CIEE Global Institute – Berlin

Course name:	Introduction to Engineering
Course number:	(GI) ENGI 1001 BRGE
Programs offering course:	Berlin Open Campus Block
Open Campus Track:	STEM and Society
Language of instruction:	English
U.S. semester credits:	3
Contact hours:	45
Term:	Spring 2020

Course Description

Introduction to Engineering is designed to teach students the application of mathematical and scientific principles to solve basic engineering problems. The course covers engineering computing tools, methods of engineering, prototyping basics and challenge-based learning techniques. Students will address complex real-world problems related to telecommunications, water and transportation infrastructure, energy supply and environmental issues.

Learning Objectives

By the end of this course, students will be able to:

- Use engineering analysis and design processes.
- Apply the engineering problem-solving method to analyze basic problems, construct multiple solutions and evaluate them with quantitative analysis.
- Internalize fundamental concepts of energy, forces, materials and manufacturing components.
- Communicate efficiently engineering information, including oral, written, visual and technological communication.
- Continue studies in future engineering classes with a solid foundation of basic engineering skills.
- Appreciate the impact of engineering in modern life, in the United States and their host country.

Course Prerequisites

High School Physics and High School Algebra, Geometry and Trigonometry or equivalents.

Methods of Instruction

The course will be taught through interactive lectures, class discussions, lecture activities, reading assignments, problem sets, presentations and experiments. In addition, students will visit national universities and industrial facilities, conducting interviews with local engineers. Students will work individually and in groups in experiments and on assigned problem sets. Students are expected to read portions of the textbooks before lectures. Students will work in groups to present current applications of engineering in their lives and in the lives of those in the local community. Students should take full advantage of generous online resources associated with the texts.

Assessment and Final Grade

Weekly Quiz (Five)	15 %
Problem Sets (Five)	20 %
Group Project	15 %
Group Presentations (Two)	10 %
Participation	20 %
Final Exam (Comprehensive)	20 %
Total	100%

Course Requirements

Participation

Participation is valued as meaningful contribution in the digital and tangible classroom, utilizing the resources and materials presented to students as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to- peer feedback (after presentations), interaction with guest speakers, and attentiveness on co- curricular and outside-of-classroom activities.

Weekly Quiz

Each week, students will take a quiz based upon the previous week's material. These short exams will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. Each exam will take approximately 20-30 minutes and comprise 5% of the final course evaluation.

Problem Sets

Problems located at the end of each chapter of the textbooks will be assigned to individuals or groups by the instructor as well as other writing activities. Student solutions to these problems will be collected and discussed in review sessions. The instructor will work through or give solutions to all problems. Similar problems will appear on weekly quizzes and the final exam. Assessment for problem sets will include timely and correct completion of problems.

Group Project
The class will be divided into groups of 3-5 students. This project will involve proving a practical application of one of the concepts seen in class. Students will take advantage of the use of accessible materials to build a simple engineering project. Further details on study group allocation and the assignment will be provided in class. All students need to participate, contribute and present.

Group Presentations
Students will design a hypothetical engineering solution to an area of opportunity identified in the host country. This will be done in groups using information from various sources, including interviewing each other and local people. A 15 minute presentation with a demonstration using engineering communication will be graded on the overall presentation as well as each student's part in it.

Final Exam
The final exam is comprehensive. As with quizzes, this exam will include standard exam formats of True/False, Multiple Choice, Short Answer and Problem Solving. It will include material from both lecture and laboratory.

Class Attendance

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*
Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**
More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1 Introductory Concepts

Session 1.1 Introduction to Engineering and Engineering Design

This session will form the introduction to the class; we will outline the course requirements and formal aspects of participation and engagement in class. This will be followed by the introduction to engineering, providing basic facts and concepts, and defining engineering as opposed to science. Students will also learn the steps in the design process: 1) recognize a need, 2) define a problem, 3) do preliminary research and preparation, 4) conceptualize possible solutions, 5) summarize results, 6) evaluate the solution alternatives, 7) optimize to arrive to the best possible solution, and 8) present a solution. Students will use this process to complete their group presentations and project.

Readings:

- Chapter 1 Introduction to Engineering http://cnx.org/content/m13680/1.2/
- "Engineering Design Process" of *Engineering Fundamentals* http://ascslab.org/courses/ek132/reading/chapter3.pdf

Problem Set 1:

- Find a real-life example of any product or service and research about its design process. Describe in as much detail as possible what were the steps that the engineers followed to get to the final product or service.

Week 2 **Fundamental Dimensions and Units: Length, Time, Mass and Force**

Session 2.1 Length and Time

This is a review of fundamental parameters, measurement and concepts related to length (area and volume) and time (periods, frequencies and angular motion) that students learned in high school. Students will use these concepts to solve engineering problems and exercises in class.

In this session, students are expected to form teams and brainstorm ideas of needs and areas of opportunities they identify in the host country that they would like to address through the course.

Quiz 1 (covers material from Week 1)

Readings:

- Chapter 1 Introduction: The Nature of Science and Physics https://cnx.org/contents/Ax2o07Ul@14.43:EC6WBNqn@10/1-2-Physical-Quantities-and-Units
- Chapter 2.3 Time, Velocity and Speed https://cnx.org/contents/Ax2o07Ul@14.43:FalnnAQi@7/2-3-Time-Velocity-and-Speed#88664

Due: Problem Set 1

Session 2.2 Mass and Force

Students will review fundamental parameters, measurement and concepts related to mass (density, gravity, mass flow rate, mass moment of inertia, momentum and conservation of mass) and force (Newton's Laws in Mechanics, moment, torque, work, pressure and stress, linear impulse, elasticity, rigidity and compressibility). They will explore how to apply these concepts in the engineering discipline and how to address problems related to the concepts in real-life scenarios.
Readings:

- Chapters 8.1- 8.5 Linear Momentum and Collisions https://cnx.org/contents/Ax2o07UI@14.43:Zyl5ofSI@7/Introduction-to-Linear-Momentum-and-Collisions
- Chapter 9 Statics and Torque https://cnx.org/contents/Ax2o07UI@14.43:Vpx1oNLV@7/Introduction-to-Statics-and-Torque

Problem Set 2:

- Questions 8, 9, 10, 19 of https://cnx.org/contents/Ax2o07UI@14.43:x2DKb0fr@14.43/Problems-Exercises,
- Questions 8, 11, 12, 14 and 15 of https://cnx.org/contents/Ax2o07UI@14.43:uV6pWDSS@14.43/Problems-Exercises and
- Questions 7, 10, 12 and 27

Week 3 **Fundamental Dimensions and Units: Temperature, Electricity, Energy and Power**

Session 3.1 Temperature

This is a review of fundamental parameters, measurement and concepts related to temperature (temperature difference, heat transfer, temperature-related material properties and energy estimation) that the students learned in high school. There should an in-depth understanding of temperature and heat transfer. Students will be able to apply these concepts in real-life engineering problems.

Quiz 2 (covers material from Week 2)

Readings:

- “Introduction to Engineering Heat Transfer”. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-050-thermal-energy-fall-2002/lecture-notes/10_part3.pdf
- Chapter 13.1 Temperature https://cnx.org/contents/Ax2o07UI@14.43:2ou0Jg2y@6/13-1-Temperature
- Chapter 14 Heat and Heat Transfer Methods https://cnx.org/contents/Ax2o07UI@14.43:eJLN3YM-@6/Introduction-to-Heat-and-Heat-Transfer-Methods

Session 3.2 Electricity

This session is a review and introduction of fundamental parameters, measurement and concepts related to electricity (voltage, direct and alternating current, electrical circuits and components and electric motors). Students will understand in-depth the main electricity concepts. They will be able to solve electricity problems for engineering purposes.

Readings:

- Chapter 18. Electric Charge and Electric Field https://cnx.org/contents/Ax2o07UI@14.43:mbRj4L0x@5/Introduction-to-Electric-Charge-and-Electric-Field
- Chapter 20. Electric Current, Resistance, and Ohm's Law https://cnx.org/contents/Ax2o07UI@14.43:En9j99Z_@5/Introduction-to-Electric-Current-Resistance-and-Ohm-s-Law

Session 3.3 Energy and Power

Students will learn and internalize the fundamental parameters, measurement and concepts related to energy and power (work, mechanical energy, thermal energy, conservation of energy-First Law of Thermodynamics, watts and horsepower, efficiency, energy sources, generation and consumption). They will be able to understand, abstract and solve engineering problems related to energy and power.

Readings:

- Chapter 7. Work, Energy, and Energy Resources https://cnx.org/contents/Ax2o07UI@14.43:ZDtuSt4h@4/Introduction-to-Work-Energy-and-Energy-Resources

Due: Problem Set 2

Problem Set 3:

- Questions in document https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/unified-concepts/u02_ps06_fall03.pdf,
- Questions 13, 15, 16, 21, 34, 42 of https://cnx.org/contents/Ax2o07UI@14.43:L7ryMjL_@14.43/Problems-Exercises and

- Questions 37, 42 and 49 of https://cnx.org/contents/Ax2o07Ul@14.43:OusU2hy_@14.43/Problems-Exercises

Week 4 **Engineering Communication and Material Selection**

Session 4.1 Engineering Graphical Communication

During this session, students will learn how to create effective graphical communication. They will learn the importance of Engineering Drawing and they will get familiar with orthographic views, dimensioning and tolerancing, isometric view, sectional views, solid modeling and civil, electrical and electronic drawings. They will practice in class how to draw accurately different views of an object. Students will need a sketchbook to collect all their designs in the course.

Quiz 3 (covers material from Week 3)

Readings:

- Design Handbook: Engineering Drawing and Sketching https://ocw.mit.edu/courses/mechanical-engineering/2-007-design-and-manufacturing-i-spring-2009/related-resources/drawing_and_sketching/
- “Engineering Drawings and Symbols” of Engineering Fundamentals

Session 4.2 Technical Reports and Oral Communication

To communicate highly technical and complicated engineering concepts can be a challenge. The intension of this session is that students will learn the basic and most important information that should be included in detailed technical reports. They will also practice how to communicate engineering concepts in an oral presentation. For this session, they will visit a local factory or business in which they will be able to talk to practicing engineers and how they communicate their work and what are the deliverables they usually give to their clients.

This concepts will be helpful for their first group presentation that will be due the next session. For this presentation, students are expected to prepare a hypothetical engineering solution to any area of opportunity they identify in the host country.

Readings:

- "Guide to Technical Report Writing" https://www.sussex.ac.uk/webteam/gateway/file.php?name=guide-to-technical-report&site=356
- "Engineering Communication" of Engineering Fundamentals.

Due: Problem Set 3

Session 4.3 Engineering Materials

Material selection determines the success or failure of a product. During this session, students will learn about material selection. They will learn to take into consideration electrical, mechanical, and thermophysical properties of the materials. They will also get familiar with common solid and fluid engineering materials. Students will take a time to experiment with everyday materials and start the design of a product for their final group projects. Ideally, they would plan to build something simple that they can put together with accessible materials.

Readings:

- "Materials Selection for Mechanical Design I" https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/lec_ms1.pdf
- "Engineering Materials" of Engineering Fundamentals.

Watch: https://www.youtube.com/watch?v=1k89OTpDvIU

Due: First Group Presentation

Problem Set 4:

- Write a technical report about any selected product. Include materials selected and reasons to select those materials. Sketch the product using one of the techniques learnt in class.

Week 5 Mathematics, Statistics and Engineering Economics

Session 5.1 Mathematics in Engineering

During this session, students will review mathematical concepts that are often used for engineering purposes. They will review concepts such as linear, nonlinear, exponential and logarithmic models, matrix algebra, and calculus. Students will learn how to apply the main mathematical concepts used for engineering in real life problems.

The material for the Second Group Presentation will be handed in. For the second presentation, students will compare two transportation methods (for example: hybrid vehicles vs other fuel efficient vehicles) and will suggest the one that is most viable in the host country, given economic and technical factors. They should include their methodology and decision logic. The information needed may come from various sources, including interviewing each other and local people.

Quiz 4 (covers material from Week 4)

Readings:

- Summary of Chapters 4, 5, 6, 8, 10 and 13 of "Engineering Applications of PreCalculus https://cnx.org/contents/cCXsMC7-@3.2:IDF8s-2S@3/Exponents

Session 5.2 Probability and Statistics in Engineering

Probability and Statistics are subjects often used for the engineering professions. This session is a review of probability and statistical concepts that are commonly used for engineering purposes. Students will review concepts such as frequency distributions, mean, median, standard deviation and normal distribution. They will learn how to apply this concepts for real engineering scenarios.

Readings:

- Chapters 1 and 2 of Probability & Statistics for Engineers & Scientists http://fac.ksu.edu.sa/sites/default/files/probability_and_statistics_for_engineers_and_scientisst.pdf

Due: Problem Set 4

Session 5.3 Engineering Economics

Engineers should know basic economic concepts such as cash flow diagrams, simple and compound interest, net present value, effective interest rate and decision making to choose the best alternatives. This session will teach these concepts to the students and they will be able to use them for solving engineering problems. They will learn how to value different options to arrive to the best possible and most viable solution for a service or product.

Readings:

- "Engineering Economics: Overview and Application in Process Engineering Industry" https://ocw.mit.edu/courses/chemical-engineering/10-490-integrated-chemical-engineering-i-fall-2006/projects/eng_econ_lecture.pdf
- Chapter 1 "Foundations of Engineering Economy" of Engineering Economy http://www.m5zn.com/newuploads/2013/05/28/pdf/ed6f3d1f87b9cd2.pdf

Problem Set 5:

- Exercise 7 from Chapter 4 "Exponents" https://cnx.org/contents/cCXsMC7-@3.2:IDF8s-2S@3/Exponents,
- Exercise 2 from Chapter 5 "Linear Equations" https://cnx.org/contents/cCXsMC7-@3.2:qdV4wZF_@3/Linear-Equations,
- Exercise 8 from Chapter 6 "Quadratic Equations" https://cnx.org/contents/cCXsMC7-@3.2:UXXT6n12@3/Quadratic-Equations,
- Exercise 9 from Chapter 8 "Radicals" https://cnx.org/contents/cCXsMC7-@3.2:SqPmsQKE@3/Radicals,
- Exercise 2 from Chapter 10 "Logarithms" https://cnx.org/contents/cCXsMC7-@3.2:9L7bzMcp@5/Logarithms,
- Exercise 5 from Chapter 13 "Matrices" https://cnx.org/contents/cCXsMC7-@3.2:6GbkPw_D@3/Matrices,
- Exercises 1.28 and 1.30 from Chapter 1 and 2.95, 2.96 and 2.103 of Chapter 2 of Probability & Statistics for Engineers & Scientists http://fac.ksu.edu.sa/sites/default/files/probability_and_statistics_for_engineers_and_scientisst.pdf, and
- Problems 1.10, 1.11, 1.22, 1.30 and 1.40 from Chapter 1 of Engineering Economy

http://www.m5zn.com/newuploads/2013/05/28/pdf/ed6f3d1f87b9cd2.pdf

Due: Group Project

Week 6 **Computational Engineering Tools**

Session 6.1 Electronic Spreadsheets

During this session, students will review basic concepts of electronic spreadsheets such as Microsoft Excel. They will learn about formulas, functions, logical functions, plotting, matrix computation and curve fitting with Excel. At the end of the session, they should be able to use efficiently electronic spreadsheets for engineering purposes and to solve problems in the most efficient and resourceful way.

Quiz 5 (covers material from Week 5)

Due: Second Group Presentation

Readings:

- "Engineering Computation with Spreadsheets" https://cnx.org/contents/I4YwltqH@12.1:r65uBlM2@6/Preface

Session 6.2 MATLAB I

MATLAB has become one of the fundamental tools for engineers nowadays. During this session, students will have an introduction to MATLAB. They will learn how to use MATLAB Built-in Functions, plotting and how to import Excel and other data files into MATLAB. They will become familiar with MATLAB to solve problems and to do basic Mathematical Computations and they will solve some problems from the book in class.

Readings:

- Chapters 1-3 of "Freshman Engineering Problem Solving with MATLAB" https://cnx.org/contents/OmQ8H8G6@18.1:NnmmDRSI@1/Introduction-to-the-M-file-Connexions-Modules
- Only for reference: MATLAB https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf

Due: Problem Set 5

Session 6.3 MATLAB II

This session will be a review of the topics seen throughout the course. Students will continue to use MATLAB and learn how to graph and program. They will also learn how to do matrix computations and curve fitting with this tool. Students will think of scenarios in which they can use MATLAB to abstract engineering problems and they will solve some problems during class.

Final Exam (Comprehensive)

Readings:

- Chapters 4 and 5 of “Freshman Engineering Problem Solving with MATLAB” https://cnx.org/contents/OmQ8H8G6@18.1:NnmmDRSI@1/Introduction-to-the-M-file-Connexions-Modules
- Only for reference: MATLAB https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf

Course Materials

Course Textbooks

Moaveni, Saeed, 2011. *Engineering Fundamentals: An Introduction to Engineering*. CENGAGE Learning.

College Physics, 2017 Edition by Urone, P.P. et al. OpenStax College. https://openstax.org/details/college-physics

Starks, Scott. *MATH 1508 (Laboratory) Enginerring Applications of PreCalculus.* OpenStax College. http://cnx.org/content/col11337/1.3/

Walpole, Ronald E. et al. 2011 *Probability & Statistics for Engineers & Scientists.* Prentice Hall Pearson. http://fac.ksu.edu.sa/sites/default/files/probability_and_statistics_for_engineers_and_scientisst.pdf

Blank, Leand & Anthony Tarquin. 2012. *Engineering Economy.* McGraw Hill. http://www.m5zn.com/newuploads/2013/05/28/pdf/ed6f3d1f87b9cd2.pdf

Beyenir, Serhat. 2012. *Engineering Computation with Spreadsheets.* OpenStax College. http://cnx.org/content/col11235/1.12/

Morrell, Darryl. *Freshman Engineering Problem Solving with MATLAB.* OpenStax College. http://cnx.org/content/col10325/1.18/

Readings

Burrus, C. Sidney, 2012. *Engineering – A Modern Creative Discipline*. OpenStax College http://cnx.org/content/m13680/1.2/

"Introduction to Engineering Heat Transfer". *Aeronautics and Astronautics*. MIT OpenCourseWare. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-050-thermal-energy-fall-2002/lecture-notes/10_part3.pdf

"Guide to Technical Report Writing". University of Sussex Open Resources. https://www.sussex.ac.uk/webteam/gateway/file.php?name=guide-to-technical-report&site=356

Online Resources

"Design Handbook: Engineering Drawing and Sketching". *Design and Manufacturing I.* MIT OpenCourseWare. https://ocw.mit.edu/courses/mechanical-engineering/2-

007-design-and-manufacturing-i-spring-2009/related-resources/drawing_and_sketching/

Gregory, Jeremy. “Materials Selection for Mechanical Design I: A Brief Overview of a Systematic Methodology”. *Laboratory for Energy and Environment*. Materials Systems Laboratory. MIT OpenCourseWare. https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/lec_ms1.pdf

Qiu, Fawn. “Easy DUY Projects for Kid Engineers”. TED Talks. https://www.youtube.com/watch?v=1k89OTpDvIU

Mao, Kangyi. “Engineering Economics: Overview and Application in Process engineering Industry. MIT OpenCourseWare. https://ocw.mit.edu/courses/chemical-engineering/10-490-integrated-chemical-engineering-i-fall-2006/projects/eng_econ_lecture.pdf

MATLAB. MathWorks. https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf