EEN-E1030, Thermodynamics in Energy Technology

Fall, 2020

Aalto-yliopisto
Insinööritieteiden korkeakoulu

Teaching personnel

Teacher in charge

Senior University Lecturer Henrik Holmberg
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Assistants

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Lectures and calculation exercises

Duration: I-II periods

Lectures:
1st period: Lectures will be given online via Teams/Zoom on Monday at 10.15 - 12. You will get the invitation by mail.
2nd Period: We have not yet got exact information on teaching arrangements in the second period but apparently online lectures will continue in this period, too.

Calculation exercises:
1st and 2nd period: Calculation exercises will be given online via Teams/Zoom at 12-14 on Thursday in both periods. You will get the invitation by mail.

Computer exercise HSC-chemistry. Computer exercise won't be held this Fall.

Main course content

- Enthalpy
- Entropy
- Chemical equilibrium
- Exergy analysis
- Thermodynamics of solutions
- Thermodynamics of humid air
- Real gases

Learning outcomes

Check WebOodi

About calculation exercises

- Exercises will be uploaded on MyCourses on Monday or Tuesday before the exercise. Several questions (but not all) are both in Finnish and English. Solutions are only in English.

- There will be a star problem in every exercise. If you solve and return the problem you can earn some extra points, which can improve your final grade.

- The assessment scale is 0-3 points. The final sum is divided by 10 => you can maximally get 3 extra points.

- Extra points are rounded normally. For example, 2.5 points give you 3 extra points and 2.4 give you 2 extra points.

- **Assistants give you some help online via Teams/Zoom in calculation exercises.** You must return the answer of the star problem next Thursday by 12.00 at the latest.

- You should submit your solution to a return folder on MyCourses. You find folders (Round 1, Round 2, Round 3,…) under Assigments where you can upload your solution by the dead line. You can solve the problem by hands and sumbit the picture of your solution on MyCourses.

- Answers to other calculation problems are given when the paper is uploaded on the course page. If you have any questions about other problems, you can make them in online exercises.

- Answers to star problems will be uploaded on the course page during the course.

Course material

For students, who understand Finnish, a course compendium:

- Lampinen Markku J., Seppälä Ari, Kemiallinen termodynamiikka energiatekniikassa.
- You can download the Finnish material as a pdf-file on MyCourses-page.

****For students, who do not understand Finnish, two alternative books**

OBTAIN ONLY ONE OF THE FOLLOWING BOOKS:

- Engel Thomas, Reid Philip, THERMODYNAMICS, Statistical Thermodynamics &Kinetics. See Chapters on the next slide
- Engel Thomas, Reid Philip, Physical Chemistry, 3rd edition (other editions should also be possible). See Chapters on the next slide

For all students

- A compendium about the thermodynamics of humid air in English. You can download the material as a pdf-file on MyCourses-page.
- A compendium about real gases in English. You can download the material as a pdf-file on MyCourses-page.
- All slides after the lecture will be uploaded on MyCourses-page.

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**You don't necessarily need books by Reid and Engel to pass the course event though you don't understand Finnish. Lecture slides cover comprehensively the course content.

Chapters that are included in course requirements in books

THERMODYNAMICS, Statistical Thermodynamics &Kinetics by Engel&Reid
Physical Chemistry by Engel&Reid

- Chapters 3.4 and 3.6
- Chapters 4.1, 4.2, 4.3, 4.4 and 4.5
- Chapters 5.8, 5.9, 5.10 and 5.13
- Chapters 6.1 – 6.13
- Chapters 7.1-7.4 (or the course compendium about real gases)
- Chapter 8.6
- Chapters 9.1-9.3, 9.5-9.7, 9.9-9.13
- Chapters 10.1-10.3
- Chapters 11.1-11.13 concerning only topics that the lecture focuses on.

Passing the course

To pass the course you must get 9/24 points in the exam. This is the only requirement.

About the exam

- The exam will be held on December 7 at 9-12 either as a normal exam at the university (primary option) or as a home exam (secondary option). You will get more detailed information on the exam in the second period.

- There will be four problems in the exam. You can maximally get 6 points for each problem (scale 0,1,2..6) => maximum points of the exam are 24 points.

- If you have returned star problems, the extra points are considered since you have passed the exam. In other words, you WON'T PASS the course if you get 7 points in the exam and you have 2 extra points.

- If we have a normal exam, you can take the summary of course equations and necessary thermodynamic tables and diagrams with you in the normal exam. You find these files on the course page. Start to use this material right away in the first calculation exercise. You are not allowed to take any other material in the normal exam.

Preliminary course schedule, lectures

Lecture 1, 7th September,
Introduction to the course, definitions of thermodynamic states and introduction to enthalpy, h,s diagram of water
Lecure 2, 14th September
Change of enthalpy and reaction enthalpy
Lecture 3, 21st September,
Entropy and Euler's homogenous theorem
Lecture 4, 28th September,
The Gibbs energy, chemical potential, phase equlibrium
Lecture 5, 5th October,
Equilibrium constant
Lecture 6, 12th October,
Calculating the chemical equilibrium, phase rule
Lecture 7, 26th October,
Exergy analysis
Lecture 8, 2nd November,
Thermodynamics of solutions
Lecture 9, 9h November,
Thermodynamics of humid air, part 1
Lecture 10, 16th November,
Thermodynamcis of humid air, part 2
Lecture 11, 23rd November,
Real gases and the law of corresponding states

Changes are possible