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Horizontal and Multilateral Drilling

1.0 Course Faculty Information

Name: Prof. Dr. M. Enamul Hossain
 NSRIC Chair Professor in Sustainable Energy
 NSRIC Inc.
 London, Ontario, Canada

2.0 Course Information

Course Code and Title	ENG-P-C00107
Class Days	Saturday and Sunday
Class Time	9:00 am – 10:30 am EST (Self-study)
Course Credit Hours	1 (7 Hrs.)
Class Location	NSRIC online platform
Prerequisites and/or co-requisites	Drilling Engineering I and II
Level /A, E, H, I, K12, M, P, S, T, U, V, W	Professional courses / P

Note: The below classification of courses is related any areas of knowledge:

A: Advanced level academic level courses; **C:** Canadian immigration and training courses; **E:** Executive courses; **H:** Higher-level courses (i.e., graduate courses); **I:** Intermediate courses (i.e., university preparatory courses – Grade XII+); **K12:** Foundational, and lower-level courses; **M:** Mid-level courses (i.e., undergraduate courses); **P:** Professional courses; **S:** Short/seminar courses; **T:** Training courses; **U:** Tutorial Courses; **V:** Vocational training courses; and **W:** Workshop courses.

ENG – Engineering

PET – Petroleum

3.0 Professor Information

Name	Prof. Dr. M. Enamul Hossain
Title	NSRIC Chair Professor in Sustainable Energy
Contact Information	enamulh@nsric.ca ; dr.mehossain@gmail.com
Office Location	NSRIC online platform
Office Hours	08:30 am – 09:30 am EST (Monday) by email appointment only

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4.0 Course Description

This course is designed for audiences and students who are interested to learn about the basics and in-depth of drilling engineering related to horizontal and multilateral drilling and extended reach drilling (ERD) during oil and gas operations. The course content is designed for students who are in diploma or undergraduate/graduate level, early career professionals and interested in learning horizontal, multilateral and ERD drilling engineering in details. The course covers an overview of horizontal drilling engineering with in-depth discussion on different types of horizontal, multilateral and ERD drilling. The module covers the detail basic knowledge of horizontal, multilateral and ERD drilling including different terminologies such as kick off point, dog leg, end of building section (EOB), vertical section (VS), Build-up Rate (BUR), Turn Rate, End of Drop (EOD), Dog Leg Severity (DLS) etc. In addition, an in-depth calculation related to azimuth, horizontal departure, dogleg, dogleg severity, slant angle, vertical depth, measured depth, target direction and inclination angle etc. are highlighted for well planning and design. Discussion on the multilateral levels designated by technology advancement for multi-laterals (TAML) and complex well architecture is presented in detail. The course contains only one module with seven lectures. Students are strongly advised to complete the course titled “Basics of Drilling Engineering I” and “Drilling Engineering II” by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Keywords: Horizontal drilling, multilateral drilling, extended reach drilling, well types, S-type, straight, J-type, horizontal, build-up rate (BUR), turn rate, end of drop (EOD), dog leg severity (DLS), north, south, closure distance and closure direction, gas and water coning, tangential method, balanced tangential method, average angle method, radius of curvature, ultrashort radius, short radius, medium radius, long radius, well profile, principles of surveying, minimum curvature method, laterals, branches, junctions, trunks, stacked, fishbone, technology advancement for multi-laterals, TAML and complex well architecture.

5.0 Course Learning Outcomes

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

- CLO1: Become familiar with horizontal well drilling technology for oil and gas industry.
- CLO2: Understand the different terminologies related to horizontal drilling.
- CLO3: Become familiar with multilateral well drilling technology for oil and gas industry.
- CLO4: Understand the different terminologies related to multilateral drilling.
- CL05: Ability to understand the wellbore surveying techniques and in-depth calculations for better design of the well trajectory.

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- CL06: Become familiar with the basic concepts and TAML levels of multilateral drilling and extended drilling.
- CL07: Ability to understand different horizontal drilling costs and a comparison with conventional drilling practices.
- CL08: Ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental and safety.
- CL09: Ability to use techniques, skills, and modern engineering tools necessary for engineering practices.

6.0 Course Materials

Online course materials

- Online PowerPoint presentation slides in pdf form
- Audio/visual recording of lectures (Optional)
- Online tutoring session(s) and meeting(s) with students upon request and needs
- Assignments and quizzes in the MLS system
- Reading materials if any in pdf form

Textbook and resources (If any)

- 1) **Hossain, M.E.** and Al-Majed, A.A. (2015). Fundamentals of Sustainable Drilling Engineering. ISBN 978-0-470878-17-0, John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts, USA, pp. 786.
- 2) **Hossain, M.E.** (2016). Fundamentals of Drilling Engineering: MCQs and Workout Examples for Beginners and Engineers. ISBN: 978-1-119083-56-6, John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts, USA, pp. 854.
- 3) **Hossain, M.E.** and Islam, M.R. (2018). Drilling Engineering Problems and Solutions: A Field Guide for Engineers and Students. John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts, USA, ISBN: 978-1-118-99834-2, Jul 2018, pp. 642.

7.0 Target Audiences

- Diploma and vocational training students
- University undergraduate and graduate level students
- Any students who are interested in directional, horizontal, multilateral and extended reach drilling from any disciplines

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- Students who have completed Basics of Drilling Engineering I (Module 1 – 4) and Drilling Engineering II (Module 1 – 4) offered by Prof. M. Enamul Hossain

8.0 Course Topics

- An overview of horizontal, multilateral, and extended reach drilling engineering.
- Different terminologies used for horizontal and multilateral drilling.
- Discussions on benefits, advantages, and disadvantages of horizontal, multilateral, and extended reach drilling.
- Types and detailed descriptions of horizontal and multilateral wells
- TMAL levels for multilateral drilling
- Different surveying techniques and calculations for well planning and design
- Extended Reach Drilling (ERD)

09.0 How the course supports the attainment of the student outcomes

Student Learning Outcomes (1-6)						
1	2	3	4	5	6	7
Moderate	Moderate	Moderate	Low	Moderate	Moderate	

10.0 Course Contents and Schedule

Lec. No.	Module	Topics	Remarks
Horizontal and Multilateral Drilling – One Module			
01	Introduction	Course overview and basics of horizontal drilling (1)	
02	Horizontal drilling	Basics of horizontal drilling (2)	
03	Horizontal drilling	Basics of horizontal drilling (3)	Quiz 1
04	Workout examples	Workout examples on horizontal drilling (1)	Assignment 1
05	Workout examples	Workout examples on horizontal drilling (2)	
06	Multilateral Drilling	Multilateral and extended reach drilling (1)	Quiz 2
07	Multilateral Drilling	Multilateral and extended reach drilling (2)	Assignment 2

11.0 Academic Integrity

Students are encouraged to have a look at the NSRIC's statement of academic integrity at NSRIC website. It is noted that by signing this syllabus, you will acknowledge that you have understood that any detected plagiarism should be reported.

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12. Assessment for Grade

This course contains assignment and quizzes for assessment. Student will receive a “Certificate of completion” after successful completion of the course.

Important Note:

- i) The below classified courses (i.e., academic courses) will only be evaluated based on the grade system shown in Table 2. A grade and certificate will be issued for the student(s) and participant(s).
A: Advanced level academic level courses; **H:** Higher-level courses (i.e., graduate courses); **I:** Intermediate courses (i.e., university preparatory courses – Grade XII+); **K12:** Foundational, and lower-level courses; **M:** Mid-level courses (i.e., undergraduate courses).
- ii) The below classified courses will **not** be evaluated based on the grade system shown in Table 2. A certificate will be issued for the student(s) and participant(s).
E: Executive courses; **P:** Professional courses; **S:** Short/seminar courses; **T:** Training courses; **U:** Tutorial Courses; **V:** Vocational training courses; and **W:** Workshop courses.

Participation/Engagement/Performance

Your participation in every aspect of the course is important for the learning process. Your engagement in every discussion in the course, due delivery of all assignments, quizzes, and research projects will be fruitful. These efforts from your side will reflect your performance in the course delivery and your commitments. This performance is the reflection of your dream grade!!

Assignments

You will be given **two assignments** during the course delivery. The due dates for assignments are specified in the course content and schedule section. The assignments will be given time to time to solve/answer during the term. Assignments will be posted through NSRIC online platform at least one week before they are due. Due dates are given in course schedule (tentative schedule). However, in case of any special circumstance, the date will be posted beforehand or announced in class.

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Quizzes

A **Maximum of two** quizzes (maximum of **ten MCQ @ 10** minute) will be taken based on class lectures and performance. The quiz will be taken in the beginning of the lecture through NSRIC online platform. If you miss the quiz without any valid official excuse, you will receive for the non-attended quiz. If any student fails to attend the quiz, he/she must submit a valid reason to the instructor. In such case, he/she should appear another quiz or may be averaged on the quizzes that he/she attended. It will depend on the situation and instructor.

13.0 Advice and additional requirements

I advise you to:

- Please contact me if you need any help.
- Students are expected to attend all scheduled online lecture classes.
- Students are expected to study from the course materials and/or textbooks which will help to easily read and understand.
- Students are encouraged to write their own notes during lectures/presentations (pdf PowerPoint presentations, and additional materials if any).
- Students are encouraged to attend online platform classes on time because late attendee disrupts the flow of the class for both the instructor and the other students.

Additional information (During Online Course offering Period)

- The PowerPoint course materials, and video lectures will be available at the NSRIC Platform.
- There will be scheduled discussion/tutorial sessions on **a set** scheduled time. All students should attend this session (Need student request).
- There will be an office hour for students on Monday – Friday from 08:30 am – 09:30 am EST (Toronto, Canada time). **Students need to send an email request so that a zoom meeting can be arranged.** In addition, any time student can set up an online appointment (i.e., phone, zoom, and/or other mode of communications) based on availability of the course instructor. However, student should send an email request for setting up this type of meeting.

Requirements/Instructions

Students are advised to register all drilling engineering modules and courses for becoming the master in the subject area offered by Prof. Dr. M. Enamul Hossain.

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Prepared by Prof. Dr. Mohammed Enamul Hossain, NSRIC Chair Professor in Sustainable Energy, Dept. of Petroleum Engineering, OE Division, NSRIC Inc., London, ON, Canada.

Subtitle: This is an extensive study of drilling engineering related to horizontal and multilateral drilling and extended reach drilling (ERD) for the petroleum industry during oil and gas operations.



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