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Drilling Engineering II (Module I – IV)

1.0 Course Faculty Information

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

2.0 Course Information

Course Code and Title	ENG--M-C00103, ENG-M-C00104, ENG-M-C00105 and ENG-M-C00106
Class Days	Follow posting in NSRIC LMS system
Class Time	Follow posting in NSRIC LMS system
Course Credit Hours	3
Class Location	NSRIC online platform
prerequisites and/or co-requisites	n/a
Level /A, E, H, I, K12, M, P, S, T, U, V, W	Mid-level courses / M

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.

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	10: 30 am – 11:30 am EST (Monday) by email appointment

4.0 Target Audiences

- Diploma and vocational training student.
- University undergraduate level student.

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- Any student who is interested in drilling engineering.
- Students who have completed Basics of Drilling Engineering I (Module 1 – 4) offered by Prof. M. Enamul Hossain.

5.0 Course Module Descriptions

Module I:
Module I of Drilling Engineering II covers the detail on mud circulation and hoisting system such as mud pump, calculations of pump factor calculations, HP, and efficiency etc. It also covers the in-depth bit design, selection, and evaluation. This module is designed for audiences/students who have basic knowledge of drilling engineering. In addition, workout examples related to field operations and topics are illustrated for better understanding of theories. The course contains four modules (Module I – IV) and each module covers six lectures. Students are strongly advised to complete the course title "Basics of Drilling Engineering I" by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Keywords: Mud pump, displacement, pump factor, mud circulation, duplex pump, triplex pump, hoisting system, drilling bit tooth wearing, design, selections, and evaluation.

Module II:
This module is designed for audiences/students who have basic knowledge of drilling engineering. Module II of Drilling Engineering II covers the topics such as drillstring and bottom-hole assembly (BHA) design and evaluation, factors affecting rate of penetration (ROP) and ROP optimization techniques such as drill-off test, drilling response test etc. An in-depth discussion on bust, collapse, tension, torsion, critical rotary speed, and stretch of drillpipes are presented here. In addition, workout examples related to field operations and topics are illustrated for better understanding of theories. The course contains four modules (Module I – IV) and each module covers six lectures. Students are strongly advised to complete the course title "Basics of Drilling Engineering I" by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Keywords: drillstring, drillstring design and evaluation, bottom-hole assembly, BHA design, BHA evaluation, Rate of penetration, ROP optimization, ROP factors, bust, collapse, tension, torsion, critical rotary speed, and stretch of drillpipe.

Module III:
This module is designed for audiences/students who have basic knowledge of drilling engineering. Module III of Drilling Engineering II covers the topics such as estimation of formation pore pressure and fracture pressure, prediction and detection of abnormal pressure, seismic surveys, D – Exponent, drilling rate, resistivity log, sonic log, interval transit time, Jordan and Shirley model, Rehm and McClendon Model, Eton model, Anderson et al. model, manufacturing of casing, rig side operations, handling, running and landing procedures, casing design through collapse, burst, tension etc., basic concepts of directional drilling, importance, classification, and planning of a directional well path, and illustrations on the related topics above. In addition, workout examples related to field operations and

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topics are illustrated for better understanding of theories. The course contains four modules (Module I – IV) and each module covers six lectures. Students are strongly advised to complete the course title "Basics of Drilling Engineering I" by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Keywords: Estimation of formation and fracture pressure, prediction and detection of abnormal pressure, seismic surveys, D – Exponent, drilling rate, resistivity log, sonic log, interval transit time, Jordan and Shirley model, Rehm and McClendon Model, Eton model, Anderson et al. model, manufacturing of casing, rig side operations, handling, running and landing procedures, casing design through collapse, burst, tension etc., basic concepts of directional drilling, importance, classification, and planning of a directional well path.

Module IV:

Module IV of Drilling Engineering II includes definitions of terminologies such as azimuthal direction, build up, inclination angle, kick off point, measured and true vertical depth, types of directional wells, importance of drilling directionally, directional well types, planning a directional well path, well trajectory, survey instruments such as compass, electronic and gyroscope, wellbore surveying techniques such as average angle method, balanced tangential method, minimum curvature, radius of curvature and tangential method, measurement while drilling (MWD), gyroscope, Electronic Multishot (EMS), geo-steering, pulse telemetry, logging whilst drilling (LWD). The course also covers the drilling costs analysis and authorization for expenditure (AFE), tangible costs, rig costs and services, drilling time and connection time. In addition, simple workout examples related to field operations are also covered. The course contains four modules (Module I – IV) and each module covers six lectures. Students are strongly advised to complete the course title "Basics of Drilling Engineering I" by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Keywords: Directional well types, planning a directional well path, well trajectory, survey instruments, compass, electronic and gyroscope, wellbore surveying techniques, average angle method, balanced tangential method, minimum curvature, radius of curvature and tangential method, measurement while drilling (MWD), gyroscope, Electronic Multishot (EMS), geo-steering, pulse telemetry, logging whilst drilling (LWD), drilling time, authorization for expenditure (AFE), tangible costs, rig costs and services, connection time.

6.0 Course Learning Outcomes

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

CLO1: Become familiar with different calculations related to mud pump displacement, pump factor, mud circulation and hoisting system.
CLO2: Understand the drilling bit tooth wearing, design, selections, and evaluation.
CLO3: Understand the design, selection, and evaluation of drillstring and Bottom-hole assembly (BHA).

CLO4: Understand the factors affecting rate of penetration (ROP) and become acquainted with ROP optimization techniques (i.e., drill-off test and drilling response test).
CLO5: Ability to understand formation pore and fracture pressure calculations using different established models to design the safe drilling operations.
CLO6: Ability to understand the manufacturing of casing, casing rig side operations, handling procedure (e.g., running procedures, landing procedures, casing design and selection criteria.
CL07: Become familiar with the basic concepts of directional drilling, importance, classification, and planning of a directional well path.
CLO8: Become familiar and in-depth understanding with the various drilling systems and well design techniques.
CL09: Ability to understand the wellbore surveying techniques and in-depth calculations for better design of the well trajectory.
CL10: Ability to understand different drilling costs and economic and accordingly develop a drilling plan based on economic analysis i.e., authorization for expenditure (AEF)
CL11: Ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental and safety.
CL12: Ability to use techniques, skills, and modern engineering tools necessary for engineering practices.

7.0 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	

8.0 Course Materials

Online course materials

- Online PowerPoint presentation slides in pdf form
- Audio/visual recording of lectures (Optional)
- Online tutorial and meeting with students upon request
- Assignments and quizzes in the MLS system in pdf form
- 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.

9.0 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.

10. Assessment for Grade

This course is an academic course (i.e., K12, and university level courses) and thus based on individual and team performance, students are evaluated followed by Table 1. Therefore, the program courses contain only assignments for assessment. Student will receive a "Certificate of completion" after successful completion of the course.

Table 1: NSRIC grading system

Type of Assessment	Grade %
Participation/Engagement/Performance	10%
Assignments	15%
Quizzes	10%
Research Project	20%
Midterm Exam I	15%
Midterm Exam II	15%
Final Exam	15%
Total	**100%**

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).

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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.

At the end of the term, the below Table 2 will be used for translating your marks into a "Latter Grade" based on NSRIC grading policy.

Table 2: NSRIC grading system

Marks	Letter Grade	Points	Description
≥ 93	A+	4.00	Outstanding
≥ 90	A	3.75	
≥ 87	A-	3.50	Excellent
≥ 84	B+	3.25	Very good
≥ 81	B	3.0	
≥ 78	B-	2.75	Moderately Good
≥ 75	C+	2.50	Good
≥ 72	C	2.25	
≥ 69	C-	2.0	Moderately Good
≥ 66	D+	1.75	Pass
≥ 63	D	1.50	
≥ 60	D-	1.25	Poor Pass
< 60	F	0	Failing

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 **eight 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 <u>eight</u> quizzes (maximum of **five MCQ @ five** 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, your will receive **<u>zero</u>** 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.

11.0 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 **every Monday** at the class scheduled time. All students must attend this session (Need student request).
- There will be an office hour for students on Monday from 10:30 am – 11:30 am, 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.

12.0 Course Topics

- An overview of drilling engineering and mud pump and hoisting system calculations.
- Drilling bit tooth wearing, design, selections and evaluation.
- Drillstring and bottom-hole assembly design/evaluation.
- Factors affecting rate of penetration (ROP) and ROP optimization techniques.
- Drill-off test and drilling response test.
- Prediction and detection of abnormal pressure zones.
- Estimation of formation pore and fracture pressure.
- Casing design and selection criteria including manufacturing of casing, rig side

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operations, handling running and landing procedures.
- Basic concepts of directional drilling, importance, classification, and planning of a directional well path.
- Well planning and wellbore surveying techniques.
- Drilling costs estimation and authorization for expenditure (AFE)

13.0 Course Contents and Schedule

Lec. No.	Module	Topics	Remarks
Module I			
01	Drilling system	Course overview, setting expectations, and details on circulation and hoisting system (1)	
02	Drilling system	details on circulation and hoisting system (2)	
03	Drilling bit	Rotary drilling bit design/selection (1)	Quiz 1
04	Drilling bit	Rotary drilling bit design/ selection (2)	Assignment 1
05	Drilling bit	Rotary drilling bit selection/performance evaluation (3)	Quiz 2
06	Workout examples	A summary and problem/workout example session (1)	Assignment 2
Module II			
07	Drillstring design	Drillstring and bottom-hole assembly design/evaluation (1)	
08	Drillstring design	Drillstring and bottom-hole assembly design/evaluation (2)	
09	Drillstring design	A summary and problem/workout example session (3)	Quiz 3
10	ROP factors	Factors affecting rate of penetration (1)	Assignment 3
11	ROP optimization	ROP optimization techniques (2)	Quiz 4
12	ROP optimization	A summary and problem/workout example session (3)	Assignment 4
Module III			
13	Pore pressure	Estimation of formation pore pressure (1)	
14	Fracture pressure	Estimating fracture pressure (2)	
15	Casing design	Casing design (procedures; collapse, burst, tension etc.) (1)	Quiz 5
16	Casing design	Casing design (procedures; collapse, burst, tension etc.) (2)	Assignment 5
17	Casing design	Casing design (procedures; collapse, burst, tension etc.) (3)	Quiz 6
18	Directional drilling	Directional drilling (1)	Assignment 6
Module IV			
19	Directional drilling	Directional drilling (2)	
20	Directional drilling	Directional drilling (3)	
21	Wellbore surveying	Wellbore surveying techniques (1)	Quiz 7
22	Wellbore surveying	Wellbore surveying techniques (2)	Assignment 7
23	Drilling costs	Drilling costs and economics (1)	Quiz 8
24	Drilling costs	Drilling costs and economics (2)	Assignment 8

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

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Requirements/Instructions
Students are advised to register all drilling engineering modules courses for becoming the master in the subject area.

Bundled Program Description

These bundled courses program is designed for the audiences who are interested to learn the about in-depth of drilling engineering related to oil and gas operations. The course content is designed for audiences who are in diploma or undergraduate level and early career professionals in oil and gas industry and interested in learning drilling engineering in details. The course covers a pump factor, HP and efficiency calculations that are needed for designing the pump for circulating drilling mud, with in-depth treatment of casing, rotary drilling bit, drill string and bottom-hole assembly design/evaluation. It covers different calculations related to mud pump displacement, pump factor, mud circulation and hoisting system. The student will also gain good understanding of factors affecting rate of penetration, drill-off test, and drilling response test. Various drilling techniques such as directional drilling, and wellbore surveying techniques are also introduced in addition to well design for safety and efficiency. Other topics such as introduction to drilling costs and authorization for expenditure (AFE) are discussed. In addition, simple workout examples related to field operations are highlighted too. The course contains four modules (Module I – IV) and each module contains six lectures. Students are strongly advised to complete the course title “Basics of Drilling Engineering I” by Prof. M. Enamul Hossain at NSRIC Platform to understand this course content.

Subtitle
A comprehensive overview of drilling engineering for undergraduate students, trainers, and other practicing engineers who are interested in learning detailed drilling engineering and having enough practical workout examples.