Syllabus CH EN 6181 – Drilling and Completions  
Fall 2015

| Faculty       | Ian Walton  
EGI, Suite 300, 423 Wakara Way  
801-581-8497 (office)  
iwalton@egi.utah.edu  
Office Hours: Any time or by appointment |
|---------------|-------------|
| Meetings      | Tuesdays 7:30 am to 8:50 am in WEB 1248  
Thursdays 7:30 am to 8:50 am in WEB 1248 |
| Prerequisites | Confirm with Graduate Program Coordinator |
| Teaching Assistant | TBD |
| Additional Course Information | Additional course information will be provided as needed throughout the semester and will be available on Canvas. |
| Homework Policy | Homework is due at the start of class on the day specified on the homework assignment.  
No late homework will be accepted since solutions will be posted on Canvas after class the day assignments are due. If you cannot make class the day your assignment is due, you should turn it in early or make arrangements to have someone submit it for you. |
| Exam Policy | No make-up exams will be given. If you absolutely cannot attend the scheduled examination, please see me before the exam to try and make arrangements. |
| Grading | 40% Homework  
20% Mid-Term Exam  
40% Final Exam  
Exams will be open book, open notes, open homework |
| Final Exam | Per University Academic Calendar: December 14-18 |

**Summary:**  
The Drilling and Completions course highlights the basics of accessing underground hydrocarbon or other energy resources – applied drilling engineering. This introductory course is an overview of surface and subsurface activities associated with constructing new wells and preparing them for production. Basic rock and fluid mechanics principles will be
summarized as they are related to the stability of a wellbore during drilling, the efficient removal of cuttings and subduing formation pressure. Newer technologies (directional drilling, multi-lateral drilling, and underbalanced drilling) will be introduced. Environmental awareness and procedures for minimizing footprint and impact on the environment and stake holders will be considered. Principles of well control will be introduced. Both onshore and offshore operations will be summarized.

After a well is successfully drilled, it is completed. This means ensuring that the well is stable over the duration of its life and that there are multiple hydraulic seals to prevent in-situ fluids from reaching the surface. This is usually done by running and cementing casing, although uncased (openhole) completions are becoming more common when wellbore stability is not an issue. After the well is stabilized, it is necessary to re-establish communication between the producing formation(s) and the wellbore – usually by perforating the casing and cement sheath with shaped charges. Finally, particularly in low permeability formations, hydraulic fracturing is carried out to stimulate production. In some cases, formations may simply be exposed to acid to remove drilling damage or other damage that reduces hydrocarbon inflow.

Textbooks:

student – student membership is subsidized (~$15 USD?). To join SPE, use the following hyperlink: [http://www.spe.org/students/join.php](http://www.spe.org/students/join.php). To order the textbook, go to the following hyperlink: [http://store.spe.org/Drilling-Completions-C11.aspx](http://store.spe.org/Drilling-Completions-C11.aspx) Notice that there is a digital and a softcover version. Some students in the past have found navigation in the softcover version more convenient. The price for an SPE member is ~95 USD.

- **Petroleum Well Construction**, Economides et al., 2000 (optional).
- **Petroleum Productions Systems**, Economides et al., 2nd edition 2012. This book will also be used in other courses (Production Engineering).

- Other materials will be distributed in class or are available on line.

**Course Objectives:**

1. Understanding the scope of standard activities on a well location before first production – drilling, cementing, and stimulation.
2. Appreciating the environmental considerations, regulations and the stakeholder issues associated with well construction.
3. Recognizing basic geologic input that is critical to effective and economic drilling operations.
4. Exposure to basic calculations and tools for well control, cementing, stimulation design and production estimations.
Course Curriculum:

Module 1: Introduction: overview of the course (1 lecture)
   a) Introduction
   b) Drilling process, completions, stimulation
   c) Oilfield Units

Module 2: Drilling equipment, Bottomhole assembly (2 lectures)
   a) Onshore
   b) Offshore
   c) Design Considerations
   d) Hoisting Equipment
   e) Rotary Equipment
   f) Mud Pumps and Associated Equipment
   g) Drillstring Composition and Design
   h) Bits and Downhole Tools
   i) Downhole Motors
   j) Directional Drilling
   k) Well Pressure Control
   l) ROP, WOB

Module 3: Drilling Muds and Completion Fluids (2 lectures)
   a) Role of drilling and completion fluids
   b) Oil- and Water-Based Fluids: density, rheology
   c) Additives

Module 4: Drill string design (1 lecture)
   a) Drill string Design
   b) Bit Types and Selection

Module 5: Drilling Mud Hydraulics (3 lectures)
   a) Static Pressure Calculations
   b) Circulating Pressure Calculations, ECD
      a) Friction pressure losses in drill string and annulus
      b) Pressure losses through bit nozzles
   c) Surge and Swab Pressures
   d) Well Control
Module 6:  Drilling and Logging Operations While Drilling (1 lecture)
   a) Mud Logging
   b) MWD and LWD
   c) Well Testing While Drilling

Module 7:  Rock Mechanics in Wellbore Construction (2 lectures)
   a) Fundamentals of rock mechanics: stress, strain, rock properties
   b) Wellbore Stability
   c) Bit Mechanics (energy considerations)
   d) Cuttings Reinjection
   e) Leaky Wellbores

Module 8:  Directional Drilling (1 lecture)
   a) Vertical, Deviated, Horizontal and Multilateral Well Configurations
   b) Directional Drilling Mechanics and BHAs
   c) Rotary Steerable Technology
   d) Casing Drilling
   e) Mud Motors
   f) Telemetry

Module 9:  Drilling problems and their Resolution (1 lecture)
   a) Lost Circulation
   b) Hole stability
   c) Stuck pipe
   d) Well control: kicks and blowouts

Module 10: Completions Design (2 lectures)
   a) Main Factors Affecting Completion Design
   b) Primary Completion Configurations
   c) Selecting Casing Points and Casing Type
   d) Basics of Casing Design – Including Calculations

Module 11: Cementing Design (2 lectures)
   a) Elementary Cementing – Including Calculations
Module 12: Perforating Design (2 lectures)
   a) Introduction to Perforating

Module 13: Hydraulic Fracturing (3 lectures)
   a) Rock Mechanics Overview
   b) Design Considerations: Fracture Conductivity, impact on well performance
   c) Materials (Fluids, Additives, Proppant)
   d) Pumping Equipment
   e) Planning, Execution and Back-Analysis

Module 14: Acidizing (2 lectures)
   a) Chemistry Overview
   b) Design Considerations (Volumes, Real-time Evaluations)
   c) Materials (Fluids, Additives, Proppant)
   d) Pumping Equipment
   e) Planning, Execution and Back-Analysis

Module 15: Completions for High Permeability/Low strength Formations (1 Lecture)
   a) Production Formulae and Skin
   b) Sand production
   c) Remediation: Screens, Gravel Packs and Frac Packs