Course memo (Kurs PM) for MH2039 Process Engineering

TTMVM1-IMTA, 2020, Autumn semester, period 1.

This course provides an overview of typical metallurgical processes to convert mined ores and minerals to metals ready for sale. This is a key part of Sweden's economy and it is therefore important to understand the context, challenges and fundamental calculations of the industry. The course is not intended to discuss mining or manufacturing.

Contents and learning goals

Course contents

- Material production and processing involving preparation of raw materials, metal production and the thermomechanical treatment of metal products
- Fundamental knowledge on physical and chemical processes in the area of metallurgy
- Fundamental aspects of sustainable development, circular economy and gender issues in the metals industry

Intended learning outcomes

After successful completion of the course, students should:

- Describe and analyse a production chain for the production of metals from ores and raw materials to finished products
- Describe, analyse and compare high-temperature processes in metals production, for both the liquid and solid states
- Identify relevant information for a production chain using appropriate databases and scientific literature in order to compare and evaluate them
- Apply heat- and mass-balance in metallurgical processes
- Analyse and discuss fundamental concepts in gender theory and organisation
- Account for and discuss what concepts sustainable development in the metals industry and how the metals industry is a part of the circular economy.

Organisation of teaching in the course

The course consists of eight (8) non-mandatory lectures/workshops, two (2) mandatory exercise classes and one mandatory seminar. Twenty-four hours is also booked in the teaching timetable (six four-hour sessions) for project work.

The non-mandatory lectures provide information, demonstration, practice and discussion to reinforce the online resources on the teaching and learning platform. It is highly recommended that you attend all sessions. Additional time may be required throughout the course to practice calculations and perform additional background reading on the teaching

and learning platform or elsewhere. There is also a short research task of approximately two hours between lectures three and five.

The mandatory exercise classes allow time for students to practice calculations on their own, with the chance of support from teachers. Participation in both classes is required to pass the course.

The project allows students to apply the knowledge they gain from lectures to real materials systems and report on the technical and sustainability aspects of metals processing.

Assessment for the project is by written report, oral presentation and personal reflexions. This is intended to allow students the opportunity to demonstrate their knowledge, practice two forms of communication and to reflect on their performance individually and as a group. The workload for the project is estimated to be a total of twenty-four hours, all of which is built into the timetable.

The final part of assessment is a home exam, in which students perform an extended calculation in a fixed time period (to be determined during the course). This is intended to reflect real working conditions, in which access to important information is usually possible, but time is often limited. This time is likely to result in a high workload, so it is recommended that students account for this when organising their time during the home exam.

Relevance to programme goals

MH2039 contributes to the following goals of the Engineering Materials Science master's programme:

Knowledge and understanding

- Have extensive knowledge of both materials and processes in order to be able to develop and manufacture new materials and products
- Have such knowledge as is required to be able to work in materials-related industries within research and development as well as in production and manufacturing

Skills and abilities

- Possess the skills in presentation, communication and teamwork needed to establish good conditions for effective work, both individually and in collaboration in groups with different compositions of individuals
- Demonstrate the skill required to participate in research and development work or to work independently in other advanced technical contexts

Ability to make judgements and adopt a standpoint

- Demonstrate professional and ethical accountability in scientific, technical, ecological and societal enterprises
- Have an understanding of the fact that engineering problems, viewed from a systems perspective, are often complex, can be incompletely defined and sometimes involve conflicting conditions

- Have the ability to identify their need of further knowledge and to continuously develop their skills

The sustainable development issues studied in this course have a significant impact on society, since the metals industry is one of the most polluting industries. Therefore, any improvements are likely to have a large impact on the world. This course directly contributes to sustainable development goals of the programme, namely United Nations Sustainable Development Goals 9 and 13.

Teaching language

The entire course and all examinations shall be conducted in English.

Detailed schedule

Date	Start	End	Activity	Location	Person	Content
2020-08-25	13:00	15:00	Lecture	V23	Chris Hulme-Smith	Course introduction, project, introduction to pyrometallurgical processes
2020-08-27	13:00	15:00	Lecture	V11	Chris Hulme-Smith	Introduction to steelmaking
2020-08-28	08:00	12:00	Project			
2020-09-01	13:00	15:00	Lecture	V11	Chris Hulme-Smith	Mass balance calculations
2020-09-03	13:00	15:00	Lecture	Digital (Links to an external site.)	Lina Andrén (KTH library)	Fundamental research tools at KTH
2020-09-04	08:00	12:00	Project			
2020-09-08	**13:00**	**15:00**	**Exercise**	**W38**	**Chris Hulme-Smith**	**Mass balance exercises**
2020-09-10	13:00	15:00	Lecture	Digital (Links to an external site.)	Chris Hulme-Smith	Heat in metallurgical processes
2020-09-11	08:00	12:00	Project			
2020-09-15	13:00	15:00	Lecture	Digital (Links to an external site.)	Chris Hulme-Smith	Heat balance calculations
2020-09-17	13:00	15:00	Lecture	Digital (Links to an external site.)	Charlotte Holgersson (gender equality office)	Gender equality in metallurgy
2020-09-18	08:00	12:00	Project			
2020-09-22	13:00	15:00	Lecture	Digital (Links to an external site.)	Chris Hulme-Smith	Advanced heat balance calculations
2020-09-24	**13:00**	**15:00**	**Exercise**	**V21**	**Chris Hulme-Smith**	**Heat balance exercises**
2020-09-25	08:00	12:00	Project			
2020-10-02	08:00	12:00	Project			
2020-10-09	**09:00**	**12:00**	**Seminar**	**E35**	**Andrey Karasev, Chris Hulme-Smith**	

To prepare for each session, please review the relevant material on the online teaching and learning platform. This material will be the basis of the classes.

Key concepts

Metals, thermodynamics, process metallurgy, metals extraction, sustainable development, circular economy, gender equality

Metaller, termodynamiken, processmetallurgi, utvinning av metaller, hållbar utveckling, cirkulär ekonomi, jämställdhet

Course literature and preparation

Special Requirements

None.

Recommended prior knowledge

Fundamental thermodynamics, knowledge of the concept of heat and mass balance

Equipment

A scientific pocket calculator is useful

Course literature

No specific literature, some resources recommended on the teaching and learning platform.

Reading instructions

All necessary information is provided during the course, with the exception of the topic studied in the research project.

Disabilities

If you have a disability, you can get support from “Funka”:

https://www.kth.se/en/student/studentliv/funktionsnedsattning/funka-stod-for-studenter-med-funktionsnedsattningar-1.953214
Also inform the course leader if you have special requirements. Provide a certificate form “Funka”.

Examination and completion

Grading scale

The course is graded A-FX, F, based on points gained for the home exam, project written report and project oral presentation.

Examination

Home exam (HEM), 2.0HP
Project (PRO), 3.0HP
Exercises (ÖVN), 1.0HP

Other requirements for course completion

None

Examiner

Christopher Hulme-Smith

Ethical approach

- During group work, everyone in the group is responsible for the group's work.
- During the examination, each student must honestly report the help received and the sources used.
- At the oral examination, each student must be able to account for the entire assignment and the entire solution.

Goal-oriented grading and assessment criteria

The home exam tests the following intended learning outcomes:

- Apply heat- and mass-balance in metallurgical processes

The project tests the following learning outcomes:

- Describe and analyse a production chain for the production of metals from ores and raw materials to finished products
- Describe, analyse and compare high-temperature processes in metals production, for both the liquid and solid states
- Identify relevant information for a production chain using appropriate databases and scientific literature in order to compare and evaluate them
- Analyse and discuss fundamental concepts in gender theory and organisation

The exercise sessions test the following learning outcome:

- Apply heat- and mass-balance in metallurgical processes

Examination details

The course is examined in three parts:

1. Participation in two exercise classes
2. Home exam
3. Project (written report + oral presentation)

If a student is unable to participate in an exercise class, it is possible to complete some additional exercises instead. This should be discussed with the examiner as needed.

If a student cannot attend an oral presentation session, a replacement oral presentation to a suitable audience may be arranged later. This should be discussed with the examiner as needed.

It is not possible to replace the written report or the home exam. However, additional exercises may be set if a grade of FX is achieved in the home exam to demonstrate the competence needed to pass the exam.

The results of each part of the examination will be reported in Ladok. Results of the individual parts of the project (viz. each grading criterion for the written report and oral presentation) will not be reported in Ladok but will be uploaded to Canvas.

Completion of course

The home exam may be attempted again if a grade of FX is achieved or additional exercises set to test competence, at the sole discretion of the examiner. All parts of the examination may be carried forward to future course offerings if the course cannot be completed in the original offering, subject to all applicable rules for doing so at KTH.

Possibility of replacement tasks

If a student is not able to attend a mandatory exercise session, he or she may request a supplementary home exercise in place of the exercises that would have been performed in the mandatory session.

If a student is unable to attend the final seminar, he or she may request to give a presentation to a suitable audience at a later date, on the understanding that the course may not be completed until such a presentation has been given and that it may not be possible to convene a suitable audience until after the normal date of completion of the course.

Possibility of grade improvement (“plussning”)

At the time of writing, there is no possibility to improve grades after completion of the course, in line with KTH policy.

If the course is changed or withdrawn

If the examinations are changed, If the exams are changed, the transitional provisions in the syllabus will define how those who have old exams will be examined.

When the course is no longer given, the student has the opportunity to be examined for another two academic years.

Additional information

Other regulations

Teaching and Learning platform

For this course, Canvas is used as the teaching and learning platform.

Course given by

Materials Science and Engineering, School of Industrial Engineering and Management. Please contact ITM Expedition North (Brinellvägen 66-68) for assistance with registration, de-registration or exam-related issues.

Teachers

The course leader, main teacher and examiner is Dr Christopher Hulme-Smith, chrihs@kth.se.

During the course, sessions will also be taught by Lina Andrén, linaandr@kth.se (KTH library) and Charlotte Holgersson, charlotte.hoglersson@indek.kth.se (Industrial Economics). Andrey Karasev (karasev@kth.se) is also able to answer questions about the process engineering aspects and calculations in the course.

Communication with teachers

All teachers may be contacted through Canvas. Chris Hulme-Smith can also be contacted by email or in person at Brinellvägen 23 (Bergs) office K121.

Course evaluation and course analysis

The course is evaluated using an online form sent to students after the final grades are distributed. The data gathered from the student feedback are analysed soon after they are gathered. Findings are published on the course web. Students may also send suggestions or comments directly to the course leader.

Changes for this course offering

Previous students suggested that the course was difficult to follow for those who had not studied at KTH before, as it assumed too much knowledge. This was addressed by adding more information to the teaching and learning platform for background reading.

Another suggestion was to expand the thermodynamics in the course to cover some content from different courses. However, this was seen as unfeasible, as some students in the other courses do not take this course and therefore it is not possible to change the other courses, even if the thermodynamics is added to this course. Adding more material would also make this course more difficult and lead to some topics being covered in less detail.

Intended learning outcomes were updated to include sustainable development, circular economy and gender issues.

Supplementary

None

Grading criteria

Written report

Criteria	Ratings						Pts
Description of process chain	**5.0 Pts** **Excellent** The process is described almost perfectly with no significant detail omitted or incorrect.	**4.0 Pts** **Very good** The process is described in good detail and all major stages and details are included. Most of the minor details are also present and correct.	**3.0 Pts** **Good** A process chain is described and is largely correct. The description identifies all major processing stages and describes the main details.	**2.0 Pts** **Average** A description is present but contains many minor errors or a combination of one serious error and some minor errors.	**1.0 Pts** **Pass** A description is present but contains multiple significant errors.	**0.0 Pts** **No points** The chain is completely incorrect, or no attempt is made to describe the process chain A description is present but contains multiple significant.	5.0 pts

Criteria	Ratings						Pts
Identification of thermodynamic parameters	**5.0 Pts** **Excellent** Thermodynamic parameters are correct for all processing stages and some consequences for efficiency and product quality are mentioned.	**4.0 Pts** **Very good** Thermodynamic parameters are correct for all processing stages and some consequences for efficiency and product quality are mentioned.	**3.0 Pts** **Good** Thermodynamic parameters are approximately correct for all processing stages.	**2.0 Pts** **Average** The thermodynamic parameters are approximately correct and described in good detail.	**1.0 Pts** **Pass** Thermodynamic parameters are present and are of the correct magnitude but are not correct.	**0.0 Pts** **No points** No thermodynamic parameters are included.	5.0 pts
Raw materials and sources	**5.0 Pts** **Excellent** All raw materials and sources are identified correctly, and the availability of raw materials is assessed. The consequences of changing sources are considered.	**4.0 Pts** **Very good** All raw materials and sources are identified correctly, and the availability of raw materials is assessed.	**3.0 Pts** **Good** All raw materials needed in the process are identified and sources of the raw materials are described.	**2.0 Pts** **Average** Most correct raw materials are identified, and some sources are given.	**1.0 Pts** **Pass** At least one correct raw material is identified.	**0.0 Pts** **No points** No raw materials are identified.	5.0 pts

Criteria	Ratings						Pts
Quality of final products	**5.0 Pts** **Excellent** The consequences of process chain and the thermodynamic parameters on product quality are discussed efficiently and correctly.	**4.0 Pts** **Very good** The quality of the final product and the impact of the process chain and thermodynamics parameters is discussed in good detail and entirely correctly.	**3.0 Pts** **Good** The quality of the final product and the impact of the process chain and thermodynamics parameters is discussed in good detail and almost entirely correctly.	**2.0 Pts** **Average** The quality of the final product and the impact of the process chain and thermodynamics parameters is discussed briefly.	**1.0 Pts** **Pass** The quality of the final product is considered briefly.	**0.0 Pts** **No points** No mention of the quality of the final product is given.	5.0 pts

Criteria	Ratings						Pts
Sustainable development issues	**5.0 Pts** **Excellent** Sustainable development issues related to the process in question are identified thoroughly and correctly and meaningful and insightful improvements are suggested.	**4.0 Pts** **Very good** Sustainable development issues related to the process in question are identified and improvements are suggested.	**3.0 Pts** **Good** Sustainable development issues specifically related to the process are considered in detail.	**2.0 Pts** **Average** Sustainable development issues are considered in some detail.	**1.0 Pts** **Pass** Sustainable development issues are mentioned briefly.	**0.0 Pts** **No points** No consideration is given to sustainable development.	5.0 pts

Criteria	Ratings						Pts
Circular economy	**5.0 Pts** **Excellent** At least one original and insightful suggestion is made to apply circular economy principles to the process being considered.	**4.0 Pts** **Very good** Multiple, sensible suggestions to apply circular economy principles to the process in question are given and the consequences for the process, industry and society are included.	**3.0 Pts** **Good** Multiple, sensible suggestions to apply circular economy principles to the process in question are given.	**2.0 Pts** **Average** One practicable example of the application of circular economy to the process being considered circular economy is given.	**1.0 Pts** **Pass** One correct example of the application of circular economy to the process being considered is given, but it is not realistic.	**0.0 Pts** **No points** No mention is given to circular economy.	5.0 pts
Total points: 30.0							

Oral presentation

Criteria	Ratings						Pts
Description of process chain	**5.0 Pts** **Excellent** The process is described almost perfectly with no significant detail omitted or incorrect.	**4.0 Pts** **Very good** The process is described in good detail and all major stages and details are included. Most of the minor details are also present and correct.	**3.0 Pts** **Good** A process chain is described and is largely correct. The description identifies all major processing stages and describes the main details.	**2.0 Pts** **Average** A description is present but contains many minor errors or a combination of one serious error and some minor errors.	**1.0 Pts** **Acceptable** A description is present but contains multiple significant errors.	**0.0 Pts** **No points** The chain is completely incorrect, or no attempt is made to describe the process chain A description is present but contains multiple significant.	5.0 pts

Criteria	Ratings						Pts
Gender issues	**3.0 Pts** **Excellent** Several very interesting and important issues of gender in the metals industry are presented.	**2.0 Pts** **Good** Several important issues about gender in the metals industry are presented.	**1.0 Pts** **Acceptable** A small amount of basic information on gender issues in the metals industry is presented.	**0.0 Pts** **No points** No presentation of gender issues in the metals industry.			3.0 pts
Raw materials and sources	**5.0 Pts** **Excellent** All raw materials and sources are identified correctly, and the availability of raw materials is assessed. The consequences of changing sources are considered.	**4.0 Pts** **Very good** All raw materials and sources are identified correctly, and the availability of raw materials is assessed.	**3.0 Pts** **Good** All raw materials needed in the process are identified and sources of the raw materials are described.	**2.0 Pts** **Average** Most correct raw materials are identified, and some sources are given.	**1.0 Pts** **Acceptable** At least one correct raw material is identified.	**0.0 Pts** **No points** No raw materials are identified.	5.0 pts

Criteria	Ratings						Pts
Quality of final products	**2.0 Pts** **Good** The quality of the final product and the impact of the process chain and thermodynamics parameters is discussed in good detail and almost entirely correctly.			**1.0 Pts** **Acceptable** The quality of the final product is considered briefly.		**0.0 Pts** **No points** No mention of the quality of the final product is given.	2.0 pts
Sustainable development issues	**5.0 Pts** **Excellent** Sustainable development issues related to the process in question are identified thoroughly and correctly and meaningful and insightful improvements are suggested.	**4.0 Pts** **Very good** Sustainable development issues related to the process in question are identified and improvements are suggested.	**3.0 Pts** **Good** Sustainable development issues specifically related to the process are considered in detail.	**2.0 Pts** **Average** Sustainable development issues are considered in some detail.	**1.0 Pts** **Acceptable** Sustainable development issues are mentioned briefly.	**0.0 Pts** **No points** No consideration is given to sustainable development.	5.0 pts

Criteria	Ratings			Pts
Circular economy	**2.0 Pts** **Good** Multiple, sensible suggestions to apply circular economy principles to the process in question are given.	**1.0 Pts** **Acceptable** One correct example of the application of circular economy to the process being considered is given, but it is not realistic.	**0.0 Pts** **No points** No mention is given to circular economy.	2.0 pts
Total points: 22.0				

Personal reflexion

Criteria	Ratings				Pts
Group appraisal Provide a critical assessment of how the group functioned and how each group member contributed to the project.	**3.0 Pts** **Excellent** The group performance is assessed effectively and critically. Each group member is critically assessed. Suggestions for improvements are given.	**2.0 Pts** **Good** The group and most/all group members are assessed critically.	**1.0 Pts** **Acceptable** Some comments for the group and at least one group member is given.	**0.0 Pts** **No marks** No report is submitted, or no useful content is included.	3.0 pts

Criteria	Ratings						Pts
Personal contribution Based on the comments of each group member and the oral presentation, a personal grade will be given to adjust for the individual performance of each group member.	**5.0 Pts** **Excellent** The student was actively engaged throughout the project and was valued by their colleagues.	**4.0 Pts** **Very good** The student contributed well at various stages throughout the project and was an efficient member of the project group.	**3.0 Pts** **Good** The student made some good contributions to some areas of the project and worked effectively with their colleagues.	**2.0 Pts** **Average** The student contributed in several places in the project and was able to collaborate quite well with other group members.	**1.0 Pts** **Acceptable** The student made meaningful contributions to the project.	**0.0 Pts** **No marks** The student made a minimal meaningful contribution to the project.	5.0 pts
Total points: 8.0							