operations to reverse the wells.



**Text Books:**

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17<sup>th</sup> Impression 1998).
2. B. C. Craft – M. Hawkins Applied Petroleum Reservoir Engineering, Third Edition, Revised by Ronald E. Terry & J. Brandon Rogers, Prentice Hall, New York, 2014.

**Reference Books:**

1. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
3. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.
4. Petroleum Reservoir Engineering, James W Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.

## PETROLEUM REFINERY & PETROCHEMICAL ENGINEERING

### Learning Objectives:

- To understand the properties and their significance of crude oils and petroleum fractions.
- To understand, design and analyze the various petroleum refinery processes including primary, secondary and supporting processes.
- To understand the process technologies for the petrochemical products.

### UNIT-I:

**Introduction:** Overall refinery operations & Indian scenario.

**Refinery feed stocks:** Crude oil classification-Composition and properties-Composition of petroleum crude suitable for asphalt/coke manufacture – Evaluation of crude oils.

### UNIT-II:

**Petroleum Products and their specifications:** LPG- Gasoline- Diesel fuels- Jet and turbine fuels –Lube oils-Heating oils – Residual fuel oils - Wax and Asphalt- Petroleum coke- All Product specifications-Product blending.

### UNIT-III:

**Crude distillation:** Atmospheric and Vacuum distillation units, Auxiliary equipment such as desalters, pipe-still heaters and heat exchanger trains etc.

**Catalytic reforming and isomerization:** Catalytic reforming processes (for petroleum and petrochemical feed stocks) – Isomerization Processes -Feed stocks-Feed preparation – Yields.

### UNIT-IV:

**Thermal & Catalytic cracking processes:** Visbreaking- Delayed Coking –Fluid Catalytic cracking and Hydrocracking - Feed stocks — Catalysts - Process variables –Product Recoveries- Yield estimation.

**Hydrotreating&Hydroprocessing:** Naphtha, Kerosene, Diesel, VGO &Resid, Hydrotreating / Hydroprocessing – Feed stocks – Process description and Process variables.

### UNIT-V:

**Petrochemical Industry:** – Indian Petrochemical Industry- Feed stocks – Process description and Process variables-Naphtha cracking-Gas cracking and Gas reforming.

### UNIT-VI:

**Chemicals from gas reforming:** Methanol- Acetic acid- Ammonia and urea.

**Chemicals from ethylene:** Ethylene oxide-Monoethylene glycol-Ethyl benzene-Styrene.

**Polymers:** LDPE, HDPE & LLDPE and Polypropylene – PVC - Polystyrene.

**Outcomes:**

The students will be able to gain the knowledge for applications as follows:

- For a given crude assay, how to handle and store the crude oil.
- What will be the yield, quality of the product, estimation for the primary processes and treatment considerations.
- Maximize the profitable products and minimize the quality giveaway.
- Ability to process the opportunity crudes (e.g. Blending with other crudes) to maximize the throughput and gross margin.
- Application of suitable Hydroprocessing/treatment technologies to meet product qualities and to minimize the CAPEX & OPEX (capital and operating expenditure).
- Application of suitable thermal/catalytic conversion (cracking) processes for Vacuum gas oil/Residupgradation and to produce desired fuel blend components and petrochemical feed stocks.
- Application of suitable processes (such as alkylation, reforming, isomerization) for converting light ends/ naphtha cuts to meet the desired gasoline blends.
- Understanding of various petrochemical feed stocks and their origin from refining/gas processes.
- Knowledge of various petrochemical products in the market and best available technologies to produce them.

**Text Books:**

1. Petroleum Refining: Technology and Economics, J.H. Gary and G.E. Handwerk, 4<sup>th</sup> Edition, Marcel Dekkar, Inc., 2001.
2. Elements of Petroleum Processing, D S Jones, Wiley 1995.
3. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.

**Reference Books:**

1. Petroleum Refining Engineering, WL Nelson, 4<sup>th</sup> Edition, McGraw Hill Company, 1958.
2. Chemical Technology of Petroleum, W.S. Gruese and D.R. Stevens, McGraw Hill, 1960.
3. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers, 1970.
4. Petrochemical Processes, A. Chauvel and G. Lefebvre, Volume 1 & 2, Gulf Publishing Company, 1989.
5. Chemistry of Petrochemical Processes, Sami Mater, Lewis F. Hatch, 2<sup>nd</sup> Edition, Gulf Professional Publishing, 2001.
6. Chemicals from Petroleum: An Introductory Survey, Waddams, A.L., 4<sup>th</sup> Edition, Gulf Publishing, 1978.
7. Handbook of Petrochemicals Production Processes, R.A. Meyers, TRW, Inc., 2005.
8. Petrochemicals, P. Wiseman, Ellis Horwood, 1986.
9. Petrochemical Processes Handbook, Hydrocarbon Processing, 2010.
10. Modern Petroleum Refining Processes, B.K. Bhaskara Rao, 5<sup>th</sup> Edition, Oxford & IBH Publishing, 2011.

III Year - II Semester

L	T	P	C
4	0	0	3

## ELECTRONIC INSTRUMENTATION (OPEN ELECTIVE)

### Learning Objectives:

- 

#### UNIT-I:

##### Introduction:

(a) **Measurement Errors:** Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures.

(b) **Voltmeters and Multimeters:** Introduction Multi range voltmeter, Extending voltmeter ranges, Loading, AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters.

#### UNIT-II:

**Digital Instruments:**Digital Voltmeters – Introduction, DVM's based on  $V - T$ ,  $V - F$  and Successive approximation principles, Resolution and sensitivity, General specifications, Digital Multi-meters, Digital frequency meters, Digital measurement of time.

#### UNIT-III:

**Oscilloscopes:**Introduction, Basic principles, CRT features, Block diagram and working of each block, Typical CRT connections, Dual beam and dual trace CROs, Electronic switch.

**Special Oscilloscopes:**Delayed time-base oscilloscopes, Analog storage, Sampling and Digital storage oscilloscopes.

#### UNIT-IV:

**Signal Generators:**Introduction, Fixed and variable AF oscillator, Standard signal generator, Laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator, Frequency synthesizer.

#### UNIT-V:

**Measurement of resistance, inductance and capacitance:** Whetstone's bridge, Kelvin Bridge; AC bridges, Capacitance Comparison Bridge, Maxwell's bridge, Wein's bridge, Wagner's earth connection .

#### UNIT-VI:

**Transducers & Miscellaneous:**Introduction, Electrical transducers, Selecting a transducer, Resistive transducer, Resistive position transducer, Strain gauges, Resistance thermometer, Thermistor, Inductive transducer, Differential output transducers, LVDT, Piezoelectric transducer, Photoelectric transducer, Photovoltaic transducer, Semiconductor photo devices, Temperature transducers-RTD, Thermocouple.

**Display devices:** Digital display system, classification of display, Display devices, LEDs, LCD displays; Bolometer and RF power measurement using Bolometer; Introduction to Signal conditioning.

**Outcomes:**

- 

**Text Books:**

1. Electronic Instrumentation, H. S. Kalsi, TMH, 2004.
2. Electronic Instrumentation and Measurements, David A Bell, PHI / Pearson Education, 2006.

**Reference Books:**

1. Principles of Measurement Systems, John P. Beatly, 3<sup>rd</sup> Edition, Pearson Education, 2000.
2. Modern Electronic Instrumentation and Measuring Techniques, Cooper D & A D Helfrick, PHI, 1998.
3. Electronic and Electrical Measurements and Instrumentation, J. B. Gupta, S. K. Kataria & Sons, Delhi.
4. Electronics & Electrical Measurements, A K Sawhney, Dhanpat Rai & Sons, 9<sup>th</sup> edition.
5. Instrumentation & Control Systems, K. Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.

III Year - II Semester

L	T	P	C
4	0	0	3

## BIG DATA ANALYTICS (OPEN ELECTIVE)

### Learning Objectives:

- Optimize business decisions and create competitive advantage with Big Data analytics.
- Introducing Java concepts required for developing map reduce programs.
- Derive business benefit from unstructured data.
- Imparting the architectural concepts of Hadoop and introducing map reduce paradigm.
- To introduce programming tools PIG & HIVE in Hadoop ecosystem.

### UNIT-I:

**Data structures in Java:** Linked List, Stacks, Queues, Sets, Maps; Generics: Generic classes and Type parameters, Implementing Generic Types, Generic Methods, Wrapper Classes, Concept of Serialization

### UNIT-II:

**Working with Big Data:** Google File System, Hadoop Distributed File System (HDFS) – Building blocks of Hadoop (Namenode, Datanode, Secondary Namenode, JobTracker, TaskTracker), Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files.

### UNIT-III:

**Writing MapReduce Programs:** A Weather Dataset, Understanding Hadoop API for MapReduce Framework (Old and New), Basic programs of HadoopMapReduce: Driver code, Mapper code, Reducer code, Record reader, Combiner, Partitioner

### UNIT-IV:

**Hadoop I/O:** The Writable Interface, Writable comparable and comparators, Writable Classes: Writable wrappers for Java primitives, Text, BytesWritable, NullWritable, ObjectWritable and GenericWritable, Writable collections, Implementing a Custom Writable: Implementing a Raw comparator for speed, Custom comparators

### UNIT-V:

**Pig:** Hadoop Programming Made Easier; Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Evaluating Local and Distributed Modes of Running Pig Scripts, Checking out the Pig Script Interfaces, Scripting with Pig Latin

### UNIT-VI:

**Applying Structure to Hadoop Data with Hive:** Saying Hello to Hive, Seeing How the Hive is Put Together, Getting Started with Apache Hive, Examining the Hive Clients, Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, Querying and Analyzing Data.

**Outcomes:**

- Preparing for data summarization, query, and analysis.
- Applying data modeling techniques to large data sets.
- Creating applications for Big Data analytics.
- Building a complete business data analytic solution.

**Text Books:**

1. Big Java, Cay Horstmann, Wiley John Wiley & Sons, 4<sup>th</sup> Edition, INC.
2. Hadoop: The Definitive Guide, Tom White, 3<sup>rd</sup> Edition, O'reilly.
3. Hadoop in Action, Chuck Lam, MANNING Publ.
4. Hadoop for Dummies, Dirk deRoos, Paul C.Zikopoulos, Roman B.Melnyk, Bruce Brown, Rafael Coss.

**Reference Books:**

1. Hadoop in Practice, Alex Holmes, MANNING Publ.
2. HadoopMapReduce Cookbook, SrinathPerera, ThilinaGunarathne.

**Software Links:**

1. Hadoop: <http://hadoop.apache.org/>
2. Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
3. Piglatin: <http://pig.apache.org/docs/r0.7.0/tutorial.html>

**ALTERNATIVE ENERGY SOURCES FOR AUTOMOBILES  
(OPEN ELECTIVE)**

**Learning Objectives:**

- To impart the necessity of finding alternative energy sources for automobiles. To understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

**UNIT-I:**

**Objective: The objective is to introduce the use and the application of different fuel types and characteristics. The student will be able to understand Solar photo-voltaic conversion and working principles.**

Introduction: Need for non-conventional energy sources. Energy alternative: solar, photo-voltaic, Hydrogen, Bio mass. Electrical - their merits and demerits.

Solar photo-voltaic conversion, Collection and storage of solar energy, Collection devices, flat plate collectors, concentrating type collectors, Principles and working of photo-voltaic Conversion, Applications to automobiles.

**UNIT-II:**

**Objective: The objective is to expose the student about energy from bio-mass performance characteristics.**

Energy from Bio mass: Photosynthesis, Photosynthetic oxygen production, Energy plantation. Bio gas production from organic waste, Description and types of Bio gas plants, Application and limitations - Merits and demerits performance characteristics and their comparison.

**UNIT-III:**

**Objective: The objective is to expose the students to study and understand basic principles of hydrogen energy and thermo-chemical production.**

Hydrogen Energy: Properties of hydrogen, Sources of Hydrogen, Thermodynamics of water splitting production of hydrogen, Electrolysis of water, Thermal decomposition of water. Thermo-chemical production, Biochemical production.

**UNIT-IV:**

**Objective: To learn various factors to be considered in hydrogen fuel usage, and to study performance. Design and study of future possibilities of electric automobiles.**

Hydrogen fuel, Storage and transportation methods, Applications to engines modifications necessary, precautions and safety measures - Performance characteristics in engine and their comparison.

Electric Automobiles: Design considerations, limitations. Opportunities for improvement Batteries, problems. Future possibilities, capacities, types, material requirement.



**UNIT-V:**

**Objective: To learn various factors to be considered in hydrogen fuel usage, study of performance. Design and study of future possibilities of electric automobiles.**

Applicability of electric cars, major parts, battery charging, HVAC, requirements, comparative use of fuel and energy;, Availability of energy for recharging; Impacts on use of fuel and energy; Impact on urban air quality, impact on price, material requirement traction motors and types.

**UNIT-VI:**

**Objective: To study the use of turbines in automobiles and Design of turbochargers for automobiles.**

Hybrid vehicle, benefits, types of HEVs, hybrid maintenance and service.

Use of turbines in cars, arrangement, control merits and de-merits, Design of turbochargers for automobiles, their usefulness on the performance, Use of fuel cells in automobiles.

**Outcomes:**

- The students completing the course will be able to understand the ever increasing quality of life. This phenomenon imposes high demand on conventional fossil fuels. Hence search for alternate fuels is a continuous phenomenon. The student will have an overview of various alternate fuels along with their merits and limitations.

**Text Books:**

1. Non-conventional Sources of Energy, G.D. Rai, Khanna Publications.
2. Electric Automobiles, William Hamilton, PHI.
3. Alternative Fuel Technology, Erjavec and Arias, Cengage Learning

**Reference Books:**

1. Solar Energy, S.P. Sukhatme, Tata McGraw Hill.
2. Energy Technology, S. Rao & B.B. Larulekar, Khamma Lab.
3. Principles of Solar Engineering, Frank Kreith& Jan F. Krieder, McGraw Hill.
4. Solar Energy -thermal Process, J.A. Duffie&W.A. Beckman, McGrawHill.

## **WASTE WATER MANAGEMENT (OPEN ELECTIVE)**

### **Learning Objectives:**

- Outline planning and the design of waste water collection, conveyance and treatment systems for a community/town/city.
- Provide knowledge of characterization of waste water generated in a community.
- Impart understanding of treatment of sewage and the need for its treatment.
- Summarize the appurtenance in sewage systems and their necessity.
- Teach planning and design of septic tank and imhoff tank and the disposal of the effluent from these low cost treatment systems.
- Effluent disposal method and realize the importance of regulations in the disposal of effluents in rivers.

### **UNIT-I:**

**Introduction to Sanitation:** Systems of sanitation- relative merits and demerits - collection and conveyance of waste water - Classification of sewerage systems- Estimation of sewage flow and storm water drainage- Fluctuations- types of sewers- Hydraulics of sewers and storm drains- design of sewers- Appurtenances in sewerage- Cleaning and ventilation of sewers.

### **UNIT-II:**

**Pumping of wastewater:** Pumping stations- location- components- Types of pumps and their suitability with regard to wastewaters.

House Plumbing: Systems of plumbing- sanitary fittings and other accessories- one pipe and two pipe systems- Design of building drainage.

### **UNIT-III:**

**Sewage characteristics:** Sampling and analysis of waste water- Physical, chemical and Biological examination- Measurement of BOD & COD- BOD equations.

Treatment of sewage: Primary treatment- Screens- grit chambers- grease traps- floatation- sedimentation- Design of preliminary and primary treatment units.

### **UNIT-IV:**

**Secondary treatment:** Aerobic and anaerobic treatment process - comparison.

Suspended growth process: Activated sludge process, principles, Design and operational problems, modifications of activated sludge processes, oxidation ponds, aerated lagoons.

Attached Growth process: Trickling Filters- Mechanism of impurities removal- classification- Design - operation and maintenance problems; RBCs, Fluidized bed reactors.

### **UNIT-V:**

**Miscellaneous Treatment Methods:** Nitrification and Denitrification- Removal of phosphates- UASB- Membrane reactors- Integrated fixed film reactors. Anaerobic Processes: Septic Tanks, Imhoff tanks- Working principles and Design- Disposal of septic tank effluent- FAB Reactors

## **UNIT-VI:**

**Bio-solids (sludge) management:** Characteristics- Handling and treatment of sludge-thickening- Anaerobic digestion of sludge.

Disposal of sewage: Methods of disposal- Disposal into water bodies- Oxygen sag Curve- Disposal into sea-disposal on land- Sewage sickness.

### **Outcomes:**

By the end of successful completion of this course, the students will be able to:

- Plan and design the sewerage systems.
- Characterization of sewage.
- Select the appropriate appurtenances in the sewerage systems.
- Selection of suitable treatment flow for sewage treatment.
- Identify the critical point of pollution in a river for a specific amount of pollutant disposal into the river.

### **Text Books:**

1. Waste water Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw- Hill edition.
2. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi, 2012.
3. Environmental Engineering, Howard S.Peavy, Donald R. Rowe, Teorge George Tchobanoglus- Mc-Graw-Hill Book Company, New Delhi, 1985.
4. Wastewater Treatment for Pollution Control and Reuse, Soli.JAreivala, Sham R Asolekar, Mc-GrawHill, New Delhi; 3rd Edition.
5. Industrial Water & Wastewater Management, KVSG MuraliKrishna.

### **Reference Books:**

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg, S.K.,: Khanna publishers.
2. Sewage Treatment and Disposal, Dr.P.N.Modi&Sethi.
3. Environmental Engineering, Ruth F. Weiner and Robin Matthews- 4<sup>th</sup>Edition Elsevier, 2003.
4. Environmental Engineering, D. Srinivasan, PHI Learning Pvt., Ltd., , New Delhi,2011.

III Year - II Semester

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## FUNDAMENTALS OF LIQUEFIED NATURAL GAS (OPEN ELECTIVE)

### Learning Objectives:

- To impart basic knowledge of LNG and its prospective.
- To learn different liquefaction technologies of LNG.
- To have knowledge on different functional units on receiving terminals
- To analyze transportation of LNG and regasification.
- To understand HSE of LNG industry.

### UNIT-I:

**Introduction:** Overview of LNG industry: History of LNG industry – Base load LNG – Developing an LNG Project – World and Indian Scenario – Properties of LNG.

### UNIT-II:

**Liquefaction Technologies:** Propane precooled mixed refrigerant process – Description of Air products C<sub>3</sub>MR LNG process – Liquefaction – LNG flash and storage.

**Cascade process:** Description of Conoco Phillips Optimized Cascade (CPOC) process – Liquefaction – LNG flash and storage.

**Other Liquefaction Processes:** Description of Linde MFC LNG process- Precooling and Liquefied Petroleum Gas (LPG) recovery – Liquefaction and Subcooling- Trends in LNG train capacity – Strategy for grassroots plant- Offshore LNG production.

### UNIT-III:

**Supporting Functional Units in LNG Plants:** Gas pretreatment: Slug catcher – NGL stabilization column – Acid gas removal unit – Molecular sieve dehydrating unit – Mercury and sulfur removal unit – NGL recovery – Nitrogen rejection – Helium recovery.

### UNIT-IV:

**Receiving Terminals:** Receiving terminals in India – Main components and description of marine facilities – Storage capacity – Process descriptions.

Integration with adjacent facilities – Gas inter changeability – Nitrogen injection – Extraction of C<sub>2</sub><sup>+</sup> components.

### UNIT-V:

**LNG Shipping Industry & Major Equipment in LNG Industry:** LNG Shipping Industry: LNG fleet – Types of LNG ships – Moss – Membrane – prismatic; Cargo measurement and calculations.

Major equipment in LNG industry – Cryogenic heat exchangers: Spiral – Wound heat exchangers – Plate & fin heat exchangers – Cold boxes; Centrifugal compressors – Axial compressors – Reciprocating compressors; LNG pumps and liquid expanders – Loading Arms and gas turbines.

**UNIT-VI:**

**Vaporizers:** Submerged combustion vaporizers- Open rack vaporizers – Shell and tube vaporizers: direct heating with seawater, and indirect heating with seawater. Ambient air vaporizers: Direct heating with ambient air – Indirect heating with ambient air.; LNG tanks.

**Safety, Security and Environmental Issues:** Safety design of LNG facilities – Security issues for the LNG industry – Environmental issues – Risk based analysis of an LNG plant.

**Outcomes:**

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

- Have good knowledge on LNG process.
- Classify different liquefaction techniques.
- Understand different units in LNG processing and transportation.
- Have knowledge associated with safety aspects of LNG.

**Text Book:**

1. LNG: Basics of Liquefied Natural Gas, 1<sup>st</sup> Edition, Stanley Huang, Hwa Chiu and Doug Elliot, PETEX, 2007.  
([https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook\\_demos/lng/HTML/index.html](https://ceonline.austin.utexas.edu/petexonline/file.php/1/ebook_demos/lng/HTML/index.html).)

**Reference Books:**

1. Marine Transportation of LNG (Liquefied) and Related Products, Richard G. Wooler, Gornell Marine Press, 1975.
2. Marine Transportation of Liquefied Natural Gas, Robert P Curt, Timothy D. Delaney, National Maritime Research Centre, 1973.
3. Natural Gas by Sea: The Development of a New Technology, Roger Rooks, Wither by, 1993.
4. Natural Gas: Production, Processing and Transport, Alexandre Rojey, Editions OPHRYS, 1997.
5. LNG: A Nontechnical Guide, Michael D'Tusiani, Gordon Shearer PennWell Books, 2007.
6. Natural Gas Transportation, Storage and Use, Mark Fennell Amazon Digital Services, Inc., 2011.
7. Liquefied Natural Gas, Walter Lowenstein Lom, Wiley 1974.
8. Liquefied Natural Gas, C. H. Gatton, Noyes, 1967.
9. Liquefied Gas Handling Principles on Ships and in Terminals, 3<sup>rd</sup> Edition, McGuire and White, Witherby Publishers, 2000.

**COMPUTATIONAL FLUID DYNAMICS  
(OPEN ELECTIVE)**

**Learning Objectives:**

- Understanding the governing equations of fluid dynamics and the difference between conservation and non-conservations form of equations.
- Various methods available for solutions of partial differential equations.
- Use of boundary conditions for solutions of these equations.
- Understanding the role of finite elemental methods for solutions of fluid dynamics problems.
- Understanding the concept of stability.
- Understanding various software's available for solving fluid dynamics problems.

**UNIT-I:**

**Basic Philosophy of CFD:** Governing equations of Fluid Dynamics, Incompressible Inviscid flows sources and vortex panel methods.

**UNIT-II:**

Mathematical properties of fluid dynamic equations – Discretization of partial differential equations, Courant-Friedrichs-Lewy (CFL) condition: Stability of numerical solution of simple convection equation for one-dimensional flows, Introduction to Finite-Difference and Finite-Volume methods.

**UNIT-III:**

Transformations and Grids, Explicit finite Differential methods – Some selected applications to Inviscid and viscous flows.

**UNIT-IV:**

Boundary layer equations and methods of solution.

**UNIT-V:**

Implicit time dependent methods for Inviscid and viscous compressible flows, with a discussion of the concept of Numerical dissipation.

**UNIT-VI:**

Introduction to finite element methods in computational fluid dynamics – Weighted residual formulation – Weak formulation – Piece wise defined shape functions – Numerical integration – Partial construction of a weak formulation – Examples.

**Outcomes:**

The students will be able to:

- Use of finite difference method and finite volume method for practical applications.
- Use of software tools available for arriving at some problems of interest.
- Distinguish different flow regimes while performing numerical analysis.
- Use of source and vortex panel method of inviscid flow to practical problems.
- Arrive at pressure and flow distribution for complicated flow systems..

**Text Books:**

1. Computational Fluid Dynamics: An Introduction, John F. Wendt, John David Anderson, Springer, 2009.
2. Computational Fluid Dynamics – The Basics with Applications (1-5 Chapters), John D.Anderson, Jr., McGraw – Hill, Inc., New York, 1995.

**Reference Books:**

1. Numerical Heat Transfer and Fluid flow, S.V. Patankar, Taylor & Francis, 1980.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg, H.K., and Malalasekera W., 2<sup>nd</sup> Edition, Prentice Hall, 2007.
3. Computational Fluid Flow and Heat Transfer, Muralidhar, K. Sundarajan, T., NarosaPublishing House, 1995.

III Year - II Semester

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### DRILLING SIMULATION LAB

#### Learning Objectives:

- Drilling simulation lab familiarizes student not only the normal drilling operations but also abnormal conditions in drilling.
- The student can get acquaintance with the drilling operations preventing abnormal conditions like Wall kicks, Blowouts, Mud losses etc.
- The student can have the knowledge how to handle the BOP, Panels, Choke manifold, Remote panel etc., in case of any emergency situation.
- Drilling simulation lab covers all abnormal drilling operations that help the student to have total knowledge of the drilling in live conditions.

The following experiments are to be carried out using a drilling simulator:

1. **Familiarization and line-up of operational components – I:** Sand pipe manifold, draw work console, drilling console.
2. **Familiarization and line-up of operational components – II:** Blow out preventer (BOP) panel, choke manifold, remote panel.
3. **Operation of major components:** Mud pumps, operating slow circulation rate, operating the rotary table, pulling weight on bit running in and pulling out of hole, remote choke panel operating.
4. **Kick identifications and well shut in procedures:** Setting flow alarms (deviation mud volume), setting flow alarms for return mud volume, identifying kick warning signs, Utilizing shut in procedures to kill well, well control computations.
5. Studies on the effect of weight on drill bit and rotary speed on the rate of penetration and wear of the bit.
6. Studies on the effect of mud density and flow rate on the penetration and wear of the bit.

#### Outcomes:

The student will be able to:

- Familiarizewith abnormal drilling operations and handle any drilling situation without any panic.
- Be conversant with the BOP, control panel, remote control panel etc.
- To identify the abnormal activities much in advance and plan to prevent the Kick, Blowout etc.
- Become a very good drilling engineer by improving the rate of drilling even in critical conditions.



### **PETROLEUM ANALYSIS LAB**

#### **Learning Objectives:**

- The objective of the petroleum analysis lab is to determine the physical and transport properties like Reid vapor pressure, Viscosity, Smoke point, Flash point & Fire point, Aniline point, Cloud & Pour point, Softening point, Calorific value, Water content of different petroleum products by conducting laboratory experiments using different apparatus and to determine the distillation characteristics of petroleum products.

#### **List of Experiments:**

1. Determination of Distillation characteristics of Crude Oil, Gasoline, Diesel and Kerosene.
2. Determination of Reid Vapor Pressure of Crude oil & Gasoline.
3. Determination of Viscosity of Diesel and Transformer oils.
4. Determination of Smoke Point of Kerosene.
5. Determination of Carbon Residue of petroleum oils.
6. Determination of Flash & Fire points of gasoline, kerosene and other products.
7. Estimation of Water content in petroleum products.
8. Estimation of Calorific value of solid, liquid and gaseous fuels.
9. Determination of Aniline point of Gasoline and Diesel oil.
10. Determination of Softening point of bitumen.
11. Determination of Cloud & Pour Points of petroleum products.
12. Detection of Corrosiveness of petroleum products

#### **Outcomes:**

- The students will be able to handle various apparatus/equipment in determining the physical and transport properties of different petroleum products and also will be able to analyze the various products of petroleum components.

III Year - II Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>

### **PETROLEUM RESERVOIR ENGINEERING LAB**

#### **Learning Objectives:**

- The students are made to understand experimental determinations of reservoir (Oil as well as gas) properties such as Porosity, Absolute & Relative permeability, Capillary pressure, Fluid properties like Density, Viscosity and Surface tension etc.

#### **List of Experiments:**

1. Determination of effective porosity by gas expansion method.  
Equipment: Helium Porosimeter (Nitrogen gas can be used in place of helium).
2. Determination of porosity and pore size distribution by mercury injection.  
Equipment: Mercury Porosimeter.
3. Measurement of surface tension & interfacial tension with the ring Tensiometer.  
Equipment: Tensiometer.
4. Determination of fluid density using Pycnometer and hydrometer methods.  
Equipment: Pycnometer and hydrometer.
5. Liquid viscosity measurement using capillary tube viscometer (Ostwald type).  
Equipment: Capillary tube viscometer.
6. Determination of capillary pressure of reservoir rock (core) using porous plate method.  
Equipment: Capillary pressure cell.
7. Measurement of contact angle (between oil, water and solid surface) using imaging method.  
Equipment: The image system set-up.
8. Measurement of air permeability.  
Equipment: Constant head Permeameter with the Hassler cell.
9. Absolute permeability measurement of water.  
Equipment: The Darcy apparatus.
10. Determination of relative permeability of oil-water using unsteady state method.  
Equipment: Relative permeability apparatus.
11. Determination of relative permeability of gas-oil using unsteady state method.  
Equipment: Relative permeability apparatus.

#### **Outcomes:**

- The students will become conversant in experimental procedures to acquire process, analyze and interpret the reservoir and reservoir fluid data.
- This laboratory work makes the students to become good reservoir engineers.

**III Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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**SUMMER INTERNSHIP  
(4-6 WEEKS)**

Every Student should undergo summer training (summer internship program) in a petroleum oil & gas producing industry/ petroleum machinery manufacturing industry for 4-6 weeks and submit a report.

**Learning Objectives:**

The student is guided (through the Industry representative) to learn the following aspects:

- Application of the engineering skills, learned in class room, in real world.
- Working as a team to deliver the results along with senior engineering professionals, technicians, managers etc.
- Work safely in industrial environment.
- Result oriented approach in plant operation, troubleshooting and engineering work.
- Present and / or report the work / project outcomes to various disciplines, departments & interest groups with confidence.

**Outcomes:**

The student shall be able to independently carryout the following tasks:

- Work safely in Industrial environment.
- Work with various interest groups, disciplines, professionals, managers, technicians etc.
- Polish the engineering skills by applying the knowledge in day-to-day operation, troubleshooting and minor-modifications.
- Building relations with University and Industry that will help mutual cooperation over long-term.

**III Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**MC**  
**MINI PROJECT-II**

**Learning Objectives:**

- To develop innovative and original ideas
- To promote team work

Three / four member teams will be formed to carry out the mini project which is a mandatory courses. Under the guidance of an instructor / faculty, each team is given a project in the following subjects at the beginning of II Semester of III year of the 4 – year B. Tech. Program.

Drilling Technology, Well Completions, Petroleum Production Engineering, Petroleum Reservoir Engineering.

The project involves process and mechanical design calculations of an equipment / process/system and constructing a working model based on the above calculations. Finally a report will be submitted in a standard format along with the model. The model and report will be assessed by the concerned instructor / faculty for the completion of the mini project –II.

**Outcomes:**

After successful completion of the mini project, students will be able to:

- Practice acquired knowledge within the chosen area of technology for project development.
- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Work as an individual or in a team in development of technical projects.
- Communicate and report effectively project related activities and findings.

## INTEGRATED ASSET MANAGEMENT

### Learning Objectives:

- The students will learn the general principles of asset management, integrated petroleum, reservoir management and integrated oil & gas asset management.
- Introduces the student to the processes and modeling paradigms needed to develop the skills to increase reservoir output, profitability and decrease speculation.
- Develop references to recognize the technical diversity of modern reservoir management teams.
- Develop an overview of reservoir management, fluids, geological principles used to characterization and two key reservoir parameters.
- Expose to modeling tools and additional exercises are included on a companion website.
- Seamlessly brings together concepts and terminology, creating an interdisciplinary approach for solving everyday problems.

### UNIT-I:

Asset Management: The corporate dimension – Data gathering – Interpreting the main data.

### UNIT-II:

Developing a decision making frame work: Populating asset management plans – Creating a strategic outline and business case for investment – The corporate asset management plan; Developing an integrated asset management and capital planning system: Overview.

### UNIT-III:

Reservoir management concepts – Reservoir management process – Data acquisition, analysis and management.

### UNIT-IV:

Reservoir performance analysis and forecast – Reservoir management economics – Reservoir management case studies.

### UNIT-V:

Industrial asset management strategies for the oil and gas sector: Over view of Onshore and Offshore assets – Integration and optimization methodology – A case study in OPEX of the assets – Evaluation of asset performance.

### UNIT-VI:

An asset management model – Typical oil field workflow – Workflows for asset management – An automated approach to data quality management – Change management.

**Outcomes:**

The students will be able to:

- Understand the working principles of an oil and gas asset management.
- Optimize the functions of each segment of an asset.
- Understand the concepts & terminology and develop an interdisciplinary approach for solving everyday problems.

**Text Books:**

1. A guide to Asset Management and Capital Planning in Local authorities, CIPFA, 2008.
2. The Big Picture: Integrated Asset Management Cedric Bouleau et al, Oil field Review, 2007/2008.
3. Integrated Petroleum Reservoir Management, A team approach, AbdusSatter and GaneshC. Thakur, Pennwell Books, Tulsa, 1994.
4. Integrated Reservoir Asset Management: Principles and Best Practices: Fanchi John R Fanchi, Ph.D, Publisher: Elsevier Science, Imprint-Gulf Professional Publishing, 2010. (SBN-10 -012382088X; SBN-13-9780123820884).

## PETROLEUM RESERVOIR ENGINEERING-II

### Learning Objectives:

- To make the students learn fundamentals as well as advanced topics in reservoir engineering like The constant terminal rate solution and its applications to oil well testing, gas well testing, natural water influx, immiscible displacement, material balance of unconventional gas reservoir, coal bed methane, tight gas reservoirs, gas hydrates.

### UNIT-I:

**The constant terminal rate solution of the radial diffusivity equation and its application to oil well testing:** The constant terminal rate solution – Transient, semi steady state and steady state flow conditions – Dimensionless variables – General theory of well testing – The Mathews, Brons, Hazebroek pressure build up theory - Pressure build up analysis techniques – Multi Rate Drawdown testing – The effects of partial well completion – After flow analysis.

### UNIT-II:

**Gas well testing:** Linearization and solution of the basic differential equation for the radial flow of a real gas – The Russel, Goodrich et. al. Solution technique – The Al Hussainy, Ramey Crawford solution techniques – Non-Darcy flow – Determination of the non- Darcy coefficient F - The constant terminal rate solution for the flow of a real gas – General theory of gas well testing – Multi rate testing of gas wells.

### UNIT-III:

**Pressure build up testing of gas wells :** Pressure build up analysis in solution gas drive reservoirs-Analysis of well tests using type curves- Interference and Pulse Tests - Flow after flow tests in gas wells- Isochronal & modified isochronal tests- Use of pseudo pressure in gas well test analysis- Injection Well Testing.

### UNIT-IV:

**Natural water influx:** The unsteady state water influx theory of Hurst and Van Everdingen and its application in history matching – The approximate water influx theory of Fetkovich for finite aquifers predicting the amount of water influx – Application of influx calculation techniques to steam soaking.

### UNIT-V:

**Immiscible displacement:** Physical assumptions and their implication – The fractional flow equation – Buckley-Leverette one dimensional displacement – Oil recovery calculation – Displacement under segregated flow conditions – Allowance for the effect of finite capillary transition zone in displacement calculations – Displacement in stratified reservoir.

### UNIT-VI:

**Unconventional Gas Reservoirs:** Material balance equation for conventional and unconventional gas reservoirs- Coal bed methane - Tight gas reservoirs - Gas hydrates - Shallow gas reservoirs.

**Outcomes:**

The students will be able to:

- Carry out the interpretation of Well Test Data.
- Estimate the reserves of various sands of the reservoir along with water production.
- Calculate the formation damage and water in flux, according he can recommend proper stimulation jobs.
- Learn the advanced topics like Coal bed methane and Gas hydrates.
- Recommend for tight gas reservoirs with proper hydrofracturing.
- Learn how to acquire the data through well testing in dynamic and closed conditions.
- Estimate the long term profiles of the reservoirs.

**Text Books:**

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17<sup>th</sup> Impression 1998).
2. Advanced Reservoir Engineering, Tarek Ahmed and Paul D. McKinney, Gulf Professional Publishing, Elsevier, 2005.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3<sup>rd</sup> revised Edition, Prentice Hall, New York, 2014.

**Reference Books:**

1. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
3. Basic Reservoir Engineering, Rene Cosse, Editions Technip, 1993.
4. Petroleum Reservoir Engineering, James W Amyx, Daniel M. Bass Jr., Robert L. Whiting, McGraw Hill, 1960.



## SURFACE PRODUCTION OPERATIONS

### Learning objectives:

- Operate and maintain the surface equipment installed in GGS/GCS.
- Smooth operation of equipment with minimum manpower and handling more crude oil/gas.
- Priority to safety operations so that free of even minor accidents.
- Have the knowledge of various Acts of safety and environmental protection.
- Understand modes of transportation types of storage.
- Distribution & Custody transfer.
- Pressure maintenance & Reservoir performance monitoring.

### UNIT-I:

**Production facilities:** Various types of facilities Controlling the process-Basic system configuration design & selection of facilities: Wellhead and manifold- Separation-Initial separation pressure- Stage Separation, Selection of Stages, Process flow sheets, P&IDs, monitoring well performance testing & optimization of flow.

### UNIT-II:

**Two phase liquid and gas separation:** Functional sections of a gas-liquid separator- Inlet diverter section- Liquid collection section- Gravity settling section- Mist extractor section- Equipment description of different separators- Scrubbers- Slug catchers- Selection considerations- Vessel internals- Mist extractors- Potential operating problems.

**Three phase oil, gas and water separation:** Equipment description- Horizontal separators- Derivation of equation- Free-water knockout- Flow splitter- Horizontal three-phase separator with a liquid “Boot”-Vertical separator- Selection considerations- Vessel internals- Coalescing plates- Turbulent flow coalesces and potential operating problems.

### UNIT-III:

**Crude oil treating:** Equipment description of various treaters and heaters- Indirect and fired heaters- Heater sizing- Vertical heater-treaters- Coalescing media- Horizontal heater treaters- Electrostatic heater-treaters- Oil dehydrators- Emulsion treating theory Agitation- Emulsifying agents- Demulsifies- Field optimization- Emulsion treating methods- General considerations- Chemical addition- Amount of chemical- Bottle test considerations- Chemical selection.

**Oil desalting systems:** Oil desalting systems-Equipment description of desalters- Mixing equipment- Process description- Single stage desalting- Two stage desalting; Monitoring of oil quality.

### UNIT-IV:

Storage facilities, measurements custody transfer marketing- transportation modes & dispatch. Gas dehydration compression measurements custody transfer marketing- transportation dispatch. Fire protection systems for tank farm pumping /compressor stations.

**UNIT-V:**

**Produced water treating systems:** Characteristics of produced water-Sand and other suspended solids- Dissolved gases- Oil in water emulsions- Dissolved oil concentrations- Dispersed oil-Toxicants- Gravity separation- Coalescence- Dispersion- Flotation- Filtration- Equipment description-Retention time and performance considerations-Design of produced water treating systems.Disposal standards- Disposal methods-Offshore & Onshore operations.

**UNIT-VI:**

Water injection facilities, Sources of water, Treatment system, Pumping, Chemical dosing, Identification wells, Patterns of injections well performance monitoring reservoir monitoring.

**Outcomes:**

The students can:

- Do the efficient separation of oil and gas.
- Maintain the quality of oil, required by the refineries.
- Work on the various control systems fitted on the separators/heater-treaters, so that smooth operation of GGS/GCS can be maintained.
- Figure out the crude oil emulsions produced from various wells and he can treat such crudes to the required oil quality.
- Work with various safety systems fitted from well to the surface equipment's storage, pumping stations and he can ensure accident free operation till the oil is supplied to refiners and gas to consumers.
- Perceive the treatment of produced water and disposal of the same as per the norms laid by regulatory authorities
- Carry out pressure maintenance & monitoring of reservoir performance to improve recovery.

**Text Books:**

1. Petroleum and Gas Field Processing, H.K.Abdel-Aal and Mohamed Aggour and M.A. Fahim, Marcel Dekkar Inc., 2003.
2. Surface Production Operations, Ken Arnold & Maurice Stewart, Vol. 1 & 2, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2008.

## OIL & GAS PROCESSING PLANT DESIGN

### Learning Objectives:

- The students are made to learn the design of all types of separators, pumps & compressors, heat exchangers, oil treaters, desalters, gas treating systems, different types of valves and flaring systems
- Imparting knowledge on material of construction and mechanical design of the petroleum equipment.

### UNIT-I:

**Design principles and sizing of gas-oil separators:** Principles of phase separators- Sizing of vertical & horizontal two-phase and three phase separators- Optimum pressure - Design of single and multistage flash vaporization equipment- Materials of construction and mechanical design of separators.

### UNIT-II:

**Fluid Flow equipment Design:** Basic concepts of fluid handling equipment & design-Pumps - Compressors - Blowers.

### UNIT-III:

**Design of principles and sizing of heat exchangers:** Process design of Shell & Tube heat exchangers - Double pipe heat exchangers- Plate and frame heat exchangers- Air cooled heat exchangers- Heat recovery units- Fired heaters- Materials of construction & mechanical design of heat exchangers.

### UNIT-IV:

**Design principles and sizing crude oil treaters:** Sizing horizontal and vertical treaters- Design of LTX units and line treaters- Material of construction and mechanical design.

Design of principles and sizing of crude desalting equipment - Design principles and sizing of equipment for produce water treatment and disposal.

### UNIT-V:

**Design principles and sizing of acid gas treating system design:** Design of iron sponge units - Design of H<sub>2</sub>S and CO<sub>2</sub> absorbers and strippers using amine solutions – Design of rich/lean amine exchanger- Design of amine cooler- Material of construction- Mechanical design.

Process design of glycol and solid bed dehydration systems-Materials of construction & mechanical design.

### UNIT-VI:

Design principles and sizing of pressure relief valves, vents, other relieving devices- Selection criteria- Location- Maintenance- Design of flaring systems.

**Outcomes:**

The students will be able to:

- Design of all types of separators, pumps & compressors, heat exchangers, oil-treaters, desalters, gas treating systems, different types of valves and flaring systems with necessary details.
- Specify the material of construction for the petroleum equipment.
- Carry out the mechanical design of the petroleum equipment.

**Text Books:**

1. Petroleum and Gas Field Processing, H.K. Abdel- Aal, Mohamed Aggover, M.A. Fahim, Marcel Dekkar Inc., 2003.
2. Surface Production Operations, Ken Arnold, Maurice Stewart, Butterworth Heinemann, Vol 1 & 2, 1999.

**Reference Book:**

1. Engineering Data Book, 12<sup>th</sup> Edition (Electronic), FPS Version, Volume I & II, Gas Processors Suppliers Association (GPSA), 2005.

## NATURAL GAS HYDRATES (ELECTIVE-I)

### Learning Objectives:

This course is designed to introduce a basic study of natural gas hydrates and its properties. The student will be imparted the knowledge of:

- Overview of NGH and classification of NGH.
- Hydrate formation by using different methods.
- Exhibiting hydrate formation and dehydration processes.
- Different physical and chemical properties of NGH.
- Deactivating the hydrates using heat and pressure.

### UNIT-I:

**Introduction:** Overview of natural gas hydrates- Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units.

**Hydrate types and formers:** Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane- Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition- Other hydrate formers- Mixtures- Examples.

### UNIT-II:

**Hydrate formation hand calculation methods:** Gas gravity method- K-Factor method- Baillie-Wichert method- Comments on these methods- Examples.

**Hydrate formation computer methods:** Phase equilibrium- Van der Waals and Platteeuw-Parrish and Prausnitz-Ng and Robinson methods- Calculations- Commercial software packages- Accuracy of these programs- Dehydration- Examples.

### UNIT-III:

**Inhibiting hydrate formation with chemicals:** Freezing point depression- Hammer-Schmidt equation- Nielsen-Bucklin equation- New method- Brine solutions- Comment on the simple methods- Advanced calculation methods- Inhibitor vaporization- Comment on injection rates- Kinetic inhibitors- Examples.

**Dehydration of natural gas:** Water content specification-Glycol dehydration- Molecular sieves-Refrigeration- Examples.

### UNIT-IV:

**Combating hydrates using heat and pressure:** Use of heat- Heat loss from a buried pipeline-Line heater design- Two-Phase heater transfer- Depressurization- Melting a plug with heat- Examples.

### UNIT-V:

**Physical properties of hydrates:** Molar mass - Density- Enthalpy of fusion- Heat capacity- Thermal conductivity- Mechanical properties- Volume of gas in hydrate- Ice versus hydrate- Examples.

**Phase diagrams:** Phase rule- Comments about phases- Single component systems- Binary systems- Phase behavior below 0°C- Multicomponent systems- Examples.

**UNIT-VI:**

**Water content of natural gas:** Equilibrium with liquid water- Equilibrium with solids- Examples.

**Outcomes:**

After successful completion of the course the students will be able to:

- Have good knowledge in dealing with NGH.
- Model different forms of hydrate formation using both hand calculations and computer methods.
- Understand different properties of NGH.
- Design line heaters for effective transportation.
- Have knowledge of different equilibriums of liquid water and solids with natural gas.
- Understand the challenges of NGH.

**Text Books:**

1. Natural Gas Hydrates: A Guide for Engineers, John J. Carroll, Gulf Professional Publishers, 2003.
2. Clathrate Hydrates of Natural Gases, E. Dendy Sloan, Jr., C. Koh, 3<sup>rd</sup> Edition, CRC Press, 2007.

**Reference Book:**

1. Natural Gas Hydrates in Flow Assurance, E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, Elsevier, 2010.

**PIPELINE ENGINEERING  
(ELECTIVE-I)**

**Learning Objectives:**

- Operations and maintenance of flow lines or trunk pipe lines.
- Understanding of well fluids for proper designing of flow lines/trunk pipe lines.
- Obtaining the permissions to laying of pipe line as per the State/DGMS regulations.
- Operation and maintenance of gas compressors.
- Handling of flammable fluids like gas, oil condensate to check the accident free operation.
- Protection from internal/external corrosion of pipe lines by suitable methods.

**UNIT-I:**

**Elements of pipeline design:** Fluid properties – Environment - Effects of pressure and temperature - Supply/Demand scenario - Route selection - Codes and standards - Environmental and hydrological considerations – Economics - Materials/Construction – Operation - Pipeline protection - Pipeline integrity monitoring.

**Pipeline route selection, survey and geotechnical guidelines:** Introduction - Preliminary route selection - Key factors for route selection - Engineering survey - Legal survey - Construction / As-built survey - Geotechnical design.

**UNIT-II:**

**Natural gas transmission:** General flow equation – Steady state - Impact of gas molecular weight and compressibility factor on flow capacity - Flow regimes - Widely used steady-state flow equations – Summary of the impact of different gas and pipeline parameters on the gas flow efficiency – Pressure drop calculation for pipeline in series and parallel – Pipeline gas velocity – Erosional velocity – Optimum pressure drop for design purposes – Pipeline packing – Determining gas leakage using pressure drop method – Wall thickness/pipe grade – Temperature profile – Optimization process – Gas transmission solved problems.

**UNIT-III:**

**Gas compression:** Types of compressors – Compressor drivers – Compressor station configuration – Thermodynamics of isothermal and adiabatic gas compression – Temperature change in adiabatic gas compression – Thermodynamics of polytropic gas compression – Gas compressors in series – Centrifugal compressor horsepower – Enthalpy / Entropy charts (Mollier diagram) – Centrifugal compressor performance curve- Reciprocation compressors.

**Coolers :** Gas coolers – Air-cooled heat exchangers –Heat transfer equations for coolers – Fan air mass flow rate – Required fan power – Gas pressure drop in coolers – Iterative procedure for calculations based on unknown  $T_2$ .

**UNIT-IV:**

**Liquid flow and pumps:** Fully developed laminar flow in a pipe – Turbulent flow – Centrifugal pumps – Retrofitting for centrifugal pumps (Radial-flow) – Pump station control – Pump station piping design.

**Transient flow in liquid and gas pipelines:** Purpose of transient analysis – Theoretical fundamentals and transient solution technique – Applications – Computer applications.

## **UNIT-V:**

**Pipeline mechanical design:** Codes and standards – Location classification – Pipeline design formula – Expansion and flexibility – Joint design for pipes of unequal wall thickness – Valve assemblies – Scraper traps – Buoyancy control – Crossings – Depth of cover – Aerial markings – Warning signs.

**Pipeline construction:** Construction – Commissioning.

## **UNIT-VI:**

**Materials selection:** Elements of design – Materials designation standards.

**Pipeline protection, Instrumentation and Pigging:** Pipeline coating – Cathodic protection – Cathodic protection calculations for land pipelines – Internal corrosion – Flow meters and their calibration – Sensors – Pigs.

## **Outcomes:**

The students will be able to:

- Become a specialist in pipeline designing and pipe line maintenance.
- Repair and maintenance of pipeline in short time to avoid production loss.
- Plan for suitable corrosion protection methods to improve the life of the pipeline.
- Be a good public relations officer to deal with public in acquiring the land & also during repair & maintenance operations.

## **Text Books:**

1. Pipeline Design and Construction: A Practical Approach, M. Mahitpour, H. Golshan and M.A. Murray, 2<sup>nd</sup> Edition, ASME Press, 2007.
2. Pipeline Engineering, Henry Liu, Lewis Publishers (CRC Press), 2003.

## **Reference Books:**

1. Piping Calculation Manual, E. ShashiMenon, McGraw-Hill, 2004.
2. Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair, George A. Antaki, CRC Press, 2003.
3. Pipeline Planning and Construction Field Manual, E. ShashiMenon, Gulf Professional Publishing, 2011.
4. Pipeline Rules of Thumb Handbook, E. W. McAllister, 7<sup>th</sup> Edition, 2009.
5. Liquid Pipeline Hydraulics, E. ShashiMenon, Mareel Dekker, Inc., 2004.
6. Gas Pipeline Hydraulics, E. ShashiMenon, Taylor & Francis, 2005.



IV Year - I Semester

L	T	P	C
4	0	0	3

## HORIZONTAL WELL TECHNOLOGY (ELECTIVE-I)

### Learning Objectives:

This course introduces fundamentals of horizontal wells by dealing with reservoir and production characteristics of horizontal wells and respective challenges.

The students will be able to:

- Understand the basics of horizontal wells and its reservoir properties.
- Have knowledge of different types of horizontal wells.
- Differentiate between horizontal and vertical fractured wells.
- Understand the testing and flow performance using different equations.
- Gain knowledge on critical rates of flow and challenges during different rates of flow like gas and water coning.

### UNIT-I:

**Overview of horizontal well technology:** Introduction- Limitations of horizontal wells- Horizontal well applications- Drilling techniques- Horizontal well length based upon drilling techniques and drainage area limitations- Completion techniques.

**Reservoir engineering concepts:** Skin factor- Skin damage for horizontal wells- Effective wellbore radius  $r'_w$  - Productivity index,  $f$ - Flow regimes- Influence of areal anisotropy.

### UNIT-II:

**Steady-state solutions:** Steady-state productivity of horizontal wells- Effective wellbore radius of a horizontal well- Productivity of slant wells- Comparison of slant well and horizontal well productivities- Formation damage in horizontal wells- Field histories.

**Influence of well eccentricity:** Introduction- Influence of well eccentricity- Drilling several wells- Horizontal wells at different elevations.

### UNIT-III:

**Comparison of horizontal and fractured vertical wells:** Vertical well stimulation- Types of fractures- Comparison of horizontal wells and finite conductivity fractures- Horizontal wells in fractured reservoirs- Fractured horizontal wells.

### UNIT-IV:

**Transient well testing:** Introduction-Mathematical solutions and their practical implications- Generalized flow regimes- Pressure response- Detailed well testing flow regimes- Pressure directivities- Wellbore storage effects- Practical Considerations.

### UNIT-V:

**Pseudo-steady state flow:** Generalized pseudo-steady state equation for vertical wells- Shape factors for vertical wells- Shape factors for fractured vertical wells- Shape factors of horizontal wells- Horizontal well pseudo-steady state productivity calculations- Inflow performance of partially open horizontal wells- Inflow performance relationship (IPR) for horizontal wells in

solution gas-drive reservoirs- Predicting horizontal well performance in solution gas-drive reservoirs.

#### **UNIT-VI:**

**Water and gas coning in vertical and horizontal wells:** Critical rate definition- Vertical well critical rate correlations- Critical rate by production testing- Decline curve analysis- Water breakthrough in vertical wells- Vertical well post-water breakthrough behavior- Characteristics of water cut versus recovery factor plots- Water and gas coning in horizontal wells- Horizontal well breakthrough time in a bottom- Critical rate for horizontal well in edge-water drive reservoir practical considerations.

#### **Outcomes:**

After successful completion of this course, the students will be able to:

- Have an overview of horizontal well technologies.
- Perform flow performance calculations of horizontal wells.
- Perform mathematical solutions to transient well testing for different flow regimes.
- Solve challenges for different flow rates.
- Design a horizontal well.

#### **Text Book:**

1. Horizontal Well Technology, S. D. Joshi, PennWell Publishing Company, 1991.

#### **Reference Book:**

1. Horizontal Wells: Formation Evaluation, Drilling and Production Including Heavy Oil Recovery, Roberto Aguilera, G. M. Cordell, G. W. Nicholl, J. S. Artindete, M. C. Nq., Gulf Publishing Co., 1991.

IV Year - I Semester

L	T	P	C
4	0	0	3

## COAL BED METHANE ENGINEERING (ELECTIVE-II)

### Learning Objectives:

This course introduces the student the basics of coal bed methane by giving an overview of reservoir, drilling, production.

This course makes the studentsto:

- Have overview of scenario of CBM.
- Have knowledge on the geology of coal.
- Deal with basic principles of sorption and isotherms.
- Analyze reservoir characterizes of CBM.
- Have basic idea of completions and driving of CBM reservoirs.
- Understand the hydrofrac job for coal seams.
- Learn in dealing with water from production and disposal.

### UNIT-I:

**Introduction:** Overview of coal bed methane (CBM) in India – CBM vs Conventional Reservoirs.

### UNIT-II:

Geological influences on coat formation of coals – Coal chemistry – Significance of rank – Cleat system and natural fracturing.

### UNIT-III:

**Sorption:**Principles of Adsorption-The Isotherm construction-CH<sub>4</sub> retention by coal seams-CH<sub>4</sub> content determination in coal seams-The isotherm for recovery prediction-Model of the micro-pores-coal sorption of other molecular species.

### UNIT-IV:

**Reservoir Analysis:**Coal as a reservoir-Permeability-Porosity-Gas flow-Reserve analysis-Well spacing and drainage area-Enhanced recovery.

### UNIT-V:

**Well Construction:**Drilling-Cementing.

Formation Evaluations, Logging:Borehole environment-Tool measurement response in coal-wire line log evaluation of CBM wells-Gas-In-Place calculations-Recovery factor-Drainage area calculations-Coal permeability/Cleating-Natural fracturing and stress orientation-Mechanical rock properties in CBM evaluation.

**Completions:**Open hole completions-Open hole cavitation process, Cased hole completions-Multi zone entry in cased hole.

## **UNIT-VI:**

**Hydraulic fracturing of coal seams:**Need for fracturing coals-Unique problems in fracturing coals-Types of fracturing fluids for coal-In situ conditions-Visual observation of fractures.

**Water production and disposal:**Water production rates from methane wells-Chemical content-Environmental regulations-Water disposal techniques-Economics of coal bed methane recovery.

### **Outcomes:**

By successful completion of this course, the students will be able to:

- Master the fundamentals of coal bed methane.
- Construct different isotherms.
- Evaluate different logs for CBM reservoirs.
- Have good knowledge on water disposal techniques and environmental laws.
- Understand reservoir drilling and production of CBM.
- Design a CBM well.

### **Text Books:**

1. Coal Bed Methane: Principles and Practice, R. E. Rogers, 3<sup>rd</sup> Edition, Prentice Hall, 1994.
2. Coal Bed Methane, Robert A. Lamarre, American Association of Petroleum Geologists, 2008.

### **Reference Books:**

1. Fundamentals of Coal Bed Methane Reservoir Engineering, John Seidle, Pennwell Corp., 2011.
2. Coal Bed Methane, Society of Petroleum, 1992.
3. A Guide to Coal Bed Methane Operations, B. A. Hollub, Society of Petroleum, 1992.

IV Year - I Semester

L	T	P	C
4	0	0	3

## OFFSHORE ENGINEERING (ELECTIVE-II)

### Learning Objectives:

- Introduce different types of deep water offshore structures and challenges.
- Introduce concept of wave theory for linear waves.
- Estimation of wave loads on small bodies.
- Estimation of different types of loads on offshore structures such as gravity, wind, wave and current loads.
- Detailed design of fixed offshore structures.
- Concepts of floating structures.
- Fundamental aspects of semisubmersible, TLP, spar and installation methodologies.

### UNIT-I:

**Overview of offshore structures:** Introduction- Deepwater challenges- Functions of offshore structures- Offshore structure configurations- Bottom-Supported fixed structures- Compliant structures- Floating structures- Classification societies and industry standard groups.

**Novel and small field offshore structures:** Introduction- Overview of oil and gas field developments- Technical basis for developing novel offshore structures- Other considerations for developing novel offshore structures- Novel field development systems- Future field development options.

### UNIT-II:

**Ocean environment:** Introduction- Ocean water properties- Airy's Wave theory-Wave kinematics along the depth of water.

### UNIT-III:

**Loads:** Introduction- Gravity loads- Hydrostatic loads- Current loads on structures- Wave loads on structures- Applicability of Morison force for small bodies-Steady wave drift force- Slow-Drift wave forces- Varying wind load.

### UNIT-IV:

**Formulation of mathematical model of framed structure:** Degrees of freedom of a beam element, Development of stiffness matrix of a beam element, transformation of local stiffness matrix to global stiffness matrix, Assemble of global stiffness matrix of a two dimensional frame structure, Boundary conditions, Static analysis of two dimensional frames.

### UNIT-V:

**Fixed offshore platform design:** Field development and concept selection activities- Estimation of wave loading on a structural element using linear wave theory on small bodies, Development of mathematical model with constraints, Development of global stiffness matrix of a simple two dimensional fixed offshore structure, static analysis of a simple two dimensional fixed offshore structure, Development of MATLAB coding for the analysis of a simple two dimensional fixed offshore structure.

## **UNIT-VI:**

**Floating offshore platform design:** Introduction - Floating platform types- Hydrostatic analysis of floating system with examples, Different types of anchoring systems (taut and catenary mooring), Installation of different offshore structures (Jacket, Spar, Tension leg platform, semi-submersible and Floating Production Storage and offloading systems).

### **Outcomes:**

The students will be able to:

- Identify type of offshore structure and recommend a specific offshore structure for a given site condition and requirements of the platform.
- Estimate water particle kinematics using linear Airy's wave theory and estimate maximum wave force and overturning moment for a fixed vertical circular cylinder.
- Do analysis and design of fixed offshore structure.
- Perform mass distribution of different structures such as floating structure, TLP and Spar.

### **Text Books:**

1. Handbook of offshore engineering, S. K. Chakrabarti, Volume 1 & 2, Elsevier, 2005.
2. Hydrodynamics of offshore structures, S. K. Chakrabarti, WIT Press.
3. Matrix methods of structural analysis, P. N. Godbole, R. S. Sonparote, S. U. Dhote, PHI Learning Private Limited, 2014.

### **Reference Book:**

1. Structural Analysis: A Matrix Approach, G.S. Pandit and S.P. Gupta, 2<sup>nd</sup> Edition, Tata McGraw-Hill Education, 2001.

## RESERVOIR STIMULATION (ELECTIVE-II)

**Learning Objectives:** To impart knowledge in

- Basic concepts of rock mechanics and their relevance to design stimulation task in a petroleum reservoir.
- Development and analysis of Simple 2D, Pseudo 3D and Real 3D analytical models to represent hydraulic fracturing.
- Working knowledge of fracturing fluids and their additives.
- Working knowledge of the rheology of fracturing fluids and their properties.
- Data requirements for the design of a fracturing task.
- Pressure decline analysis and interpretation techniques.
- Practical limitations in fracture design.
- Prediction of fracture height and various approaches for post-treatment measurements.
- Evaluation of post treatment and performance of fractured wells.

### UNIT-I:

**Reservoir justification of stimulation treatments:** Introduction- Fundamentals of pressure transient analysis- Well and reservoir analysis.

**Elements of rock mechanics:** Basic concepts- Pertinent rock properties and their measurement- In-Situ stress and its determination.

### UNIT-II:

**Modeling of hydraulic fractures:** Conservation laws and constitutive equations- Fracture propagation models- Fluid flow modeling- Acid fracturing.

**Fracturing fluid chemistry:** Water base fluids- Oil base fluids- Multiphase fluids- Additives- Execution.

### UNIT-III:

**Fracturing fluid proppant and characterization:** Rheology- Shear and temperature effects on fluid properties- Foam fracturing fluids- Slurry rheology- Proppant transport- Fluid loss- Formation and fracture damage- Proppants.

**Pre-Treatment data requirements:** Types of data- Sources of data- Dynamic downhole testing.

### UNIT-IV:

**Fracturing diagnosis using pressure analysis:** Basic relations- Pressure during pumping- Analysis during closure- Combined analysis pumping and closure- Field procedures.

**The optimization of propped fracture treatments:** Physical systems and mathematical formulations- Treatment optimization design procedure- Parametric studies of fracture design variables.

### UNIT-V:

**Considerations in fracture design:** Size limitations- Considerations with predetermined size or volume- Benefits of high proppant concentrations- Effect of reservoir properties- Effects of perforations on fracture execution.

**Fracture-Height predictions and post-treatment measurements:** Linear fracture-mechanics modeling for fracture height- Fracture-height prediction procedures- Techniques to measure fracture height.

#### **UNIT-VI:**

**Post-treatment evaluation and fractured well performance:** Selected references before the finite conductivity fracture models- Cinco and Samaniego model- Comments on damaged and choked fractures- Post-fracture well analysis- Interpretation for finite conductivity fracture wells with wellbore storage- Comparison of production forecasts for untreated and fractured wells- Calculation of the fracture length and conductivity of long-flowing wells.

#### **Outcomes:**

The students will be able to:

- Gain working knowledge of various approaches of fracturing approaches.
- Assimilate data for the design of stimulating treatment.
- Design and analyze fracturing approaches for petroleum reservoir stimulation.
- Solve practical problems in reservoir fracturing and remedies to resolve the same.

#### **Text Book:**

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2<sup>nd</sup> Edition, Prentice Hall, 1989.

#### **Reference Books:**

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.



## INTELLECTUAL PROPERTY RIGHTS AND PATENTS

### Learning Objectives:

- To know the importance of Intellectual property rights, which plays a vital role in advanced Technical and Scientific disciplines.
- Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latest developments.

### UNIT-I:

**Introduction to Intellectual Property Rights (IPR):** Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

### UNIT-II:

**Copyrights and Neighboring Rights:** Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

### UNIT-III:

**Patents:** Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Double Patenting — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations.

### UNIT-IV:

**Trademarks:** Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities - Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing Off Action.

### UNIT-V:

**Trade Secrets:** Introduction to Trade Secrets – General Principles - Laws Relating to Trade Secrets - Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements – Breach of Contract –Law of Unfair Competition – Trade Secret Litigation – Applying State Law.

## **UNIT-VI:**

**Cyber Law and Cyber Crime:** Introduction to Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions - E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers.

- Relevant Cases Shall be dealt where ever necessary.

### **Outcomes:**

- IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents.
- Student gets an insight on Copyrights, Patents and Software patents which are instrumental for further advancements.

### **Reference Books:**

1. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
2. Intellectual Property, Deborah E.Bouchoux, Cengage Learning, New Delhi.
3. Intellectual Property Rights, PrabhuddhaGanguli, Tata Mc-Graw –Hill, New Delhi.
4. Intellectual Property, Richard Stim, Cengage Learning, New Delhi.
5. Fundamentals of IPR for Engineers, Kompal Bansal &Parishit Bansal, B. S. Publications (Press).
6. Cyber Law - Texts & Cases, South-Western’s Special Topics Collections.
7. Intellectual Property Rights, R.Radha Krishnan, S.Balasubramanian, Excel Books. New Delhi.
8. Intellectual Property Rights, M.Ashok Kumar and Mohdiqbal Ali, Serials Pub.

**IV Year - I Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>

### **PETROLEUM EQUIPMENT DESIGN & SIMULATION LAB**

#### **Learning Objectives:**

The student will be trained in the design and simulation of various equipment used in petroleum industry.

The following experiments have to be conducted using C/C++/Simulink using MATLAB/UNISIM for design and simulation:

1. Oil- Water separator.
2. Gas- Oil-Water separator.
3. Lean / rich amine heat exchanger.
4. Air cooled heat exchanger.
5. CO<sub>2</sub> and H<sub>2</sub>S absorber unit using, MEA/DEA amine solution.
6. Stripping unit.
7. Single stage flash vaporization unit.
8. Three stage flash vaporization unit.
9. Liquid pumping system & simulation of water-hammer phenomena.
10. Gas Compressor unit.

#### **Outcomes:**

The student shall be able to carry-out the following tasks independently:

- Design and simulation of the two-phase and three phase separators.
- Design and simulation of compressors.
- Design and simulation of flash vaporization units.
- Design and simulation of absorber-stripper unit for removal of CO<sub>2</sub> and H<sub>2</sub>S from natural gas.
- Size /rate the pipeline & pumping systems for liquid pumping & simulate water hammer conditions.
- Carryout detailed thermal sizing or rating of shell & tube exchangers as per TEMA specifications and API guidelines.
- Generate sized equipment data sheets as per the industry standards with required information for detailed design / manufacture.

## PETROLEUM RESERVOIR SIMULATION LAB

### Learning Objectives:

- The main objective is to simulate the exploitation of a real reservoir without the costs of real life trial and error, e.g. to test different production scenarios to find an optimal one before the reservoir is actually put on production.
- To develop reservoir simulation models for new reservoirs to maximize recovery of oil and gas and to make investment decisions.
- To develop reservoir simulation models for existing reservoirs to study production decline and production forecasts.

### Reservoir Simulation Experiments:

The students will be trained in the software Package ECLIPSE, or any other equivalent software to model and solve reservoir engineering problems.

1. File organization and structure
2. Selection of suitable by grid sensitivity studies.
3. Fluid properties
4. Rock properties
5. Wells
6. Aquifer modeling
7. History matching consisting of adjusting the parameters of the model such as permeability, porosity etc. until the computed results for the historical period are close to historical data
8. Prediction of properties permeability, relative permeability, saturation etc.

### Outcomes:

After the laboratory course, the students will be able to:

- Explain reservoir simulation fundamentals- the underlying equations and the numerical techniques used to solve them.
- Design a reservoir simulation model, construct the data set, execute the simulator, and view simulation results visually using post-processing software.
- Plan and conduct the calibration of a reservoir simulation model.
- Apply reservoir simulation technology to solve production and reservoir engineering problems in individual wells or patterns.
- Apply reservoir simulation technology to solve production and reservoir engineering problems in entire fields or reservoirs.
- Present results of an engineering study effectively in a written report.

IV Year - II Semester

L	T	P	C
4	0	0	3

## ENHANCED OIL RECOVERY TECHNIQUES

### Learning Objectives:

- Understanding of secondary / tertiary recovery of crude oils of specific reservoirs.
- Following the selection criteria to which reservoir suits for specific EOR techniques.
- Post project monitoring.
- Knowledge of maintenance of injection wells / Production wells.
- Knowledge of ignition of injection wells in case of thermal EORs.
- Knowledge of handling of chemicals like CO<sub>2</sub>, Surfactants, Polymers etc.
- Handling of injection wells in case of any leakage or blowout situations.

### UNIT-I:

**Introduction:** Secondary oil recovery processes, Selection of lift mechanism for wells, Gas lift methods continuous & intermittent gas lift valve designs, Sucker rod pumping units parts of pumping unit, design operation maintenance, Electrical submersible pumps design operation maintenance.

### UNIT-II:

**Gas injection:** Introduction, Predictive performance, Gas injection in carbonate reservoirs, Inert gas injection, Candidates for gas injection.

**Miscible flooding:** Introduction, Sweep efficiency-High pressure gas injection, Enriched gas drive, LPG slug drive; Predictive technique, Field applications.

**Carbon dioxide flooding:** Process description, Field projects, CO<sub>2</sub> sources- problem areas, designing a CO<sub>2</sub> flood, Guidelines for selection of miscible CO<sub>2</sub> projects, Immiscible CO<sub>2</sub> flooding conclusions.

### UNIT-III:

**Polymer flooding:** Introduction, Polymer products and theory of use, Planning polymer flood projects.

**Polyacrylamides:** Introduction, Polyacrylamides chemistry, Application of PAM/AA in enhanced oil recovery, Factors affecting flow in porous media, Field considerations- Site factors, Field operation.

### UNIT-IV:

**Alkaline flooding:** Introduction, Types of caustic used, Entrapment of residue oil, Displacement mechanisms in alkaline flooding, Crude oil properties, Alkali consumption, pH of injected caustic, Effect of sodium ions and sodium chloride, Effect of divalent ions, Reservoir selection- Documented alkaline flooding field's tests.

**Surfactants flooding:** Introduction, Classification of EOR surfactants, Mechanism of oil displacement by surfactant flooding, Ultra low interfacial tension in relation to oil displacement by surfactant flooding, Factors influencing oil recovery, Surfactant gas flooding for oil recovery, Interfacial phenomena in surfactant gas flooding, Mechanism of surfactant loss in porous media, Present status of the use of surfactants in oil recovery.

### UNIT-V:

**Steam flooding for enhanced oil recovery:** Introduction, Theory- Screening criteria for steam flood prospects, Reservoir rock and fluid properties, heat losses and formation heating, Oil recovery calculations, An overview of steamflood modeling, Parametric studies in steam flooding, Economics of the steam flooding process.

**In-situ combustion technology:** Introduction, Reservoir characteristics, Ignition-Ignition methods, Process In-situ Combustion, Use of In-situ Combustion, Conclusions, Current status of In-situ Combustion.

#### **UNIT-VI:**

**Microbial enhanced oil recovery:** Microorganisms, Historical development of microbial enhancement of oil recovery, Laboratory experiments show the potential of microbial enhancement oil recovery, Field application of microbial enhancement of oil recovery, Microbes associated with oilfield problems, Microbial interactions with produced oil, Potential of microbial enhancement of oil recovery, Injection of cells and spores.

other EOR techniques

**Environmental factors associated with oil recovery:** Introduction, Primary and secondary production, Chemical flooding, Micellar-polymer processes, Thermal processes, Gas flooding-Research.

**Outcomes:**The students can

- Have the knowledge of that specific reservoir before designing of any EOR project.
- Be a very good team members in the multidiscipline team where key decisions can be taken in this project work.
- Be a very good operator and maintenance engineer of EOR techniques.
- Take all safety precautions while handling of various types of chemicals used in EOR.
- Become good reservoir managers / production engineers in monitoring the reservoir after post project activities.
- Handle the wells during work over operations.

#### **Text Books:**

1. Applied Enhanced Oil Recovery, Aural Carcoane, Prentice Hall, 1992.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.

#### **Reference Books:**

1. Enhanced Oil Recovery Processes and Operations, E.C. Donaldson, G.V.Chillingarian, T.F. Yew, Elsevier, 1998.
2. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
3. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.
4. Enhanced Oil Recovery, Marcel Latil, Editions Technip, 1980.
5. Fundamentals of Enhanced Oil Recovery, H. R. Van Pollew and Associates, PennWell, 1980.
6. Enhanced Recovery of Residual and Heavy Oil, M. M. Schumacher, Noyes Data Corp., 1980.
7. Recent Advances in Enhanced Oil and Gas Recovery, IstvanLaktos, Academy Kiado, 2001.
8. Enhanced Oil Recovery, Don W. Greew, G. Paul Willfite, Society of Petroleum Engineers, 1998.
9. Enhanced Oil Recovery: Field Planning and Development Strategies, Vladmir Alvarado, Eduardo Marriglee, Gulf Professional Publishing, 2010.

10. Modern Chemical Enhanced Oil Recovery: Theory and Practice, Gulf Professional Publishing, 2011.
11. Enhanced Oil Recovery, Teknica, Teknica Petroleum Services Ltd., 2001.

## HSE & FE IN PETROLEUM INDUSTRY

### Learning Objectives:

- Knowledge of environment issues and all related Acts.
- Knowledge of drilling fluids and its toxic effects with environment.
- Proper disposal of drilling cutting after appropriate treatment.
- Treatment of produced water and makeup water and its disposal as per state pollution control board norms.
- Knowledge of oil mines regulations and proper implementation in drilling & production mines as per Act.
- Knowledge of Hazop in drilling rigs & production installations.
- Knowledge of disaster management to fight any fire accident at drilling rig/ production installation/production platform.

### UNIT-I:

**Introduction to environmental control in the petroleum industry:** Overview of environmental issues- A new attitude.

**Drilling and production operations:** Drilling- Production- Air emissions.

### UNIT-II:

**The impact of drilling and production operations:** Measuring toxicity- Hydrocarbons- Salt- Heavy metals- Production chemicals- Drilling fluids- Produced water- Nuclear radiation- Air pollution- Acoustic impacts- Effects of offshore platforms- Risk assessment.

**Environmental transport of petroleum wastes:** Surface paths- Subsurface paths- Atmospheric paths, Planning for environmental protection.

**Waste treatment methods:** Treatment of water- Treatment of solids- Treatment of air emissions-Waste water disposal: surface disposal.

### UNIT-III:

**Oil mines regulations:** Introduction>Returns, Notices and plans- Inspector, management and duties- Drilling and workover- Production- Transport by pipelines- Protection against gases and fires- Machinery, plants and equipment- General safety provisions- Miscellaneous-Remediation of contaminated sites- Site assessment-Remediation process.

### UNIT-IV:

Toxicity, physiological, asphyxiation, respiratory, skin effect of petroleum hydrocarbons and their mixture- Sour gases with their threshold limits- Guidelines for occupational health monitoring in oil and gas industry. Corrosion in petroleum industry- Additives during acidizing, sand control and fracturing.



**UNIT-V:**

Hazard identification- Hazard evaluation- Hazop and what if reviews- Developing a safe process and safety management- Personal protection systems and measures.

Guidelines on internal safety audits (procedures and checklist) - Inspection & Safe practices during electrical installations- Safety instrumentation for process system in hydrocarbon industry- Safety aspects in functional training-Work permit systems.

**UNIT-VI:**

Classification of fires- The fire triangle- Distinction between fires and explosions- Flammability characteristics of liquids and vapors- Well blowout fires and their control- Fire fight equipment- Suppression of hydrocarbons fires.

**Outcomes:** The students will be able to:

- Be conversant with the knowledge of various Acts related to safety, Health and environment in petroleum industry.
- Have the knowledge of various drilling fluids handling and safe disposal such toxic products.
- Gain Knowledge of disaster management to fight any crisis.
- Apply Hazop to petroleum equipment operation and assess risk involved
- Mitigate occupational health hazards in the industry.

**Text Books:**

1. Environmental Control in Petroleum Engineering, John C. Reis, Gulf Publishing Company, 1996.
2. Application of HAZOP and What if Reviews to the Petroleum, Petrochemical and Chemical Process Industries, Dennis P. Nolan, Noyes Publications, 1994.
3. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India and Oil Mines Regulations-1984, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India.

**Reference Books:**

1. Guidelines for Process Safety Fundamentals in General Plant Operations Centre for Chemical Process Safety, American Institute of Chemical Engineers, 1995.
2. Guidelines for Fire Protection in Chemical, Petrochemical and Hydrocarbon Processing Facilities, Centre for Chemical Process Safety, American Institute of Chemical Engineers, 2003.
3. Guidelines for Hazard Evaluation Procedures Centre for Chemical Safety, Wiley-AIChE, 3<sup>rd</sup> Edition, 2008.
4. Guideline for Process Safety Fundamentals in General Plant Operations, Centre for Chemical Process Safety, AIChE, 1995.
5. Chemical Process Industry Safety, K S N Raju, McGraw Hill, 2014.

## **PETROLEUM ECONOMICS, POLICIES&REGULATIONS**

### **Learning Objectives:**

- Understand the importance of petroleum sector in the world economy, both the macro and micro-economic environment and as applicable to India.
- Understand the commercial aspect and capital budgeting and capital efficiency related to the oil and gas industry value chain from exploration to consumers.
- Carry out a project risk evaluation, breakeven and sensitivity analysis and develop a model to know which petroleum projects is viable and relative priority.
- Understand geopolitical risks and opportunities and hedging strategies to mitigate market and price risks.
- Understand the regulations regarding refining, processing, storage, transportation distribution, marketing& sale of petroleum products.
- To have an overview of the regulatory frame related to exploration as per NELP.

### **UNIT-I:**

**Macro-Economic Approach of Petroleum Industry:** Political environment related to petroleum industry and issues related to government and corporate interests, Need for understanding petroleum economics required to make investment decisions; Introduction, Role and value of Oil & Gas, Evolution of national oil companies, Organization of petroleum exporting countries.

### **UNIT-II:**

**Principles, Methods and Techniques of Petroleum Engineering Economics:** Introduction, outline and key terminologies and generic issues of micro-economic analysis applicable to all sectors of the oil and gas supply chain, Capital budgeting and capital efficiency, Sources of revenue and cost and profitability analysis, Operating expenditures (opex) and their fixed, variable and marginal components, Economic indicators and yardsticks used to rank asset values (NPV, IRR, etc.)

### **UNIT-III:**

**Managing and Mitigating Uncertainty and Risk:** Risk, uncertainty and decision analysis, Analysis of alternative selections and replacements, Managing and Mitigating uncertainty and Risk-Break even and sensitivity analysis, Optimization Techniques, Geopolitical risks and opportunities and hedging strategies to mitigate market and price risks, Asset valuation process: fair market value, probability and risk.

### **UNIT-IV:**

**Application and Project Evaluation:** Project lifecycles, optimum economic life and multi-year cash flows, Oil fields exploration and drilling operations, Oil fields' estimation of oil reserves and evaluation of an oil property, Project financial analysis, Project development and Joint development utilization oil fields production operations, Oil transportation, Crude oil processing.

## **UNIT-V:**

**Valuing Petroleum Assets, Portfolios and Companies:** Asset valuation process: fair market value, probability and risk, Risk adjustments when valuing petroleum reserve categories, The portfolio approach to asset and corporate management, Portfolio characterization, balance and diversification.

**Demand and Marketing of Petroleum Products:** Crude oil fundamentals, Price of crude, Crude oil prices in transactions, Internal Markets and Prices, Marketing and sale of Motor, Aviation, Lubricant, Asphalt and Propane;. Transportation: Fundamentals of transportation, Pipelines, Oil tankers, Downstream transportations, Distribution of petroleum products.

## **UNIT-VI:**

**Petroleum or Oil & Gas Policies and Regulations:** Petroleum and Oil & Gas rules and regulations in India, The Oil fields regulations and development Act, New Exploration Licensing Policy (NELP), Functions of directorate general of hydrocarbons, Petroleum and Natural Gas Regulatory Board.

### **Outcomes:**

On completion of the course the students should be able to:

- Explain the inter-relations between Oil industry petroleum sector and its impact on national and global economy.
- Evaluate a strategic policy framework of a firm and comment on its relative position within the industry.
- Develop the capability to analyze the global oil and gas industry, focusing on its strategic, economic and fiscal position.
- Demonstrate decision making skills in analyzing basic financial results related to petroleum industry.
- Capable of analyzing the petroleum industry involving pricing, risk profiling, optimization and profitability choosing appropriate techniques.
- Develop generic marketing plans for petroleum products downstream.
- Understand and apply the regulatory framework and related to petroleum industry in the area of licensing and exploration.

### **Text Books:**

1. Petroleum Economics and Engineering, Third Edition, Hussein K. Abdel-Aal, Mohammed A. Alsahlawi, CRC Press, 2013. (ISBN: ISBN; 1466506660, 9781466506664)
2. The Global Oil & Gas Industry: Management, Strategy and Finance, Andrew Inkpen & Michael H. Moffett, 2011. (ISBN-10: 1593702396, ISBN-13: 978-1593702397)

### **Reference books:**

1. Petroleum Economics, Jean Masseron, Technip; 4<sup>th</sup> revised Edition, 2000. (ISBN-10: 2710805979; ISBN-13: 978-2710805977)  
(The instructor can download information required from internet to teach the topics in UNIT VI).

**IV Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>

**SHALE GAS RESERVOIR ENGINEERING  
(ELECTIVE-III)**

**Learning Objectives:**

- To understand the global significance and distribution of shale gas reservoirs
- To gain knowledge in petro-physical properties, pore pressure prediction, performance analysis, production and testing of shale gas reservoirs.
- To study gas shale asset life cycle and environmental issues and challenges.

**UNIT-I:**

Gas Shale – Global significance, Distribution – Organic matter – Rich shale depositional environments – Geochemical assessment of unconventional shale gas resource system.

**UNIT-II:**

Sequence stratigraphy of unconventional resource shales – Pore Geometry in gas shale reservoirs.

Petro-physical evaluation of gas shale reservoirs.

**UNIT-III:**

Pore pressure prediction of shale formations using well log data: Overpressure generating mechanisms – Overpressure estimation methods – Role of tectonic activity on shale pore pressure – Geo-mechanics of gas shales.

**UNIT-IV:**

Performance analysis of unconventional shale reservoirs: Shale reservoir production – Flow rate decline analysis – Flow rate and pressure transient analysis – Reservoir modeling and simulation – Specialty short term tests – Enhanced oil recovery.

Resource estimation for shale gas reservoirs – Introduction – Methodology – Reservoir evaluation of shale gas plays.

**UNIT-V:**

Wettability of gas shale reservoirs: Wettability – Imbibition in gas shales – Factors influencing water imbibition in shales – Quantitative interpretation of imbibition at the field scale – initial water saturation in gas shales.

**UNIT-VI:**

Gas shale challenges over the asset life cycle: Asset life cycle – Exploration phase – Appraisal phase – Development phase – Production phase – Rejuvenation phase.

Gas shale environmental issues and challenges: Overview – water use – the disposal and reuse of fracking waste water – Ground water contamination – Methane incursions – Other air emissions – social impacts on shale gas communities – Waste water injection – Earth quakes – Regulatory developments.

**Outcomes:**

- With the knowledge gained on the different aspects of shale gas reservoirs such as organic geo-chemistry, mineralogy, petrophysical properties, geomechanics, reservoir engineering, the students will be able to evaluate and map shale gas pockets in sedimentary basins. Further, they will be able to devise the production mechanisms to extract shale gas.
- Knowing the shale gas environmental issues and challenges such as high water demands and ground water contamination risks posed by hydro-fracturing fluids and waste, the students will be able to address these problems during the exploration of shale gas reservoirs.

**Text Book:**

1. Fundamentals of Gas Shale Reservoirs, Reza Rezace, John Wiley & Sons, 2015.

**Reference Book:**

1. Shale Oil and Gas Handbook: Theory, Technologies and Challenges, SohrabZendehboudi & A. Bahadori, Elsevier Science, 2016.

### SUBSEA ENGINEERING (ELECTIVE-III)

#### Learning Objectives:

- To understand the subsea development operations.
- To learn the hydraulic / equipment / system design considerations.
- To learn the process control and power supply consideration.
- To understand the reliability issues & design challenges involving subsea systems.

#### UNIT-I:

**Overall View of Subsea Engineering:** Introduction – Subsea production systems – Flow Assurance & System engineering – Subsea structures & Equipment – Subsea pipelines.

**Subsea Field Development:** Subsea field development overview – Deepwater or Shallow-Water development – Wet Tree & Drain tree systems – Subsea Tie-back development – Stand-Alone development – Artificial lift methods and Constraints – Subsea processing – Template, Clustered Well Systems & Daisy chain – Subsea field development assessment.

#### UNIT-II:

**Subsea Distribution System:** Introduction – Design Parameters – SDS component design requirements.

**Installation & Vessels:** Introduction – Typical installation vessels – Vessel requirements & selection – Installation positioning & Analysis.

#### UNIT-III:

**Subsea Control:** Introduction – Types of control systems – Topside equipment – SCMMB – SCM – Subsea transducers & Sensors – HIPPS – SPCS – IWOCS.

**Subsea Power Supply:** Introduction – Electrical power system – Hydraulic power system.

#### UNIT-IV:

**Subsea System Engineering:** Introduction – Typical flow assurance process - System design & Operability.

**Hydraulics:** Introduction – Composition & Properties of hydrocarbon – Emulsion – Phase behaviour – Hydrocarbon flow – Slugging & Liquid handling – Slug catcher design – Pressure surge – Line sizing.

#### UNIT-V:

**Heat Transfer & Thermal Insulation:** Introduction – Heat transfer fundamentals – U value – Steady state heat transfer – Transient heat transfer – Thermal management strategy & Insulation.

**Hydrates:** Introduction – Physics & Phase behaviour – Hydrate prevention – Hydrate remediation – Hydrate control design philosophies – Recovery of thermodynamic hydrate inhibitors.

**UNIT-VI:**

**Wax & Asphaltenes:** Introduction - Wax - Wax management – Wax remediation – Asphaltenes – Asphaltenes control design philosophies.

**Subsea Corrosion & Scale:** Introduction – Pipeline internal corrosion – Pipeline external corrosion – Scales – Overview of Erosion & Sand management.

**Outcomes:** The students will be able to:

- Do flow assurance calculations and size the piping & distribution system.
- Deliver the equipment & system design required for a given subsea project requirement.
- Anticipate reliability issues such as hydrate, wax formation, corrosion etc. during design.

**Text Books:**

1. Subsea Engineering Handbook, Yong Bai & Qiang Bai, Gulf Professional Publishing, New York, 2012.
2. Offshore Drilling and Completions Training Manual, Drill – Quip, Inc.
3. Manual on Subsea Technology, IOGPT, ONGC.

## RESERVOIR MODELING & SIMULATION (ELECTIVE-III)

### Learning Objectives:

- Theoretical and working knowledge of reservoir simulation models of varying complexities:
  - i. Single-phase fluid equations in multiple dimensions
  - ii. Volume finite difference approaches
  - iii. Block centered grids
  - iv. Point distributed grids
  - v. Well representation
- Applicable numerical methods for the solution of simple and complex reservoir simulation models. Emphasis shall be towards the general approaches such as direct solution and iterative solution methods.
- Parametric analysis of reservoir simulation models.

### UNIT-I:

**Introduction:** Milestones for the engineering approach-Importance of the engineering and mathematical approaches.

**Single-phase fluid equations in multidimensional domain:** Properties of single-phase fluid- Properties of porous media- Reservoir discretization- Basic engineering concepts- Multidimensional flow in Cartesian coordinates- Multidimensional flow in radial-cylindrical coordinates.

### UNIT-II:

**Flow equation using CVFD terminology:** Introduction- Flow equations using CVFD terminology- Flow equations in radial-cylindrical coordinates using CVFD terminology- Flow equation using CVFD terminology in any block ordering scheme.

### UNIT-III:

**Simulation with a block-centered grid:** Introduction- Reservoir discretization- Flow equation for boundary grid blocks- Treatment of boundary conditions- Calculation of transmissibilities- Symmetry and its use in solving practical problems.

### UNIT-IV:

**Simulation with a point distributed grid:** Introduction- Reservoir discretization- Flow equation for boundary grid points-Treatment of boundary conditions-Calculation of transmissibilities - Symmetry and its use in solving practical problems.

### UNIT-V:

**Well representation in simulators:** Introduction- Single block wells- Multi block wells- Practical considerations dealing with modeling and well conditions.

**Single-phase flow equations for various fluids:** Pressure dependence of fluid and rock properties-General single-phase flow equation in multi dimensions.



**UNIT-VI:**

**Linearization of flow equation:** Introduction- Nonlinear terms in flow equations- Nonlinearity of flow equations for various fluids- Linearization of nonlinear terms- Linearized flow equations in time.

**Methods of solution of linear equations:** Direct solution methods- Iterative solution methods.

**Outcomes:**

For a given reservoir characterization and assumed geometry, the students with good knowledge of this course shall be able to carry the following tasks:

- Develop a simple mathematical model to represent the reservoir production capabilities using mathematics and fundamentals of fluid flow.
- Enhance the complexity of mathematical model to represent realistic reservoir conditions
- Working knowledge of model solution approaches using mathematical rules such as linearization.
- Parametric case studies and remedies to bypass numerical instabilities and stiff formulations.

**Text Book:**

1. Petroleum Reservoir Simulation: A Basic Approach, Jamal H. Abou – Kasem, S. M. Fariuq Ali, M. Rafiq Islam, Gulf Publishing Company, 2006.

**Reference Books:**

1. Principles of Applied Reservoir Simulation, John R. Fanchi, Elsevier, 2005.
2. Practical Reservoir Simulation, M.R. Carlson, PennWell, 2003.
3. Reservoir Simulation: Mathematical Techniques in Oil Recovery, Zhangxin Chen, Cambridge University Press, 2008.
4. Mathematics of Reservoir Simulation, Richard E. Ewing, Society for Industrial and Applied Mathematics (SIAM), 1983.

**IV Year - II Semester**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>

**SEMINAR  
(SIP REPORT PRESENTATION)**

**Learning Objectives:**

- To give a clear, organized and accurate oral presentation of Summer Training Report.
- To provide verbally/ through power point presentation of condensed large amounts of technical information into concise, condensed analysis.
- Sharing the practical knowledge obtained during training with fellow students.

The presentation and evaluation of the summer training report for 50 marks should be conducted by a committee constituted by the University.

**Outcomes:**

The students will extend their abilities to:

- Get themselves good clarity in the technical topics being presented.
- Develop good communication skills.
- Practice the behaviors of effective speakers.
- Assess strengths in speaking and set goals for future growth.

## PROJECT WORK

### Learning Objectives:

The students are guided to learn the following aspects:

- Understanding & evaluating the design / operation / environmental aspects of a petroleum equipment/ process.
- Understanding & evaluating the technology aspects of various alternatives available, called “Best Available Technologies (BAT)”, through literature & references and select a suitable equipment/ process with optimum capacity.
- Carrying-out the basic design of the process using steady state simulation.
- Preparation of equipment layout & plot plan drawing.
- Preliminary cost estimation of CAPEX and OPEX.
- Presentation & project management skills.

The project work may consist of any one of the following:

- a) The project work should consist of a comprehensive design project of any one of the petroleum upstream processes concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery in the form of a report.
- b) Modeling & Simulation of any petroleum upstream unit concerned with reservoir, drilling, production, surface production operations, stimulation, enhanced oil recovery.
- c) Any experimental work with physical interpretations.

### Outcomes:

The student shall be able to carry out independently the following tasks:

- Preparation of project feasibility reports for petroleum processes/plants.
- Gather & use various sources such as market data, literature, customer feed-backs etc. to evaluate the Best Available Technologies in the market and select suitable process meeting the site conditions, environmental regulations, product quality etc.
- Simulation of overall plant including estimation of utility consumptions.
- Generation of equipment diagrams and MSD (Material Selection Diagrams).
- Sizing of all plant equipment and preliminary cost estimation using cost indexes, charts & literature.
- Preliminary cost estimation of piping, instrumentation, electrical equipment, civil works & construction as % of equipment cost, to determine Installation cost of the equipment/ plant.
- Preliminary utility & chemical consumption estimation and using this data estimating the operating cost.
- Manage a comprehensive project in a planned manner, within specified time and present the salient features of the result to the audience with confidence and clarity.

# English for Oil & Gas

# 2

Vocational English  
Course Book



Evan Frendo with David Bonamy  
Series editor David Bonamy



CD-ROM

ALWAYS LEARNING

PEARSON

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	Transport to site p. 10	Explaining how to get to work	Prepositional phrases for describing location	Types of transport
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# 1

## People and jobs

- talk about roles and responsibilities
- explain an oil rig's organisation
- describe work routines
- discuss transportation

### Roles and responsibilities

**Reading 1** Read the information and match words 1–4 to photos A–D.

- 1 geophysicist 2 lab technician 3 production engineer 4 roughneck

A



I work in the downstream sector of the industry, in a refinery. We manufacture a wide range of products for domestic and industrial uses, such as lubricants, bitumen, liquefied petroleum gas (LPG) and petrochemicals.

B



I work on an offshore oil rig. I spend a lot of my time tripping drill pipe in and out of the hole, and operating the tongs to make or break connections. I also do other jobs around the rig, such as looking after equipment.

C



I look at seismic data and help the company make decisions about where to drill. At the moment we are looking at a shale gas reservoir in the USA. Shale gas is natural gas found in shale formations.

D



I work for an E&P independent. I'm part of the team of people responsible for the operation, production and maintenance of different facilities in this area. My main job is to find the best way to bring the oil to the surface.

**Vocabulary 2** Match words 1–6 to definitions a–f.

- |                     |  |
|---------------------|--|
| 1 downstream sector | a) put a pipe in/pull a pipe out of a drill hole                       |
| 2 LPG               | b) activities to do with refining, transportation, sales and marketing |
| 3 trip in/out       | c) connected with earth vibration                                      |
| 4 E&P independent   | d) independent exploration and production company                      |
| 5 seismic           | e) liquefied petroleum gas   |
| 6 shale gas         | f) natural gas found in a type of sedimentary rock                     |

Listening

3  02 Listen to four conversations. Are these statements *true* (T) or *false* (F)?

lube oil =  
lubricating oil

**Conversation 1**

- 1 Lab technicians mix oils and additives. (T / F)
- 2 Customers come to the refinery and pump oil from the storage tanks. (T / F)

**Conversation 2**

- 3 Roustabouts don't work in the rain. (T / F)
- 4 Roustabouts work alone. (T / F)

**Conversation 3**

- 5 Production engineers work in offices all day. (T / F)
- 6 Production engineers have to follow health and safety procedures. (T / F)

**Conversation 4**

- 7 The layers of rock reflect shock waves. (T / F)
- 8 Geophysicists analyse seismic data. (T / F)

4 Answer these questions. Then listen again and check your answers.

- 1 What does the lab technician optimise?
- 2 Does a roustabout clean and paint?
- 3 Is production engineering a technical job?
- 4 What do vibrator trucks do?

Language

Present simple

We use the <b>present simple</b> to talk about facts, repeated actions and habits.	Geophysicists <b>analyse</b> seismic data. We <b>manufacture</b> a wide range of products. Roustabouts <b>don't work</b> alone.
Yes/No questions	<b>Do you work</b> in a crew? <b>Is it an easy job?</b>
Wh- questions	<b>What do you do?</b> <b>Where do you work?</b> <b>Who does she work for?</b>



5 Put this conversation in the correct order.

- B: Yes, I do. I stand on the monkey board at the top of the derrick. I guide the drill pipe when we trip out or in. I'm also responsible for the fluid pumps and the circulation system.
- B: Yes, it is. But I know what I'm doing and I'm careful.
- A: A derrickhand? So do you work high up?
- A: What do you do, Adel?
- B: I'm a derrickhand on an oil rig.
- A: Isn't that dangerous?

6 Read the conversation in 5 again. Write a paragraph about Adel.

*Adel is a derrickhand on an oil rig. He ...*

Speaking

7 Work in pairs. Choose an oil industry job you are familiar with. Explain the job to your partner.

*Roustabouts work on oil rigs. They do jobs like cleaning ...*



# The organisation

Reading 1 Read the text and complete this organisation chart with the job titles in the box.

hand = a crew member who does physical work

derrickhand driller drilling engineer motorhand  
mud engineer roughnecks roustabouts toolpusher



## A guide to jobs on an oil rig

### Employees of the exploration or operating company

- **Company representative:** Works for the operating or exploration company. Can give instructions to the toolpusher but does not directly supervise the toolpusher or the drilling crews.
- **Drilling engineer:** Specialises in the technical aspects of drilling. Reports to the company representative.
- **Mud/Drilling fluids engineer:** Responsible for the drilling fluid. Reports to the company representative.

### Employees of the drilling company contractors

- **Toolpusher:** Manages the drilling crews on the rig and the support staff. Can receive instructions from the company representative but reports to the manager of the drilling contractor company.
- **Driller:** Supervises a drilling crew. Controls the rig's machinery during the drilling operation. Has an assistant driller.
- **Derrickhand:** Handles the top of the drill string when the crew are tripping it in or out of the well hole. Also responsible for the flow of drilling fluid into and out of the well hole. Reports to the assistant driller and works closely with the mud engineer.
- **Roughnecks:** Skilled workers on the floor of the rig. Operate the tongs to make up and break out drill strings. Also trip pipe in and out of the well hole. Report to the derrickhand.
- **Roustabouts:** Semi-skilled workers. Do most of the painting and cleaning jobs on the rig. Report to the roughnecks.
- **Motorhand:** Responsible for the maintenance and operation of drilling engines and motors. Acts as a mechanic and an electrician. Reports to the toolpusher.



**2** Look at the organisation chart and text in 1 again. Answer these questions.


- 1 Who is responsible for the drilling fluid?
- 2 Who looks after the engines?
- 3 Who represents the operating or exploration company?
- 4 Who does the painting and cleaning jobs?
- 5 Who reports to the manager of the drilling contractor company?
- 6 Who supervises the drilling crew?
- 7 Who operates the tongs?

**Vocabulary 3** Complete this table with words from the text in 1. Which nouns refer to people?

Noun	Verb
1 _____	maintain
supervisor	2 _____
3 _____	instruct
operation	4 _____
5 _____	drill
6 _____	assist
manager	7 _____
8 _____	represent
9 _____	explore

**4** Complete these sentences with the correct form of words from 3.

- 1 The company \_\_\_\_\_ works for the \_\_\_\_\_ company.
- 2 As a motorhand, I'm responsible for the \_\_\_\_\_ and \_\_\_\_\_ of all the engines.
- 3 My job is to support the driller. I'm his \_\_\_\_\_.
- 4 Each driller \_\_\_\_\_ one of the crews.
- 5 In some places the toolpusher is called the rig \_\_\_\_\_.

**Listening 5**  Listen to Abdul as he introduces Harish to the rig crew. What is Harish's job and where will he work?

**6** Listen again. Match the names to the job titles.

- |            |                                 |
|------------|---------------------------------|
| 1 Mr J     | a) motorhand                    |
| 2 John     | b) driller                      |
| 3 Mohammed | c) toolpusher                   |
| 4 Ali      | d) drilling engineer            |
| 5 Samir    | e) company representative       |
| 6 Abdul    | f) mud/drilling fluids engineer |

**Speaking 7** Work in pairs. Choose and complete one of the following tasks.

- 1 Draw an organisation chart for your own school or organisation. Explain it to your partner.
- 2 Make a list of different job titles in your school or organisation. Explain the jobs to your partner.

## Work routines

- Speaking 1** Work in pairs. What is the app in photo A for? What about the software in photo B? Discuss with a partner.



**B**

Schedule View

File Edit View Help

New Schedule Delete Schedule Print Schedule

Name	Thu 14/6	Fr 15/6	Sa 16/6	Su 17/6	Mo 18/6
S Bowler					
E Hill					
H Schwarz					
D LeBlanc					
A Fox					

- Listening 2** Listen to three conversations and answer these questions.

- Where do the speakers in conversation 1 work?
- Where does the woman in conversation 2 work?
- Where does the man in conversation 3 work?

- 3** Complete these sentences with the words in the box. Then listen again and check your answers.

call clock downtime reschedule routine set shifts straight

- On this rig, workers are on the job for 12 hours a day for seven \_\_\_\_\_ days.
- The night \_\_\_\_\_ were the worst.
- For \_\_\_\_\_ tests, we take samples at specific times from specific locations, according to a \_\_\_\_\_ schedule.
- Last week we had a problem with some of the crude inflow, so we had to \_\_\_\_\_ all our tests.
- I'm on \_\_\_\_\_ 24 hours a day.
- Everything had to be planned properly to minimise \_\_\_\_\_.
- We had to work around the \_\_\_\_\_ to complete the job.

- Vocabulary 4** Match phrases 1-7 to definitions a-g.

- |                       |                                   |
|-----------------------|-----------------------------------|
| 1 out of the ordinary | a) available for work             |
| 2 week-long break     | b) unexpected or non-routine      |
| 3 around the clock    | c) seven days off work            |
| 4 reschedule          | d) day and night without stopping |
| 5 on call             | e) make a new timetable/schedule  |
| 6 seven days on       | f) working from sunset to sunrise |
| 7 the night shift     | g) working for a week             |

## Past simple

	Regular verbs	Irregular verbs
We use the <b>past simple</b> to talk about a completed action in the past.	He <b>called</b> me an hour ago. He <b>didn't call</b> me. <b>Did</b> he call you? When <b>did</b> he call you?	They <b>had</b> a problem yesterday. They <b>didn't have</b> a problem yesterday. <b>Did</b> they have a problem yesterday? What kind of problem <b>did</b> they have yesterday?

5 Complete this conversation with the past simple form of the verbs in the box.

finish use want you/have you/see

Ahmed: Ahmed Bin Mohammed.

Kevin: Hi, Ahmed. It's Kevin.

Ahmed: Hi, Kevin. What's up?

Kevin: I just wanted to say that we (1) \_\_\_\_\_ the repairs an hour ago.

Ahmed: That's excellent news. (2) \_\_\_\_\_ any problems?

Kevin: No, not really. We (3) \_\_\_\_\_ some of the off-shift crew for a couple of hours.

Ahmed: OK. (4) \_\_\_\_\_ Joe yesterday? He (5) \_\_\_\_\_ to give you some documents.

Kevin: No, I didn't. I'll catch him tomorrow in the office.

Ahmed: Sounds good. OK. Thanks for calling.

Kevin: You're welcome. Bye, Ahmed.

Ahmed: Bye.

Reading 6 Read this text about a refinery shutdown and answer the questions.



Normally, the refinery runs 24 hours a day, seven days a week but last week was different. The refinery was on a scheduled shutdown in order to inspect, upgrade and clean our equipment. We also replaced one of the coke coolers. Over a thousand extra contractors came in to do this maintenance work, so we had a lot of extra traffic, especially during shift changes. This sort of turnaround maintenance takes place every four to five years.

- 1 Why was the refinery shut down last week?
- 2 Was the shutdown planned?
- 3 What type of equipment was changed?
- 4 Why was there extra traffic?
- 5 How often does the refinery shut down for turnaround maintenance?

Speaking 7 Work in pairs. Explain what you typically do each week over a period of one month.

*A couple of weeks ago was very typical. I was on night shift the whole week, so I started work at ...*



# Transport to site

**Vocabulary 1** Label these photos with the words in the box.

helicopter low loader tracked vehicle transfer basket



**Reading 2** Read these comments by oil workers and underline the words for forms of transport. Which comments refer to the types of transport in 1?

- 1 'The rig camp is in the middle of the Omani desert. It takes several hours to get to the location. First, a taxi to the airport. Then, an early flight to the oil industry base at Fahud, normally in a propeller aircraft. And then two hours by crew bus.'
- 2 'I'm a driller on an exploration platform in the Campos basin, which is a large oil field off Rio de Janeiro. Every day approximately 2,000 workers fly by helicopter from the mainland to the platforms in the area, so it's very busy. Sometimes there are delays due to bad weather but normally the total travel time from hotel to rig is about four hours.'
- 3 'I'm a roustabout on a production rig which is quite close to the shore, so we travel by crew boat. The total distance is only about 600 m. When we get to the rig, the operator lowers the transfer basket and hoists us up.'
- 4 'I work on pipeline repairs. We use different vehicles to get to the work site, depending on the type of ground we have to cover. Our fleet has both wheeled and tracked vehicles, with payload capacities up to 40 tons. For long distances we use low loaders to transport the vehicles.'
- 5 'I'm a chemist in a refinery just outside the town where I live. It takes me 20 minutes by bicycle to get from my home to my office. On rainy days I take my car. The refinery is at the mouth of the river, on the south bank. You often see oil tankers there.'

**Vocabulary 3** Match 1–5 to a–e to make forms of transport.

- |             |             |
|-------------|-------------|
| 1 low       | a) vehicle  |
| 2 crew      | b) loader   |
| 3 tracked   | c) tanker   |
| 4 propeller | d) bus      |
| 5 oil       | e) aircraft |

**Describing location**

We use a number of different phrases to describe short distances. The meaning is similar.

*The refinery is **just outside/quite close** to the town.  
My office is **quite close to** Main Street.  
The oil field is **just off** the coast.*

We can use different phrases to say where things are.


*The airport is **in the middle of** the desert.  
The jetty is **on the south bank of** the river.  
The rig is **at the mouth of** the river.*

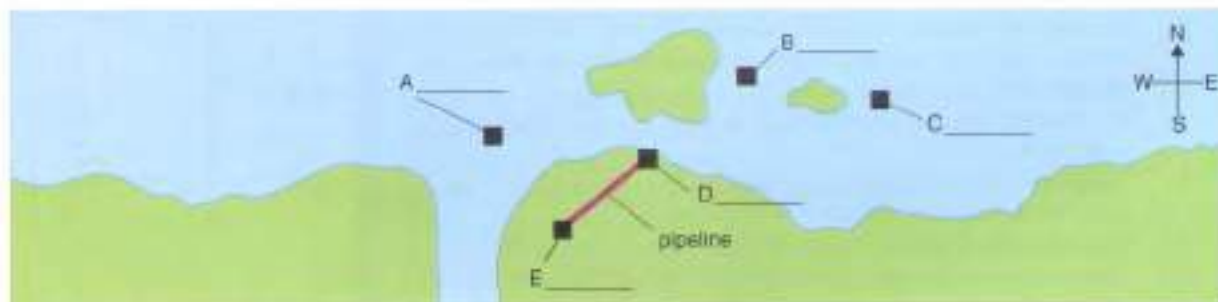
**4** Read the sentences in the Language box and write the names of the places for A-F on this map.



**5** Match 1-7 to a-g to make sentences.

- |                                |                             |
|--------------------------------|-----------------------------|
| 1 The oil field is             | a) the mouth of the river.  |
| 2 The oil field is             | b) to the shore.            |
| 3 The distance is              | c) of the desert.           |
| 4 The rig is close             | d) off Rio de Janeiro.      |
| 5 The refinery is just outside | e) the town.                |
| 6 The refinery is at           | f) south bank of the river. |
| 7 The refinery is on the       | g) about 600 m.             |

**Listening 6**  Look at this map. Then listen to a conversation and label the rigs, the harbour and the refinery.



**Speaking 7** Work in pairs. Discuss the different types of transport you use to get to your place of work/study.



- read and understand safety rules and regulations
- explain decontamination procedures
- follow load handling instructions
- describe hazards at the place of work

## Rules and regulations

**Heading 1** Read this accident report. Then read the safety poster and tick ✓ the safety rules which were broken.

### Accident report

**Date:** 13 October  
**Time:** 1742Z  
**Location:** drilling rig Alpha 341

#### Description of incident

John Brown (motorhand) was injured when his fall protection lanyard was caught and wrapped around a rotating kelly bar. According to Brown, this is what happened: he completed some work in the derrick using a full body harness. His lanyard was attached to the D-ring on the back of the harness. He climbed down and detached the lanyard from the lifeline but did not remove the harness or the lanyard from his body. Then he walked across the rig floor, near to the rotating kelly. The lanyard was caught by the kelly and Brown was pulled towards the moving parts. Fortunately, another man (Kevin Watts) quickly pressed the emergency stop button.

#### Description of injuries



### Safety rules on an offshore rig

- The rig must have a temporary safe refuge (TSR), or safe room, a safe escape route to the sea and a safe route to the lifeboats.
- A safety boat must always be on standby near the platform, to rescue people who fall into the sea.
- Workers must not enter the danger zone when the rotary table is in motion.
- Workers must remove fall protection equipment, such as lanyards, immediately when it is not needed.
- Workers must remove or confine loose clothing, long hair, jewellery, watches, etc.
- Workers must not bring dangerous items, such as matches, lighters or other flammable items aboard offshore oil rigs.
- Before coming aboard an offshore oil rig, all luggage must be checked.
- Every piece of equipment on the offshore oil rig must be tested regularly.
- When equipment is tested, it must be identified with a colour code.
- Workers must not use equipment with an out-of-date colour code.




**Vocabulary 2** Match 1–7 to a–g to make collocations.

- |          |               |
|----------|---------------|
| 1 loose  | a) route      |
| 2 fall   | b) protection |
| 3 safety | c) zone       |
| 4 escape | d) clothing   |
| 5 danger | e) code       |
| 6 rotary | f) boat       |
| 7 colour | g) table      |

**3** Complete these sentences with the collocations in 2.

- The visitor's \_\_\_\_\_ was caught in the \_\_\_\_\_.
- The \_\_\_\_\_ was waiting near the platform.
- The new roustabout forgot his \_\_\_\_\_ equipment.
- Do not use equipment with an out-of-date \_\_\_\_\_.
- The \_\_\_\_\_ went from the \_\_\_\_\_ to the sea.

**Listening 4**  Listen, write the words you hear and underline the word stress. Then find the words in the safety poster in 1.

- jewellery
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**Language**

**The passive**

We often use **the passive** in written English. To transform an active sentence into a passive sentence, we use this pattern:

subject of the passive sentence (object of the active sentence) + to be + past participle + by + agent (the doer of the action, the subject of the active sentence).

It is not always necessary to include by + agent.

We use the passive:

- to focus on what happened, not on who or what performed an action.
- when the doer of the action is self-evident or not important.
- to talk about processes.

Active:

*The rotating kelly injured the motorhand.*

Passive:

*The motorhand **was injured** by the rotating kelly.*

*The motorhand **was injured**.*

*The equipment **is tested** regularly.*

*The lanyard **was caught**.*

*This equipment **is made** in Germany.*

*The well **was drilled** last week.*

*The kelly **is fixed** to the drill pipe. Then the drill string **is tripped** into the well hole.*

**5** Rewrite these sentences in the passive.

- The rotary table caught the derrickhand's lanyard.
- The visitor wore loose clothing.
- The toolpusher reported the accident.
- The engineer pressed the emergency stop button.
- The driller supervised the workers.
- A company in Germany makes these tools.
- The security guard checks the luggage.

**Speaking 6** Work in pairs. Discuss accidents you have seen or heard about. Was anyone injured? Were any safety rules broken?

# Decontamination procedures

Vocabulary 1 Label photos A-E with the words in the box.

cloth hose contaminated water porous material  
soiled gloves steam cleaning



2 Complete this extract from a company's standard operating procedures (SOPs) with the words in the box.


bits cleaned minimise porous soiled water

## PROCEDURES

### Drilling equipment cleaning and decontamination

- 1 Prior to departure, the drill rig and all drilling equipment should be thoroughly \_\_\_\_\_ to remove all oil, grease, mud, etc.
- 2 Before each drilling operation, all downhole drill equipment, the rig and other equipment should be steam cleaned or cleaned using high pressure hot \_\_\_\_\_ and rinsed with pressurised potable water to \_\_\_\_\_ cross-contamination.
- 3 Equipment with \_\_\_\_\_ surfaces, such as rope, cloth hoses and wooden blocks or tool handles, cannot be thoroughly decontaminated. These should be disposed of properly.
- 4 Cleaned equipment should not be handled with \_\_\_\_\_ gloves. Surgical gloves, new clean cotton work gloves or other appropriate gloves should be used and disposed of, even when only slightly soiled.
- 5 The use of newly painted drill \_\_\_\_\_ and tools should be avoided, since paint chips will likely be introduced into the monitoring system.



- Listening 3**  **07** Listen to a supervisor explaining decontamination procedures to a new employee. Match these procedures (a–e) to the supervisor's instructions.
- Clean the drill rig and all drilling equipment prior to departure. \_\_\_
  - Steam clean the equipment, then rinse with potable water. \_\_\_
  - Dispose of equipment with porous surfaces. \_\_\_
  - Dispose of soiled gloves. \_\_\_
  - Do not use newly painted tools or equipment. \_\_\_

- 4** Listen to conversations 1–3 again. Write words that match these definitions.
- prior to \_\_\_\_\_
  - rinse \_\_\_\_\_
  - potable \_\_\_\_\_
  - dispose of \_\_\_\_\_
  - soiled \_\_\_\_\_

- Vocabulary 5** Complete these sentences with the words in the box. There is one extra word.

away cleaned cleaner cleaning mud water

- This equipment should be thoroughly \_\_\_\_\_.
- First, use the steam \_\_\_\_\_.
- Remove all the grease and \_\_\_\_\_.
- Then wash the equipment with potable \_\_\_\_\_.
- Don't forget to throw the old ropes \_\_\_\_\_.

### Language

#### Should and must

We use <b>should</b> to make recommendations or suggestions.	You <b>should clean</b> the drill bits first. You <b>shouldn't wear</b> jewellery.
We use <b>must</b> for rules. <i>Must</i> is stronger than <i>should</i> .	You <b>must use</b> the steam cleaner. You <b>mustn't wear</b> soiled gloves.
<i>Should</i> and <i>must</i> can also be used in the passive ( <i>must/should</i> + <i>be</i> + past participle).	Active: You <b>should/must clean</b> the drill bits. Passive: The drill bits <b>should/must be cleaned</b> .

- 6** Complete these sentences with the correct active or passive form of *should*.
- You \_\_\_\_\_ (remove) the contamination.
  - \_\_\_\_\_ (we/steam clean) the drill pipes next?
  - Contaminated cloth hoses \_\_\_\_\_ (dispose) of.
  - You \_\_\_\_\_ (avoid) newly painted drill bits.
  - All this equipment \_\_\_\_\_ (clean) using high pressure hot water.

- Speaking 7** Work in pairs. Discuss procedures for cleaning equipment you are familiar with.

A: I use a steam cleaner quite often.

B: Really? What do you use it for?

A: To clean the workshop floor.

B: What's the procedure?

A: Well, first we normally sweep the floor. And we put any tools away.

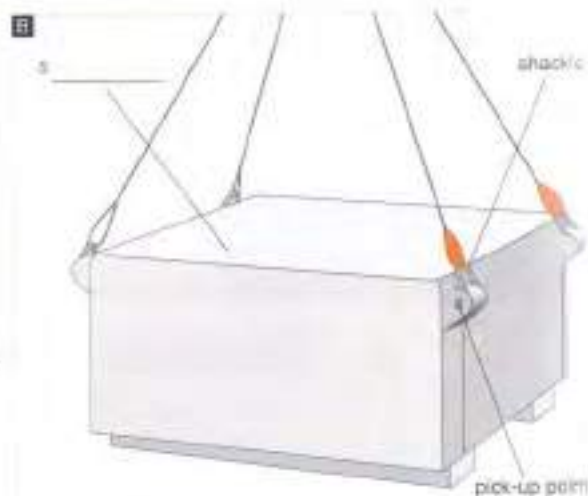
B: OK.

A: Then we ....

# Load handling instructions

**Speaking 1** Label illustrations A and B with the words in the box.

block container hook load wire rope



**Listening 2** Listen to a supervisor (S) giving instructions to a roustabout (R) and complete their conversation.

S: Right, now let me give you some general rules about working with (1) \_\_\_\_\_. Listen carefully. First of all, make sure the work area is clear. If there's an obstruction, (2) \_\_\_\_\_ it. And by obstruction I mean anything which shouldn't be there: tools, equipment, boxes – you name it. OK?

R: OK.

S: Good. Next, always (3) \_\_\_\_\_ the condition of the equipment. If you see any damage, just (4) \_\_\_\_\_ me. For example, corroded or broken (5) \_\_\_\_\_ ropes or worn slings. That kind of thing is very dangerous. Understand?

R: Yes. OK.

S: Always use taglines to control a load. If a load swings to the left or right, you just (6) \_\_\_\_\_ it back. And another thing: attach (7) \_\_\_\_\_ or shackles to pick-up points. If there are no pick-up points, use slings and packing to prevent damage.

R: Got it.

S: Now, do you know the emergency stop signal?

R: Yes. Like this?

S: Yes, exactly. Well, if you see a problem, (8) \_\_\_\_\_ the signal.

R: OK.

S: Oh, yeah. If you aren't a qualified rigger, you mustn't rig loads.

R: Aha. OK.

S: And finally, if you don't understand your task, (9) \_\_\_\_\_ the person in charge.

**3** Listen again and tick ✓ the topics that are mentioned.

- |   |                                      |   |
|---|--------------------------------------|---|
| 1 <input type="checkbox"/> transport    | 4 <input type="checkbox"/> equipment | 6 <input type="checkbox"/> stop signals |
| 2 <input type="checkbox"/> taglines     | 5 <input type="checkbox"/> clothing  | 7 <input type="checkbox"/> cleanliness  |
| 3 <input type="checkbox"/> obstructions |                                      |   |

Vocabulary 4 Label photos A–E with words and phrases from the conversation in 2.



### Language

#### **if + present simple + imperative**

We can use the conditional structure **if + present simple + imperative** to give instructions. When the sentence starts with *if*, we put a comma after the *if* clause.

*If you see some damage, tell your supervisor. Tell your supervisor if you see some damage.*  
*If you don't understand your task, ask the person in charge. Ask the person in charge if you don't understand your task.*

5 Match 1–5 to a–e to make sentences.

- |                                   |                                    |
|-----------------------------------|------------------------------------|
| 1 If you don't know,              | a) pull it to the right.           |
| 2 If the load swings to the left, | b) throw them away.                |
| 3 If there is a problem,          | c) ask.                            |
| 4 If your gloves are soiled,      | d) clean it.                       |
| 5 If the equipment is dirty,      | e) give the emergency stop signal. |

6 Complete these sentences.

- If you see a fire, \_\_\_\_\_.
- If you are hungry or thirsty, \_\_\_\_\_.
- If you want to speak better English, \_\_\_\_\_.

Speaking 7 Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 76. Follow the instructions.

#### **Student A**

You are a supervisor. Practise the conversation in 2 with Student B. Then swap roles and repeat the activity. Remember to discuss the following:

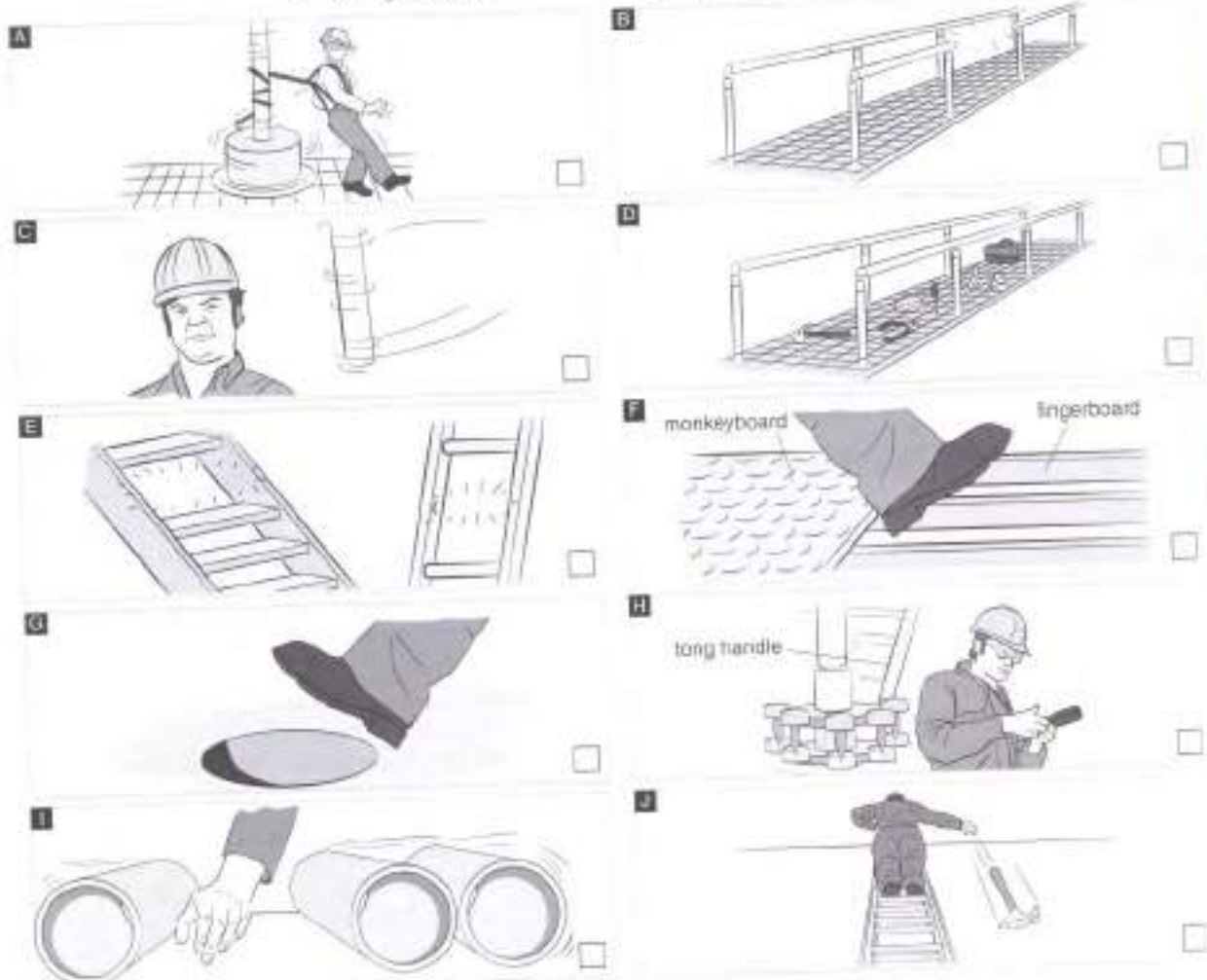
- obstructions
- stop signals
- taglines
- condition of equipment



## Hazards

Vocabulary 1 Match words 1-10 to illustrations A-J.

- |                     |                      |
|---------------------|----------------------|
| 1 falling hammer    | 6 missing guard rail |
| 2 mouse hole        | 7 moving pipes       |
| 3 obstructions      | 8 rotating kelly     |
| 4 short monkeyboard | 9 steps and rungs    |
| 5 swinging kelly    | 10 tong handle       |



Reading 2 Match hazards 1-10 to illustrations A-J in 1.

### Safety hazards on an oil rig

- |   |   |
|---|---|
| 1 If there are obstructions in the walkway, you might trip or fall over them. —   | 6 If a guard rail is missing from a walkway, you could fall off. —        |
| 2 If you carry tools when you are climbing, you might drop them on someone. —     | 7 If you step off a monkeyboard onto a fingerboard, you might fall off. — |
| 3 If rungs are missing from a stairway or ladder, you could fall from a height. — | 8 Moving pipes could trap your hand and crush it. —                       |
| 4 The rotating kelly might catch your loose clothing. —                           | 9 When the handle of the tong swings, it might strike you. —              |
| 5 A kelly or pipe could swing and strike your head. —                             | 10 You could fall into an uncovered mouse hole. —                         |

**Listening 3** Listen to three conversations. Choose the hazard you hear.

- |                             |                           |                           |
|-----------------------------|---------------------------|---------------------------|
| 1 a) wet rung               | b) broken rung            | c) missing rung           |
| 2 a) missing<br>monkeyboard | b) broken<br>monkeyboard  | c) twisted<br>monkeyboard |
| 3 a) loose clothing         | b) helicopter landing pad | c) helicopter rotor       |

**4** Listen again. What exactly happened in each situation?

### Language

#### Might and could

We use **might** and **could** to say there is a possibility of something happening.

You **might** fall over an obstruction.  
The pipes **could** trap your hand.

We can also use **might** and **could** in conditional sentences.  
We use *if + present simple + might/could + infinitive*.

*If we get bad weather, we might stop work.*

**5** Match 1–5 to a–e to make short exchanges.

- |  |   |
|--|---|
| 1 If it rains, you might get wet.                                | a) No, sorry. But John might know.                  |
| 2 If the pipes arrive late, we might have to delay the drilling. | b) Yes, the sea is quite high already.              |
| 3 If the weather gets worse, we could be in for a rough night.   | c) The company rep won't like that.                 |
| 4 Could you make the tea?  | d) Yes, but only if I forget my raincoat.           |
| 5 Do you know where the incident file is?                        | e) No, sorry. I made it yesterday. Your turn today. |

**Writing 6** Use these notes to write a report.

*guard rail on stairway missing – no guards on winch – 3 drillers with no hand hats – nuts and bolts missing from swivel – no cables for tools – walkway blocked with hoses*

### Safety report

I inspected the oil rig on 24 August and I observed these safety hazards:

- 1 A guard rail on a stairway was missing.
- 2 There were no \_\_\_\_\_.
- 3 Three drillers did not \_\_\_\_\_.
- 4 \_\_\_\_\_.
- 5 \_\_\_\_\_.
- 6 \_\_\_\_\_.

**Speaking 7** Work in pairs. Make a list of hazards in your place of work/study. Discuss what could happen.

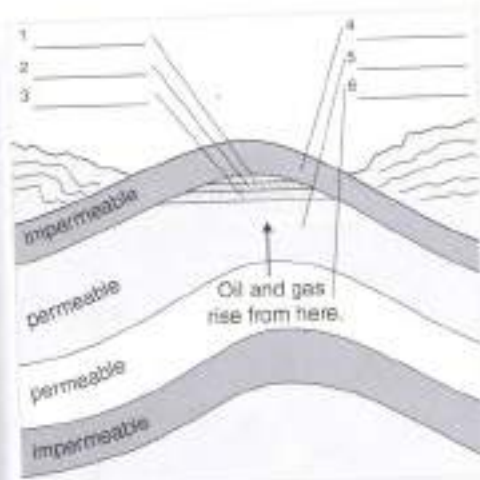
- describe how oil is formed
- explain typical oil industry processes
- give a short presentation about refining processes
- clarify pipeline laying techniques

## Exploration

**Reading 1** Read this text and label the diagram with the words in the box.

cap rock gas oil reservoir rock source rock water

Petroleum geologists look at two important properties of rocks: permeability and impermeability. Some rock types, such as limestone and sandstone, are highly permeable (or porous) – that is, they contain small pores (or holes) which allow fluids, such as oil, gas and water, to flow through them. Other rock types, such as granite and marble, are impermeable (or non-porous) – that is, they do not contain pores and fluids cannot pass through them. This diagram shows how permeable and impermeable rock layers are arranged in a typical oil and gas field. The oil and gas deposits are found in a layer of reservoir rock, which is permeable. In the reservoir rock, gas is at the top, oil is in the middle and water is at the bottom. The reservoir rock is trapped between two layers of impermeable rock. A long time ago, the petroleum was in a layer of source rock, such as shale, below the reservoir rock. Over a long period of time, the oil and gas flowed upwards out of the source rock into the reservoir rock, where it was trapped by the top layer of impermeable cap rock.

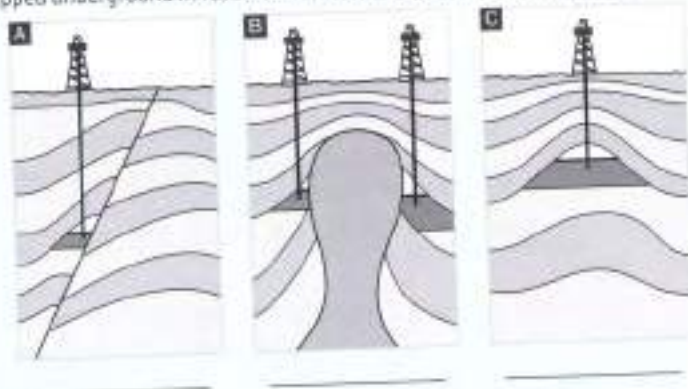


**2** Read this follow-up text and label diagrams A–C Fig 1, Fig 2 or Fig 3.

How were oil fields formed? It began millions of years ago, when the remains of microscopic plants and animals (organic matter) settled on the sea bed. Sediments, such as clay and sand, covered the organic matter. More sedimentary layers were added and the sediments became heavier. Pressure and temperature increased. The heat and pressure converted much of the organic matter into the hydrocarbons that make up oil and gas. The oil and gas then flowed upwards. Some of it reached the surface and escaped. However, some of it was trapped underground in reservoir rock below a layer of cap rock. The oil remains in this geological 'trap' until it is drilled for and brought to the surface.


Here are three types of geological trap. They were all caused by movements in the Earth's crust:

- 1 A fold (or anticline). The layers of rock were bent into a dome shape (see Fig 1).
- 2 A fault. The layers of rock cracked and one side moved upwards or downwards (see Fig 2).
- 3 A pinch-out. A mass of impermeable rock pushed upwards into the reservoir rock (see Fig 3).





- 3 Are these statements about the texts in 1 and 2 *true* (T) or *false* (F)?
- 1 Granite and marble are examples of reservoir rock. (T / F)
  - 2 If there is no layer of cap rock, oil and gas can flow to the surface and escape. (T / F)
  - 3 Oil, gas and water can flow through small holes in rocks. (T / F)
  - 4 Oil is composed of hydrocarbons, formed underneath the sea. (T / F)

**Listening** 4  10 Complete this conversation between an engineer and a visitor to a drill site with words from 1 and 2. Then listen and check your answers.

- A: Can you tell me how oil fields are formed?  
 B: Yes, of course. It's really very simple. First, you have organic matter which falls to the sea (1) \_\_\_\_\_.  
 A: Organic matter is things like plants and animals?  
 B: Yes, exactly. Next, this organic matter gets covered by sediments, such as clay or sand. Over time more and more sediments fall, so we end up with different sedimentary (2) \_\_\_\_\_.  
 A: And the pressure increases?  
 B: Yes, and the (3) \_\_\_\_\_ increases too. And this process converts the organic matter into (4) \_\_\_\_\_; in other words, oil and gas.  
 A: I see.  
 B: Now this oil and gas is in what we call the source rock. After a while, it flows upwards to what we call the (5) \_\_\_\_\_ rock. And finally, it stops in a so-called (6) \_\_\_\_\_ trap.  
 A: Why do you call it a trap?  
 B: Because it can't flow upwards any more. The cap rock, which is above the reservoir and is impermeable, stops the oil and gas escaping to the surface. It traps the oil and gas.  
 A: I see.  
 B: There are different types of traps, of course. Look at these diagrams. The first one is an anticline. You can see it's shaped like a(n) (7) \_\_\_\_\_.

**Pronunciation** 5  11 Listen and repeat.

- 1 sedimentary layers
- 2 hydrocarbons
- 3 reservoir rock
- 4 geological trap
- 5 impermeable

### Language

#### Sequencers

We usually use **sequencers** when we describe the different steps in a process.

*first, second, third, next, then, after that, finally*

We can also use certain phrases to talk about processes.

*after a while, over time, over a long period of time*

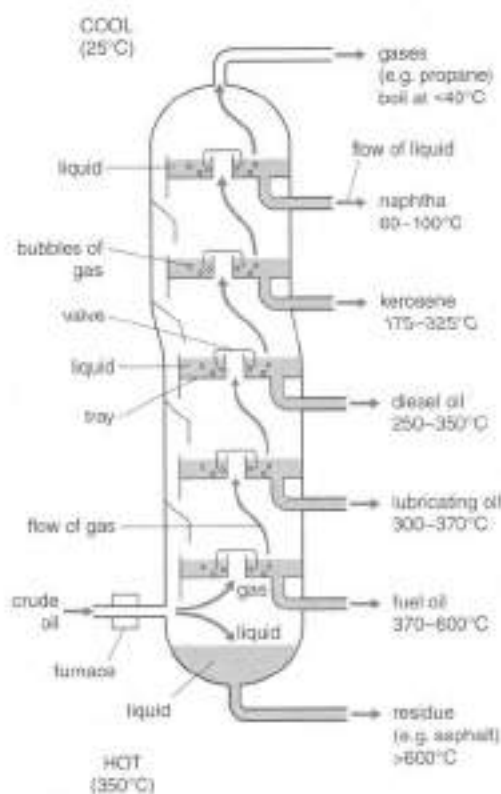
- 6 Put these sentences in the correct order. Then complete them with the words in the box.

after finally first over then

- \_\_\_\_\_ the hydrocarbons are trapped by impermeable rock or escape to the surface.
- ? \_\_\_\_\_ organic matter falls to the sea bed.
- \_\_\_\_\_ time the hydrocarbons flow upwards.
- \_\_\_\_\_ that, the weight of the sedimentary layers converts the organic matter into hydrocarbons.
- \_\_\_\_\_, sediments fall and cover the organic matter.

# Distillation

**Reading 1** Look at this diagram of the oil distillation process. Are statements 1–6 *true* (T) or *false* (F)?



- 1 Crude oil is heated and pumped into the column. (T / F)
- 2 When this happens, all the crude oil evaporates and the vapour (or gas) rises through the column. (T / F)
- 3 As the vapour goes up the column, the temperature decreases. (T / F)
- 4 All the vapour from the crude oil flows to the top of the column and leaves it through a pipe. (T / F)
- 5 When the temperature falls to between 175°C and 325°C, some of the vapour condenses into liquid kerosene. (T / F)
- 6 This substance condenses at a higher temperature than naphtha. (T / F)

**2** Work in pairs. Read this description of the distillation process and answer the questions.

## The oil refining process: fractional distillation

Crude oil (or petroleum) is a mixture of different hydrocarbons. Many useful products can be made from them but first they must be extracted and separated from one another.

The different hydrocarbon components of crude oil are called fractions and they are separated using fractional distillation. This process is based on the principle that different substances boil at different temperatures. For example, crude oil contains kerosene (which is made into jet fuel) and naphtha (which is made into petrol for cars). When the mixture of kerosene and naphtha is heated so that it evaporates and then is cooled, the kerosene condenses at a higher temperature than the naphtha. As the mixture cools, the kerosene condenses first and the naphtha condenses later.

This is how fractional distillation works: the main equipment is

a tall cylinder called a fractionator (or fractional distillation column). Inside there are many trays, or horizontal plates, located at different heights. Each tray collects a different fraction when it cools and condenses.

The crude oil is heated to at least 350°C, which makes most of the oil evaporate. The vapour then enters the column and moves up through the fractionator. As each fraction condenses, the liquid is collected in the trays. Substances with higher boiling points condense on the lower trays in the column. Substances with lower boiling points condense on the higher trays.

The trays have valves, which allow the vapour to bubble through the liquid in the tray. This helps the vapour to cool and condense more quickly. The liquid from each tray then flows out of the column.

- 1 Why do different substances need to be extracted from crude oil?
- 2 What scientific fact does fractional distillation use?
- 3 Which components in the column collect the condensed liquid from each fraction?
- 4 What do the valves do?



3 Match 1-7 to a-g to make collocations.

- |              |                 |
|--------------|-----------------|
| 1 boiling    | a) oil          |
| 2 fractional | b) cylinder     |
| 3 crude      | c) plates       |
| 4 tall       | d) fuel         |
| 5 liquid     | e) kerosene     |
| 6 horizontal | f) distillation |
| 7 jet        | g) point        |

4 Put these stages of the distillation process in the correct order.


- As the vapour rises through the trays in the column, the temperature falls.
- The condensed liquid of the fraction is collected in a tray.
- When a fraction in the vapour cools to its own boiling point, it condenses.
- This is how the distillation process in the fractionator works.
- Most of the fractions in the crude oil evaporate.
- The condensed liquid flows out of the fractionator through a pipe from the tray.
- A furnace is used to heat the crude oil to a high temperature.
- The crude oil vapour enters the fractionator and rises up the column.

Language

Talking about temperature

We often use verb + preposition to describe temperature changes.

The temperature **falls to** 325°C.  
The temperature **rises to** between 60°C and 100°C.  
The temperature **ranges from** 370°C to 600°C.

Listening 5  12 Complete these sentences with information from the diagram in 1. Then listen and check your answers.

- 1 Jet fuel is made from kerosene, which condenses between \_\_\_\_\_ and \_\_\_\_\_°C.
- 2 When naphtha vapour is cooled to between \_\_\_\_\_ and \_\_\_\_\_°C, it condenses.
- 3 Diesel oil is produced by cooling crude oil vapour to between \_\_\_\_\_ and \_\_\_\_\_°C.
- 4 The boiling point of industrial fuel oil ranges from \_\_\_\_\_ to \_\_\_\_\_°C.

Speaking 6 Work in small groups. Answer these questions.

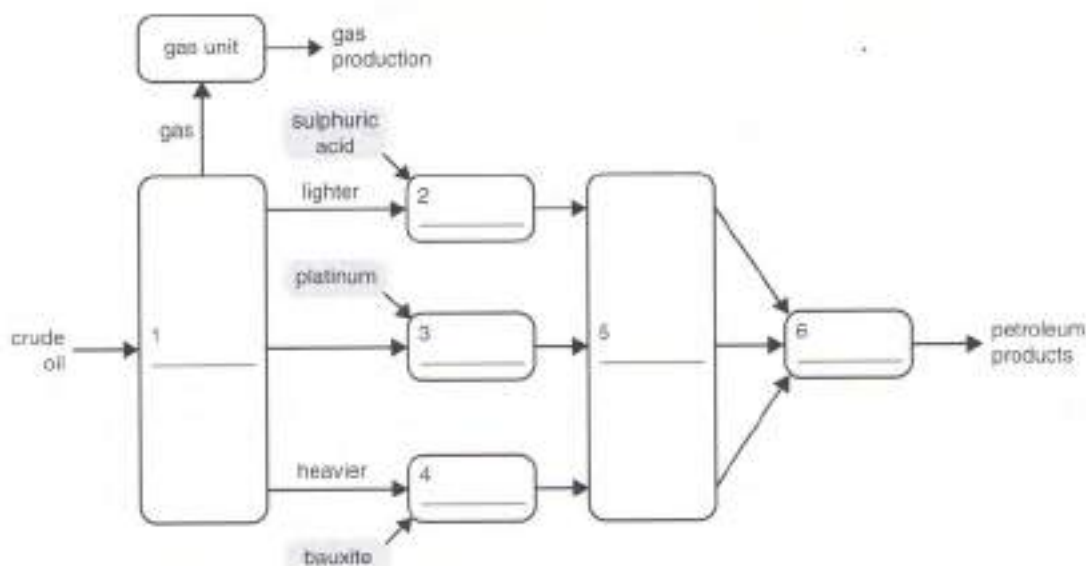
- 1 What is a fraction?
- 2 What is fractional distillation?
- 3 What are the main components in a fractionator?



# Refining

**Reading 1** Read the text and complete this flow chart with the words in the box.

alkylation blending cracking fractional distillation reforming treating



## The oil refining process: cracking, reforming, alteration, treating and blending

The molecules in petroleum are hydrocarbons and consist mainly of carbon (C) and hydrogen (H).

Hydrocarbons may be gaseous, liquid or solid at room temperature and atmospheric pressure. Solids have a higher number of carbon atoms and a higher boiling point. Gases have a lower number of carbon atoms and a lower boiling point.

After fractional distillation, petroleum fractions can be changed in three main ways: by cracking, reforming or alteration.

**Cracking** breaks down larger, heavier hydrocarbons into smaller, lighter hydrocarbons. For example, heavy gas oil can be broken down into lighter products, such as petrol and diesel. The process takes place in a cracking unit. The hydrocarbons are heated under pressure to high temperatures until they break apart (thermal cracking). Sometimes a catalyst, such as bauxite or hydrogen, is used to speed up the process.

**Reforming** combines smaller, lighter hydrocarbons to make larger, heavier

hydrocarbons. The process takes place in a reformer. It uses heat, pressure and a catalyst (usually containing platinum) to convert naphtha into high octane petrol and petrochemicals.

**Alteration** rearranges or changes the hydrocarbons in one fraction to produce a different fraction. The most common method is called alkylation, which takes place in an alkylation unit. In this process, lighter hydrocarbons are converted into high-octane petrol using a catalyst, such as sulphuric acid.


After the above processes, the fractions are treated in the treatment unit where they are passed through chemical filters to remove impurities, such as sulphur, water or salts. Finally, different fractions can be blended or mixed together in the blender to create products for making plastics and other polymers, such as petrol, lubricating oils, kerosene, jet fuel, diesel oil, heating oil and petrochemicals.

**Vocabulary 2** Tick ✓ which of the following are used as catalysts in the refining process.

- 1  kerosene      3  diesel oil      5  sulphuric acid  
 2  bauxite      4  water      6  platinum

**3** Match the items in this table.

Process	Location	Purpose	Method
1 fractional distillation	a) reformer	i) remove sulphur	A) heat under high pressure
2 cracking	b) blender	ii) break down heavy hydrocarbons	B) cool fractions at different temperatures
3 reforming	c) alkylation unit	iii) separate fractions from crude oil	C) heat under pressure; use platinum as catalyst
4 alkylation	d) treatment unit	iv) create products, such as petrol	D) use sulphuric acid as catalyst
5 treating	e) distillation column	v) change hydrocarbons	E) mix fractions together
6 blending	f) cracking unit	vi) combine hydrocarbons	F) pass through chemical filters

**Listening 4**  13 Complete these sentences from a presentation about the refining process with the words and phrases in the box. Then put the sentences in the correct order. Then listen and check your answers.

brings me to by saying for coming let's look at  
 like to move shown shows to explain turn to

- (1) \_\_\_\_\_ cracking first.  
 That (2) \_\_\_\_\_ the three main processes: cracking, reforming and alteration.  
 My objective in this talk is (3) \_\_\_\_\_ some of the processes in oil refining.  
 As (4) \_\_\_\_\_ in the flow chart, after treatment we have blending.  
 I'd like to start (5) \_\_\_\_\_ a few things about hydrocarbons.  
 Now let's (6) \_\_\_\_\_ on to reforming.  
 And thirdly, let's (7) \_\_\_\_\_ alteration.  
 And finally, I'd (8) \_\_\_\_\_ mention some of the products of refining.  
 As the flow chart (9) \_\_\_\_\_, the next process is treatment.  
 Good morning everyone, and thanks (10) \_\_\_\_\_ to this presentation.

### Language

#### The passive with *can*

We use *can* + *be* + past participle to form the passive with *can*.

Active	Passive
We <b>can change</b> fractions in three main ways.	Fractions <b>can be changed</b> in three main ways.
We <b>can break</b> large hydrocarbons <b>down</b> into smaller ones.	Large hydrocarbons <b>can be broken down</b> into smaller ones.

**5** Read the text in 1 again. Underline the passives with *can*.

**Speaking 6** Work in small groups. Prepare a short presentation on the refining process. Use the expressions in 4 to help you. Then give a presentation to your group.



## Laying a pipeline

**Reading 1** Read the text and match headings 1–7 to gaps a–g.

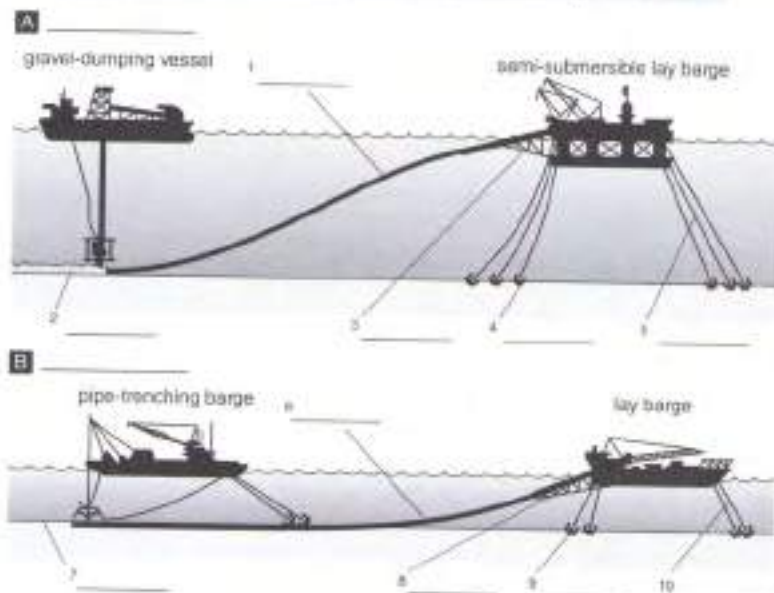
- 1 Burying the pipeline under the sea bed
- 2 Connecting the pipes into a pipeline
- 3 Laying the pipeline on the sea bed
- 4 Surveying and mapping the sea bed
- 5 Cleaning out the pipeline before use
- 6 Constructing the pipes
- 7 Planning the route of the pipeline

Most offshore oil and gas is brought to shore by pipelines, which can operate in all weathers. Here are the main stages of laying a sub-sea pipeline:

- a) \_\_\_ The sea bed is mapped to identify unstable areas and obstacles and to see if it will be possible to bury the pipe.
- b) \_\_\_ Pipeline routes are planned to be as short as possible. Slopes that could put stress on unsupported pipe are avoided.
- c) \_\_\_ Pipeline construction is begun onshore. Lengths of pipe are waterproofed with bitumen and coated with polymers or steel-reinforced concrete. This coating protects the submarine pipeline and also weighs it down on the sea bed.
- d) \_\_\_ The prepared lengths of pipe are welded together offshore on a lay barge.
- e) \_\_\_ The barge is winched forward on its anchor lines. At the same time, the pipeline drops gently to the sea bed. The pipeline is guided by a 'stinger'.
- f) \_\_\_ Two methods are often used to cover and protect the pipeline on the sea bed:
- 1 (see Fig 1 in 2) In shallower water, a pipe-trenching barge is used. This vessel follows the lay barge. When the new pipeline is laid on the sea bed, the trenching barge digs a shallow trench under the pipeline and covers it with debris.
  - 2 (see Fig 2 in 2) In deeper water, a gravel-dumping vessel is used. This vessel follows the semi-submersible lay barge and drops gravel onto the pipeline. The pipeline has more weight in deeper seas.
- g) \_\_\_ The insides of pipelines are cleaned regularly to remove wax deposits and water. A pipeline inspection gauge is forced through the pipe. This device collects deposits and cleans the pipe.

**2** Look at methods 1 and 2 in the text in 1. Label these diagrams Fig 1 or Fig 2. Then label the diagrams with the words in the box. Use four of the words twice.

anchor anchor line gravel pipeline slinger trench



**Vocabulary 3** Match 1–8 to a–h to make sentences.

- |               |                        |
|---------------|------------------------|
| 1 Routes      | a) are dug.            |
| 2 The sea bed | b) are planned.        |
| 3 Slopes      | c) are avoided.        |
| 4 Pipes       | d) is dropped.         |
| 5 The barge   | e) are cleaned.        |
| 6 Trenches    | f) is mapped.          |
| 7 Gravel      | g) are welded.         |
| 8 The insides | h) is winched forward. |

**Listening 4**  14 Listen to three conversations about laying pipelines. What mistakes do the speakers make?

- 1 She says \_\_\_\_\_ instead of \_\_\_\_\_.
- 2 He says \_\_\_\_\_ instead of \_\_\_\_\_.
- 3 She says \_\_\_\_\_ instead of \_\_\_\_\_.

**5** Listen again and answer these questions.

- 1 What words and phrases do the speakers use to correct themselves?
- 2 What do the speakers say to point out the mistakes?

### Language

#### Correcting

We use certain expressions to **correct** ourselves when we make mistakes.

*Oh sorry, my mistake. Onshore, not offshore. I mean/I meant shallow water, not deep water. I got that wrong. I meant the pipeline.*

We can correct other people by repeating the word we think is wrong or by asking for clarification.

*Did I understand you correctly? You use trenches in deep water?  
Do you mean 'offshore'?  
So in other words, the stinger places the gravel in the right place?*

**6** Read these conversations about laying pipelines and complete them with suitable expressions. Use language from the Language box.

- 1  
A: Yes, so we try to make the pipeline routes as long as possible.  
B: As long as possible?  
A: \_\_\_\_\_

- 2  
A: We have a team of engineers on the lay barge. Their job is to weld the pipes together.  
B: Do you mean 'welders'?  
A: \_\_\_\_\_

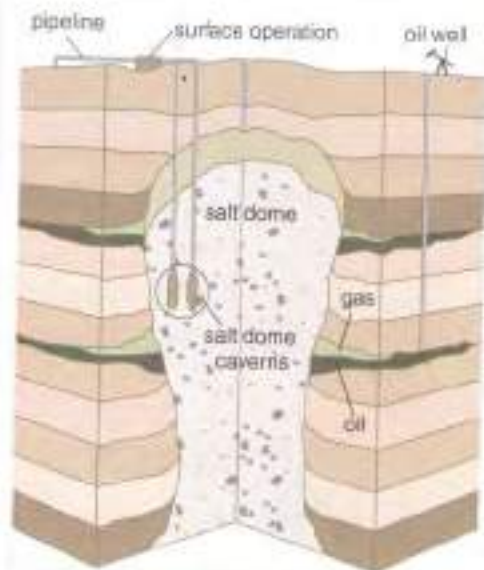
- 3  
A: We use a pipeline inspection gauge to clean the outside of the pipe.  
B: Sorry, did you say the outside?  
A: \_\_\_\_\_

**Speaking 7** Work in pairs. Student A, explain how pipes are laid underwater but make some mistakes. Student B, correct Student A or ask for clarification where necessary.

## Storage

- Reading 1** Read this article. Which three factors are important when choosing an underground storage site?

Natural gas, a colourless, odourless, gaseous hydrocarbon, may be stored in a number of different ways. It is most commonly held underground under pressure in three types of facilities. These are: (1) depleted reservoirs in oil and/or gas fields, (2) aquifers and (3) salt cavern formations. Natural gas is also stored in liquid form in above-ground tanks. Each storage type has its own physical characteristics and economics, which influence how it is used. Two of the most important characteristics of an underground storage reservoir are its capacity to hold natural gas for future use and the rate at which gas inventory can be withdrawn – its deliverability rate.



- Vocabulary 2** Find words in the article in 1 that match these definitions.

- 1 having no smell \_\_\_\_\_
- 2 emptied out \_\_\_\_\_
- 3 water-bearing rock \_\_\_\_\_
- 4 large cave \_\_\_\_\_
- 5 all the material in storage \_\_\_\_\_
- 6 taken out \_\_\_\_\_

- 3** Gas and gas storage facilities can be measured in different ways. Match 1-6 to a-f to complete the definitions.

### Storage measures

- 1 Total gas storage capacity is the maximum volume of gas that
  - 2 Total gas in storage is the volume of storage in the underground facility
  - 3 Base gas (or cushion gas) is the volume of gas in a storage reservoir which is needed to maintain adequate
  - 4 Working gas capacity refers to total gas storage capacity
  - 5 Working gas is the volume of gas in the reservoir above the level of base gas. Working gas is available
  - 6 Deliverability is a measure of the amount of gas that can be delivered (withdrawn) from
- a) at a particular time,
  - b) minus base gas.
  - c) can be stored in an underground storage facility.
  - d) to the marketplace.
  - e) a storage facility on a daily basis.
  - f) pressure and deliverability rates throughout the withdrawal season.



mcf = million cubic feet  
 mmcf = bcf = billion cubic feet  
 mcm = million cubic metres  
 bcm = billion cubic metres

4 Complete this table using the information in 3.

Total capacity (bcf)	Base gas (bcf)	Working gas (bcf)	Working gas capacity (bcf)	Total gas in storage (bcf)
7,563	3,728	2,473	1 _____	2 _____


### Language

#### Compound nouns

A <b>compound noun</b> is made up of two or more nouns. Some are written as two words and some as one word.	<i>storage reservoir</i> <i>marketplace</i>
The first noun normally indicates what type of thing the second noun is:	<i>working gas, base gas, cushion gas (types of gas)</i> <i>gas inventory (a type of inventory)</i> <i>gas storage capacity (a type of storage capacity)</i> Note: <i>total gas storage</i> = the total storage <i>total gas in storage</i> = the total gas

**Speaking** 5 Work in pairs. Discuss the difference(s) between the following.

- cushion gas/gas cushion
- wall paper/paper wall
- workbook/book work
- safety helicopter/helicopter safety
- test apparatus/apparatus test

**Listening** 6  25 Listen to a conversation about storage measures in a facility in North America. Which types of storage are mentioned?

7 Listen again. What do these numbers refer to?

- 123 \_\_\_\_\_
- 2,657 bcf \_\_\_\_\_
- 24,464 mmcf \_\_\_\_\_
- 30 million \_\_\_\_\_


**Speaking** 8 Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 77. Follow the instructions.

**Student A**

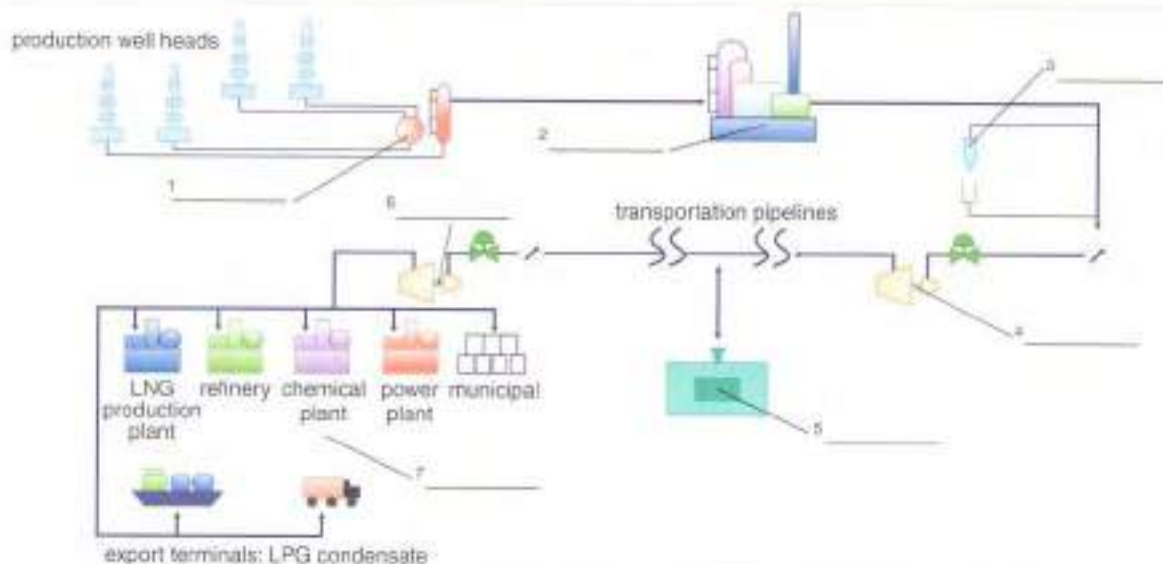
You own the following gas storage facility and you want to sell it. Answer the telephone.

**Type:** salt caverns  
**Number of caverns:** 7  
**Capacity:** 135 mcm  
**Base gas:** 45 mcm  
**Deliverability:** 18 mcm/day

## Contamination control

**Listening 1**  26 Label this illustration with the phrases in the box. Then listen to part of a presentation about contamination control and check your answers.

compressor/metering/regulation stations (x2) end users processing plants  
 pipeline inspection gauge receivers production plants underground storage



**2** Listen again and write one or more examples of each of the following. Then read audio script 26 on page 73 and check your answers.



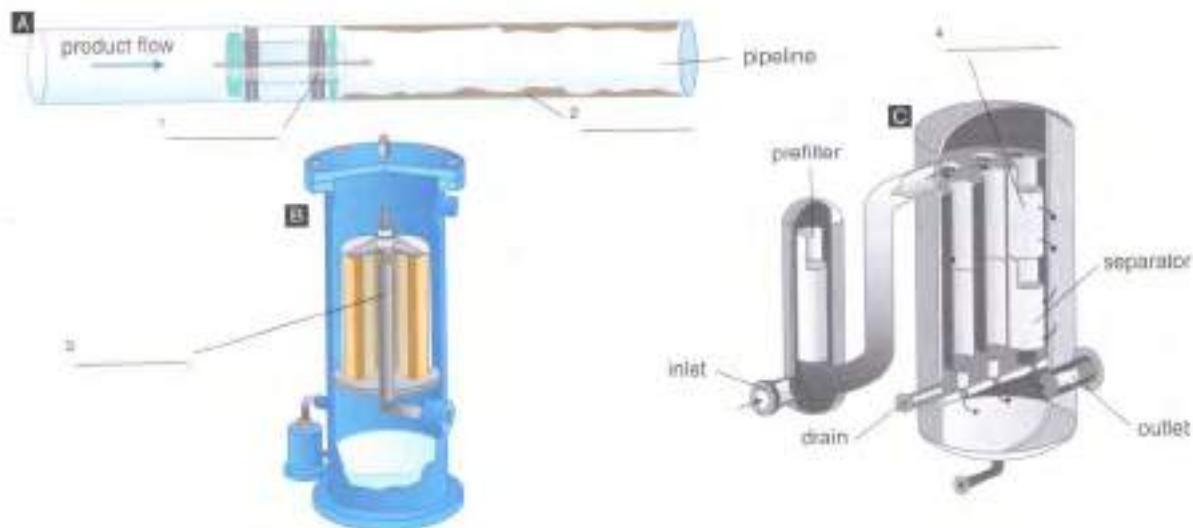
- 1 solid contaminant: \_\_\_\_\_
- 2 liquid contaminant: \_\_\_\_\_
- 3 typical problem(s) that contaminants can cause:  
 \_\_\_\_\_

**Reading 3** Read this information sheet and label diagrams A-C on page 49.

Three common ways of removing contamination from pipelines are pipeline inspection gauges, filters and coalescers.

- 1 A pipeline inspection gauge is a device that scrapes the walls of the pipe. It cleans the deposits from the pipe as it moves along it.
- 2 A filter allows liquid to flow through but stops solid particles.
- 3 There are two main types of coalescers. Liquid-gas coalescers are used to separate water and hydrocarbon liquids from gas. Liquid-liquid coalescers separate liquid contaminants such as water from liquid products.





**Vocabulary 4** Complete this text with the words in the box.

contamination filters filtration liquid pipelines

Most pipeline systems use a combination of techniques to prevent or reduce (1) \_\_\_\_\_. For example, (2) \_\_\_\_\_ are often used to collect the solids removed after a pipeline inspection gauge has been through a pipe.

Pipeline inspection gauges are very common but cannot be used on all (3) \_\_\_\_\_. In such cases, (4) \_\_\_\_\_ systems can be used to remove contaminants from the (5) \_\_\_\_\_ before it enters the pipeline.

#### Language

#### Vague language

Sometimes we use **vague language** when we want to give people an impression of something without going into all the facts and details.

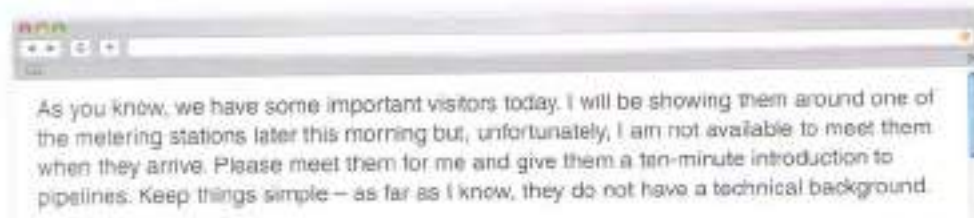
We're talking about *things like* rust and pipe scale. These contaminants can cause **all sorts of** problems. They can lower the quality of the product **quite a bit**.

**5** Read audio script 26 on page 73 and underline examples of vague language.

**Speaking 6** Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 77. Follow the instructions.

#### Student A

You work for a company called JK Pipelines. Student B, who works for a bank, is visiting your company today. Read this email from your boss and follow his/her instructions.



## Transport of dangerous goods

- Speaking** 1 Work in small groups. Can you drive? Do you have a driving licence? What extra skills do you need in order to drive a tanker? Discuss.

driving licence (BrE)  
driver's license (AmE)



- Listening** 2 27 Listen to a driving instructor talking about a training course. What type of course is it? What sorts of things will it cover?
- 3 Listen again and choose *yes (Y)* or *no (N)* for each of these questions. Then read audio script 27 on page 73 to check your answers.
- 1 Are the rules the same in every country? (Y / N)
  - 2 Is there a written test? (Y / N)
  - 3 Will emergencies be covered on the course? (Y / N)
  - 4 Is a placard necessary *only* at the front and rear of the vehicle? (Y / N)
  - 5 Is there an emergency telephone number in the shipping documents? (Y / N)
- Reading** 4 Read this extract about shipping documents and label the diagram with the words in the box.

diamond hazard shipping sides telephone

### SHIPPING DOCUMENTS (PAPERS)

The shipping document contains the four-digit ID number preceded by the letters *UN* or *NA*, the proper shipping name, the hazard class or division of the material(s) and, where appropriate, the Packing Group. The shipping document will also display a 24-hour emergency response telephone number.

EMERGENCY CONTACT 1-000-000-000		Example of emergency contact (1) _____ number	
		(2) _____ class or division number	
NO. AND TYPE OF PACKAGES			QUANTITY
1 TANKTRUCK	UN/219	ISOPROPANOL	3 II 12,000 LITRES
	ID number	(3) _____ name	PACKING GROUP

#### Example of placard and panel with ID number

The four-digit ID number may be shown on the (4) \_\_\_\_\_-shaped placard or on an adjacent orange panel displayed on the ends and (5) \_\_\_\_\_ of a cargo tank, vehicle or rail car:



a numbered placard

or

a placard and an orange panel



1219

**Vocabulary 5** Match 1–7 to a–g to make collocations.

- |             |              |
|-------------|--------------|
| 1 shipping  | a) materials |
| 2 hazardous | b) group     |
| 3 hazard    | c) users     |
| 4 diamond-  | d) licence   |
| 5 driving   | e) class     |
| 6 packing   | f) shaped    |
| 7 road      | g) document  |

### Language

#### Abbreviations

We often use **abbreviations** (the short forms of words) when we speak or write.

*hazardous materials* → *hazmat*  
*shipping documents* → *shipping docs*  
*identification number* → *ID number*  
*commercial driver's license* → *CDL*

**6** These abbreviations have been used in this book. What do they stand for?

- 1 LPG \_\_\_\_\_
- 2 E&P \_\_\_\_\_
- 3 SOP \_\_\_\_\_
- 4 MFP \_\_\_\_\_
- 5 DWT \_\_\_\_\_

**Speaking 7** Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 78. Follow the instructions.

#### Student A

Read these details about a training course and answer Student B's questions. Then swap roles. Ask Student B about his/her course.

*How long is it?*

*What will I learn on the course?*

*Who is the course for?*

## Dangerous goods regulations – Initial

Learn about shipping dangerous goods and the procedures, regulations, responsibilities and best practices involved.

#### Course details

Available as: classroom and in-company course  
Duration: 5 days (40 hours)  
Recommended level: entry-level and professional  
Prerequisites: none

#### What you will learn

Upon completing this course, you will have the skills to:

- prepare and process dangerous goods shipments.
- understand legal requirements, operational restrictions and governing entities.

- champion dangerous goods compliance standards in your organisation.
- identify weak links in your handling procedures.
- examine safety issues and apply them appropriately in the workplace.

#### Who should attend

- airline acceptance staff, shippers and freight forwarders
- cargo training and development specialists
- ground handling and load control staff involved in the cargo chain
- regulatory compliance specialists
- personnel from the Departments of Transportation and Civil Aviation Authorities
- operations and station managers



# 7


## Impact

- describe incidents
- understand causes of accidents
- complete incident report forms
- handle oil spills

### Incidents

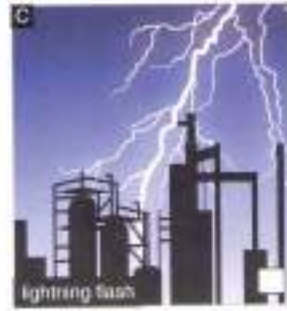
**Speaking 1** Look at this photo. What type of installation is on fire?



**Listening 2**  Listen to a report about an incident that took place at the Texaco Refinery, Milford Haven, Wales, on 24 July 1994. Answer these questions.

- 1 Was anyone injured?
- 2 What exploded?
- 3 What on-site damage occurred?
- 4 What off-site damage occurred?

**3** Listen again and put the events in the correct order.



4  29 Listen to a conversation. What are the people talking about?

5 Listen again. What four errors are mentioned?

Vocabulary 6 Match 1–5 to a–e to make collocations.

- |           |             |
|-----------|-------------|
| 1 sustain | a) a cloud  |
| 2 cause   | b) injuries |
| 3 provide | c) a fire   |
| 4 form    | d) damage   |
| 5 suffer  | e) feed     |

7 Complete these sentences with the correct form of the collocations in 6.

- 1 There were no deaths in the incident but 26 people \_\_\_\_\_.
- 2 The smoke from the fire \_\_\_\_\_ over the refinery.
- 3 The lightning strike \_\_\_\_\_.
- 4 Several units \_\_\_\_\_ in the fire.
- 5 The crude distillation unit \_\_\_\_\_ to the PCC units.

### Language

#### Collocations with fire

Verb + fire	start a fire, cause a fire, control a fire, contain a fire, put out/extinguish a fire Note: If something <b>catches fire</b> , it starts to burn. (e.g. The building <b>caught fire</b> .)	
Fire + verb	A fire <b>broke out</b> at the refinery. The fire <b>spread</b> quickly. The fire <b>went out</b> after a few hours.	A fire <b>started</b> when lightning struck. A fire <b>occurred</b> last night in a factory.
Compound nouns with fire	fire brigade, fire risk, fire equipment, fire alarm, fire fighter, fire extinguisher, fire incident	
Adjective + fire	secondary fire, serious fire, small fire, large fire, hydrocarbon fire	
Compound adjectives with fire	fireproof material, fire-retardant jacket, fire-resistant clothing	

8 Complete this article with the words in the box.

burn extinguished fire spread started

The (1) \_\_\_\_\_ incident occurred at approximately 4.40 hours, according to reports from on-site personnel. As they were tripping out the drill string from the ground, the bit cleared from the hole, went up through the annular BOP and passed through the deck of the drilling rig, at which time the incident occurred. Fire (2) \_\_\_\_\_ in the immediate

area around the drilling hole and (3) \_\_\_\_\_ upwards throughout the rig. The fire continued to (4) \_\_\_\_\_ freely until well control personnel were able to regain down-hole pressure and kill the well with water weighted with mud. The fire response team then (5) \_\_\_\_\_ the remaining fires.

Speaking 9 Work in pairs. Student A, look at the information on page 68. Student B, look at the information on page 78. Follow the instructions.

## Equipment problems

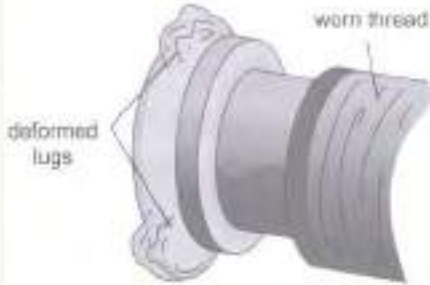
**Vocabulary 1** Label photos A–C with the words in the box.

LPG loading arms    LPG storage tanks    LPG road tanker



**Reading 2** Read this extract from a report about an incident at an LPG road tanker loading facility in a refinery. Tick ✓ the most likely cause of the accident.

- The driver did not tighten the connector.
- The connection thread was worn.
- The driver over-tightened the connector.



The incident took place at 9.45, when the driver had already loaded 12 tons of LPG. The coupling connecting the loading arm to the vehicle failed, which led to a spontaneous release of LPG. The escaping gas ignited and caused a fireball, which covered the driver. As a result, the driver sustained severe injuries and died two days later.

The investigation found that the thread in the coupling was badly worn. In addition, the lugs of the coupling were deformed. It is likely that the driver had used a hammer to tighten the coupling.

**Vocabulary 3** Find words in the text in 2 that match these definitions.

- not planned \_\_\_\_\_
- started burning \_\_\_\_\_
- surrounded \_\_\_\_\_
- inquiry \_\_\_\_\_
- a piece of equipment which connects two things \_\_\_\_\_
- misshapen \_\_\_\_\_



**Vocabulary 4** Complete this table with words from the text in 2.

Verb	Noun
investigate	1 _____
2 _____	ignition
couple	3 _____
4 _____	failure
release	5 _____
6 _____	deformation
connect	7 _____

**Language**

**Explaining why something happened**

<i>This led to ...</i>	<i>This led to a release of LPG.</i>
<i>This caused ...</i>	<i>The released hydrocarbons formed a vapour cloud, which ignited. This caused a major hydrocarbon fire.</i>
<i>The cause of ... was ...</i>	<i>The cause of the LPG release was the failure of the threaded coupling.</i>
<i>... was caused by ...</i>	<i>The deformation was caused by hammering the lugs.</i>
<i>... resulted in ...</i>	<i>A combination of errors resulted in the release of hydrocarbons.</i>
<i>... as a result of ...</i>	<i>The unit was shut down as a result of the fire.</i>

**5** Complete this conversation with the words in the box. There is one extra word.

cause caused corrosion hole ignited led released was

- A: So let me get this straight: there (1) \_\_\_\_\_ a fire, and the fire (2) \_\_\_\_\_ to an explosion.  
 B: No, no ... the other way round.  
 A: Pardon?  
 B: The explosion caused the fire. The fire didn't (3) \_\_\_\_\_ the explosion. The explosion came first.  
 A: OK. And what (4) \_\_\_\_\_ the explosion?  
 B: Leaking gas. There was a(n) (5) \_\_\_\_\_ in the pipe. Gas leaked out, formed a cloud and then (6) \_\_\_\_\_.  
 A: I see. And what caused the hole in the pipe?  
 B: That's what we don't know. We think maybe it was (7) \_\_\_\_\_. But we'll have to wait for the investigation to be sure.  
 A: Fair enough.

**Listening 6**  30 Listen and check your answers in 5.

**Vocabulary 7** Rewrite these sentences, inserting the missing words.

- There was a fire. This led to explosion.
- The fire caused explosion.
- The fire led an explosion.
- The report stated that the cause death was a heart attack.
- As a result the accident, all drivers received additional safety training.
- The fire caused by an electrical storm.
- The fire resulted a number of injuries.

**Speaking 8** Work in pairs. How would you prevent an accident like the one in 2 re-occurring? Make a list of recommendations.  
*Check the thread couplings currently in use.*

## Doing the paperwork

- Reading 1** Read this extract from accident/incident reporting regulations. Find words and phrases that are related to injury.

The regulation applies to liquid hazardous materials pipelines. An accident report is required for any of the following:

- 1 an explosion or fire not intentionally set by the operator
- 2 the loss of 50 or more barrels (eight or more cubic metres) of hazardous liquid
- 3 the escape to the atmosphere of more than five barrels (0.8 cubic metres) a day of highly volatile liquids
- 4 the death of any person
- 5 bodily harm resulting in one or more of the following:

- a) loss of consciousness
  - b) the necessity of carrying the person from the scene
  - c) the necessity for medical treatment
  - d) disability which prevents the discharge of normal duties or the pursuit of normal activities beyond the day of the accident
- 6 estimated property damage, including the cost of clean-up and recovery, the value of lost product and damage to the property of the operator or others, or both, exceeding \$50,000.

- 2** Do these incidents on a pipeline system need to be reported according to the regulations in 1? Choose *yes (Y)* or *no (N)*.

- 1 a fire at a compressor station, resulting in two operators being treated for burns (Y / N)
- 2 a leaking valve, resulting in a small pool of oil underneath the valve (Y / N)
- 3 an explosion at a metering station, resulting in the death of two operators (Y / N)
- 4 the fracture of a pipe, resulting in the loss of 400 barrels of oil (Y / N)

- 3** Read the extract from an incident report form below and find words or phrases that match these definitions.

- 1 deaths \_\_\_\_\_
- 2 people who have nothing to do with the pipeline \_\_\_\_\_
- 3 the time at a particular location \_\_\_\_\_
- 4 taken to another place \_\_\_\_\_
- 5 extra \_\_\_\_\_

<p>11 Were there fatalities? <input type="radio"/> Yes <input type="radio"/> No If Yes, specify the number in each category:</p> <p>11a operator employees _____</p> <p>11b contractor employees working for the operator _____</p> <p>11c non-operator emergency responders _____</p> <p>11d workers working on the right-of-way but NOT associated with this operator _____</p> <p>11e general public _____</p> <p>11f total fatalities (sum of the above) _____</p>	<p>12 Were there injuries requiring inpatient hospitalisation? <input type="radio"/> Yes <input type="radio"/> No If Yes, specify the number in each category:</p> <p>12a operator employees _____</p> <p>12b contractor employees working for the operator _____</p> <p>12c non-operator emergency responders _____</p> <p>12d workers working on the right-of-way but NOT associated with this operator _____</p> <p>12e general public _____</p> <p>12f total injuries (sum of the above) _____</p>
<p>13 Was the pipeline/facility shut down due to the incident? <input type="radio"/> Yes <input type="radio"/> No = Explain: _____</p> <p>If Yes, complete Questions 13a and 13b. (Use local time, 24-hour clock.)</p> <p>13a local time and date of shutdown _____ hour month day year</p> <p>13b local time pipeline/facility restarted _____ hour month day year <input type="radio"/> still shut down (supplemental report required)</p>	
<p>14 Did the gas ignite? <input type="radio"/> Yes <input type="radio"/> No</p> <p>15 Did the gas explode? <input type="radio"/> Yes <input type="radio"/> No</p> <p>16 number of general public evacuated _____</p> <p>17 time sequence (Use local time, 24-hour clock.)</p> <p>17a local time operator identified incident _____ hour month day year</p> <p>17b local time operator resources arrived on site _____ hour month day year</p>	



## Telling the time: the 24-hour clock


07.00	oh seven hundred
16.00	sixteen hundred/sixteen hundred hours (not sixteen o'clock)
16.15	sixteen fifteen (not sixteen fifteen o'clock)

**Listening 4**  **31** Listen to a conversation between two workers about an incident. What happened?

**5** Listen again and complete the form in 3.

Examples:

00.00 = midnight = /0/0/0/0/  
 08.00 = 8:00 a.m. = /0/8/0/0/  
 12.00 = noon = /1/2/0/0/  
 17.15 = 5:15 p.m. = /1/7/1/5/  
 22.00 = 10:00 p.m. = /2/2/0/0/

**6**  **32** Listen and complete this report with the correct times.

From what I understand, this is what happened: at (1) \_\_\_\_\_ the safety officer issued a hot work permit to two employees – two welders. The permit was valid from (2) \_\_\_\_\_ to (3) \_\_\_\_\_ in the afternoon. The task was to weld a handrail to the stairs on storage tanks 387 and 388. All the preparation work had been done the day before. The welders took a break at around (4) \_\_\_\_\_ and returned to work at around (5) \_\_\_\_\_. They were unable to restart the engine on their

welding machine, so they called maintenance. At around (6) \_\_\_\_\_ a maintenance truck gave their welding machine a jump start. At around (7) \_\_\_\_\_ an explosion occurred in tank 387, followed a minute later by an explosion in tank 388. Both welders were killed. Another tank in the area, 392, was damaged but did not catch fire. The firefighters were called at (8) \_\_\_\_\_, arrived at (9) \_\_\_\_\_ and had extinguished the flames by (10) \_\_\_\_\_.

**Writing 7** Read the report in 6 again and complete this hot work permit.



## Hot work permit

Date: 6 Jan

Valid from: (1) \_\_\_\_\_ to: (2) \_\_\_\_\_

Location: (3) \_\_\_\_\_

Name(s): H. Jahar ID 11/11/11


Job description: (4) \_\_\_\_\_

\_\_\_\_\_

Signed: K. Zammit

Job title: (5) \_\_\_\_\_

## Cleaning up

- Speaking** 1 Work in pairs. What are the main causes of oil spills?
- Listening** 2  Listen to a person talking about oil spills. Compare what he says with your answer in 1.
- 3 Listen again and complete these phrases.
- 1 routine operations such as \_\_\_\_\_, loading or unloading
  - 2 mishaps and collisions between vessels or tankers and other transportation \_\_\_\_\_
  - 3 ships running \_\_\_\_\_
  - 4 ruptured \_\_\_\_\_
  - 5 oil \_\_\_\_\_ activities
  - 6 mechanical failure of oil collection and \_\_\_\_\_ equipment
- Reading** 4 Look at this photo of an oil spill kit. Can you identify any of the items? How do you think these items are used? What else might an oil spill kit contain?



1 pound = 0.454 kg  
 curb (AmE) = kerb  
 (BrE)

- 5 Read this extract from procedures for spill prevention control and countermeasures (SPCC) and check your answers in 4. What type of spill is the extract about?

### Planning and preparation

Spill kits have been established at oil storage locations subject to SPCC regulations. The amount of spill materials kept at each location depends on the volume of oils stored there. Spill kit materials can be used for two main purposes: to absorb spilled oils and to block their flow.

The absorbents are of two types: diatomaceous earth (Oil Sorb) and polypropylene. Oil Sorb is supplied in 25-pound paper bags. Polypropylene is supplied as socks, pillows and pads. The use and limitations of each are described below:

Absorbent type	Use	Limitations
Oil Sorb	Spread on the leading edge of an oil spill and work back to the source.	Can absorb its weight in oil. Will absorb both water and oil. Does not float on water.
Polypropylene	Spread on the leading edge of an oil spill and work back to the source.	Can absorb 25 times its weight in oil. Will only absorb oil. Will float on water even if saturated with oil.

Blocking materials are also of two types: sandbags and elastomer mats and berms. The use and limitations of each are described below:

Blocking material	Use	Limitations
Sandbags	Place in path of flow and butt the ends of the bags tightly to each other to form a barrier.	Getting a good seal between adjacent bags and the ground can be difficult. Use absorbent to catch leakage. Each bag weighs about 70 pounds and thus is difficult for some to move.
Elastomer mats	Place over storm or sanitary drains to seal them.	May not completely cover some larger drains. May not form a perfect seal on rough surfaces or along curbs.
Elastomer berms	Place in the path of flow to form a barrier or lay around drain openings to form a barrier.	May not completely encircle some larger drains. May not form a perfect seal on rough surfaces or along curbs.

**Vocabulary 6** Match 1-6 to a-f to make collocations.

- |           |            |
|-----------|------------|
| 1 rough   | a) seal    |
| 2 drain   | b) edge    |
| 3 paper   | c) surface |
| 4 perfect | d) opening |
| 5 leading | e) bag     |
| 6 spill   | f) kit     |

**7** Match words 1-7 to definitions a-g.

- |                |   |
|----------------|---|
| 1 butt         | a) nearby, neighbouring                       |
| 2 leading edge | b) soaked                                     |
| 3 curb         | c) front part                                 |
| 4 adjacent     | d) weaknesses                                 |
| 5 limitations  | e) push                                       |
| 6 saturated    | f) stones/concrete along the edge of a street |
| 7 absorb       | g) take in                                    |

### Language

#### Be supplied

The phrase *be supplied* collocates with different prepositions.

<i>Oil Spill is supplied in 25-pound paper bags.</i>	<i>Polypropylene is supplied as socks, pillows and pads.</i>
<i>The tool is supplied with/without a plug.</i>	<i>The kit is supplied by a company in Chicago.</i>
<i>Oxygen is supplied to the flame.</i>	<i>The software is supplied on a separate DVD.</i>

**8** Complete these sentences with the correct prepositions.

- This area is supplied \_\_\_\_\_ gasoline from the Oston refinery.
- Water is supplied \_\_\_\_\_ the blowdown drum to cool hot process steams.
- Gas is supplied \_\_\_\_\_ most homes in this town.
- The chemicals were supplied \_\_\_\_\_ powder.
- Propane is also supplied \_\_\_\_\_ canisters.
- Power is supplied \_\_\_\_\_ a 12-volt battery.
- The mats are supplied \_\_\_\_\_ part of the spill kit.

**Speaking 9** Work in pairs. Student A, look at the information on page 68. Student B, look at the information on page 78. Follow the instructions.



## 8

## Supply and demand

- explain the process of buying and selling natural gas
- explain how oil is priced
- talk about trends
- discuss innovation in the oil industry

## The markets

**Speaking 1** Work in pairs. Where do industrial users in your country go to buy natural gas? Discuss.

**Reading 2** Read the text and answer these questions.

- 1 What is the difference between on-system and off-system end users?
- 2 How do marketers get the gas to their customers?
- 3 Do pipeline companies sell natural gas in the USA? Why/Why not?

## How natural gas is traded

The diagram shows some of the types of natural gas transactions that take place as gas makes its way from the fields where it is produced to the end user.

The natural gas industry in the United States is highly competitive, with thousands of producers. Some producers market their natural gas and may sell it directly to local distribution companies or to large industrial buyers of natural gas. (Some of these large industrial buyers are 'on-system' end users, meaning that they receive physical natural gas deliveries from a local distribution company. Others are 'off-system' end users, meaning that they are directly connected to an interstate pipeline.) Other producers sell their gas to marketers who sell the natural gas in quantities that fit the needs of different types of buyers and who transport gas to their buyers. Marketers may be large

or small and sell to local distribution companies or to commercial or industrial customers connected directly to pipelines or served by local distribution companies.

Most residential and commercial customers purchase natural gas from a local distribution company.


In contrast, many industrial customers purchase natural gas from a marketer or producer instead of from the distribution company.

Note that pipeline companies do not buy and sell natural gas. Most of the major natural gas pipeline companies are federally regulated interstate pipeline companies. These companies are limited to providing transportation services, including storage. Thus pipeline companies move gas at government-regulated rates on behalf of buyers and sellers but do not participate in the buying and selling of natural gas.



3 Match 1-7 to a-g to make collocations. Then find the collocations in the text in 2.

- |                  |                |
|------------------|----------------|
| 1 highly         | a) customers   |
| 2 transportation | b) company     |
| 3 federally      | c) services    |
| 4 interstate     | d) connected   |
| 5 directly       | e) competitive |
| 6 distribution   | f) regulated   |
| 7 industrial     | g) pipeline    |

Listening 4  Listen to a marketer explaining how he sells gas to his customers and complete these expressions with the words in the box.

futures spot term

- \_\_\_\_\_ price
- longer \_\_\_\_\_ contract
- \_\_\_\_\_ contract

5 Listen again. Explain the meaning of the expressions in 4.

### Language

#### On behalf of someone/On someone's behalf

We use **on behalf of someone** to explain that we are doing something for someone else.

*Pipelines move gas **on behalf of buyers and sellers**.  
I signed the letter **on behalf of my boss**.*

We can also use **on someone's behalf** in the same way.

*Pipelines move gas **on their behalf**.  
I signed the letter **on her behalf**.*

6 Complete these sentences with the words in the box.

behalf my of on our

- Please don't do it \_\_\_\_\_ my behalf.
- The distribution companies deliver the gas on behalf \_\_\_\_\_ the marketers.
- On \_\_\_\_\_ of Mr Schultz, I would like to welcome you to the department.
- I'm here on behalf of \_\_\_\_\_ crew.
- We need an agent to get a good price on \_\_\_\_\_ behalf.

Speaking 7 Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 79. Follow the instructions.

#### Student A

You represent a power station. You need to buy natural gas to supply your turbines. Telephone Student B, a marketer, and discuss options for the delivery of the gas.

*What is an off-system end user?*

*Can I buy direct from the producers?*

*Do pipeline companies sell gas?*

## Prices

**Reading 1** Read the article about crude oil prices and answer these questions.

- 1 What is the difference between WTI and Brent Blend?
- 2 What do *light*, *sweet* and *sour* mean in relation to oil?
- 3 Which oil is sweeter: WTI, Brent Blend or OPEC Basket?

Crude oil prices measure the spot price of various barrels of oil, most commonly either the West Texas Intermediate or the Brent Blend. The OPEC Basket Price and the NYMEX Futures price are also sometimes quoted.

West Texas Intermediate (WTI) crude oil is of very high quality because it has a low density and a high proportion of light hydrocarbon fractions. It also has low sulphur content. For these reasons, it is often referred to as 'light', 'sweet' crude oil. These properties mean it is excellent for making gasoline, which is why it is the major benchmark of crude oil in the Americas.

Brent Blend is a combination of crude oil from 15 different oil fields in the North Sea. It is less 'light' and 'sweet' than WTI but still excellent for making gasoline. It is primarily refined in Northwest Europe and is the major benchmark for other crude oils in Europe or Africa. For example, prices for other crude oils in these two continents are often set as a differential to Brent (for example, Brent minus \$0.50).

The OPEC Basket Price is an average of the prices of oil from Algeria, Indonesia, Nigeria, Saudi Arabia, Dubai, Venezuela and Mexico. OPEC uses the price of this basket to monitor world oil market conditions. OPEC prices are lower because the oil from some of the countries has higher sulphur content, making it more 'sour' and therefore less useful for making gasoline. Transportation distance is also a factor.

The NYMEX is the value of 1,000 barrels of oil, usually WTI, at some agreed upon time in the future. In this way, the NYMEX gives a forecast of what oil traders think the WTI price will be in the future.

**Vocabulary 2** Match words 1-5 to definitions a-e.

- 1 benchmark
- 2 differential
- 3 proportion
- 4 value
- 5 average


- a) relative quantity
- b) monetary worth (how much money you get for this commodity)
- c) amount of difference
- d) a standard used for comparison
- e) arithmetic mean (all items added together and then divided by the number of items)

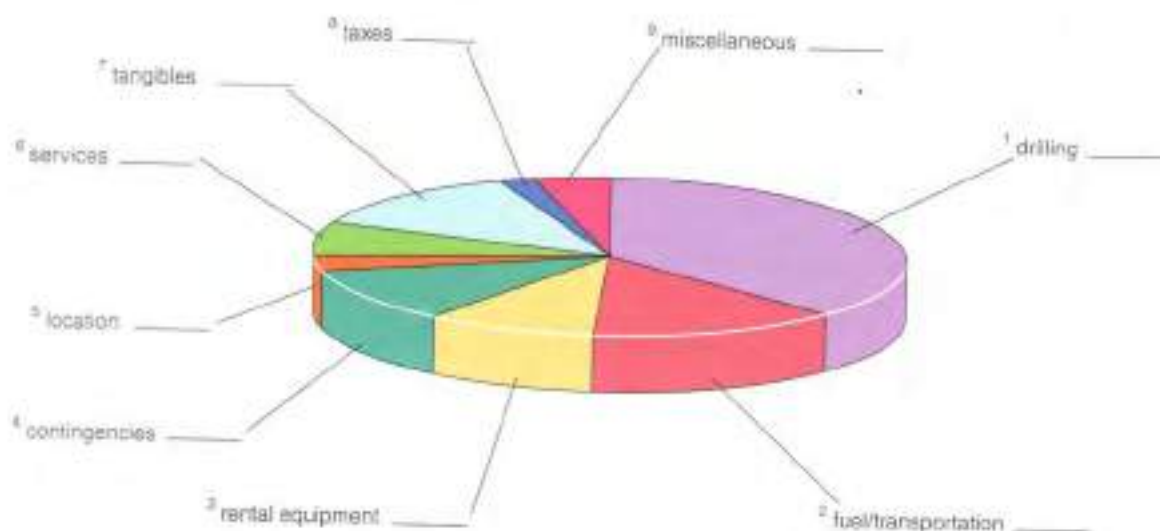
**3** Complete these sentences with the words in 2.

- 1 The price \_\_\_\_\_ between Brent and WTI was only 50 cents.
- 2 The \_\_\_\_\_ price of a litre of gasoline was \$3.45.
- 3 The market \_\_\_\_\_ of an oil tanker is in the tens of millions of dollars.
- 4 Heavy crude oils contain a high \_\_\_\_\_ of heavy hydrocarbons.
- 5 Brent Blend is used as a(n) \_\_\_\_\_ in Europe and Africa.

**Speaking 4** Work in pairs. The market price depends on many factors, including the cost of production. What does it cost to produce a barrel of oil? Brainstorm some factors.



**Listening 5**  35 Listen to an employee from an exploration company talking about the costs for the drilling operations of an exploration project. Complete the percentages on this pie chart.



**6** Listen again. Explain what the speaker means by these terms.

- 1 contingencies  
2 services

- 3 tangibles  
4 miscellaneous

### Language

#### Phrasal verbs

**Phrasal verbs** often consist of a verb + preposition. The meaning of the phrasal verb is often different to the meaning of the separate words.

*Brainstorm some **factors** with your partner. (factors = noun, meaning 'items')*  
*We normally **factor in** a contingency cost. (factor = part of a phrasal verb, meaning 'include')*

**7** Complete these sentences with the correct form of phrasal verbs formed from the words in the boxes. All the phrasal verbs come from previous units.

clean look make start switch

after on out up (x2)


- It's dark in here. Please \_\_\_\_\_ the lights.
- If the oil has a low pour point, the engine is easier to \_\_\_\_\_ in winter.
- My job is to \_\_\_\_\_ the drilling equipment.
- We are talking about the hydrocarbons that \_\_\_\_\_ oil and gas.
- \_\_\_\_\_ the pipeline before use.

**Speaking 8** Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 79. Follow the instructions.

#### Student A

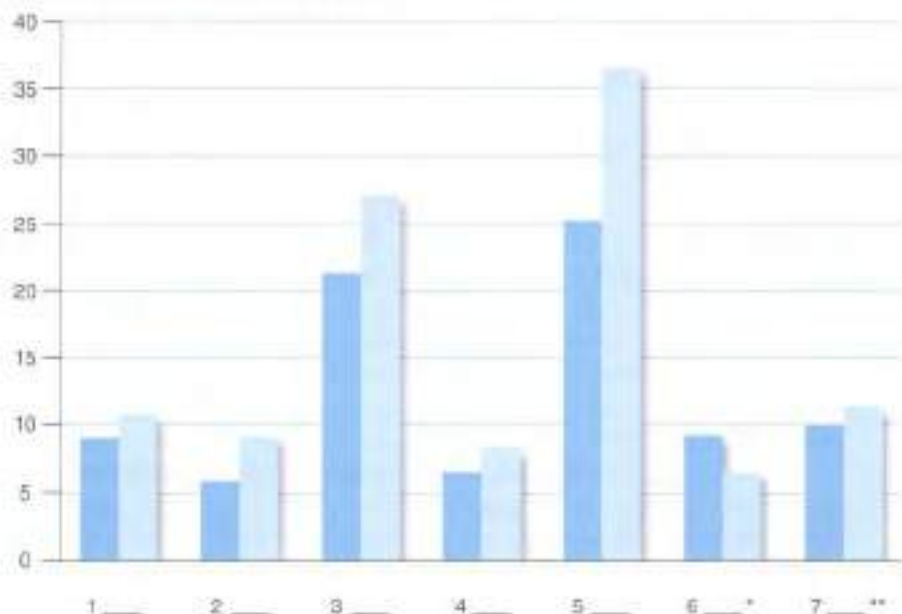
Ask Student B about the difference between WTI, Brent, OPEC and NYMEX prices. Then answer his/her questions.

## Trends and forecasts

**Listening 1**  **36** Listen to a talk about OPEC's World Oil Outlook 2011 and match words a-g to 1-7 in the bar chart.

- |                  |                 |                   |
|------------------|-----------------|-------------------|
| a) diesel/gasoil | d) naphtha      | f) other products |
| b) ethane/LPG    | e) jet/kerosene | g) residual fuel  |
| c) gasoline      |                 |                   |


Global product demand, 2010 and 2035



\*Includes refinery fuel oil.

\*\*Includes bitumen, lubricants, waxes, still gas, sulphur, direct use of crude oil, etc.

**2** Listen again. What do *go up* and *go down* mean?

**3**  **37** Listen to five experts talking about trends in the oil and gas industry. Match speakers 1-5 to these topics.

- shale gas
- buying and selling companies
- deepwater drilling
- China as an importer of oil
- natural gas

**4** Listen again and answer these questions.

- How deep are E&P companies now drilling?
- Why are there so many mergers, acquisitions and joint ventures?
- Why does China need to import more oil?
- Where are most of the world's natural gas reserves?
- One reason for the success of shale gas is new technology. What is the other reason?

**Speaking 5** Work in pairs. Do you agree with the trends mentioned in the recording? What other trends can you think of? Discuss.



**Presenting visual information: adjectives and adverbs**

We often use **adjectives** and **adverbs** to describe graphs or trends.

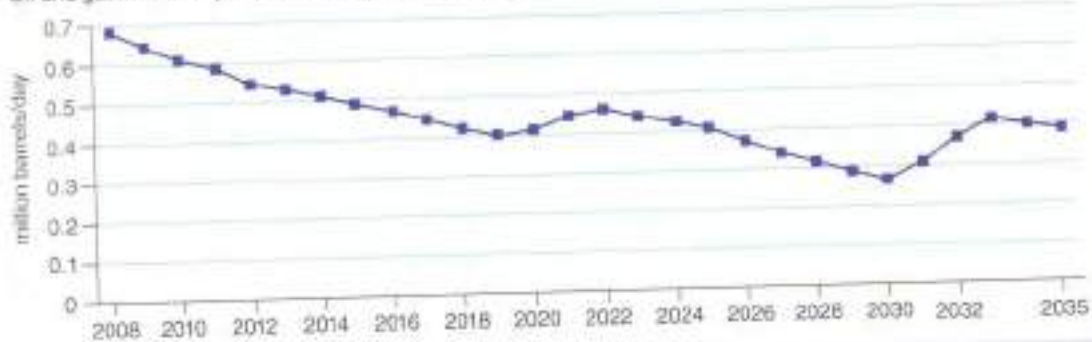
Adjectives	a <b>dramatic</b> rise a <b>significant</b> change a <b>slight</b> drop
Adverbs	It rose <b>dramatically</b> . It changed <b>significantly</b> . It dropped <b>slightly</b> .

**6** Underline the adjectives and adverbs that describe trends in audio scripts 36 and 37 on page 75.

**7** Complete this text using the information in the graph.

This graph shows the outlook for (1) \_\_\_\_\_ in Alaska from 2008 to (2) \_\_\_\_\_. As you can see, we start off in 2008 with 0.7 (3) \_\_\_\_\_. This will drop steadily to 0.4 in (4) \_\_\_\_\_. It will then (5) \_\_\_\_\_ to around 0.46 by 2022 and then (6) \_\_\_\_\_ to 0.28 in 2030. There will be another rise to around 0.41 in (7) \_\_\_\_\_ followed by a drop to just (8) \_\_\_\_\_ 0.4 in 2035.

Oil and gas: crude oil production: Alaska: reference case

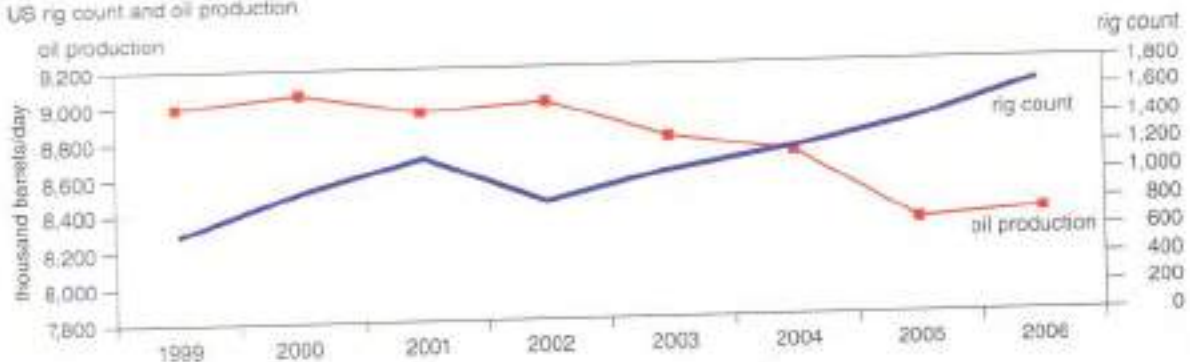


**Speaking 8** Work in pairs. Student A, look at the information on this page. Student B, look at the information on page 79. Follow the instructions.

**Student A**

Describe this graph for Student B to draw. Then draw the graph Student B describes.

US rig count and oil production



## Innovation

- Speaking 1** Read this quotation. Was the Sheikh right about fuel cell technology and the changes in the oil industry? What new technologies do you know about?

'30 years from now there will be a huge amount of oil and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones, and the Oil Age will come to an end, not because we have a lack of oil. [Fuel cell technology] is coming before the end of the decade and will cut gasoline consumption by almost 100 percent. On the supply side it is easy to find oil and produce it, and on the demand side there are so many new technologies, especially when it comes to automobiles.'


*Sheikh Zaki Yamani, Oil Minister of Saudi Arabia (1962-1986), June 2000*

- Reading 2** Read this programme from a conference on innovation in the oil and gas industry. What sessions would you be most interested in? Why?

Innovation in the oil and gas industry: Programme	
09.00	Coffee and registration
09.30	Welcome address Keynote speaker: Harold J. Curtiss, CEO HJC Enterprises (main hall)
10.30-11.00	Coffee
11.00-12.30	<b>Session A</b> A1 Focus on floating production systems: lowering the costs (room 203) A2 Drilling rigs and quality control: our experience in Texas (room 208) A3 Natural gas storage: the case for salt caverns (room 304)
12.30-13.30	Lunch
13.30-15.00	<b>Session B</b> B1 Blowout preventers: what you need to know (room 203) B2 Deepwater exploration: where are we and where are we going? (room 208) B3 Perspectives on shale reserves (room 304)
15.00-15.30	Coffee
15.30-17.00	<b>Session C</b> C1 Pipelines and pipeline inspection gauges: old technology, new ideas (room 203) C2 Refinery maintenance: fewer shutdowns, more profit (room 208) C3 Transporting LPG: new regulations and what they mean (room 304)
17.00-18.00	Panel discussion (main hall) Representatives from leading E&P companies discuss innovation and answer your questions.
19.30	Dinner

**Vocabulary 3** Match words 1-5 to definitions a-e.

- 1 registration
  - 2 keynote speaker
  - 3 opening address
  - 4 networking
  - 5 panel discussion
- a) making new contacts; sharing ideas and information
  - b) a formal conversation on selected topics in front of an audience, with selected speakers
  - c) someone who gives an important talk at a conference
  - d) the first talk at a conference
  - e) signing in to the conference

**Listening 4**  38 Listen to two co-workers at the conference discussing the programme in 2 and tick ✓ the sessions they decide to attend.

Session	Tony	Jane
A1		
A2		
A3		
B1		
B2		
B3		
C1		
C2		
C3		
Panel discussion		

**5** Listen again. Why doesn't Jane want to talk to Tony at the next coffee break?

### Language

#### Using yes to agree and disagree

Agreement	Yes, good idea./Yes, OK./Yes, definitely./Yes, exactly.
Partial agreement	Yes and no.
Disagreement	Yes, but ...

**6** Underline all the phrases with yes in audio script 38 on page 75. Do they show agreement, partial agreement or disagreement?

**7** Disagree with the following statements. Start with *Yes, but ...*

- 1 We should stop searching for fossil fuels and use more renewables.
- 2 Salaries in the oil industry are too high.
- 3 There is hardly any innovation in the oil industry – just the same old ideas.
- 4 Technology is the answer to all our problems.
- 5 There are too many accidents with deepwater drilling.

**8** Work in pairs. How do you think the following phrase is used in conversation?  
*Let's agree to disagree.*

**Speaking 9** Work in pairs. Your English lessons are coming to an end. Discuss the best way to continue learning in the future. Think of at least three options. Your partner can agree or disagree with what you say.



# Partner files: Student A

## 4 Equipment

**The blowout preventer**

**Speaking exercise 6 page 31**

Make notes about the function of the items in these photos. Then describe the items to Student B.



## 5 Project management

**In a meeting**

**Speaking exercise 7 page 37**

You are the project manager. Ask Student B, the supervisor, questions about the dismantling of the rig. You want to know if all the tasks in this list have been done yet.

- |  |                                       |
|--|---------------------------------------|
| 1 Detach the Kelly from the travelling block.            | 5 Lower the derrick.                  |
| 2 Uninstall the power system.                            | 6 Dismantle the rig platform.         |
| 3 Take down all the electric cables.                     | 7 Fill in the mud and reserve pits.   |
| 4 Disconnect the mud pipes and hoses from the equipment. | 8 Remove the equipment from the site. |

## 7 Impact

**Incidents**

**Speaking exercise 9 page 53**

- 1 Read this incident report. Explain what happened to Student B. Answer his/her questions.
- 2 Student B will explain a similar incident to you. Ask questions to find out what happened. Use 2 on page 52 to help you.

On 23 February 1999 a fire occurred in the crude unit at Tosco Corporation's Avon oil refinery in Martinez, California. Workers were attempting to replace piping attached to a 150-foot-tall fractionator tower while the process unit was in

operation. During removal of the piping, naphtha was released onto the hot fractionator and ignited. The flames engulfed five workers located at different heights on the tower. Four men were killed and one sustained serious injuries.

**Cleaning up**

**Speaking exercise 9 page 59**

Explain to Student B how sandbags, elastomer mats and elastomer berms are used in the event of an oil spill. Use the words in the box.

butt cover drains encircle place rough surfaces seal

# Audio script

## Unit 1 People and jobs

02

- 1 A: What do you do exactly?  
B: Well, my specific job at the moment is optimizing lube oil production. We blend different oils and we use additives to get the right properties in the products. When we're happy with the product, we transfer it to large storage tanks. From there it's pumped into barrels or bottles and sent to the customer.
- 2 A: Is it an easy job?  
B: Easy job? No! It's hard, physical and very dirty! We normally work for 12 hours at a time in all weathers – painting, cleaning, carrying, you name it. All the other people on the crew, from driller to motorhand to derrickman, started as roostabouts. It's normal in this industry.
- 3 A: Do you work in a crew?  
B: Well, I'm part of the production support team, so I move around from rig to rig. I work with different crews on different rigs, sometimes inside an office and sometimes outdoors.  
A: And the job is mainly technical?  
B: Yes, but I also have to work with people, co-ordinating and managing. So my job isn't only technical. And of course there are a lot of health and safety procedures to follow as well.
- 4 A: So where do you work?  
B: I'm a geophysicist at Ergos. I'm based in Anchorage.  
A: A geophysicist? Er ... what does that mean exactly?  
B: Well, in my case, I work in a team. We're responsible for finding out what's under the surface, so things like types of rock, different layers, where the oil is and so on. Basically, we use vibrator trucks to send shock waves into the ground, and receivers to pick up the reflected waves from the different layers. My job is to analyse the data.

03

- [Ab = Abdul; H = Harish; J = John; M = Mohammed; Al = Ali; S = Samir]
- Ab: Hello, and welcome to the rig. I'm Abdul Suleman.  
H: Harish. Harish Bajjal.  
Ab: I'm afraid Mr J is away today, visiting JK Enterprises.  
H: JK Enterprises? In Aberdeen?  
Ab: Yes, that's right. They're the exploration company that hired the rig.  
H: I see.  
Ab: The rest of us work for Ali Basri under contract. Let me introduce you to the crew. Here we have John Gregory, in charge of all things mud.  
J: Hi.  
H: Hi, Harish. I'm the new medic.  
J: First time on a rig?  
H: Er ... yes. It looks complicated.  
J: Ah, you'll get used to it.  
Ab: And this is Mohammed. He runs the drilling crew which goes on shift in about ten minutes. Right, Mohammed?  
M: Yes, that's right. Hi, Harish. Welcome. And if you'll excuse me, off to work I go!  
Ab: And this is Ali. He is responsible for all the engines on the rig.

- H: Pleased to meet you.  
Al: Likewise.  
Ab: And finally we have Samir, who reports directly to Mr J. Samir is responsible for all the technical stuff, while I look after the crews and support staff.  
S: Hello.  
H: Hi.  
Ab: How about a cup of tea? Then I'll take you out to meet the crew coming off shift. And after that I'll show you the quarters and the sick bay.  
H: Great, thanks.

04

- 1 A: On this rig, workers are on the job for 12 hours a day for seven straight days. Then they get a week-long break.  
B: Ah, that's different to my old rig. We operated in three-week shifts. So three weeks on the rig and three weeks off.  
A: That's hard.  
B: Yes. The night shifts were the worst but the breaks were great!
- 2 A: We do routine tests and non-routine tests. For routine tests, we take samples at specific times from specific locations, according to a set schedule. This is an important part of the quality control programme in the refinery.  
B: What about non-routine tests?  
A: Ah ... we do those when something out of the ordinary happens, for example, equipment breakdown or maintenance.  
B: I see.  
A: For example, last week we had a problem with some of the crude inflow, so we had to reschedule all our tests.  
B: Did you manage it?  
A: Yes, but it was hard work. Long hours.  
B: Do you work shifts at this refinery?  
A: Some people do, yes. But I don't. I'm on call 24 hours a day, seven days a week.
- 3 A: My company specialises in gas pipeline repair and maintenance. Last week was a typical week.  
B: What did you do?  
A: Well, we did a job here in Germany. The job was to install a new pipe liner and also to replace some flanges. We spent the first week getting things ready. Everything had to be planned properly to minimise downtime.  
B: I see. And what happened next?  
A: It all went according to plan. The operators shut down a four-mile section of underground pipe. We only had three days, so we had to work around the clock to complete the job, which meant three shifts. As supervisor, I was at work, or at least available for work, the whole time.  
B: Did you finish on time?  
A: Actually, we finished two hours early. And next week we're doing the same thing on a different section.  
B: Sounds very interesting.  
A: Yes, always a different location.



## 05

- A: OK, have a look at this map. You can see the coast here, with the mouth of the river here. And here are two islands, just north-east of the mouth.
- B: Yep, OK.
- A: The scale is 1:63,360, so one inch is a mile.
- B: OK.
- A: Now, this is the plan: the refinery will be here, on the east side of the mouth. We can't use the west side because the tankers will need the harbour here, just opposite the larger island, and we want to be as close as possible. This means that the pipeline is quite short, only about a mile from the refinery, to the west side of the harbour.
- B: Why not put the refinery closer to the harbour?
- A: Good question. Basically, this area here, around the harbour, is a fishing village. So we don't want to get too close.
- B: I see.
- A: Now the rigs. The plan is to have three platforms at first. Each platform will be named after one of the director's daughters. So we have Platform Sally here, just east of the small island. We have Platform Debbie here, in between the two islands, and we have Platform Marjorie here, in the middle of the mouth of the river.
- B: OK.

## Unit 2 Procedures

## 06

- jewellery
- flammable items
- temporary
- rotary table
- regularly

## 07

- 1 A: OK, before we start the drilling, we should clean all the equipment. We don't want any cross-contamination.
- B: What should I use? The steam cleaner?
- A: Yes, that's fine. And afterwards wash it with potable water.
- B: Potable?
- A: That means drinkable water.
- B: Ah, OK.
- 2 A: We shouldn't use any newly painted tools for this job.
- B: Why not?
- A: The paint chips off and goes into the monitoring system.
- B: Right.
- 3 A: Make sure you throw your old gloves away - before you touch the clean equipment.
- B: These should be OK. They're only slightly dirty.
- A: No, throw them away. Even slightly soiled gloves contaminate.
- B: OK.
- 4 A: See this rope? It's porous, so we can't decontaminate it properly.
- B: I see.
- A: It should be thrown away.
- B: OK, boss. No problem.
- 5 A: Before we leave base camp, all the equipment should be thoroughly cleaned.
- B: That's a lot of work.
- A: Yep, so better get started!
- B: OK.

## 08

- [S = Supervisor; R = Roustabout]
- S: Right, now let me give you some general rules about working with loads. Listen carefully. First of all, make sure the work area is clear. If there's an obstruction, remove it. And by obstruction I mean anything which shouldn't be there: tools, equipment, boxes - you name it. OK?
- R: OK.
- S: Good. Next, always check the condition of the equipment. If you see any damage, just tell me. For example, corroded or broken wire ropes, or worn slings. That kind of thing is very dangerous. Understand?
- R: Yes, OK.
- S: Always use taglines to control a load. If a load swings to the left or right, you just pull it back. And another thing: attach hooks or shackles to pick-up points. If there are no pick-up points, use slings and packing to prevent damage.
- R: Got it.
- S: Now, do you know the emergency stop signal?
- R: Yes. Like this?
- S: Yes, exactly. Well, if you see a problem, give the signal.
- R: OK.
- S: Oh, yeah. If you aren't a qualified rigger, you mustn't rig loads.
- R: Aha, OK.
- S: And finally, if you don't understand your task, ask the person in charge.

## 09

- 1 A: I visited Platform Sally yesterday.
- B: Oh yes? How did it go?
- A: No problems. The weather was bad, so we went by boat.
- B: Rough?
- A: Yes. Very rough. The hardest part was getting onto the boat in the harbour. There was a missing rung on the ladder and I nearly fell in the water ... it's not funny! I could have died!
- B: Or maybe just got very wet!
- 2 A: Sorry I'm late. Had a bit of an accident.
- B: Really? Where?
- A: On the derrick.
- B: The derrick? What happened?
- A: I went up to have a look at the block. There was a broken monkeyboard, believe it or not! I twisted my ankle.
- B: Ouch! You OK?
- A: It's OK now but I was not a happy man, I can tell you. And the derrickhand was not a happy man either, after I finished with him. A broken monkeyboard! I could have fallen!
- 3 A: Did you hear what happened yesterday? At the airfield?
- B: No, what?
- A: Some idiot forgot he was wearing a cap. On the pad.
- B: So?
- A: So the cap got blown away by the rotors.
- B: Whoops!
- A: Yes. Whoops! The idiot ran after it. He nearly lost his head on the tail rotor!
- B: What? Everyone knows not to wear loose clothing on an airfield!
- A: Yes. And that's not the worst thing.
- B: Why? What happened?
- A: The idiot was me! And I might have to see the boss.
- B: Oh no!

## Unit 3 Processes

10

- A: Can you tell me how oil fields are formed?  
B: Yes, of course. It's really very simple. First you have organic matter which falls to the sea bed.  
A: Organic matter is things like plants and animals?  
B: Yes, exactly. Next, this organic matter gets covered by sediments, such as clay or sand. Over time, more and more sediments fall, so we end up with different sedimentary layers.  
A: And the pressure increases?  
B: Yes, and the temperature increases too. And this process converts the organic matter into hydrocarbons; in other words, oil and gas.  
A: I see.  
B: Now this oil and gas is in what we call the source rock. After a while it flows upwards to what we call the reservoir rock. And finally, it stops in a so-called geological trap.  
A: Why do you call it a trap?  
B: Because it can't flow upwards any more. The cap rock, which is above the reservoir and is impermeable, stops the oil and gas escaping to the surface. It traps the oil and gas.  
A: I see.  
B: There are different types of traps, of course. Look at these diagrams. The first one is an anticline. You can see it's shaped like a dome. Here you can ...

11

- 1 sedimentary layers
- 2 hydrocarbons
- 3 reservoir rock
- 4 geological trap
- 5 impermeable

12

- 1 Jet fuel is made from kerosene, which condenses between 175 and 325 degrees.
- 2 When naphtha vapour is cooled to between 60 and 100 degrees, it condenses.
- 3 Diesel oil is produced by cooling crude oil vapour to between 250 and 350 degrees.
- 4 The boiling point of industrial fuel oil ranges from 370 to 600 degrees.

13

Good morning, everyone, and thanks for coming to this presentation. My objective in this talk is to explain some of the processes in oil refining. I'd like to start by saying a few things about hydrocarbons. ...

... That brings me to the three main processes: cracking, reforming and alteration. Let's look at cracking first. ...  
... Now let's move on to reforming. ...  
... And thirdly, let's turn to alteration. ...  
... As the flow chart shows, the next process is treatment. ...  
... As shown in the flow chart, after treatment we have blending. ...  
... And finally, I'd like to mention some of the products of refining. ...

14

- 1 A: So can you tell me more about the pipeline laying process?  
B: Yes, sure. We use different types of vessels, depending on the job. If we're in deep water we normally use a pipe-trenching barge behind the lay barge.

- A: Did I understand you correctly? You use trenches in deep water?  
B: Sorry, I mean shallow water, not deep water. In deep water we use a gravel-dumping vessel. It covers the pipe with gravel because it's too deep to dig a trench.  
A: Ah, I see.  
2 A: We waterproof the pipes offshore.  
B: Pardon?  
A: With bitumen and concrete.  
B: Offshore? On the lay barge?  
A: Oh sorry, my mistake. Onshore. Not offshore.  
3 A: And what does the stinger do?  
B: The stinger? The stinger is used to guide the gravel.  
A: So in other words, the stinger places the gravel in the right place?  
B: Oh, No ... not the gravel, I meant the pipeline, of course. As we lay the pipeline, the stinger is used to make sure that everything goes smoothly. For example, it stops the pipeline from bending and breaking.  
A: Thank you.

## Unit 4 Equipment

15

- 1 Tension leg platforms are more rigid than fixed platforms.
- 2 Fixed platforms are more flexible than compliant towers.
- 3 Fixed platforms are the smallest platforms and operate in the shallowest waters.
- 4 Tension leg platforms are larger than sea star platforms.
- 5 Spar platforms can operate in deeper water than tension leg or sea star platforms.
- 6 All of the platforms move sideways in storms, except fixed platforms.

16

One of the most dangerous accidents during the drilling and production stages of a well is a blowout. This is an uncontrolled flow of oil, gas or water at high pressure out of the well. The blowout preventer, or BOP, is designed to shut down the well quickly in an emergency blowout. It prevents fluids from escaping under extreme pressure. The BOP is located between the drilling platform and the ground. It is operated remotely by means of hydraulic pistons. There are three main types of blowout preventer: annular, blind ram and shear ram. Don't worry, I'll explain what these mean in a minute. But very briefly, in this diagram, the annular preventer is at the top, the blind rams are below that and the shear rams are at the bottom. Because these are stacked on top of each other, we sometimes call this a BOP stack.

17

The pumps suck the drilling mud out of the mud pits. They then pump the fluid through a hose to the rotary equipment. From the rotary hose the fluid enters the swivel and the Kelly. It then flows down through the drill string. Then it leaves the drill bit and flows around the annulus. The fluid picks up pieces of rock and sand. Then the mud rises up the well hole between the drill pipe and the casing. At the top of the well, the fluid flows through the mud return line into the shaker. The shaker takes the cuttings out of the fluid. The fluid then goes into the mud pits again and the cuttings enter the reserve pit.

18

- [K - Kevin; R - Rob]  
K: Hello? Hello? Can you hear me?  
R: Hello? Yes, I can hear you. Is that you, Kevin?  
K: Yes, yes! Hi, Rob. Bad connection!  
R: Yes.



- K: Pardon?  
 R: I said yes.  
 K: Are you at the terminal?  
 R: Yes, yes I am.  
 K: Good. Have you checked the gauges yet?  
 R: No, no, I haven't, I just arrived.  
 K: OK. Call me when you check them, please. I think we have a problem. We're getting some funny readings here at the control station.  
 R: I can't.  
 K: You can't? What? You can't check the gauges? Why not?  
 R: I can check the gauges. But I can't call you. My battery is almost dead.  
 K: Ah! Didn't you check the battery before you left?  
 R: No, I didn't. I forgot. Sorry.  
 K: Ah, OK. I'll send Jack out.  
 R: Pardon?  
 K: I'll send Jack out. With new batteries.  
 R: OK. That's great. Thanks.  
 K: Don't mention it! Just check the gauges. OK?  
 R: OK. Will do.

## Unit 5 Project management

### 19

- A: Hello, Hamish. How are you getting on? Have you raised the derrick on the platform yet?  
 B: Yes, we have.  
 A: Great. When did you assemble the rig platform?  
 B: Let's see. Yes, we assembled it in the first week of February.  
 A: So are you installing the lifting and rotary system now?  
 B: Yes, we are.  
 A: What else are you doing now?  
 B: We're setting up the tanks and pumps, and connecting the pipes and hoses.  
 A: OK. That's good. When will you string the electrical cables?  
 B: We'll do that in the second week of March.

### 20

- 1 A: OK, guys. Here's the plan: we can't use the helicopters because of the fog. So we're going to go out to the rig by bus and boat. The bus will be here in about an hour, so you all have time to grab a cup of coffee. It's going to be a long day.  
 B: How long will the drive take?  
 A: About three hours, I guess. And then the boat will take another six or seven hours on top of that.  
 B: It'll be dark when we get there.  
 A: Maybe, yes. I'll amend the schedule on the bus. We'll start the inspections tomorrow morning.  
 B: OK.
- 2 Welcome, everybody, and thanks for coming. As you know, this meeting is basically to discuss the new schedule for the refinery visits. Now, I know this is very unusual but this project comes straight from the minister. There have been several refinery shutdowns in the last few months, both planned and unplanned, and the result has been shortages in various products. Diesel oil has been in very short supply, for example. The minister is not happy and has asked for a full report. So this office will be visiting all refineries in the country to check exactly what is happening on the ground. We'll be handing in our report exactly seven weeks from today. After that it's back to normal. I'll be leaving tomorrow morning for a meeting with the minister, so I wanted to discuss the schedule with you before I go.

- 3 A: OK, so the next item on the agenda is the drilling equipment packages for the ETW drill ships.  
 B: Sorry, what ETW drill ships?  
 A: Ah! Forgot you weren't here last week. Toxy. It's a new contract. We're supplying drilling equipment packages, including pressure control equipment, for four drill ships belonging to ETW. It's a Brazilian company.  
 B: Ah, OK, thanks. Sounds good.  
 A: Yes, it is. The contract was signed last week and we're starting deliveries next month. In fact, Harry is flying out next week and I'll be joining him just before the first delivery.  
 B: Four packages. Must be worth a bit.  
 A: It's the biggest order in the company's history, so it's pretty good. And I understand there are more orders on the way, so ...

### 21

- [Jo - Joe; Ja - Jack; T - Tom]  
 Jo: OK, moving on to Pipeline Emerald, it looks like our planned route is no longer possible. The impact on the environment is just not acceptable - too much damage to vegetation, historic sites, wildlife and so on. I'll send you the full report. So now we're looking at alternatives. The first option is to use pipeline systems we already have. Jack, any thoughts?  
 Ja: Yes, this is a possibility. But existing pipelines won't give us the capacity we need without more money, more investment. We'll need to expand the facilities, new compressor stations, valve stations, communication towers, you name it. Probably a lot more expensive than the original route.  
 Jo: Hm ... OK. Can you do the maths, please? I'll need facts, even if in the end we simply say no to the idea.  
 Ja: Sure, no problem. If I start my team on it today, you'll have something on your desk by, say, next Monday. How does that sound?  
 Jo: Great, thanks. The second option is to look at other routes. This area to the north is unacceptable for geological reasons - there are too many faults. But this area to the south looks quite good. Tom, any comments?  
 T: Yes, we looked at that area last year when we did the original planning. If I remember correctly, we'll need to cross a lot of water.  
 Jo: Yes, that's right. It's mostly wetlands ... but still possible.  
 T: Yes, yes, of course. Definitely feasible. And there was another issue ...  
 Jo: Go on.  
 T: Yes, the area to the south doesn't have many roads or towns. If we build a pipeline there, we'll have to build access roads and housing for the workers. Probably around five to six hundred people, which is quite an impact. OK, the housing will be temporary and we'll take it away afterwards, but still ...  
 Jo: Yes, that's a good point. Thank you.

### 22

- [T - Tom; J - Joe]  
 T: Hi, Joe, it's Tom.  
 J: Hi, Tom. How's it going?  
 T: Good, thanks. Listen, I wanted to discuss the water crossings for the new pipeline. In the wetlands, I've been reading the regulations. Got some good news.  
 J: Go on.  
 T: OK, well, you know that in this area they classify three types of water bodies, right? Minor water bodies, like streams and so on, which we can cross using normal open-cut methods.



- J: Yep.  
 T: Secondly, major water bodies, which we'll have to cross using HDD – horizontal directional drilling, you know.  
 J: Yes, yes, I got that, OK.  
 T: The third category is intermediate water bodies, OK? That's something between minor and major.  
 J: OK.  
 T: Now here's the thing: if we want to cross intermediate water bodies, we'll have to divert the water – you know, using dams and pumps or flumes. Except if we work in the dry season. If we work in the dry season, we'll be able to use open-cut methods. A lot cheaper.  
 J: Ha ... yes, I see what you mean. So let me get this right. Basically, if there's no water flow, we'll be allowed to use open cut?  
 T: Yes, exactly. So if we time things right, we'll save a lot of money.  
 J: Yes, yes, that's excellent! Good news indeed.

23

OK, let's look at the project scope. This project really consists of three main elements. First of all, we're looking at a new tanker jetty to replace the current one. Basically, the new jetty will be able to handle tankers of up to 50,000 DWT instead of 12,000. Secondly, we want to expand the bulk fuel storage facility. The expansion will include bonded storage tanks as well as a new customer collection facility. The capacity will increase from 80,000 m<sup>3</sup> to 189,000 m<sup>3</sup> and we'll be able to store seven different product types. And thirdly, we're looking at a new pipeline system to transfer fuel from the jetty to the storage facility. This will replace the old system and, hopefully, follow the same route. I say 'hopefully' because we haven't finished our survey yet.

## Unit 6 Products

24

- 1 viscous – viscosity
- 2 miscible – miscibility
- 3 flammable – flammability
- 4 volatile – volatility
- 5 fluid – fluidity
- 6 immiscible – immiscibility
- 7 non-flammable – non-flammability
- 8 stable – stability

25

- A: We have 123 sites in the USA. Most of them are aquifers and salt caverns but we also have a few depleted reservoirs. Our working gas capacity is 2,657 bcf and our daily deliverability is 24,464 mmcf.  
 B: Sorry, could you tell me what *mmcf* stands for?  
 A: Sure, no problem. *M* stands for 'one thousand'. So *mm* is a million.  
 B: I see. And *bcf* is one billion cubic feet?  
 A: Yes, that's exactly right. You got it.  
 B: And one last question. Could you tell me about costs?  
 A: Oh, I'm sorry, I don't really know much about that. You'll have to ask Pete when he comes back.  
 B: Thank you.  
 A: But I can tell you that the last salt cavern facility that we commissioned costs around 30 million dollars per bcf of working gas capacity, give or take a little. I know because I read the report yesterday. But as I say, you're better off asking Pete for specific details.  
 B: I see. Thank you.

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Here we have a diagram showing the process of getting the product to the customer. Starting at the production well heads in the top left, we move to the production plants and the processing plants. After that, we have the PIG receivers – that's pipeline inspection gauge receivers – on the right here. And then the various stations in the pipeline: compressor, metering and regulation stations. Sometimes we have underground storage facilities, shown here, just under the transportation pipelines. Then there are more compressor, metering and regulation stations. And finally, we get to the various end users. OK so far? Good. Now, what I want to do today is tell you something about contamination in the system and, in particular, the pipeline system. As you probably know, we have two main types of contamination: solid and liquid. Solid contaminants include things like black powder, which is a term for all the corrosion that takes place in any pipeline system. So we're talking about stuff like rust and pipe scale. Liquid contaminants are things like water, glycols, hydrocarbon condensates, as well as compressor oils. And these contaminants can cause all sorts of problems, such as corrosion, erosion, blockages and so on.

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Welcome to the course. OK, now I know that some of you have transported dangerous goods in the past but, as you know, every country is different, so I want to go over some of the main rules. The first thing, which I am sure you all know, is to explain why we are here. In this country you have to pass an extra test before you can transport dangerous goods. We call this a hazmat endorsement – *hazmat* stands for 'hazardous materials'. And you also need a tank endorsement if you want to drive a vehicle which needs a class A or B CDL and has a tank to carry liquids or gas. *CDL* stands for commercial driver's license. I'll give you the exact details later.

The point is, to get those endorsements, you must pass a test. A written test. The training will be in this building, mostly on this floor. The practical training will be done on the hard standing in front of Building 7, which is where we have all the vehicles, as well as on the road. During the week we'll be looking at a number of topics, including bulk tank loading and unloading, driver responsibilities, parking rules, dealing with emergencies and so on. The full list and schedule is in your file.

Let's go over some of the basics. The system we use to warn other road users is very simple. Each vehicle has four placards, which are these diamond-shaped signs you can see here. Each side of the vehicle has to have a placard, so that's front, rear and both sides. The important thing is that they're easy to see. If you carry dangerous goods, you will also have the shipping documents. These documents have the identification number of what you are carrying, as well as an emergency telephone number in case you have a problem. These documents must stay in the cab.

## Unit 7 Impact

26

- [A – Alicia; TJ – Tom Jeffries]  
 A: We interrupt this programme to bring you some breaking news. An explosion, followed by a number of fires, occurred early this morning at the Texaco Refinery in Pembroke. 26 people sustained injuries on site, some serious. We go now to our reporter Tom Jeffries, who is on site. Tom, can you tell us what happened?  
 TJ: Hi, Alicia. Well, it seems that the whole incident started during an electrical storm early this morning. A lightning strike hit the crude distillation unit that provides feed to the Pembroke Cracking Company units. This caused a

fire and the unit was shut down by stall at the refinery. During the course of the morning, all the other FCCU units except the FCCU were shut down. FCCU stands for 'fluid catalytic cracking unit', which is basically where the crude oil is turned into gasoline. What happened next is a little confusing. It seems that a combination of errors resulted in the release of 20 tonnes of flammable hydrocarbons from the outlet pipe of the flare knock-out drum of the FCCU. This formed a vapour cloud which ignited and exploded. The explosion caused a major fire at the flare drum outlet itself, as well as a number of secondary fires. Alcia.

- A: Thank you, Tom. What can you tell us about damage to the refinery?  
 T: Well, the refinery suffered quite severe damage to process plant, buildings and storage tanks. But the refinery is well away from centres of population, so off-site damage is very limited.

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- A: The report mentions a combination of errors. Could you tell me more about that?  
 B: Well, you know that later in the morning we shut down the FCC units?  
 A: Except for the FCCU.  
 B: Right. Except for the FCCU. Big mistake. Well, after the FCC units were shut down, we thought that everything would be OK. But there were a couple of other issues we didn't know about. First of all, a control valve was shut but the control system said it was open.  
 A: I see. So there was a problem with the control system?  
 B: Yes, exactly. And we didn't have an overview of the whole process. The control panel allowed us to look at different elements but not everything together. So the operators were only looking at the known problem areas. They didn't see the big picture.  
 A: Ah ... What about alarm systems?  
 B: Yes, we had those. But so many different alarms were going off that it wasn't easy for the two operators to work out exactly what was happening. In the last few minutes before the explosion there were nearly 300 alarms going off. And as I said, the biggest mistake was to try and keep the FCCU running when it should have been shut down.

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- A: So let me get this straight: there was a fire, and the fire led to an explosion.  
 B: No, no ... the other way round.  
 A: Pardon?  
 B: The explosion caused the fire. The fire didn't cause the explosion. The explosion came first.  
 A: OK. And what caused the explosion?  
 B: Leaking gas. There was a hole in the pipe. Gas leaked out, formed a cloud and then ignited.  
 A: I see. And what caused the hole in the pipe?  
 B: That's what we don't know. We think maybe it was corrosion. But we'll have to wait for the investigation to be sure.  
 A: Fair enough.

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- [R - Robin; Y - Yusuf]  
 R: Hey, Yusuf. How's it going?  
 Y: Robin! Welcome back!  
 R: So what's new?  
 Y: Well, we had a fire while you were away.  
 R: Really? When?  
 Y: Friday the eleventh.  
 R: Wow! That's amazing! The eleventh of the eleventh of 2011?

Y: Yes.

R: Don't tell me it happened at eleven o'clock!

Y: No, no, it didn't. That would be too much of a coincidence!

R: Anyone hurt?

Y: Yes. One person. Do you know Suresh Mishra? He works in the control room.

R: Yes, I do.

Y: He was burnt quite badly, I think. They took him to hospital by helicopter. There was also a party of university students visiting but, from what I heard, they were all OK. Around 20 of them - quite a large group. Anyway, they were evacuated straight away, of course.

R: Do you know when they'll open the pipeline again?

Y: Well, Duncan thinks maybe early next week. But it depends on what they find.

R: When did they actually shut everything down?

Y: Pretty quickly, I think. Suresh radioed the control room straight away. So 20.00, give or take a couple of minutes. I know the time because the football had just started.

R: You and your football! What was the score?

Y: 3-1.

R: Was it just a fire? Or did the gas explode?

Y: Just a fire. Suresh was burnt while he was trying to put it out.

R: He should have waited for the fire brigade.

Y: Yep. They were there by 20.30, I heard.

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From what I understand, this is what happened: at 14.30 the safety officer issued a hot work permit to two employees - two welders. The permit was valid from 14.30 to 18.40 in the afternoon. The task was to weld a handrail to the stairs on storage tanks 387 and 388. All the preparation work had been done the day before. The welders took a break at around 15.45 and returned to work at around 16.05. They were unable to restart the engine on their welding machine, so they called maintenance. At around 16.15 a maintenance truck gave their welding machine a jump start. At around 16.50 an explosion occurred in tank 387, followed a minute later by an explosion in tank 388. Both welders were killed. Another tank in the area, 392, was damaged but did not catch fire. The firefighters were called at 16.53, arrived at 17.09 and had extinguished the flames by 18.45.

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Oil spills? Let's see. Well, a lot of oil is spilled during routine operations such as refuelling, loading or unloading, that sort of thing. Then there are mishaps and collisions between vessels or tankers and other transportation vehicles. Those are the ones that often get in the news. Er ... ships running aground is another one. Then we have ruptured pipelines at sea or on land. And oil exploration activities, drilling and so on. And of course, there's also mechanical failure of oil collection and storage equipment.

## Unit 8 Supply and demand

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Yes, so most of my transactions are done on the phone or the internet. I negotiate with the buyer and agree a price for the gas. I also arrange delivery to a specific location on their behalf. This is called a spot price, and fluctuates depending on supply and demand. Some customers like longer term contracts so that they know that their gas will be delivered over a period of time. The price is not fixed beforehand but again depends on the market. A futures contract is different. Here the price is fixed when the contract is agreed. This means that the buyer and seller are locked into a price - both sides know exactly how much the gas will cost.



- A: OK, let's see: a typical breakdown for our drilling operations? Well, let's look at this project here, which will give you an idea. Our biggest cost is always the drilling costs. This covers payments to the drilling contractors for the rig and the people who do the drilling. Costs here can vary, depending on the area and the type of rig. In this project it was around 37 percent.
- B: What about fuel? To run the rig, I mean.
- A: Well, we calculate that separately. In this case it was 14 percent. That includes running the rig, as well as moving it to and from the location.
- B: Ah, I see. OK.
- A: Now the drilling costs don't cover all the equipment we have to rent, so things like mud processing equipment, monitoring equipment, forklifts, pumps and so on come under rental equipment. In this project it was nine percent of the total cost. Then we have another big cost, which is contingencies.
- B: You mean emergencies and things?
- A: Well, not only emergencies. Just things we don't foresee. Like bad weather, for example, or stuck drill strings and so on. We always factor in a contingency cost.
- B: Always the same?
- A: No, no, not at all. If we have a difficult location, the contingency cost will be higher, or if we have an inexperienced crew or very deep wells. It varies, depending on how we see the risk. In this project, it came to 11 percent.
- B: OK.
- A: Then we have smaller costs. The location cost – in this project, three percent – covers the costs to prepare the site for drilling – levelling, for example, and adding a foundation for the drilling equipment. Service costs – here, seven percent – cover other things we have to buy, like drill bits, drilling mud and so on.
- B: Aren't things like that included in the drilling costs?
- A: No, not always. It varies. But in this project they were additional costs.
- B: I see.
- A: And then, of course, there are the tangibles like pipe casing and tubing. These are directly related to the price of steel on the world market. In this project it came to 13 percent.
- B: OK.
- A: And that's about it. Oh, sorry. There's also taxes. Around two percent. And of course, miscellaneous, around four percent, which covers all the things we haven't covered in the other sections.
- B: Like?
- A: Let's see ... um ... permits, insurance, legal fees, communications, that sort of thing.
- B: OK. That's all very clear. Thank you.

As you can see from this bar chart, we have divided the products into seven main types. The dark blue column shows demand in 2010 and the light blue column shows 2035. The highest demand is clearly for diesel and gasoil, projected to rise to 37 million barrels per day in 2035. This is quite a sharp increase. Next comes gasoline at 27. Both these products are directly related to the growth in road transport all over the world. The other five products are all around the ten million barrels per day mark. So we have ethane and LPG, around nine in 2010 but only a slight rise to around eleven in 2035, naphtha around six in 2010, rising to nine in 2035, and jet

kerosene around seven, rising to eight. The only area which is set to decrease is residual fuel, which we think will drop slightly from nine to seven.

- 1 I think a major trend is the move towards more deepwater drilling. E&P companies are drilling down to more than 5,000 feet on a regular basis, trying to find those last remaining pockets of oil. So, as I say, for me the major trend is more deepwater drilling, which I think will increase significantly.
- 2 We've already seen a dramatic increase in the number of mergers, acquisitions and joint ventures in recent years, and this trend is set to continue. We're all trying to make our companies stronger in a difficult economic environment.
- 3 China's industrial and commercial demands have risen sharply and this trend will continue. China will continue to be one of the world's biggest importers of oil.
- 4 Natural gas is already the fastest growing energy source in the world and this will not change for the foreseeable future – and most of it is in Russia.
- 5 New technologies such as hydraulic fracturing and horizontal drilling, as well as the rising cost of conventional drilling, mean that shale gas will continue to play an increasingly important role.

[T = Tony; J = Jane]

- T: White, one sugar, please. Thank you. Oh hi, Jane. Didn't see you there.
- J: Hi, Tony. Good to see you.
- T: Did you enjoy the opening address?
- J: You mean Harold Curtiss? Well, he made some good points but I found him a bit difficult to understand.
- T: Yes, yes, you're right. He's always like that. I guess he needs to learn to speak a bit more slowly. His accent was very difficult.
- J: Yes, exactly. He spoke like he had an apple in his mouth! Anyway, Session A next. The salt caverns should be interesting.
- T: Yes, definitely. But the other two look good, too.
- J: It's a shame we can't go to all of them.
- T: Eh? Why not?
- J: Oh Tony! The sessions are concurrent – A1, A2 and A3 are at the same time.
- T: Oh! Are they? I thought they followed on from each other.
- J: No, look, they're in different rooms. Weren't you listening when they explained the programme at the beginning?
- T: Well, in that case, it makes sense if we go to different sessions. That way we can report back on more sessions.
- J: Yes, OK. Right, I'll do A3, the salt caverns, then.
- T: OK, let's see. I'll go to A1, the FPSO one, then.
- J: Yes, good idea. Now Session B. You choose first.
- T: Er ... B1, blowout preventers for me, I think. No, wait. Er ... yes, blowout preventers. Yes.
- J: OK, I'll do B3, the shale gas, then. And then in Session C I'll go to C3, about the new LPG regs.
- T: OK. Then I'll do C1, pipelines and pipeline inspection gauges.
- J: Great. That's sorted, then, I guess I'll see you at the panel discussion.
- T: Or at one of the coffee breaks. Or lunch.
- J: Yes. But let's network, not just chat to each other. We're here to make new contacts, after all. We can compare notes next week in the office.
- T: Yes, yes, of course.

# Partner files: Student B

## 2 Procedures

- Load handling instructions** **Speaking exercise 7 page 17**  
You are a new roustabout. Practise the conversation in 2 on page 16 with Student A. Then swap roles and repeat the activity. Remember to discuss the following:
- obstructions
  - stop signals
  - taglines
  - condition of equipment

## 4 Equipment

- The blowout preventer** **Speaking exercise 6 page 31**  
Make notes about the appearance of the items in these photos and the materials they are made of. Then describe the items to Student A.



- Pipeline components** **Speaking exercise 7 page 35**  
You are an engineer at the control station. Listen to track 18 again and roleplay a similar conversation with Student A, a line walker inspecting a pipeline.

## 5 Project management

- In a meeting** **Speaking exercise 7 page 37**  
You are the supervisor. Read this list of tasks. The tasks with ticks ✓ have been done. The notes in brackets reflect your plan. Report to Student A, the project manager, and answer his/her questions.

- |  |  |
|--|--|
| 1 Detach the kelly from the travelling block. ✓            | 5 Lower the derrick. ✓                                   |
| 2 Uninstall the power system. ✓                            | 6 Dismantle the rig platform. <i>(today)</i>             |
| 3 Take down all the electric cables. ✓                     | 7 Fill in the mud and reserve pits. <i>(tomorrow)</i>    |
| 4 Disconnect the mud pipes and hoses from the equipment. ✓ | 8 Remove the equipment from the site. <i>(next week)</i> |

**Presenting your idea**

**Speaking exercise 7 page 43**

- 1 Read this newspaper ad. What is it about? Discuss with Student A.
- 2 Look at this map of an aviation fuel delivery system for Vancouver International Airport. Find the elements in the key on the map. Then describe the delivery system to Student A.

**Vancouver International Airport**

will be holding a press conference tomorrow to present their plans for a new aviation fuel delivery system. The press conference will take place in Terminal 1 and will start at 10 a.m. Members of the public are welcome.



## 6 Products

**Storage**

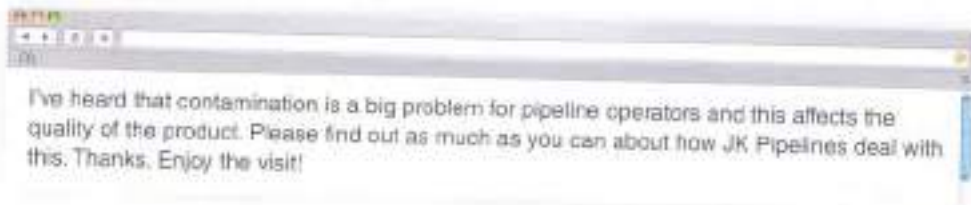
**Speaking exercise 8 page 47**

You work for a company which needs to buy additional gas storage capacity. You have heard that Student A may have a facility for rent or sale. Call him/her and ask for information.

**Contamination control**

**Speaking exercise 6 page 49**

You work for a bank. Today you are visiting JK Pipelines, a company which operates pipelines. Your bank is thinking about investing in it and has arranged a fact-finding visit so that you can learn about its operations. Unfortunately, your colleague is ill, so you are alone. Just before you leave, you receive this email. Read it and meet with Student A, an employee of JK Pipelines, to find out about the company's operations.





**Transport of dangerous goods**

**Speaking exercise 7 page 51**

Student A has got information about a training course. Ask questions to find out about it. Then swap roles. Read these details about a training course and answer Student A's questions.

*How long is it?*

*What will I learn on the course?*

*Who is the course for?*

## IATA dangerous goods regulations (DGR) – Initial

Review IATA (International Air Transport Association) cargo dangerous goods regulations and understand the legality and the responsibility of shippers, agents and airlines.

### Course details

Available as: distance learning course

Duration: 35–45 hours for course, plus 3,5 hours for exam

Recommended level: entry-level and professional

Prerequisites: none

### What you will learn

Upon completing this course, you will have the skills to:

- apply the IATA cargo dangerous goods regulations correctly.

- discern the legal aspects and the responsibility of shippers, agents and airlines involved in transporting dangerous goods.
- identify and classify individual dangerous goods items.
- verify goods are properly packed, marked and labelled.
- fill in and check the 'Shipper's Declaration for Dangerous Goods'.

### Who should attend

- dangerous goods processing staff
- freight forwarders
- cargo agents
- shippers and operators staff preparing COMAT (Company Material)
- cargo operations managers and frontline supervisors

## 7 Impact

**Incidents Speaking exercise 9 page 53**

- 1 Student A will explain an incident to you. Ask questions to find out what happened. Use 2 on page 52 to help you.
- 2 Read this incident report. Explain what happened to Student A. Answer his/her questions.

BP plc said a crude distillation unit (CDU) caught fire on 4 October at the 88,528-b/cd Lingen refinery in northwest Germany. One person was hospitalised. 'The fire was brought under control in about 30 minutes and damage was contained to that unit,'

a BP spokesman in London said. 'The CDU that caught fire has been shut down but the refinery has a second CDU that remains operational,' BP said. The fire broke out while the unit was coming back after summer maintenance.

**Cleaning up Speaking exercise 9 page 59**

Explain to Student A how polypropylene socks, pillows and pads, and diatomaceous earth (Oil Sorb) are used in the event of an oil spill. Use the words in the box.

absorb back edge float source spread work

## 8 Supply and demand

### The markets **Speaking exercise 7 page 61**

You work for a natural gas marketing company as a marketer. Your company supplies gas to a wide range of users, both commercial and industrial. Student A, a representative of a power station, is calling for information. Answer his/her questions.

### Prices **Speaking exercise 8 page 63**

Answer Student A's questions. Then ask him/her about typical costs in drilling operations.

### Trends and forecasts **Speaking exercise 8 page 65**

Draw the graph Student A describes. Then describe this graph for Student A to draw.

Btu = British thermal unit

Energy consumption in the United States, China and India, 1990 – 2035 (quadrillion Btu)

