Research Skills in Petroleum Engineering
Week 1, Wednesday 28 February

Background/Rationale

The University environment is one in which you will be exposed to many new and different experiences and challenges. You will meet people from different backgrounds; encounter different methods of course delivery and course materials of a more challenging nature, and need to cope with varying expectations of what, and how much, you will successfully achieve. Initially, courses may appear to be presented in a foreign language, as lecturers routinely use unfamiliar, discipline-specific terminology in classes. As part of your studies you will be required to read and interpret various course materials, critically evaluate and synthesize them into a coherent story, and effectively communicate ideas and findings using the appropriate format and language for the discipline area. All of these requirements assume at least a basic level of skill in accessing and critically analysing discipline-appropriate literature.

The short task that you are asked to undertake is aimed at identifying your current level of ability in recognising, extracting and logically organising key points from literature available on a topic. The outcomes of this task will enable us to provide you with appropriate support (e.g. tutorials, workshops, online guides) to enable you to develop and refine the research skills necessary to succeed in Petroleum Engineering.

Task Instructions:

Read the two short articles about Drill Cuttings printed on the reverse side of this handout and complete tasks 1 and 2.

1. *Integrate the information presented in the two articles to write your own dot-point notes on the worksheet attached*. To do this:
   - Identify 3-4 key ideas from the articles
   - Use these key ideas to formulate headings and underline each
   - Make bullet-point notes and list them under these headings.
   - After each point, indicate its source, i.e. whether the idea came from article 1, article 2, or both
   - Provide a title that embodies the content of your notes.

2. Which of the two articles do you consider to be the better source? On what characteristics/features of the article have you based your choice?

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Source1
Removal of Drill Cuttings

Drilling fluid, also called drilling mud, is a kind of lubricating fluid used during drilling oil and natural gas wells and in exploration drilling rigs in order to serve many purposes. One of the principle purposes of drilling fluid is to remove continuously from the hole the drilled rock materials through circulation. The circulation of the drilling fluid causes cuttings to rise from the bottom of the hole to the surface. Efficient cuttings removal requires certain circulating rates that are sufficient to override the force of gravity acting upon the cuttings. Other factors affecting the cuttings removal include drilling fluid density and its rheological properties, annular velocity, wellbore angle, and cuttings-slip velocity (V_s). The annular velocity (V_a) is velocity of drilling fluid through the annular space (space between the drillpipe and the hole). The lifting velocity (V_l) of the cutting can be expressed as:

$$V_l = V_a - V_s$$

It is clear fro above equation that the slip velocity has to be maintained below the annular velocity in order to lift the cutting to the surface. It is sometimes necessary to increase the mud viscosity to decrease the slip velocity of the particles to a point where the particles can be removed. Increasing mud viscosity causes increased pump circulation pressure at a given rate, which consequences higher pressures on the walls of the hole. This higher wall pressure is susceptible to lost circulation.

During connections, and trips (trip out operation), it is necessary to halt circulation for a while. In such situation, cuttings that have not been removed from the hole must be suspended otherwise they will fall to the bottom (or, in highly deviated wells, to the low side of the hole). The rate of fall of a particle through a column of drilling fluid is dependent upon the density of the particle and the fluid, the size of the particle, the viscosity of the fluid, and the thixotropic (gel-strength) properties of the fluid. The controlled gelling of the fluid prevents the solid particles from settling, or reduces their rate of fall. High gel strengths also require higher pump pressure to break circulation. In some cases, it may be necessary to circulate for several hours before a trip in order to clean the hole of cuttings and to prevent fill in the bottom of the hole from occurring during a round trip. In addition mud density, mud additives, borehole conditions, cuttings size, and caving problems influence the mud viscosity. Therefore, it is necessary to maintain and keep the mud viscosity in a certain limit.

Source 2
Cutting Removal Efficiency

Drilling fluid, also known as drilling mud is a specially designed fluid, which is an essential component in drilling petroleum wells. It serves a number of functions. One of the principle functions of this fluid is the cuttings removal and transport.

In drilling a well, chips of formation cut by the bit, known as drilling cuttings must be continuously removed from the hole. In some cases, sloughing of formation from the walls of the hole occurs and these cavings also must be removed. The cuttings removal efficiency is affected primarily by annular capacity of the wellbore, drilling fluid circulation rate, drillstring eccentricity & movement, and slip velocity (the difference between net rise velocity of cuttings and annular mud velocity) of the cuttings. Of these factors, the slip velocity of the cuttings can be influenced by drilling fluid density, fluids effective viscosity and cutting sizes.

To enhance cuttings removal efficiency, a reduced slip velocity is desired. Increasing the mud density will have a direct effect on reducing the slip velocity, while increasing the effective viscosity of the drilling fluid will have an inverse squared effect. That is, increasing the drilling fluid density by 25% will have far more effect than increasing the effective viscosity by 25%.

In large, washed-out vertical or near-vertical hole sections, the annular velocity may be less than the slip velocity of the particles to be removed. In this case, the cuttings or cavings settle and may cause problems such as bridging, fill-up, and stuck pipe. It is sometimes necessary to increase the mud viscosity to decrease the slip velocity of the particles to a point where the particles can be removed. Increasing mud viscosity, however, also increases the pump pressure necessary to circulate the mud at a given rate. This produces higher pressures on the walls of the hole and may result in loss of circulation.

Therefore, during fluid circulation, the rate of fluid flow should be regulated, so that optimum hydraulic horsepower is available to clean the face of the hole ahead of the bit. Since the rheological properties of the drilling fluid (plastic viscosity and yield point) have a considerable influence upon hydraulics, these properties should be monitored at all times. In other word the plastic viscosity and yield point of drilling fluid should be maintained up to a certain value to optimize the hydraulic horse power.

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Research Skills in Petroleum Engineering: O-Week Evaluation

Student Name: ……. ID number: ……..

Title: ……

Part 2 (which is the better source? Why?)

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Student Name removed

Electronic Engineering Research Skill

Title: Semiconductor Optical Amplifier Technology and Application

Structure and Characteristics of SOA

- Consist of amplifying medium inside a resonant cavity [1]
- Works like Fabry-Perot laser diode [1]
- Two types: Resonant SOA and Travelling-wave SOA [1]
- Amplification achieved by externally pumping the energy level of material using current [2]
- Gain is influenced by input signal and noise of SOA [2]
- Gain saturation occurs if input signal power is high [2]

Non-linearities of SOA

Cross gain modulation (XGM)

- Strong signal at one wavelength affects the gain of a weak signal at another wavelength [2]
- Caused by carrier density changes [2]

Cross phase modulation (XPM)

- Phase and gain of optical wave propagating are coupled via gain saturation [2]
- XPM can be used to create wavelength converters [2]

Four-wave mixing (FWM)

- Occur in SOA between two optical fields [2]
- Injected fields cause gain to be modulated at beat frequency, and create a new field [2]
- Useful for wavelength converters, dispersion compensators and optical demultiplexers [2]

Application of SOA

Amplifiers

- Such as booster amplifier, preamplifier and in-line amplifier [2]
- To increase high power input signal prior to transmission (booster), to increase receiver sensitivity via increasing power level (preamp), and to compensate for fibre loss (in-line) [1&2]

Optical gates

- SOA can be constructed as optical gate (or switch) with high-speed switching capability that is required by high-speed optical communication network nowadays [1&2]
- Can be integrated into gate arrays for high density switching [1&2]

Wavelength converters

- SOA can be used in optical time division demultiplexer and add/drop multiplexer in optical network [2]

Optical clock recovery

- High-speed clock recovery is best achieved by optical solution [2]
- Uses phase locked loop with SOA based interferometric switch [2]

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Marking Criteria for 'O-Week' Research Skills Evaluation

Student Name: _____ Student ID: _____

Marker: _____

Facet of Inquiry ↑

	Level 1 *Students research at the level of a **closed inquiry*** and require a **high degree of structure/guidance***	Level 2 *Students research at the level of a **closed inquiry*** and require a **moderate degree of structure/guidance***	L3
A. Students embark on inquiry *and so determine a need for knowledge/ understanding*	❑ Identifies some peripheral or duplicated ideas as key	❑ Identifies KEY ideas	
B. Students find/generate *needed information/data using appropriate methodology*	❑ Points/notes generated partially relate to the headings under which they are listed ❑ Notes produced are sourced predominantly from 1 text only	❑ Points/notes generated elaborate on the key ideas to which they are linked ❑ Notes produced draw on ideas from both texts	
C. Students critically evaluate *information/data and the process to find/generate*	❑ Identifies indicators of source credibility and reliability but does not fully apply them in evaluating data or process	❑ Identifies several relevant indicators of source credibility and reliability and provides appropriate rationale for usage/inclusion of information	
D. Students organise *information collected/ generated*	❑ Has attempted a note-taking framework, but information is organised predominantly as a list of undifferentiated bullet points	❑ Uses a hierarchical note-taking framework that organises related information under the appropriate key headings.	
E. Students synthesise and analyse *new knowledge*	❑ Produces point form notes (information not directly copied or sentence format) but notes separated according to source	❑ Combines and integrates ideas/data from different sources to generate notes	
F. Students communicate *knowledge and understanding and the process used to generate them*	❑ Title is present ❑ Partial and/or incorrect acknowledgement of sources of information	❑ Title relates clearly to the key ideas presented in the notes ❑ Full and correct acknowledgement of sources of all noted information	

↓

- Inquiry may range from closed (lecturer specified) to open (student specified) in terms of: i) question, hypothesis or aim of research; ii) procedure or equipment; iii) answer, resolution or further inquiry.