5ª edición, 5th edition

PLAN DE ESTUDIOS DEL MASTER PROPIO EN

INGENIERÍA DE PETRÓLEO Y GAS (mip)

(Syllabus Oil & Gas Engineering Master Degree)

Inscripciones (enrolments): https://www.upm.es/atenea/

ESCOLEA DE MINAS Y ENERGÍA

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The Master is made up of the following modules:

1. PETROLEUM GEOLOGY
2. GEOPHYSICS
3. DRILLING ENGINEERING
4. RESERVOIR ENGINEERING
5. PRODUCTION AND COMPLETION ENGINEERING
6. SURFACE FACILITIES ENGINEERING
7. SHALE OIL AND GAS: RESERVOIRS AND COMPLETIONS
8. GAS AND CO2 STORAGE
9. LIQUEFIED NATURAL GAS (LNG)
10. HEALTH, SAFETY AND ENVIRONMENT
11. PETROLEUM ECONOMICS
12. PETROPHYSICS Lab
13. FIELD TRIP
14. FINAL WORK
Lecturers:

José Eugenio Ortiz. Ph.D. in Mining engineering-U.P.M. Professor at the Madrid School of Mines. Member and responsible of the Biomolecular Stratigraphy Laboratory. Expert in Stratigraphy, Palaeoclimatology, Palaeontology and Organic Geochemistry. He was Director of the Geological Engineering Department of the Madrid School of Mines and Secretary of the Geological Society of Spain.


Objectives:

1. Learn the depositional environment for different sedimentary rocks.
2. Learn the compaction processes of sedimentary depositions.
3. Learn the cementation processes.
4. Reservoir rocks and sealing rocks.

Syllabus:

1. Sedimentary Geology (J.E. Ortiz)
   1.1. Erosion, transport and sediment: Sediment genesis.
   1.2. Weathering.
   1.3. Dissolution, Oxidation and Hydrolysis.
   1.4. Transport.
   1.5. Sediments and bedding.
   1.6. Sedimentary rocks.

2. Sedimentary environment (T. de Torres)
   2.1. Fluid characteristics.
   2.2. Geographical aspects.
   2.3. Climatic aspects.
   2.4. Types.

3. Initial concepts. Sedimentary basin definition (E. Hernández)
   3.1. Subsidence.
   3.2. Sediments.
   3.3. - Deformations.

4. Sedimentary basin types (E. Hernández)
   4.1. Extensional basins.
   4.2. Compressional basins.
   4.3. Strike & Slip basins.

5. Basin & Tectonic plate margins (E. Hernandez)
   5.1. Divergent margins.
   5.1.1 Rift basins.
   5.1.2 Passive margins (Drift).
   5.1.3 Ocean basins.
   5.1.4. Aulacogens.
5.2. Convergent Margins.
   5.2.1. Trench basins.
   5.2.2. Fore arc basins.
   5.2.3. Back arc basins.
   5.2.4. Foreland basins & Piggy back basins.

5.3. Transform boundary (Strike & Slip basins).

6. Sequence Stratigraphy. (E. Hernandez)
6.1. Initial concepts.
6.2. System tracts.
   6.2.1. Lowstand sequence (LST).
   6.2.2. Transgressive sequence (TST)
   6.2.3. Highstand sequence (HST)
   6.2.4. Regressive Sequence (FSST)

6.3. Cycle and type of sequences.
6.4. Sequence boundaries.
6.5. Spanish sedimentary basin examples.
   6.5.1. Western Mediterranean basin.
   6.5.2. Guadalquivir basin.

Program:
This course lasts 4 days.

Day 1: Sedimentary Geology. (J.E. Ortiz)
Day 2: Sedimentary Environment. (J.E. Ortiz)
Day 3: Definition and types of sedimentary basin. (E. Hernández)
Day 4: Examples from Spain Geology. (E. Hernández)

Bibliography:

Scientific papers:
Objectives:

To introduce the basic concepts of structural geology and the hydrocarbon trap.
1. To understand the Theory of Plate Tectonics.
2. To understand the factors required to produce the Hydrocarbon Trap.
3. To recognize the main Extensional Trapping Styles.
4. To recognize the main Strike-Slip Trapping Styles.
5. To recognize the Contractional Trapping Styles.
6. To introduce the basic concepts of structural geology.

Syllabus:

1. Extensional Tectonics. (Enrique Hernández)
   1.1. Basement Involved.
   1.2. Extensional Detached Sediments.

2. Compressional Tectonics. (Enrique Hernández)
   2.1. Basement Involved.
   2.2. Inverted Extensional Features.
   2.3. Detached Sediments.

3. Strike & Slip Tectonic. (Enrique Hernández)
   3.1. Basic Terminology.
   3.2. Sequence of structures.
   3.3. Transcurrent & Transform faults.
   3.4. Contractional Pop-Ups.
   3.5. Extensional Pull-Aparts.
   3.6. Seismic Expression
   3.7. Field Examples

4. Salt Tectonics. (Enrique Hernández)
   4.1. Some physical characteristics of Salt.
   4.2. Salt Tectonics Mechanisms.
   4.3. Salt Tectonic Evolution.
   4.4. Seismic Expression.

5. Traps. (Enrique Hernández)

6. Basque-Cantabrian Tectonic Evolution. (Enrique Hernández)

7. The Theory of Plate Tectonics. (José Antonio Espí)
7.2. Seafloor Spreading.
7.3. Plate Tectonic Theory and Types of Plate Margin.
7.4. Intracratonic Deformation and Crustal Stress

8. An Introduction to Rock Mechanics and Rock Failure Modes. (José Antonio Espí)
8.2. Mohr Circles.
8.3. Coulomb-Navier Failure.
8.4. The Effect of Pore Pressure.
8.5. Neotectonics.

9. Contractional Tectonics. (José Antonio Espí)
9.1. Thin-skinned Deformation (terminology, detachments, wedge theory, controls, evaporites).
9.2. Thick-skinned Deformation (basement involvement, pre-existing weaknesses).
9.3. Seismic Expression.
9.4. Field Examples

Program:

This course lasts 4 days.

Day 1: (Enrique Hernández)
- Strike-Slip Tectonics and Trapping Geometries.
- Gravitational Tectonics and Trapping Geometries.

Day 2: (Enrique Hernández)
- Extensional Tectonics and Trapping Geometries.
- Stratigraphic Trapping Geometries.

Day 3: (José Eugenio Ortiz)
- Plate Tectonics.
- Rock Failure.

Day 4: (José Eugenio Ortiz)
- Contractional Tectonics
- Trapping Geometries.

Bibliography:


Scientific papers:

Objectives:

This course aims to improve participants’ understanding of the basic concepts and techniques of Basin Analysis and Petroleum Systems and their applications to petroleum exploration, via lectures, some practical exercises and presenting case histories from around the world. It will cover:

1. Concept and application of the Petroleum System exploration approach
2. The geological elements and processes are essential for the development of a petroleum accumulation
3. Different concepts for Basin Modeling and Petroleum System analysis
4. Relevant geological data required for constructing a computer-based Basin Model to be used in petroleum exploration
5. A simple computer-assisted Petroleum System exercise with BasinMod to apply the learnt concepts

Syllabus:

1. Petroleum Systems
   1.1. Revision of petroleum exploration historical approach
   1.2. Petroleum System concept: geological elements and processes
   1.3. Source rock. Sedimentary environments, types, quality, parameters distribution over geological time and geography
   1.4. Reservoir. Types, properties and characterization: porosity, permeability, geometry, continuity, fluid saturation
   1.5. Generation and migration through space and time. Processes, mechanisms, kinetics, maturity indicators and evaluation techniques
   1.6. Seal. Types (lateral/top seal), assessment and properties. Leakage mechanisms and seal failure examples. Fault seal analysis
   1.7. Trap. Types and geometries: structural, stratigraphic, hydrodynamic and other complex traps
   1.8. Petroleum System event chart: geological elements, processes, timing and critical moment
   1.9. Petroleum System: Algeria case history
   1.10. Exercise: construction and analysis of a Petroleum System event chart
   1.11. Play fairway and exploration risk analysis: quantification and mapping

2. Basin and Petroleum System Modeling
   2.1. Petroleum System and Basin modeling principles, input data required and source of the information
   2.2. Backstripping, forward modeling and Basin modeling work flow
   2.3. Burial history. Construction of burial and chronostratigraphic charts. Subsidence, depositional history (thickness, age, lithology) and tectonic history (uplifts, erosion, unconformities)
   2.4. Thermal history reconstruction: geothermal gradient, heat flow, thermal conductivity and paleothermometers
   2.5. Subsurface pressure distribution: lithostatic and hydrostatic pressure
   2.6. Model simulation (1D, 2D & 3D) and calibration
   2.7. Basin and Petroleum System modeling (BasinMod): Peru case history
Program:

This course lasts 3 days.

Day 1 (Jorge Navarro)
• Petroleum Systems.

Day 2 (Jorge Navarro)
• Petroleum Systems.
  • Basin and Petroleum System Modeling.

Day 3 (Jorge Navarro)
• Basin and Petroleum System Modeling

Bibliography:


Scientific papers:

Lecturers:

Juan F. Llamas. Ph.D. in Mining engineering, full professor of Geochemistry, Environmental Quemistry and Instrumental Analysis at the Polytechnic University of Madrid. Specialist in Geochemistry applied to prospecting and environmental control of hydrocarbons. He has directed various doctoral theses on these subjects and more than 30 research works in international journals.

Emilio Carro. Mining Engineer by ETSIM (UPM). Master in E&P by French Institute for Petroleum Master in E&P and Master in Petroleum Engineering by H.K. Van Poolen. 33 years of experience in E&P business with Repsol and Hispanoil in technical positions, as well as managerial positions. After retirement I was the Director of ISE’s E&P Master and Technical Director of the Instituto Petrofisico. Co-director of "Master en Ingeniería de Petróleo y Gas -Oil & Gas Engineering Master degree-" (mip) of UPM.

Objectives:

1. Learn how hydrocarbons are generated in the sedimentary source rock.
2. Learn how the maturation of organic matter progress during rocks compaction.
3. Evaluate TOC and reflectance vitrinita.
4. Lab analysis by the Rock Eval.

Syllabus:

1. Organic matter:
   1.1. Organic matter sedimentation.
   1.2. Types of organic matter.
   1.3. Organic matter maturation: Diagenesis, Catagenesis and Metagenesis.

2. Van-Kevelen Diagram.

3. Petroleum Formation and Composition.
   3.1. API gravity versus depth.
   3.2. Crude Oil Fractions.
   3.3. Inorganic

4. Rock Eval and Migration: (FIP)
   4.2. Reflectance of vitrinite.
   4.3. Migration of hydrocarbons

Program:

This course lasts 4 days:

Day 1. (Juan F. Llamas)
   • Organic matter.

Day 2. (Juan F. Llamas)
   • Van-Kevelen Diagram.

Day 3. (Juan F. Llamas)
   • Hydrocarbons formation and oil composition.
Day 4: (Emilio Carro / Juan F. Llamas)

- Rock Eval and migration

Bibliography:


Scientific papers:


General Bibliography of PG1 Module:

Objectives:

1. Become acquainted with the main geophysical methods used in exploration, their applications and their limitations.
2. Understand the basic concepts of seismic wave propagation, reflection, diffraction and refraction.
3. Understand in broad terms how 3D-seismic land and marine data are acquired.
4. Understand in broad terms how seismic data is processed.

Syllabus:

1. Introduction to Geophysics.
   1.1. The Objective.
   1.2. The Different Survey Methods.
      1.2.1. Gravity.
      1.2.2. Magnetic.
      1.2.3. Reflection Seismic.
   1.3. The Importance of Seismic in Hydrocarbon Exploration.

2. Seismic Waves.
   2.1. Waves Propagation.
   2.2. Sinusoids.
   2.3. Amplitude, Frequency and Phase.
   2.4. Energy Decay.
   2.5. Type of Elastic Waves.
   2.6. Reflections and Refractions.
   2.7. Reflection Coefficient.
   2.8. Reflection Hyperbola.
   2.9. Diffractions, Ground Roll, Multiples and Noise.

3. Data Acquisition.
   3.1. Seismic Sources.
   3.2. Seismic Receivers.
   3.3. Seismic Spreads.
   3.4. Key Parameters in 3D-Seismic Acquisition.
   3.5. Logistics of Land Acquisition.
   3.6. Logistics of Marine Acquisition.
   3.7. Acquisition Time.
   3.8. Acquisition Cost.
4. Data Processing
4.1. Processing Objective.
4.2. Main Processing Steps.
4.3. Interpretive Elements in Seismic Processing.
4.4. Processing Time.
4.5. Processing Cost.

Program:

This course last 4 days.

Day 1: Introduction to Geophysics. Seismic waves. (Alvaro Garcia-Hourcade)
Day 2: Data acquisition. (Massimo de Giulio)
Day 3: Data Processing. (Massimo de Giulio)
Day 4: Exercises and control (Massimo de Giulio y Alvaro Garcia-Hourcade)

Bibliography:

- www.ipims.com

Scientific papers:

Lecturers:

Juan Klimowitz Picola. Geologist-geophysicist with more than 30 years of experience in seismic interpretation. Co-director and founding partner of Gessal, since 1987, has been responsible for several exploration subsurface studies of natural resources, mining, hydrocarbon exploration, as well as of underground gas, CO2 or radioactive waste storage. Moreover, he is a specialist in computer applications applied to seismic interpretation. In addition, he has several papers published in specialist journals related to tectonics and stratigraphy.

Serafín Escalante García. Geology graduated by Universidad Complutense de Madrid. He has 12 years’ experience in different geological investigation: geological mapping, geophysical interpretation and geological modelling. He has been working for Gessal since 2003 and within this period he has worked as a technical support geologist for Repsol’s Argelia exploration team over three years. He is a specialist in geological and geophysical computer applications, with high experience in Petrel interpretation and modelling software.

Objectives:

Become acquainted with the main geophysical methods used in exploration, their applications and their limitations.

1. Understand how seismic data can be linked to geology by using well data.
2. Learn how seismic data can be converted from time to depth.
3. Get to know how 2D-seismic data is interpreted and how horizon maps are made.
4. Learn how 3D-seismic data is interpreted. How horizon maps are made, the principle of attribute extraction.

Syllabus:

1. 2D and 3D Seismic Interpretation
   1.1. The Seismic Interpretation Objective.
   1.2. Identification and Interpretation of Geologic Horizons.
   1.3. Seismic stratigraphy & seismic structural expression
   1.4. Problems and Pitfalls in Seismic Interpretation.
   1.5. Seismic attributes

2. 2D and 3D Seismic Interpretation exercises
   2.1 Introduction to interpretation software. Petrel
   2.2. Fault/Horizon Interpretation in 2D and 3D software.
   2.3. 2D and 3D Seismic Interpretation exercises.
   2.4. How to Create a Horizon Map.

3. The Link between Seismic and Well Information.
   3.1. Overview Well Calibration.
   3.2. Well Shooting and VSP.
   3.4. Sonic and Density Logs.
   3.4. Synthetic Seismograms.
   3.5 Exercises in Well tying

4. Time to Depth Conversion.
   4.1. Overview Depth Conversion.
   4.2. Velocity Information.
   4.3. Depth Conversion Methods.
   4.4. Exercises in Depth Conversion
   4.3. How to Create a Horizon Map.
Program:

This course lasts 4 days.

Day 1: Seismic Interpretation. (Juan Klimowitz, Serafín Escalante)
Day 2: The Link between seismic and well information. (Juan Klimowitz, Serafín Escalante)
Day 3: Time to Depth Conversion. 3D Interpretation software Exercises. (Juan Klimowitz, Serafín Escalante)
Day 4: 3D Interpretation software Exercises. (Juan Klimowitz, Serafín Escalante)

Introduction to geophysics tasks of Final Project.

Bibliography:


Scientific papers:

Lecturers:

Alfonso Maldonado. PhD Mining Engineer. Full professor of Geophysics at the Polytechnical University of Madrid. He has been Director of the School of Mines and Energy of this University and he is currently collaborating with Lukoil Overseas and PDVSA.

Juan Luis Plata. PhD Mining Engineer. In 1972 he joined the Geophysical Department of the Geological Survey of Spain (IGME), where he has developed his entire career, been in charge of geophysical surveys using all the geophysical methods, specially reflection seismic and potential fields. From 1991, he has also been involved in geophysical research, developing projects for new techniques and methods and promoting digital geophysical data bases and the recovery of old geophysical documents. Is author of more than one hundred of technical and scientific IGME open files reports and of more than 50 papers and presentations in national and international Magazines and Geophysical Meetings. He was appoint-ed part-time Professor of Applied Geophysics at Madrid School of Mines (UPM) in 1979, participating also at more than thirty postgraduate courses at several Spanish universities. He is retired at present.

Objectives:

1. Become acquainted with the controls of deposition and the basement geometry.
2. When to use those less expensive methods to explore a sedimentary basin.
3. Understand the basic concepts for gravity and magnetic prospecting techniques.
4. Interpret the techniques.
5. To know the principles of magnetic anomalies interpretation

Syllabus:

1. Gravity and magnetic techniques.
   1.1 Gravity technique supporting concepts
   1.2 Magnetic technique supporting concepts.

2. Data acquisition
   2.1 Gravity data acquisition.
   2.2 Magnetic data acquisition.

3. Data interpretation.
   3.1 Gravity data interpretation.
   3.2 Magnetic data interpretation.

Syllabus specific for magnetic techniques:

1. Magnetic method supporting concepts
   1.1 Magnetic susceptibility of rocks
      - Concept of magnetic susceptibility (intensity of magnetization / magnetizing field).
      - Diamagnetic, paramagnetic and ferromagnetic minerals. Induced field.
      - Distribution of magnetic minerals in the rocks: ternary solutions diagram.
      - Magnetic susceptibility contrast between rocks.
   1.2 Geomorphic field
      - Origin and components of the geomagnetic field.
      - Internal dipolar field; change of polarity. Paleomagnetism.
      - No dipolar component; secular variation. IGRF.
      - External field: diurnal variation.
1.3 Magnetic anomaly
- Concept of magnetic anomaly.
- Polarization pattern: influence of body geometry, orientation and latitude.
- Difference with gravity anomalies.

2. Magnetic data acquisition
2.1 Magnetometers
- Protons precession magnetometers.
- Optically pumped magnetometers.

2.2 Air and sea magnetic surveys
- Instrumentation: platforms, magnetometers installation, positioning requirements.
- Sample theorem
- Air acquisition parameters: flight altitude, distance between profiles.

2.3 Data processing to draw a map of magnetic anomalies
- Field data corrections: diurnal variation, elevation reduction (levelling) and IGRF.
- Isolines drawing: interpolation techniques.

3.1 Analysis of magnetic anomalies maps
- Representation techniques: colour pallets, imaging, shadowing.
- Transformation techniques: reduction to the pole, derivatives and filtering.

3.2 Anomalies interpretation
- Intrasedimentary and basement anomalies.
- Qualitative interpretation: facies (pattern) analysis; drawing of structural axis.
- Quantitative interpretation: Euler depth determination; inversion and modelling.
- Examples.
- Data Bases.

Program:

This course last 2 days:

Day 1: Magnetic techniques: Acquisition and interpretation. (Juan Luis Plata)
Day 2: Gravity techniques: Acquisition and interpretation. (Alfonso Maldonado)

Bibliography:

Scientific papers:
- Bishop C. 2012. Interpretation and Modelling of the Pedirka Basin (central Australia) using Magnetics, Gravity, Well-log and Seismic data. 22nd International Geophysical Conference and Exhibition, 26-29 February 2012 - Brisbane, Australia
- Gadjrov V.G. and Eppelbaum L.V. 2012. Detailed gravity, magnetics successful in exploring Azerbaijan onshore areas. Oil and Gas Journal 11/05/2012, volume 110, Issue 11

More learning materials:
- When Seismic is not enough - Exploit the Potential of Gravity and Magnetic Data. Duration: 1 h 26min https://www.youtube.com/watch?v=3tw8pH3NlWg
- Integrating Potential Field data with seismic data and structural geology. Duration: 31 min. https://www.youtube.com/watch?v=MmLhGvJuwQ
MODULE PGPH2
GEOPHYSICS
COURSE PGPH2.4
WELL LOGGING

Lecturers:


**Manuel Gutiérrez Alonso.** Geologist working for Gessal, since 2006 as consultant in Repsol as Senior Petrophysicist in Regional Studies Group. Studies carried out in basin all around the world, both clastic and carbonatic environment. Also in No Conventional group involved in shale gas plays studies.

**Lorenzo Serra.** Senior petrophysicist with more than fifteen years’ experience in well logging interpretation. He is the Petrophysicist team leader at Cepsa. Before that he worked successively for Schlumberger, Techsia, BakerHughes, GDFSuez, EonRuhrgas and GeoPetrol. He holds a Master of Science in Applied Physics from Paris-XI Orsay University. He has been conducting petrophysical evaluation projects for numerous E&P companies such as BP, Chevron, Shell, ConocoPhillips, TOTAL, Statoil, Anadarko. He also gave lectures on well logging and petrophysics to various E&P companies such as TOTAL, PEMEX, ETAP, ONGC, BG, Burlington Resources, Cairn Energy, Libyan Petroleum Research Center, etc...

Schlumberger.

Objectives:
1. Rock Recognition / Lithology.
2. Rock Properties calculation.
3. Fluids & contacts (OWC, GWC & GOC).
4. Logging equipment and Operations.

Syllabus:

1. **Nomenclature and Types of Logs.**

2. **Acquisition and Recording of Wireline Log Data.**

3. **Course Outline and Objectives.** Nature of a Hydrocarbon Accumulation; Porosity, Permeability, Wetness and the Matrix Concept; Invasion.

4. **Wireline Open Hole Tools and Services.** The Electric Logs and SP and their Interpretation; the Sonic Log and its Interpretation; the Radioactive Logs and their Interpretation; Qualitative Interpretation of Logs, Lithology Determination and Gas Detection.

5. **Quantitative Interpretation.** Introduction and Objectives; Shale and Hydrocarbon Correction; Effective Porosity; Formation Factor; RwSw and Sxo determination; Estimation of the Depth of Mud Filtrate Invasion; Evaluation of Clean Sandstone Reservoir and Carbonate Reservoir.
Main Exercises and Tutorials:

- Exercise 1: Qualitative Interpretation.
- Exercise 2: Lithology and Porosity Identification.
- Exercise 3: Quantitative Interpretation: Rw, Sw and Sxo Determination.
- Exercise 5: Evaluation of a Carbonate Reservoir.

Program:

This course lasts 7 days.

Day 1: Course by Schlumberger, Tools and Operations.
Day 2: Tools and Operations. Production logs. (Lorenzo Serra)
Day 3: Wireline Open Hole Tools and Services. (Gonzalo Ruiz Cebrían, Manuel Gutiérrez Alonso)
Day 4: Qualitative Interpretation of Logs. (Gonzalo Ruiz Cebrían, Manuel Gutiérrez Alonso)
Day 5: Quantitative Interpretation of Logs. (Gonzalo Ruiz Cebrían, Manuel Gutiérrez Alonso)
Day 6: Quantitative Interpretation of Log. Interpretation with software. (Gonzalo Ruiz Cebrían, Manuel Gutiérrez Alonso)
Day 7: Quantitative Interpretation of Log. Interpretation with software. (Gonzalo Ruiz Cebrían, Manuel Gutiérrez Alonso)

Bibliography:

- Schlumberger: Log Interpretation Principles/ Applications. Schlumberger; several editions (downloadable from the SLB web page http://www.slb.com/resources/publications/books/log_charts.aspx)
- Schlumberger: Log Interpretation Charts. Schlumberger; several editions

Scientific papers:

- Doveton, J. H. (2001). All models are wrong, but some models are useful: “solving” the Simandoux equation. From Session J of the International Association for Mathematical Geology Conference, Cancun, Mexico.
Objectives:

1. Understand how the petroleum industry assesses and quantifies oil and gas reserves and resources.
2. Identify uncertainties and risks intrinsic to the hydrocarbon exploration and production.
3. Understand the basic statistical measures and probability distributions.
4. Learn how to calculate oil & gas volumes.
5. Be able to assign technical risks, and to calculate Probability of Success.
6. Use Reserves Evaluation Programme (REP) and apply Monte-Carlo techniques to estimate oil & gas volumes.

Syllabus:

1. Introduction
   1.1. Petroleum Resources Management System (SPE-PRMS)
   1.2. Uncertainty & Risk
   1.3. Basin / Play / Lead / Prospect

2. Probability & Statistics Applied to the E&P
   2.1. Probability Density Functions
   2.2. The Central Limit Theorem & the Normal Distribution
   2.3. The Normal Cumulative Probability Distribution, Percentiles
   2.4. The Lognormal Distribution
   2.5. The Lognormal Cumulative Probability Distribution

3. Oil & Gas Volumetrics
   3.1. Methods of volume estimation
       - Analogy Methods
       - Volumetric Methods
         Deterministic Approach
         Probabilistic Approach
       - Other Methods
   3.2. Data source

4. Probability of Success
   4.1. Probability of Geologic Success (Pg)
   4.2 Probability of Economic Success (Pe)

5. Computer lab: Monte Carlo analysis
   5.1 Introduction to Reserves Evaluation Programme (REP)
   5.2 Prospect/Field evaluation
       - input parameters
       - Entering probability distributions
       - Calculations
       - Tools
   5.3 Consolidations
       - Types of consolidation forms
   5.4 Understanding the results
Main Exercises and Tutorials:

Exercise 1. Volumetric stochastic approach
Exercise 2. Volumetric Consolidation
Exercise 3. Frontier prospect volumetric assessment

Program:

This course lasts 3 days.


Bibliography:


Scientific papers:

Lecturer 1: Fernando Steegmann. Mining Engineering from the Polytechnic University of Madrid and a diploma in Business Administration (PDD) from IESE. Head of the Department of Drilling CAMPSA and in Hispanoil, being successively Operations Manager in Brazil, Equatorial Guinea and Algeria. He worked in the design of Gaviota gas field platform and Drillmar drilling rig. Drilling Director of Repsol Exploration, with responsibility for all operations performed in Spain and abroad. Then E&P Director and later Technical Director in the Corporate Office of Repsol YPF.

Lecturer 2: Juan Herrera Herbert (UPM). Backed by a PhD in Mining Engineering from the Technical University of Madrid, a MSc in Mining Engineering also from the Technical University of Madrid and a MSc in Civil Engineering of Mines from the University of Chile (Chile), has a proven track of more than 20 years of experience in Industry (engineering and Consulting) and in Higher Education. Coming from a position of Head of a Department in the Technical University of Madrid, he is now involved in the creation, launch and running of EIT Raw Materials’ Learning and Education activities as Education Officer of the Southern Co-Location Center. As Professor at the Madrid School of Mines and Energy, he coordinates several subjects related with oil and gas production and technology.

Objectives:

This is an introduction to Drilling Engineering. The objectives are to introduce the concepts and equipment used in drilling; to examine the design requirements and techniques and to examine the optimization of the drilling activity.

Syllabus:

1. Introduction
2. Overview
3. Rig Components
4. Drill String
5. Bits
6. Formation Pressure
7. Well Control
8. MWD
9. Offshore Drilling

Program:

This course lasts 2 days.

Day 1: (Fernando Steegmann)

- Module Introduction
  - History
  - Drilling equipment and operations
  - Circulating System. Mud
  - Casing and bits
  - Directional Drilling
  - Wellsite drilling logs
  - BOP and wellhead
  - Onshore, offshore drilling
Day 2: (Juan Herrera)

- Overview of Drilling.
- Rig Components.
- Bits.
- Film: Rotary Rig.
- Exercises:
  - Bit Selection and Grading.
  - Start Equipment List/Rig Spec.

Bibliography:

- "Drilling Data Handbook", Ed. Technip - IFP. Halliburton Table
- "Field Data Handbook". Dowell Schlumberger.
- "IADC Drilling Manual".
- "Petróleo Moderno: Un manual básico para la Industria". Bill D. Berger, January
Lecturer: Juan Herrera Herbert (UPM). Backed by a PhD in Mining Engineering from the Technical University of Madrid, a MSc in Mining Engineering also from the Technical University of Madrid and a MSc in Civil Engineering of Mines from the University of Chile (Chile), has a proven track of more than 20 years of experience in Industry (engineering and Consulting) and in Higher Education. Coming from a position of Head of a Department in the Technical University of Madrid, he is now involved in the creation, launch and running of EIT Raw Materials’ Learning and Education activities as Education Officer of the Southern Co-Location Center. As Professor at the Madrid School of Mines and Energy, he coordinates several subjects related with oil and gas production and technology.

Objectives:
1. Understand the hydraulics of the mud fluid system of a drilling rig.
2. Understand the functions of the mud fluid during drilling.
3. Chemistry of the mud fluid.

Syllabus:
1. The mud fluid chemistry.
   1.1. Water base muds.
   1.2. Oil base muds.
   1.3. Heavy muds, components and operations.

2. The mud fluid circuit in a drilling rig.
   2.1. Pumps and containers.
   2.2. Subsurface mud pathway.
   2.3. Mud parameters and measurement. Daily Reporting
   2.4. Mud system hydraulics.
   2.5. Power at the bottom of the hole.

Program:
This course lasts 2 days.

Day 1: (Juan Herrera)

Day 2: (Juan Herrera)

Bibliography:
- "Drilling Data Handbook", Ed. Technip - IFP. Halliburton Table
- "Field Data Handbook". Dowell Schlumberger.
- "IADC Drilling Manual".
- "Petróleo Moderno: Un manual básico para la Industria". Bill D. Berger, January

Objectives:

1. Understand the casing depth selection.
2. Understand the casing design.
3. Understand the cement selection and placement.

Syllabus:

1. Casing design.
   1.1. Introduction
   1.2. Functions and types of casings
   1.3. Materials
   1.4. Casing Design
   1.5. Exercise

2. Cementing.
   2.1. Introduction
   2.2. Factors affecting primary cementing
   2.3. Cementing operations
   2.4. Cementing design
   2.5. Cement integrity
   2.6. Exercise
   2.7. Cementing program example

Program:

This course lasts 2 days.

Day 1: (Jesús Cáceres)
   • Types of casings and casing design.

Day 2: (Jesús Cáceres)
   • Types of cements and cementing operations:
Bibliography:

- “Drilling Data Handbook”, Ed. Technip - IFP. Halliburton Table
- “IADC Drilling Manual”.
- “Petróleo Moderno: Un manual básico para la Industria”. Bill D. Berger, January
Objectives:

1. Understand the fundamentals of directional drilling
2. Understand how to plan a directional well
3. Understand the techniques used in directional, horizontal and multilateral drilling.
4. Know the tools used in directional, horizontal and multilateral drilling.

Syllabus:

1. Fundamentals of Directional drilling.
   1.1.- Definitions and Principles of Directional Drilling
   1.2.- Applications and type of deviated wells
   1.3.- Directional Well Planning. Challenges drilling highly deviated wells.
   1.4 – Horizontal and Multilateral wells.

2. Techniques and Tools used in Directional Drilling
   2.1.- Directional tools.
   2.2 – Measure while drilling tools
   2.3 – Logging while drilling tools

Program:

This course lasts 1 day.

Day 1: (Jesús Cáceres)

Bibliography:

- "Drilling Data Handbook", Ed. Technip - IFP. Halliburton Table
- "Field Data Handbook". Dowell Schlumberger.
- "IADC Drilling Manual".
- "Petróleo Moderno: Un manual básico para la Industria". Bill D. Berger, January
**Objectives:**

1. Understand the steps required to design a well. Review the geological data.
2. Previous available data. Required analysis.
3. How to specify the drilling rig specifications.
4. Learn how to specify the Mud fluid requirements.

**Syllabus:**

1. **Previous data to be collected.**
   1.1. Rig availability.
   1.2. Others wells drilled in the area.
   1.3. Bit selection.
   1.4. Casing depths selection.

2. **Drilling parameters.**
   2.1. Weight on bit.
   2.2. rpm.
   2.3. Hydraulics.
   2.4. Well progress (depth vs. time).

**Program:**

This course lasts 3 days.

**Day 1:** (Javier Moro)
- Analysis of previous available data.

**Day 2:** (Fernando Steegmann)
- Well design.

**Day 3:** (Fernando Steegmann / Javier Moro)
Bibliography:

- "Drilling Data Handbook", Ed. Technip - IFP. Halliburton Table
- "Field Data Handbook". Dowell Schlumberger.
- "IADC Drilling Manual".
- "Petróleo Moderno: Un manual básico para la Industria". Bill D. Berger, January
Objectives:

1. Become acquainted with the controls of deposition on the properties and geometries of reservoirs.
2. Get to know how to recognize reservoir flow units.
3. Learn how to define the flow unit geometry in the subsurface.
4. Learn how to draw maps of flow units.
5. Learn how to define properties of flow units.
6. Learn how to determine volumetric hydrocarbons in place.

Syllabus:

1. Sedimentology.
   1.1. Texture and properties – clastics.
   1.2. Fluvial reservoirs – geometries.
   1.3. Shallow marine reservoirs – geometries.
   1.4. Deep water reservoirs – geometries.

2. Correlation.
   2.1. Introduction.
   2.2. Stratigraphy.
   2.3. Correlation panels and cross sections.
   2.4. Stratigraphy and reservoir performance.
   2.5. Architecture, drive mechanism and recovery.
   2.6. Compartmentalization and reserves.

   3.1. Introduction.
   3.2. Data types.
   3.4. Computer contouring.
   3.5. Structural maps.
   3.7. Isopachs.
   3.8. Grid manipulation.
   3.9. Fault maps.

   4.1. Introduction.
   4.2. Measures of central tendency.
   4.3. Measures of variability.
   4.4. Distributions.
   4.5. Sample sufficiency.
   4.6. Measures of spatial correlation
5. Volumetrics.
5.1. Introduction.
5.2. Gross reservoir and Net Pay.
5.3. Deterministic HIP calculations.
5.4. Monte Carlo HIP calculations.
5.5. Reserves definitions and categories.
5.6. Handling Uncertainty.

6. Reservoir Static Modelling.
6.2. Reservoir Correlation and Zonation.
6.3. Gridding Design.
6.4. Facies modelling / Petrophysical Property modelling.

Program:

This course lasts 4 days.
Day 1: (José E. Ortiz)
  • Sedimentology of reservoirs on deep waters and fluvial, and Correlation.
Day 2: (José E. Ortiz)
  • Mapping and Geological statistics.
Day 3: (Raul Rodriguez)
  • Volumetrics and Reservoir Static Modelling
Day 4: (José E. Ortiz)
  • Exercises about Sedimentology of reservoirs on deep waters and fluvial, Correlation, Mapping, and Geological statistics.

Bibliography:

  o "Drilling Data Handbook", Ed. Technip - IFP, Halliburton Table.


Emilio Carro Puente. Mining Engineer by ETSIM (UPM). Master in E&P by French Institute for Petroleum Master in E&P and Master in Petroleum Engineering by H.K. Van Poolen. 33 years of experience in E&P business with Repsol and Hispanoil in technical positions, as well as managerial positions. After retirement I was the Director of ISE's E&P Master and Tecnical Director of the Instituto Petrofisico. Co-director of “Master en Ingeniería de Petróleo y Gas -Oil & Gas Engineering Master degree-” (mip) of UPM.

Objectives:
1. Understand Reservoir Rock Properties: Porosity, Permeability and Fluid-rock properties Saturation, capillary pressure and relative permeability
2. Understand Reservoir Pressure and Temperature Regimes and the techniques used for Distributed Pressure Measurements.
3. Understand the Phase Behavior of Reservoir Fluids.
4. Understand oil PVT analysis
5. Understand Gas reservoir behavior.
6. Understand Reservoir Production Mechanisms.
7. Become acquainted with the Material Balance Technique.
8. Understand the water influx calculations.

Syllabus:

1. Reservoir Rock Properties.
   1.1. Porosity.
   1.2. Absolute Permeability (Darcy's Law).
   1.3. Saturations.

2. Reservoir description: Rock-Fluids Properties
   2.1. Interfacial tension
   2.2. Wettability
   2.3. Capillary Pressure-Saturation
   2.4. Effective and Relative Permeability. Lab measurements and reporting

3 A. Reservoir Pressure and Temperature.
   3A.1. Reservoir Fluid Pressure and Temperatures Regimes.
   3A.2. Techniques for Pressure Measurements: WFT.

3 B. Phase Behaviour of Reservoir Gas.
   3B.1. Pure Substances.
   3B.3. Pressure-Temperature Phase Diagram Classification of Gas Reservoirs.

4. Oil PVT Analysis:
4.1. Definition of the Basic Parameters (Bo, Rs, Bg) and their Evolution with Pressure.
4.2. Oil Viscosity.
4.3. Black Oil Correlations.
4.4. Sampling Methods (Subsurface and Surface Recombined Samples).
4.5. Laboratory Experiments (Flash Expansion, Differential Liberation, Separator Tests).

5. Gas and Gas-Condensate:
5.1. Ideal Gases.
5.2. Behavior of Real Gases: Equation of State.
5.3. Definition of the Basic Parameters (Z, Eg, CGR) and their evolution with Pressure.
5.4. Gas Viscosity.
5.5. Correlations.
5.7. Laboratory Experiments (Retrograde Condensation).
5.8 Vapour Liquid Equilibrium Calculations: Equations of State.

6. Properties of Formation Waters.

7.2. Reservoir Drives and Production Mechanisms.
7.3. Primary, Secondary and Improved Oil Recovery.
7.4. Recovery Factors.
7.5. Reserve Determination and Classification.

8.2. The Material Balance Expressed as a Linear Equation.
8.3. Material Balance Applied to Oil Fields:
   a) Depletion above Bubble Point.
   b) Solution Gas Drive.
   c) Gas-Cap Drive.
   d) Compaction Drive.
   e) Natural Water Drive.
8.4. Gas Material Balance:
   a) Volumetric Depletion.
   b) Natural Water Drive.
8.5. Limitations of the Material Balance.

Tutorials:
Reservoir rock properties exercises
Reservoir Rock-Fluids properties exercises
Determination of the HWC from a RFT Survey.
MB exercises.
Decline curves exercises.

Program:
This course lasts 8 days

Days 1 and 2: (Laura Valle Falcones)
- Reservoir rock properties.
- Reservoir Rock-Fluids properties

Day 3 and 4: (Ana Maria Garcia)
- Reservoir properties: pressure and Temperature.
- Phase behavior of hydrocarbon Systems gas reservoir

Days 5, 6, 7 and 8: (E. Carro Puente)
- Oil PVT Analysis.
- Gas and Gas-Condensate reservoirs.
- Production mechanisms and Material Balance.
- Material Balance.
- Control
Bibliography:

Module RE4  
Reservoir Engineering  
Course RE4.3  
Well Testing Design and Analysis.

Luis Gibbons (Repsol).

MSC. Luis Gibbons studied Industrial Engineering at ITBA in Buenos Aires (graduating in 2001). With more than 15 years in the Oil and Gas Industry, working both for Operators and Service companies in different countries and environments. Starting his career at Chevron, he was responsible for the Procurement Management of Service Companies required to explore and develop its assets in Argentina. Later, he moved to Madrid as part of Repsol Scholarship Program, to obtain a Master degree in Oil & Gas Exploration and Production from the CSF Repsol (former ISE).

After graduation, Luis worked as Professor Assistant in the CSF Repsol, being in charge of the Oil & Gas Master coordination and Project Executions. He was part of Weatherford Integrated Project Management Team, delivering several IPM Projects World Wide mainly in Drilling and Well Testing activities. Endesa CO2 Storage, UGS in Italy, Heavy Oil Production in Albania, HPHT in the North of Spain are some of the Projects he was involved. Currently, Works with Repsol in Russia as Well Testing and Completion Lead Engineer for the Exploration Blocks in Western Siberia.

Objectives:
1. Become acquainted with Well Testing Data Acquisition and Interpretation Techniques.
2. Understand the basic theory of well testing.
3. Be able to design a well test.
4. Get to know the tools needed to implement a well test.
5. Understand a well test report.
6. Be able to recognize different well-reservoir models in a pressure derivative response.
7. Understand the differences between oil and gas well testing.
8. Be able to interpret a well test flow period in terms of reservoir properties and boundary conditions using Saphir.

Syllabus:

1. Fundamentals:
   1.1. Darcy’s Law and its Applications.
   1.2. Fluid and Pore Isothermal Compressibility.
   1.4. Outer Boundary Conditions Transient (Infinite), Semi Steady State and Steady State.
   1.5. Superposition in Time and Space.

2. Well test Design and Execution:
   2.1. Objectives.
   2.2. Types of Tests.
   2.3. Downhole and Surface Equipment.
   2.4. Pressure Gauges and Rate Measurements.
   2.5. Sampling of Produced Fluids.

3. Basic well test Interpretation:
   3.1. Methodology.
   3.2. Techniques: Pressure Derivative, Type Curve Matching, and Specialized Plots.
   3.3. Early Time Near Wellbore Effects: WBS, Dimensionless Skin Factor.
   3.4. Radial Homogeneous Flow: Determination of Reservoir Parameters (k, S).
   3.5. Late Time Boundary and Depletion Effects:
      a) Single Fault.
      b) Intersecting Faults.
      c) Linear Flow (Channel Sands and Parallel Faults).
      d) Constant Pressure Boundaries.
      e) Closed Reservoirs.

4. Gas Well Testing:
   4.1. Pseudo Pressure and Time.
   4.2. Non-Darcy Flow.
   4.3. Deliverability Tests.
Exercises and Tutorials

Calculate tubing thermal expansion
Calculate Gas flow rate through choke
Calculate liquid rate through choke
Calculate rw
Calculate Ri (Radius of Investigation)
DD Analysis in semilog plot
BU Analysis in Horner plot
Oil and Gas well test Interpretations exercises using Saphir & Pansystem.

Program:

This course lasts 4 days

Days 1 and 2: (Luis Gibbons)
  ● Reservoir rock properties.
  ● Reservoir pressure and Temperature. Phase behavior of gas reservoir gas

Day 1: (Luis Gibbons)
  ● Fundamentals.
  ● Well testing Design and Execution.

Day 2: (Luis Gibbons)
  ● Drillstring and SWT Layout exercise
  ● Basic well test Interpretation.
  ● Questions & Answers

Day 3: (Luis Gibbons)
  ● Basic well test Interpretation (cont’d).
  ● Gas well testing.
  ● Questions & Answers.

Day 4: (Luis Gibbons)
  ● Artificially fractured well.
  ● Exercises using Saphir & Pansystem.
  ● Practice

Bibliography:

Objectives:

1. To understand the role of numerical reservoir simulation in the context of reservoir economic development.
2. To understand the fluid flow equations in a porous media.
3. To understand the differences between compositional and black-oil model equations.
4. To understand the numerical discretization of fluid flow equations.
5. To grasp the general structure of an Eclipse Input Data File.
6. To be able to use Eclipse 100.

Syllabus:

Part I: Reservoir Simulation Overview.

1. Introduction to Reservoir Simulation.
   1.1. Purpose and benefits of numerical reservoir simulation.
   1.2. Relationship with other E&P matters.
   1.3. Main steps in the construction of a Reservoir Simulation Model.
   1.4. Types of Reservoir Simulation Models.
   1.5. Software for Reservoir Simulation.

   2.1. Continuity or Mass Conservation Equation.
   2.2. Darcy’s Law.
   2.3. Black Oil and Compositional Model Equations.

   3.1. Notions about Finite Differences.
   3.2. Types of Numerical Schemes:
       a) Explicit, implicit, Crank-Nicholson
       b) IMPES
       c) Streamlines.
   3.3. Comments about numerical stability and accuracy.

Part II: Tutorial on General Structure of an Eclipse Input Data File.

Case Study: Basic vertical cross-section model to estimate vertical sweep efficiency under Waterflooding for an Undersaturated oil reservoir.
Part III: Tutorial on Practical Use of Reservoir Simulation.

Case Study: 3D Full Field simulation model for a real reservoir.
- Data gathering.
- Geological model. Grid construction.
- Fluid and rock-fluid properties.
- Aquifer modelling.
- Initialization.
- Well description.
- History matching.
- Forecast simulations.

Exercises and Tutorials

Basic exercises about finite difference discretization.
Modify and run with Eclipse 100 a vertical cross-section model to estimate sweep efficiency under waterflooding for an undersaturated oil reservoir.
Analyze input data and results of a 3D full field simulation model with different Pre and Post-Process

Program

This course lasts 7 days.

Days 1 and 2: (C. Iglesias & R. Rodríguez)
- Reservoir simulation overview

Day 3: (C. Iglesias)
- General structure of an Eclipse input data file

Days 4, 5, 6 & 7 (C. Iglesias & R. Rodríguez)
- Tutorial on practical use of reservoir simulation

Software Applications

Eclipse 100.
Eclipse Office, Graf, Floviz.

Bibliography:

- Crotti, M.A. Distribución de Fluidos. Actualización 2003
Objectives:

1. Understand the main physical mechanisms affecting the petroleum recovery.
2. Understand the typical evolution of a field life, and the logic behind the different recovery processes applied through it.
3. Understand the EOR methods commonly used and their applicability.
4. Being able to perform an analysis of the possible types of recovery mechanisms (including EOR) that can be applied to a given field.
5. Being able to identify the main technical and non-technical aspects that should be considered for an EOR project.

Syllabus:

1.- Recovery Methods
   1.1.- Recovery Factor, concept and calculation
   1.2.- Primary, Secondary and Tertiary recovery techniques
   1.3.- The EOR Project

2.- Enhanced Oil Recovery
   2.1.- Miscible Injection.
   2.2.- Thermal EOR.
   2.3.- Chemical EOR.
   2.4.- Other EOR Methods.

Program:

This course lasts 2 days plus one Seminar.

Exercises and tutorials:

Team Exercise (Seminar): Analyze your field case and propose the most adequate type/s of recovery technique (may include EOR)
   1. Identify main technical aspects of your field case
   2. Review and screen all known recovery and EOR techniques
   3. Identify main uncertainties and risks for your field case
   4. Propose a road map describing your proposal for reducing uncertainties, risk mitigation and field development

Bibliography:

- "Enhanced Oil Recovery ". Larry W. Lake, 2010, SPE.
- "Enhanced Oil Recovery Field Case Studies", James Sheng, 2013, GPP
- "Enhanced Oil Recovery: Field Planning and Development Strategies", Vladimir Alvarado & Eduardo Manrique, 2010, GPP
Objectives:

1. Evaluate the bottom hole completion options.
2. Assess geometrical configurations for drilled wellbores for both production and injection applications.
3. Evaluate functional capability of completion strings for a variety of situations.
4. Describe the purpose of major completion equipment components.
5. Identify limitation of well completion schematic designs.
6. Well safety requirements and capabilities inherent in well design.
7. Describe the option for producing multiple reservoir units.
8. General completion schematic options for producing two, three or more zones simultaneously.
9. Define the equipment requirements in terms of packers, tubing hangers and Xmas trees for multiple completion strings.
10. Describe the options and their advantages and disadvantages for casing/liner perforation.
11. Describe how to select between over balance and under balanced casing/liner perforating.

Syllabus:

1 Wellbore completion concepts
   1.1 Introduction
   1.2 Bottom hole completion
   1.3 Selection of flow conduit
   1.4 Completion string facilities
   1.5 Completion string components
   1.6 Well completion designs

2 Multiple zone completion concepts
   2.1 Introduction
   2.2 Co-mingled Flow
   2.3 Segregated - Multiple Zone Depletion
   2.4 Alternate Zone Well Completion Strategy
   2.5 Selection of Development Strategy
   2.6 Multiple completion equipment

3 Perforating.
   3.1 Shaped charge design and performance.
   3.2 Perforation Pattern and Well Inflow Performance.
   3.3 Perforation Charge Performance.
   3.4. Perforation Gun Types.
   3.5. Perforating Techniques.

Program:

This course lasts 3 days.

Days 1&2: (Isidro Solorzano)
   - Well completion, perforating and surface & subsurface operations

Day 3: (Halliburton)
   - Wellcat software
Bibliography:

Isidro Solorzano Herrera (ExRepsol), Technical Mining Engineer by the University of Cantabria, PhD by the Polytechnic University of Madrid and Master in Financial Economics by Business School of Bilbao. He’s developed his professional career at Repsol and its joint venture companies in the areas of production and development of oil and gas field projects. Currently, Honorary Professor of the University of Cantabria.

Objectives:
1. Learn the concept of systems analysis.
2. List four segments in the production system where pressure losses occur.
3. Define inflow performance curve, outflow performance curve and the solution node.
4. Learn how systems analysis is used to estimate production rates.
5. List the three components of pressure loss for fluid flow in pipes.
6. Learn the fundamentals of Multiphase Flow.
7. Learn how to estimate pressure drop in tubing using graphical techniques.
8. Understand the purpose of a choke.
9. Understand critical and subcritical flow.

Syllabus:

1. Introduction.

2. Systems Analysis of the Production System.
   2.1. Importance of Hydrocarbon Phase Behavior.
   2.2. Reservoir Inflow Performance Review.

3. Tubing (Outflow) Performance.
   3.1. "Gradient" or Pressure Traverse Curves.
   3.2. Flow Maps and Correlations.
   3.3. Temperature Modelling.

4. Surface Pressure Losses.
   4.2. Computerized Well Performance Prediction Programs.

Program:

This course lasts 2 days.

Days 1&2: (Isidro Solorzano)
- Systems analysis of the production system, tubing performance and surface pressure losses

Bibliography:

MODULE P5  PRODUCTION AND COMPLETION ENGINEERING
COURSE P5.3  WORKOVER AND WELL STIMULATION

Sergio Jiménez Gil (Repsol). Mining Engineer at the UPM, ETSIM and Energy of Madrid. Since 2007 working as Completion and Well Testing Engineer, involved on workover, completion and well testing operations in Repsol.

Susana Gómez (Repsol) is a Chemical Engineer by Universidad Rey Juan Carlos of Madrid, with 10 years experience in the Oil and Gas Industry in the Upstream Division. She joined Repsol in 2006 and since then has been developing her career as a Flow Assurance specialist within the Production and Facilities Engineering discipline. She has participated in worldwide projects (North of Africa, Gulf of Mexico, artic conditions, pre-salt...) involving assets on production and under development with complex fluid characterization, solid deposition and fluid-dynamic behaviour.

Objectives:
1. Recognize the different types of workover or well interventions.
2. To have a well understanding of the completion equipment subject of being intervene.
3. Identify the different elements of the most common workover technics, such as coiled tubing or slick line techniques.
4. Understand the importance of the near wellbore area in terms of formation damage and poor well performance.
5. Identify the major sources of formation damage e.g. during drilling and completion formation, production etc. as well as the appropriate remedial actions.
6. Provide guidelines for minimizing formation damage during workover operations.
7. Indicate how the presence of formation damage can be identified in a production or injection well.
8. Describe the role of and mechanism by which matrix stimulation improves well production performance.
9. Describe the well stimulation design methodology.
10. Identify well stimulation candidates.
11. Prepare a treatment design i.e. select the acid formulation, acid volume and acid pump rate.

Syllabus:
1. Completion: Description and design
   1.1. Introduction
   1.2. Well Completion Equipment
   1.3. Well Completion Design
2. Well Interventions
   2.1. Wireline Operations
   2.2. Coiled Tubing Operations
   2.3. Snubbing Unit Operations
3. Flow Assurance and Well Stimulation
   Seminar to be confirmed

Program:
This course lasts 2 days plus a seminar to be confirmed.

Days 1&2: (Sergio Jiménez Gil)
• Workovers and Well Stimulation.

Seminar: Susana Gómez Álvarez

Bibliography:
- Society of Petroleum Engineers – PetroWiki: http://petrowiki.org/PetroWiki
Objectives:

1. Explain the importance of Artificial Lift (AL) for world oil production.
2. List the different types of AL and explain their operating principle.
3. Discuss AL selection criteria.

Syllabus:

1. Introduction to Artificial Lift.
   1.1. The need for Artificial Lift.
   1.2. Types of Artificial Lift.
   1.3. Other Artificial Lift Systems.
2. Sucker-Rod pumps
   2.1. Definition
   2.2. Applications Considerations
   2.3. Advantages and Disadvantages
   2.4. Components
3. Progressing Cavity pumps
   3.1. Definition
   3.2. Applications Considerations
   3.3. Advantages and Disadvantages
   3.4. Components
4. Electrical Submersible pumps
   4.1. Definition
   4.2. Applications Considerations
   4.3. Advantages and Disadvantages
   4.4. Components
5. Gas lift
   5.1. Definition
   5.2. Applications Considerations
   5.3. Advantages and Disadvantages
   5.4. Components
6. Selection of Artificial Lift Systems

Program:

This course lasts 2 days:
Days 1&2: (Sergio Jiménez Gil)

Bibliography:

Isidro Solorzano Herrera (ExRepsol). Technical Mining Engineer by the University of Cantabria, PhD by the Polytechnic University of Madrid and Master in Financial Economics by Business School of Bilbao. He’s developed his professional career at Repsol and its joint venture companies in the areas of production and development of oil and Gas field projects. Currently, Honorary Professor of the University of Cantabria.

Emilia Arias Gallego (TTRR). Bachelor in Chemical Sciences from the Complutense University of Madrid. More than 20 years of experience in developing projects Oil & Gas. Holds the position of Process and Technology General Director at Initec Plantas Industriales S.A.U (Tecnicas Reunidas). Currently, besides her functions, she is leading an LNG project in USA.

**Objectives:**

1. Provide a general overview of crude oil/gas processing, the elements and equipment in an integrated surface facility plant and the impact in field development.
2. Understand the technical factors for the design and operation of a surface facility: fluid characteristics, quantities, specifications, location, data quality, etc.
3. Review the fluid behaviour aspects relevant for the design and operation of a “surface facility”.
4. Provide a general understanding of process operations: separation, dehydration, gas treatment, gas processing, water treatment, fluid transportation, etc.
5. Provide a basic understanding on how process equipment work and how they are designed and rated.
6. Safety aspects.
7. Discuss main elements related to managing a surface facility project: methodology, cost, schedule, etc.

**Syllabus:**

1. **Introduction:**

2. **Field development:**
   2.3. Liquid hydrocarbon properties: Density and specific gravity. Characterization factor.

3. **Production philosophy**
   3.1. Separation objectives, oil and gas fields.
   3.2. Basic process scheme.
   3.3. Operational production problems: foaming, solids, emulsion, surging, etc.
   3.4. Separators sizing basics: gas and liquid capacity.
   3.5. Test separator

4. **Separation and oil treatment:**

5. **Natural gas treatment and processing:**

6. **Water Treatment:**
   6.2. Basic Principles: mineral scale, scale inhibition, corrosion and oxygen.
6.4. Process equipment.
6.5 Corrugated plates, flocculation/coagulation, flotation, hydrocyclones, coalescer units, centrifuges.
6.6. Disposal of produced water.
6.7 Water injection treatment

7. Oil & Gas transportation:

8. Measurement and control:

9. Safety:
9.2. Pressure Relieving Systems: Overpressure protection philosophy, Pressure relieving devices HIPPS.

10. Project Management:
10.1. Project Management Stages.
10.4. Contract types.

Program:
This course lasts 5 days:
Day 1: (Isidro Solorzano Herrera)
  • Introduction and Sections 2, 3 and 4.
Day 2: (Isidro Solorzano Herrera)
  • Sections 5 and 6
Day 3: (Isidro Solorzano Herrera)
  • Sections 7 and 8
Day 4: (Emilia Arias Gallego)
  • Safety. Section 9
Day 5: (Emilia Arias Gallego)
  • Project Management. Section 10.

There will be two days dedicated to the Aspen Software

Bibliography:
- “Diseño en Ingeniería Química” Serie de ingeniería Química Coulson & Richardson. Traducción de la 5ª Edición original. ISBN:978-84-291-7199-0
- A guide to the Project Management Body of Knowledge. (PMBOK).
Objectives:

Review the offshore oil and gas technology:
1. Introduction to the Offshore Installations.
2. The fixed production units.
3. Mobile Offshore Drilling Units.
4. Floating Production.
5. The Hybrid solution.
6. The subsea production.
7. Export.
8. Support fleet.
9. Planning and costing.

Syllabus:

1. The start of the offshore.
   1.1. Origin of offshore development.
   1.2. Environmental conditions.
   1.3. Water depth.

2. The Jacket.
   2.1. Considerations for Design.
   2.2. Jacket, piling, MSF and topsides.
   2.3. The installation.
   2.4. Drilling.
   2.5. Production.

3. MODU - Mobile Offshore Drilling Units.
   3.1. Considerations for Design.
   3.2. The drilling riser.
   3.3. The motion compensation.
   3.4. The mooring system.
   3.5. The D. P.

4. Subsea wellheads.

5. Floating production.
   5.1. From a MOU.
   5.2. From a FPSO. The storage.
   5.3. The production risers.

   6.1. Shuttle.
   6.2. Single point mooring.
   6.3. Pipeline.

7. Offshore development.
   7.1. Planning.
   7.2. Project definition and specifications.
   7.3. Project management and costs.

Program:

This course lasts 2 days:

Days 1 & 2: (Manuel Moreu)
Bibliography:

- IMO MODU CODE
- Harris Deepwater Floating Drilling Operations.
- ETA Offshore Seminars. The technology of offshore drilling, completion and production.
Objectives:
1. Planning, execution and controlling of an Oil and Gas project
2. Use of IT tools for developing a project
3. Provide a general overview of the main IT tools for planning, risks and costs used in projects

Syllabus:

1. Plan, Program and Control of projects
   1.1. Objectives of the project
   1.2. WBS
   1.3. Activities definition
   1.4. Activities duration
   1.5. Precedence network development
   1.6. IT tools
      1.6.1. MS Project
      1.6.2. Primavera P6
      1.6.3. MindManager

2. 4D Planning
   2.1. BIM for scheduling
   2.2. AEC technology
   2.3. Synchro 4D Software

3. Project Risks
   3.1. Introduction
   3.2. Risks analysis processes
   3.3. Oracle Primavera Risks Analysis

4. Project Costs
   4.1. Introduction
   4.2. Presto

Program:

This course lasts 4 days.

Day 1, 2, 3 & 4: (Luis Mazadiego & Rafael Guadalupe).

Bibliography:

- Manual de Risk Analisys. Lorenzo Sánchez Pacheco y Rafael Guadalupe
- Manual de Primavera 6.8. MP José Fresneda Garrido, Raúl García-Caro del Real y Rafael Guadalupe
- "Integrated Learning of Production Engineering Software Applications in a Shipbuilding Context.", Souto Iglesias, Antonio; Martínez Barrios, Israel; Tomán, Mirko; Fernández Coracho; Guadalupe García, Rafael. "International Journal of Engineering Education" Pág:1400-1409, Volume 29 Number 6, ISSN 0949-149X
- Métodos de Planificación y Control de Obras, del diagrama de barras al BIM. Aldo Mattos y Fernando Valderrama, Ed. Reverté
Lecturers:

Alfonso Maldonado. PhD Mining Engineer. Full professor of Geophysics at the Polytechnical University of Madrid. He has been Director of the School of Mines and Energy of this University and he is currently collaborating with Lukoil Overseas and PDVSA.

Maria Teresa González Aguado. Ph.D. in Mining engineering UPM). Professor at the Madrid School of Mines. General Secretary of the UPM.


Emilio Carro Puente. Mining Engineer by ETSIM (UPM). Master in E&P by French Institute for Petroleum Master in E&P and Master in Petroleum Engineering by H.K. Van Pooien. 33 years of experience in E&P business with Repsol and Hispoxoil in technical positions, as well as managerial positions. After retirement I was the Director of ISE’s E&P Master and Tecnical Director of the Instituto Petrofísico. Co-director of "Master en Ingeniería de Petróleo y Gas -Oil & Gas Engineering Master degree" (mip) of UPM.

Objectives:

1. Learn how to characterize a shale oil or gas reservoir. Understand the possibilities of the gas hydrate.
2. Understand the differences with conventional reservoir characterization.
3. Understand how to evaluate “reserves” of a shale oil or gas reservoir.
4. Learn drilling and completion operations and cost of shale oil and gas reservoirs.

Syllabus:

1. Introduction to unconventional oil and gas.
   1.1. Shale gas approach.
   1.2. Gas hydrates potential.
2. Gas hydrate.
   2.1. Petrophysical model
   2.2. Geochemical measurements
   2.3. Petrophysical measurements
   2.4. Log responses
3. Reserves calculation and field development history.
4. Examples.

Program:

This course lasts 3 days:

Day 1: (Alfonso Maldonado / Mª Teresa González)
   • World business of the shale gas and hydrate gas.

Day 2: (Raúl Rodríguez)
   • Laboratory analysis. Reservoir characterization.

Day 3: (Emilio Carro)
   • Barnett gas shale resource development history.
   • Reserves calculation. Examples.
Bibliography:

- Glorioso, J.C., Rattia, A., "Unconventional reservoirs: Basic Petrophysical Concepts for Shale Gas". SPE 153004
Lecturers:

Luis Mazadiego (UPM). Ph.D. in Mining engineering-U.P.M. Professor at the Madrid School of Mines. He has worked on projects on geochemical prospecting of oil and gas shale. Secretary of the Oil & Gas Engineering Master degree (UPM).

Objectives:

1. Learn how to do the fracking operations.
2. Learn the additives and their environmental impact.
3. Learn how aquifers are protected

Syllabus:

1. Fracking operations.
2. Environmental issues.
   2.1 Seismology
   2.2 Surface and subsurface hydrology
   2.3 Atmospheric emissions associated
   2.4 Noise and light emissions
   2.5 Radioactivity
   2.6 Surface footprint
   2.7 Risks Analysis
   2.8 Conclusions

Program:

This course lasts 2 days:

Day 1: (Halliburton)
   • Fracking Operations.

Day 2: (Luis Mazadiego)
   • Fracking environmental issues. It is organized in for levels:
     The General.
     Further information (shown by the label MORE INFORMATION).
     Basic concepts, (IMPORTANT).
     Bibliographic references (BIBLIOGRAPHY).

In addition to the presentation, the lecturer (Luis F. Mazadiego) will supply scientific articles relating to the themes dealt with. The session last for 4 hours. Of these, the last hour will be taken up by an individual work to be assessed. It will consist in reading a scientific article connected with Shale Gas and in answering some questions.

Bibliography:

- EPA (2011), Plan to study the potential impacts of hydraulic fracturing on drinking water resources, US Environmental Protection Agency. Washington DC. [link](http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/final-study-plan-hf_web_2.pdf)
Lecturers:

José Eugenio Ortiz. Ph.D. in Mining engineering-U.P.M. Professor at the Madrid School of Mines. Member and responsible of the Biomolecular Stratigraphy Laboratory. Expert in Stratigraphy, Palaeoclimatology, Palaeontology and Organic Geochemistry. He was Director of the Geological Engineering Department of the Madrid School of Mines and Secretary of the Geological Society of Spain.

Bernardo Llamas (UPM). PhD in Mining Engineering in the field of site selection methodology to storage CO2 underground. With different international patents in the field of microalgae production and biofuels, he has published several articles and books on Greenhouse Gases technologies. He is professor at Madrid School of Mines and Head of Environment and Energy Department at BIORIZON company.


Roberto Martínez Orío (IGME). is the Deputy Director of Research on Geological Resources at the Spanish Geological Survey (IGME). He is a Mining Engineer from the Technical University of Madrid (UPM, 2002) and his line of expertise is geoenergy and geological storage of CO2. He has been the project manager from IGME in several 6th and 7th Framework Program Projects, as GeoCapacity, COMET or CGS Europe and has developed different works in national projects regarding coalbed methane (CBM), geological storage and unconventional hydrocarbon.

Objectives:

1. Learn how gas can be stored underground in depleted gas reservoirs or in aquifers.
2. Understand how a gas underground storage may be operated.
3. Understand how a CO2 gas may be stored in a deep aquifer.
4. Understand the necessary requirements to assure that CO2 is not linking from the subsurface structure.

Syllabus:


2. CO2 underground storage.
   2.1. Reservoir characterization and storage structure capacity.
   2.2. CO2 phase behavior at reservoir conditions.
   2.3. Monitoring.

3. The possible underground structures in Spain for CO2 storage.

Program:

This course lasts 2 days:

Day 1: (José Eugenio Ortiz and Bernardo Llamas)
   • CO2 underground storage / Gas underground storage.

Day 2: (Roberto Martinez and Laura Valle)
   • Characterization and storage structure capacity / Monitoring and possible underground structures in Spain for CO2 storage
Bibliography:

- Ley 40/2010, de 29 de diciembre, de almacenamiento geológico de dióxido de carbono.
Lecturer:


Objectives:

1. Understand the equipment used in surface facilities to compress the gas.
2. Learn the monitoring to be used to control the gas in the reservoir.
3. Learn the need for a cushion gas to operate the gas storage.
4. Learn to calculate the operating gas volume.
5. Understand the hysteresis.

Syllabus:

Introduction
- Gas chain
- UGS in the word
- UGS in Spain
- UGS terminology
- UGS types
- UGS function

1. Surface facilities.
   Process involved
   1.1. Compressors.
   1.2. Metering.
   1.3. Treatment of the produced gas.

2. Wells completions.
   2.1. Injection/production wells.
   2.2. Monitoring.

Program:

This course lasts 2 days:

Day 1 & 2: (Ana Maria Garcia)
- Surface facilities & Well completions.

Bibliography:

- Underground Storage of Natural Gas. Theory & Practice. Tek, M.R. NATO series E
- Underground Gas Storage Facilities. Design & implementation. Orin Flaningan
Objectives:

1. Understanding of surface facilities and equipment for CO₂ injection.
2. Learning on reservoir monitoring, leakage control and plume tracking.
3. Understanding of safe and efficient injections.
4. Learning of impurity impacts on CO₂ geological storage

Syllabus:

1. Reservoir characterization and CO₂ plume tracking
   1.1. Innovative geophysical techniques for reservoir characterization and plume tracking
   1.2. Low cost drilling

2. Well completions.
   2.1. Injection/observation wells.
   2.2. Monitoring

3. Surface facilities.
   3.1. CO₂ injection facilities
   3.2. Water conditioning
   3.3. Microseismicity and hydrogeological monitoring networks

4. Hydraulic characterization of pair seal-reservoir
   4.1. Laboratory works
   4.2. Field tests

5. CO₂ transport conditions for the injection
   2.1. Efficient and safe injection strategies

6. Effects of impurities on CO₂ injection
   5.1. Thermodynamic and geochemical impacts
   5.2. Effects on efficiency and safety

Program:

This course lasts 1 day:

Day 1: (JC de Dios)
   - CO₂ thermodynamic, transport, surface facilities and wells completions

Bibliography:

- Fundación Ciudad de la Energía. Project OXYCFB 300
## Module LNG9

### Course LNG9.1

<table>
<thead>
<tr>
<th>LIQUEFIED NATURAL GAS (LNG)</th>
<th>LIQUEFACTION PLANTS TECHNOLOGY</th>
</tr>
</thead>
</table>

### Lecturers:


**Enrique Dameno García-Cuerva,** holds a degree in Industrial Engineering from University of Buenos Aires and an MBA Information Technology from Universidad del Salvador, Argentina. He has almost 30 years experience in companies such as Amoco Argentina, Occidental Petroleum, ASTRA CAPSA and Repsol. From 2005 to 2012 he worked at Repsol-Gas Natural LNG first in the Business Development & Technology area and later as LNG Sales Director. In 2013 he returned to Repsol as Gas/LNG Supply and Sales Long Term Director with responsibility for long-term deals worldwide. Among others deals, he successfully advised or conducted mid-term LNG sales in Korea, Thailand and Japan, two long term LNG acquisitions sourced from USA and midterms gas supply deals in Spain. In 2016 he moved to Repsol Marketing Executive Division as Digitalization and Customer Integrated Management Director.

### Objectives:

1. Learn the used technology to liquefy the natural gas.
2. Understand the natural gas thermodynamic.
3. Learn, from examples, the used technologies.

### Syllabus:

1. **Liquefaction plants technology**
   1.1. Natural gas treatment equipment
   1.2. Liquefaction processes.
   1.3. Heat exchangers.
   1.4. Compressors and drivers.
   1.5. Cryogenic pumps
   1.6. Tanks

2. **Plants**
   2.1. Plants in operation.
   2.2. Plants under construction

3. **Examples of plants in operation.**
   3.1. Kenay (Alaska)
   3.2. Nigeria LNG
   3.3. SEGAS LNG Damietta (Egypt)
   3.4. Qatar Gas LNG terminals.
   3.5. Qalhat LNG (Oman)
   3.6. Yemen LNG
   3.7. Snohvit LNG (Norway)
   3.8. Atlantic LNG
   3.9. Peru LNG.

### Program:

This course lasts 2 days:

**Day 1:** (Enrique Querol)
- Technology of liquefaction plants.

**Day 2:** (Enrique Dameno)
- Examples of plants in operation around the world.

### Bibliography

Objectives:

1. Learn how to storage LNG.
2. Understand the need of the Cryogenic tanks and pumps.
3. Understand the process of LNG regasification.
4. Learn the LNG maritime transport.

Syllabus:

1. Introduction
   1.1 Objectives of the Course
   1.2 Safety
   1.3 Regasification terminals in the world
   1.4 Process flow chart

2. Terminal equipment and elements
   2.1 Main equipment
   2.2 Offsite and utilities

3. Terminal design and construction
   3.1 Terminal design initial considerations
   3.2 Design process and phases
   3.3 Terminal construction

4. Operations in LNG Terminals
   4.1 Terminal organization
   4.2 Ships unloading
   4.3 Vaporization and send-out
   4.4 Truck loading
   4.5 Energy balance
   4.6 Working permits
   4.7 Consumables

5. Wrap-up and conclusions
   5.1 Safety

6. LNG Tankers
   6.1 Actual technology.
   6.2 Capacity.
   6.3 Loading operations.
   6.4 Unloading operations.
Program:

This course lasts 2 days:

Day 1: (Pablo Quiroga)
- Introduction, Terminal Organization and Maintenance. Safety

Day 2: (Jorge Zickermann)
- LNG Tankers. Loading and unloading.

Bibliography

- SEDIGAS. Manual de Plantas de Regasificación. 2009
MODULE LNG9  
LIQUEFIED NATURAL GAS (LNG)  
COURSE LNG9.3  
LNG INTERNATIONAL MARKETS

Lecturers:

Carmelo Mayoral. Graduated as MSc Chemistry from Madrid University (1973) and Master of Business Administration from IESE (1990). Working in the Oil & Gas industry for more than forty years. LNG Business: Enagas (Commercial Director), Atlantic LNG (Commercial Vice President) and Repsol YPF (Head of LNG Business). Independent Consultant Oil & Gas

Victor Tuñon Valladares (Gas Natural Fenosa). He has spanned over 26 years with Gas Natural Fenosa and Repsol. He is now the Executive Director LNG & Gas Supply of Gas Natural Fenosa, having spent the previous years in the position of Global Gas Sales and General Manager of Gas Natural Comercializadora, Director Planning and Control, Gas for Repsol and the two previous years in the same role but with Gastream (LNG). Before this, he has been in the Gas and Power Vicepresidency (Repsol) and has been the General Manager of La Energía (Cogeneration Unit in Gas Natural Fenosa). He is a Mining Engineer (Madrid Polytechnic University) and MBA (IESE).

Objectives:

1. Understand the international LNG markets.
2. Understand the contracts main concerns.
3. Understand the GN and the LNG markets differences.
4. Understand the sellers/buyers balance.

Syllabus:

1. Contracts
   1.1. GN versus LNG
   1.2. Spot versus MP and LP
2. -Hubs in USA and in UE
3. -Sellers/Buyers balance
   3.1. Actual
   3.2. Medium and long term.
4. Spain market.

Program:

This course lasts 2 days:

Day 1: (Carmelo Mayoral)
   • Contracts and Hubs

Day 2: (Pedro Vaticón)
   • Sellers/buyers balance. Spain market.

Bibliography

- SEDIGAS. Manual de Plantas de Regasificación. 2009
- SEDIGAS Annual Report
- ENAGAS : El Sistema Gasista Español / Informe 2013
- CEDIGAZ
- BP Statistical Review
- BP Energy Outlook
- PLATTS LNG Daily
- Argus Global LNG (monthly)
- PLATTS LNG Daily TERMINAL TRACKER

The last four publications are available by subscription. The first four can be unloaded from web free of charge.
OBJECTIVES:

1. Understand the Spanish market.
2. Understand the GN price and the LNG price.

SYLLABUS:

1. Spanish market
   1.1. GN by pipeline
   1.2. LNG terminals and regasification plants.
   1.3. Spanish consumers.
2. International Contracts
3. Economics.

PROGRAM:

This course lasts 2 days:

Day 1: (Pedro Vaticón)
- Spanish market

Day 2: (Manuel Justribó)
- International contracts. Economics.

BIBLIOGRAPHY

- SEDIGAS. Manual de Plantas de Regasificación. 2009
- SEDIGAS Annual Report
- ENAGAS: El Sistema Gasista Español / Informe 2013
- CEDIGAZ
- BP Statistical Review
- BP Energy Outlook
- PLATTs LNG Daily
- PLATTs GAS Daily
- Argus Global LNG (monthly)
- PLATTs LNG Daily TERMINAL TRACKER

The last four publications are available by subscription. The first four can be unloaded from web free of charge.
## MODULE HSE10
### HEALTH, SAFETY AND ENVIRONMENT
### COURSE HSE10.1
### SAFETY MANAGEMENT SYSTEM

### Lecturers:

**Angel Vega Remesal (UPM).** Doctor Engineer in Mining, Technical University of Madrid (UPM). Senior Professor at the Department of Energy and Fuels at the Technical University of Madrid (UPM). Head of Explosion Equipment Tests Section of Laboratorio Oficial J.M. Madariaga (LOM). Chairman of AEN/CTN202/SC31 Technical Committee. Member of European ExNB Group regarding explosions hazards, European Directive 94/9/CE.

**Ljiljana Medic Pejic** (UPM). Industrial Engineer Specialized in Energy at the Faculty of Mechanical Engineering at the Technical University of Belgrade. She obtained her PhD degree at the Technical University of Madrid (UPM) and the Oil & Gas Engineering Master degree (UPM). Professor at the Department of Energy and Fuels at the UPM. Head of Solids Safe Handling Laboratory Section of Laboratorio Oficial J.M. Madariaga (LOM). Researcher of over 10 R+D Projects in the last 5 year for national and foreign institutions and companies. Member of national and international working groups for the elaboration of Rules and Standards in the field of Safety.

**Eduardo Conde Lázaro (UPM).** Ph. D. in Mining Engineer, Technical University of Madrid (UPM). Professor at the Department of Energy and Fuels at the Technical University of Madrid (UPM).

### Objectives:

1. Understand the needs to manage the risks in operations.
2. Understand the needs to anticipate problems.
3. Understand the need to high management implication.

### Syllabus:

1. Industrial Safety - Regulations and Risk Analysis
2. An introduction to equipment safety rules
3. Zone classification
4. Electrical installation in hazardous areas
5. Explosion risks - ATEX generation
6. ATEX in industrial plants
7. Equipment types of protection and their use
8. Minimizing explosion risk sources

### Program:

This course lasts 2 days:

Day 1: (Ljiljana Medic, Ángel Vega & Eduardo Conde)

Day 2: (Ljiljana Medic, Ángel Vega)

### Bibliography:

**MODULE HSE10**  
**HEALTH, SAFETY AND ENVIRONMENT**  
**COURSE HSE10.2**  
**ENVIRONMENTAL IMPACT ASSESSMENT IN E&P OPERATIONS**

**Lecturer:**  
Juan F. Llamas. Ph.D. in Mining engineering, full professor of Geochemistry, Environmental Chemistry and Instrumental Analysis at the Polytechnic University of Madrid. Specialist in Geochemistry applied to prospecting and environmental control of hydrocarbons. He has directed various doctoral theses on these subjects and more than 30 research works in international journals.

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**Objectives:**

1. Understand the need to eliminate the environment impact in operations.  
2. Understand the need to convince the public.  
3. Understand the need of the high management involvement in the process.

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**Syllabus:**

1. Environment impact associated with EP activities  
2. Upstream Operations and challenges  
3. Environment impact Identification. Methodology  
4. Environment impact tolerability  
5. Environment impact Management System

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**Program:**

This course lasts 2 days:

Day 1: Environment impact assessment. Sections 1 to 4 (Juan F. Llamas)  
Day 2: Management. Section 5 (Juan F. Llamas)

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**Bibliography:**

MODULE PE11
PETROLEUM ECONOMICS
COURSE PE11.1
BASIC PRINCIPLES OF ECONOMICS IN E&P

Lecturers:

Miguel Ángel Remón Gil. Ph.D. in Mining engineering, Polytechnic University of Madrid, Spain. 1973. B.Sc. Economics & Business Administration, Complutense University, Madrid, Spain. 1975. He spent 35 years working for Repsol. He spent 17 years as Exploration and Production Engineer, and 18 years as Number Two Executive of the company. Seven years as Executive Vice-President, Chief of Exploration and Production, member of Repsol YPF’s Executive Committee, and responsible for the negotiation and implementation of the merger of Repsol with YPF in 1999. Since 2006 he has been the Technical Director and Board Counsellor of two Spanish independent companies: H Oil & Minerals Ltd., Star Petroleum Inc. and Quantum Minería.

Silvia Centeno Rodríguez (UPM). Ph.D Professor of Business Administration as well as Natural Resources and Energy Economics at Universidad Politécnica de Madrid (UPM), since 1998 where she also served as Responsible of Institutional Relations for the ETSIME. She has a Ph.D. from the UPM, an M.Sc from Universidad de Alcalá, and a BA from CUNEF, Universidad Complutense de Madrid. Her areas of specialization include Energy Finance and Economics, Valuation Modeling in Excel, Financial Statement Analysis and Risk Management. Professor Centeno is also a certified Coach and has been involved in educational innovation projects as an advisor and as a coach. She worked for more than ten years in SARAS Energía SA as Trading and Supply Manager.

Antonio Martín holds an MSc in Mining Engineering from the Universidad Politécnica de Madrid. He has more than 23 years’ experience in Asset/Country Management, Business Development and Strategic Analyst positions at international oil & gas upstream companies (Repsol, Cepsa, Cairn Energy). Background in exploration, well operations & field development (reservoir & production engineering) in Europe and North Africa. Expertise in Commercial / Business Development roles on international projects, including the search for new opportunities in A&D worldwide, as well as the techniques used in petroleum exploration, development, economic evaluation and contractual frameworks. Coordination of the evaluations, presentations at Committee and Board level, partnerships and stakeholders engagement plans implementations have been a key part of his roles in the last +12 years. Since June 2016, when he joined SGS Horizon, Antonio has been head of Acquisitions and Divestments where he coordinates all Assets Evaluations, Reserves Certifications and advisory services for Companies and Governments related to portfolio management (A&D).

Objectives:

1. Learn the basic principles of accounting in E&P operations.
2. Learn the basic principles and tools of economics in E&P operations.
3. Learn how to perform an economic evaluation of an E&P project.
4. Get to know and understand the fundamentals of decision analysis.
5. Learn how to deal with risk and construct decision trees analysis.
6. Understand risks/uncertainties management and strategic decisions.
7. Understand methods for Portfolio analysis and optimization.

Syllabus:

1. Initial economic oil data
   - Importance (size, consequences, etc.).
   - Technical uncertainty.
   - Geopolitical uncertainty.
   - Environment and controversy:
     - Fracking.
     - BP accident.
     - Castor uncertainty.
     - Accident of the Prestige.
2. Tools for project valuation.
   - Measures of Project Value: NPV, IRR, Payback.
   - Using discounted cash flows: cost and cash flows projections as support to the project analysis
- Project Risk Analysis: dealing with uncertainty, sensitivity analysis (scenario analysis, breakeven analysis, simulation), decision trees-valuing project flexibility.
- Cost of Capital: estimating required rates of return for projects.

   - Modeling and Structuring Decisions.
   - Decision Analysis Tools and Methodologies in the E&P Setting
   - Value of Information
   - Risk Sharing, Diversification and Portfolio Analysis
   - Modeling Risk Propensity in the E&P Sector
   - Managerial Perspectives on Risk

Program:

This course lasts 2 days:

Day 1: Initial economic oil data (M.A. Remón) & Tools for project valuation (S Centeno)
Day 2: Risk analysis, diversification and portfolio management (A. Martín)

Bibliography:

Lecturers:

**Margarita Hernando.** Law Degree by UCM and an L.L.M. on Commercial Law by Bristol University. She has developed her career as an international energy lawyer with vast experience in oil and gas, drafting and negotiating related agreements, from upstream to downstream and including LNG and UGS, and ancillary issues on the corporate and financing side, including compliance, M&A, cross-border transactions, international bid rounds, and advising on business development. She is in private practice after having worked at Eversheds Lupicinio leading the Energy & Infrastructure practice (two years) and as Upstream Legal Services Director at Repsol (16 years).

**Silvia Centeno Rodríguez (UPM).** Ph.D Professor of Business Administration as well as Natural Resources and Energy Economics at Universidad Politécnica de Madrid (UPM), since 1998 where she also served as Responsible of Institutional Relations for the ETSIME. She has a Ph.D. from the UPM, an M.Sc from Universidad de Alcalá, and a BA from CUNEF, Universidad Complutense de Madrid. Her areas of specialization include Energy Finance and Economics, Valuation Modeling in Excel, Financial Statement Analysis and Risk Management. Professor Centeno is also a certified Coach and has been involved in educational innovation projects as an advisor and as a coach. She worked for more than ten years in SARAS Energía SA as Trading and Supply Manager.

Objectives:

1. Distinguish between different contract types and different procedures to acquire exploration and production rights
2. Become acquainted with the E&P license application.
3. Understand the main targets of the E&P companies.
4. Be acquainted with E&P contract features.

Syllabus:

**1. Contract types**

1.1. Each country sets its own rules for allowing the exploration and production of hydrocarbons; we will briefly examine how some jurisdictions are more welcoming than others, why history plays an important role as well as the impact of risk’s perception. Main contract types will be described to learn to distinguish between them and main terms will be reviewed.

1.2. The different alternatives for acquiring hydrocarbons rights: farmouts, licensing rounds and direct negotiation will be compared

**2. Economic performance of different petroleum fiscal system designs.**

2.1. Introduction to petroleum fiscal systems. Government view vs. Contractor/Investor view.

2.2. Rent theory. Tax base spectrum. Regressive vs. progressive.

2.3. Design Elements: royalties, taxes, profits splits, cost recovery limits, uplifts, sliding scales-production based, "R" factor, IRR, windfall profit taxes, government participation.

2.4. Valuation Criteria and Analytical tools: the project economic limit, government take, effective royalty rate, savings index, progressiveness, payout (R).

Program:

This course lasts 1 day:

Day 1: E & P Contract evolution (M. Hernando) & Petroleum fiscal systems (S. Centeno)

Bibliography:

- Host Government Contract Handbook (for international petroleum industry) by AIPN published by BARROWS COMPANY INC.
- The Quest, Daniel Yergin
- The Prize, Daniel Yergin
- S. Centeno. Estudio y diseño de un régimen fiscal que optimice la inversión en exploración y producción de hidrocarburos. 2015 Tesis Doctoral (UPM)
Objectives:

1. Understand the main targets of the E&P companies.
2. Become acquainted with the main management indicators in a E&P company.
3. Learn how to perform an economic evaluation of an E&P project.
4. Get to know and understand the fundamentals of decision analysis.

Syllabus:

1. Main economics factors.
   1.1. Oil and gas prices.
   1.2. Discount rate.
   1.3. Technical presentation of an oil real block.

2. Economic data to value oil block.
   2.2. Essential economic data to value an oil block (cost data): OPEX, CAPEX, performance of each well (production and drained reserves).

3. Economic evaluation.
   3.1. Objectives of an economic evaluation.
   3.3. Phases of a project’s economics. Evaluation network.
   3.5. Economic evaluation. Full cycle and half cycle.
   3.7. Measures of profitability more commonly used: payback period, maximum financial exposure, profit to investment ratio, internal rate of return, net present value, discounted profit to investment ratio, etc. Characteristics. Pros and cons.
   3.8. The discount rate. Factors to be considered.
   3.10. Sustainable development in the energy sector.

4. Decision analysis.
   4.1. Concepts: uncertainty, exposure to uncertainty, risk, etc.
   4.2. Basics of probability and statistics concepts.
   4.3. The “shape” of oil patches uncertainty.
   4.4. Expected value concept. Meaning and interpretation.
   4.6. Solving a decision tree.
   4.7. Maximum tolerable dry hole risk.
Program:

This course lasts 2 days:

Day 1: Petroleum fiscal systems & More economic factors (M.A. Remón)
Day 2: Prospect & block valuation (L. Rodríguez)

Exercises and Tutorials
- Exercise 2: Making estimations. Uncertainty Game.
- Exercise 4: Assigning Prospect Risk.

Bibliography:
- Schuyler, J. R. (1996), Decision Analysis in Projects. Project Management Institute, Sylva, North Carolina, 144 pp
**MODULE PE11**

**PETROLEUM ECONOMICS**

**COURSE PE11.4**

**BUSINESS STRUCTURE, STRATEGIC PLANNING & FINAL REMARKS**

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**Lecturer:**

*Miguel Ángel Remón Gil.* Ph.D. in Mining engineering, Polytechnic University of Madrid, Spain. 1973. B.Sc. Economics & Business Administration, Complutense University, Madrid, Spain. 1975. He spent 35 years working for Repsol. He spent 17 years as Exploration and Production Engineer, and 18 years as Number Two Executive of the company. Seven years as Executive Vice-President, Chief of Exploration and Production, member of Repsol YPF’s Executive Committee, and responsible for the negotiation and implementation of the merger of Repsol (*) with YPF in 1999. Since 2006 he has been the Technical Director and Board Counsellor of two Spanish independent companies: H Oil & Minerals Ltd., Star Petroleum Inc. and Quantum Minería.

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*Oscar Aguado.* PhD. in Mining Engineering from Madrid School of Mines & Energy (UPM), graduated from HEC-Paris Business School, and awarded Masters in Petroleum Economics and Management from IFP-School, Managerial Energy Economics from OU at the US. Currently acts as Head of Strategic Projects for the second largest Asset Manager in Spain, being responsible for the business plans in the 10 countries belonging to the geographical footprint. Prior to that he has been the Oil Companies analyst for the 2nd Spanish bank in different areas: Equity Research, M&A and Risk. He is also finance teacher at the University College of Financial Studies (CUNEF-UCM) both at the Master in Financial Institutions and Markets and at the CUNEF Finance Summer School.

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*Raquel Vergara.* Mining Engineer and Msc in Oil&Gas Engineering by the Polytechnic University of Madrid. With 7 years’ experience as a Consultant in Oil/Gas Exploration in Africa and Middle East, which main activity is the exploration and production of oil and gas in several countries. And 6 years’ experience in Quantum Minería S.L., which main activity is the exploration and development of mining projects focused in Spain, Latin America and Africa. In both companies is involved within the research and investigation team of the minerals and oil/gas sectors around the world.

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**Objectives:**

1. Get to know and understand the factors of the price evolution.
2. Understand the consequences of the current crisis and learn how to deal with the future circumstances.
3. Be acquainted with the strategic planning of the upstream sector, taking into account several factors to understand better the performance of the execution.
4. Learn how to perform an economic evaluation of an E&P project taking your own strategy.

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**Syllabus:**

1. **Value chain of oil companies.**
   1.1. Exploration - Production - Refining - Marketing - Chemistry.
   1.3. The case of electricity generation.
   1.4. Sharing links between oil companies and gas companies.
   1.5. Critics margins of the value chains.
   1.6. The recent evolution of the chains.

2. **Margin volatility, companies and oil prices.**
   2.1. Importance in the integration.
   2.2. Importance of the crude oil costs.
   2.3. Importance of the taxation.

3. **The consequences of the recent crisis on businesses.**
   3.1. Stock aspects.
   3.2. Investments aspects.
   3.3. Production aspects.

4. **Reflections on the future.**
   4.1. Strategies and Prices
5. **Upstream Strategic Planning.**
   5.1. Definition (general science).
   5.2. Importance (Leningrad and Casandra).
   5.3. Cell.
   5.4. Ambient.
   5.5. Execution.
   5.6. Period.
   5.7. Management control.
   5.8. Historical strategy.
   5.9. Current strategy.
   5.10. Momentous and contentious planning decisions.
   5.11. Future reflections.

6. **Evaluation exercise: how valuate an oil block.**
   6.1. Comments of the work realized.
   6.2. Review calculation assumptions.
   6.3. Historical valuations.
   6.4. Simplified Valuations.
   6.5. NPV.
   6.6. Sensitivities.

**Program:**

This course lasts 2 days:

Day 1: Business Structure (O. Aguado)
Day 2: Strategic Planning & Final Remarks (M.A. Remón)
| MODULE 12 | **PETROPHYSICS Lab**  
|           | Petrophysics Lab course |
| MODULE 13 | **FIELD TRIP (FT)**  
|           | One week field trip in order to know better sedimentary basins and petroleum systems |
| MODULE 14 | **FINAL WORK (FW)**  
|           | A case study work group of modeling and simulation of an oil or gas field. Each group will write a Final Project Report that will be presented and defended before an academic and industrial board. |