Syllabus CH EN 6161 – Petroleum Engineering Basics

<table>
<thead>
<tr>
<th>Credit Hours</th>
<th>3 (required for MS in Petroleum Engineering)</th>
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<tbody>
<tr>
<td>Class Schedule</td>
<td>Tuesdays and Thursdays 7:30 a.m. – 8:50 a.m.</td>
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<td>Class Location</td>
<td>WEB 2460 and distance Learning</td>
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| Instructor | Ian Walton, Ph.D.  
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V.1 Text:
No Textbook is available for all the material in the course. Reference material will be made available.

V.2 Course Objective:
Students are expected to enter the course from a variety of engineering backgrounds. The objective of the course is to provide sufficient petroleum engineering background to all the students.

V.3 Curriculum
The course is divided into six modules.

Module 1: Introduction and Applied Mathematics (2 Weeks)
- REVIEW OF ENGINEERING BASICS NEEDED (define some key cases to look at)
- REVIEW OF MATHEMATICAL BASICS
  - Integration, Differentiation – where to look up
  - ODEs and PDEs with examples that have oilfield applications – temperature and flow
  - Regression
  - Basic statistics
- ESSENTIAL NUMERICAL METHODS
  - Finite Difference, Finite Element,
- ESSENTIAL COMPUTER TOOLS
  - MatLab, Comsol, CMG, Eclipse, Petrel

Module 2: Oilfield Chemistry (2 weeks)
- ORGANIC CHEMISTRY AND OIL COMPONENTS.
o What are hydrocarbons? How many covalent bonds do carbon, hydrogen, nitrogen, oxygen form? ...

o What is an alkane? What is an aromatic? What is an acid? What is pH? What is a polymer? What is an olefin? Oil components: waxes, aromatics, resins, asphaltenes, WAT, pour point, API ...

- Newtonian and Non-Newtonian flow
- Flow assurance and drilling fluids relevance
- Corrosion
- Fluid Incompatibility
  - Understanding the causes of scaling during production and the causes of scaling when incompatible fluids are injected
  - Souring is a big issue - biologic degradation to produce H2S
  - Many formations are acidized with HCl or HF-HCl blends. Students need to be reminded of simple principles of physical chemistry so that they can understand the potential for undesirable precipitation.
  - Produced water remediation - RO etc.

**Module 3: Thermodynamics Relevant to Petroleum Engineering (3 Weeks)**
- Basic thermodynamic principles (chemical engineering)
- Thermodynamics of gases
- Phase equilibria and software such as Winprop or PVTSim
- Applications in oil and gas

**Module 4: Physical Properties of Oilfield Fluids (1 week)**
- Densities, viscosities and other properties of interest – This is introductory fluid mechanics – what they are and how they are measured
- Oil, water, drilling fluids, cement, fracturing and completion fluids

**Module 5: Fluid Mechanics for Petroleum Engineers (3 Weeks)**
- **HYDROSTATIC PRESSURE**
  - Bottomhole pressure calculations (static)
- **PIPE FLOW**
  - Reynolds Number, Laminar, Turbulent
  - Pipeline calculations
  - Injection and production through tubulars
  - Minor losses through valves
- **SLURRY AND SOLIDS TRANSPORT**
• Proppant

• DIFFERENT FLOW REGIMES
  o Oilfield scenarios with turbulent and laminar flow
  o Polymers – Bingham plastic, power law

• MULTI-PHASE FLOW
  o Vertical and inclined wells
  o Concepts of Holdup
  o Different flow regimes

**Module 6: Rock Mechanics for Petroleum Engineers (2 Weeks)**

• Stress and Strain and Strength in Two and Three Dimensions
  o 6 hours
  o Definitions
  o Principal Stresses
  o Effective Stresses and Poroelasticity

• Measurements of Mechanical Properties and Stress
  o 3 hours
  o Laboratory and the Field
  o Correlations, Rules of Thumb

• Applications
  o 3 hours because will cover elsewhere
  o Drilling and Wellbore Stability
  o Hydraulic Fracturing
  o Sand Production
  o Compaction and Compressibility
  o Thermal Operations

**Module 7: Heat Transfer and Reactions (3 Weeks)**

• Thermochemistry
• Essentials of heat transfer
• Basics of reactions
• Reaction thermodynamics for petroleum engineers