Unit Outline
PRRE5002 Pyrometallurgy Techniques
Semester 2, 2021

Unit study package code: PRRE5002
Mode of study: Internal
Tuition pattern summary: Note: For any specific variations to this tuition pattern and for precise
information refer to the Learning Activities section.
This unit does not have a fieldwork component.
Credit Value: 25.0
Pre-requisite units: Nil
Co-requisite units: Nil
Anti-requisite units: Nil
Result type: Grade/Mark
Approved incidental fees: Information about approved incidental fees can be obtained from our website. Visit fees.curtin.edu.au/incidental_fees.cfm for details.

Unit coordinator:
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Location: Building: 703 - Room: 3113

Teaching Staff:
Name: Laurence Dyer
Phone: 08 9088 6122
Email: Laurence.Dyer@curtin.edu.au
Location: Building: 703 - Room: 112

Administrative contact:
Name: Teaching Support Team
Acknowledgement of Country

We respectfully acknowledge the Indigenous Elders, custodians, their descendants and kin of this land past and present. The Centre for Aboriginal Studies aspires to contribute to positive social change for Indigenous Australians through higher education and research.

Syllabus


Introduction

Pyrometallurgy is a branch of extractive metallurgy that deals with the extraction of metals from ores or other sources (i.e. in recycling) using thermal methods. Pyrometallurgical processes play a very important role in minerals and metals industry. The basic premise of most pyrometallurgical operations is simple: high-temperature chemistry is employed to segregate valuable metals in one phase while rejecting gangue and impurities in another phase.

Metallurgical engineers, metallurgists and metallurgical scientists are expected to understand the fundamentals of pyrometallurgy and be able to apply principles in plant operations and/or in research and development applications. Operating data from metallurgical plants can sometimes defy useful interpretation without some knowledge and insight of the fundamentals driving the process. This unit introduces a range of fundamental knowledge and skills to assist the metallurgical practitioner with the interpretation and prediction of metallurgical process behaviour and trends, with a view to process optimisation and improvement.

This unit covers the following materials: material and heat balances for metallurgical processes, metallurgical thermodynamic fundamentals and applications, and metallurgical kinetics. A descriptive overview of pyrometallurgical processes/basics will be included in the unit introduction part.

All students in this unit will have access to a weekly ONLINE lecture delivered through Blackboard Collaborate Ultra and a weekly face-to-face workshop/tutorials. In addition to the weekly face-to-face workshops, all students have the opportunity to contact me for additional consultation. I am available for both virtual and face-to-face consult. Email the UC or Lecturers to arrange suitable time. I encourage all students to connect during my scheduled hours.

Unit Learning Outcomes

All graduates of Curtin University achieve a set of six Graduate Capabilities during their course of study. These inform an employer that, through your studies, you have acquired discipline knowledge and a range of other skills and capabilities which employers would value in a professional setting. Each unit in your course addresses the Graduate Capabilities through a clearly identified set of learning outcomes. They form a vital part in the process referred to as assurance of learning. The learning outcomes notify you of what you are expected to know, understand or be able to do in order to be successful in this unit. Each assessment for this unit is carefully designed to test your knowledge of one or more of the unit learning outcomes. On successfully completing all of the assessments you will have achieved all of these learning outcomes.

Your course has been designed so that on graduating you will have achieved all of Curtin’s Graduate Capabilities through the assurance of learning processes in each unit.
Learning Activities

The unit will be presented in a series of lecture and workshop/tutorial sessions of up to 4 hours per week (lecture: 1 x 2 hours per week; workshop/tutorial: 1 x 2 hours per week). Concepts and problem-solving examples will be presented during lectures. Tutorial sessions will be focused on problem-solving exercises and the applications of the concepts discussed on pyrometallurgical operation problems or process optimisation requirements. Some problem-solving exercises will be done during lectures in order to elucidate properly the concepts being considered. Materials, information and announcements regarding the unit will be available in Blackboard. Students are expected to check Blackboard regularly and be updated.

All students in this unit are expected to participate in every weekly learning activity, whether they are face-to-face or online. For online content simply go to Blackboard to attend the live sessions or access recordings as appropriate. Each week there is an expectation that you will arrive in a face-to-face or online class having completed any previous assigned work.

The unit consists of three modules: (1) material and heat balances, (2) metallurgical thermodynamics, and (3) metallurgical kinetics. Problem-solving exercises applying the principles of Pyrometallurgy will be nominated within the semester. The coverage and due dates will be announced in the Unit Blackboard.

You are not expected to memorize volumes of material and equations to pass this unit. The focus is on understanding and skill development.

The first expectation is that you understand the material sufficiently to complete all of the exercises. The assessments will be focused towards problem solving and case study or analysis.

The second expectation is that you understand the material sufficiently to be able to succinctly explain important concepts from each section, as outlined in each section objectives.

The third expectation is that you are fully conversant with the equations used in this unit. This means (1) that you know the relevance of each equation and its utilisation (2) that you can define the exact meaning of each symbol in the equation and (3) that you can recognise the equation when included in an equation list with no other identifiers. You are not expected to memorize (only recognise & utilise) the equations given in this unit.

Overall, you should endeavour to understand completely all the examples and problem-solving questions, understand and prepare answers for other stated objectives. It is best to summarise the material in a form easily understood by you, using a separate booklet/notebook. Revision is always more efficient from your own notes and not from the original notes or book.
Learning Resources

Essential texts

The required textbook(s) for this unit are:

- Notes for all sections of this unit have been prepared by Professor Eric Grimsey using a range of references and will be available to the student (electronic copy). No textbooks need be purchased; however the following references are recommended as useful background references:
  


Assessment

Assessment policy exemptions

- There are no exemptions to the assessment policy

Assessment schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Value %</th>
<th>Date Due</th>
<th>Unit Learning Outcome(s) Assessed</th>
<th>Late Assessments Accepted?*</th>
<th>Assessment Extensions Considered?*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30%</td>
<td>Week 6, Day: Tuesday/31 August 2021, Time: TBA</td>
<td>1,2</td>
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<td>Yes</td>
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<tr>
<td>2</td>
<td>40%</td>
<td>Week 11, Day: Friday/8 October 2021, Time: 5:00PM</td>
<td>2,3,4</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>3</td>
<td>30%</td>
<td>Week 16 or 17, Day: TBA, Time: TBA</td>
<td>1,2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Please refer to the Late Assessment and the Assessment Extension sections below for specific details and conditions.

Detailed information on assessment tasks

1. Assessment 1: Midterm Test (30%)
The midterm test will be conducted on Week 6 of the semester and will be an online and time-limited test. Details of timing and schedule will be announced in Blackboard. The test should cover topics in Pyrometallurgical Basics, Material and Heat Balances, and some parts of Metallurgical Thermodynamics (if possible). Check Blackboard announcements for updates and details of test coverage and requirements.

2. Assessment 2: Report (40%)
   This assessment will be part of the Work-Integrated Learning (WIL) concept and students are expected to write and submit a professionally-done report (due on Week 11) based on an industry-related topic or practical applications of pyrometallurgical processes. Submissions should be done through TURNITIN.

3. Assessment 3: Examination (30%)
   The final examination is a centrally-scheduled online and timed exam and will be given on Week 16 or 17 (examination week). The exam should cover parts of Metallurgical Themrodynamics and Metallurgical Kinetics and other topics related to pyrometallurgical processes. Details will be announced in Blackboard. Submissions should be done through TURNITIN.

Pass requirements
You are expected to perform satisfactorily in all sections of the unit to be awarded a pass. Students must achieve a Final Mark of 50 or greater to pass this unit. In practice, this usually means at least 40% in all three (3) assessments, with an overall average of 50% or above. Students awarded a further assessment (if eligible) will then be expected to achieve an overall average of 50% or above in the examination, regardless of their mark.
Assessment Moderation

Fair assessment through moderation

Moderation describes a quality assurance process to ensure that assessments are appropriate to the learning outcomes, and that students work is evaluated consistently by assessors. Minimum standards for the moderation of assessments are described in the Assessment and Student Progression Manual, available from policies.curtin.edu.au/findapolicy/

Pre-marking moderation

1. Peer review of the assessment design for constructive alignment
2. Peer review of assessment task details (provided to students)
3. Peer review of examination questions for ambiguity, bias etc.
4. Peer review of marking guide/rubric

Intra-marking / Post-marking moderation

1. Achieving consensus on final mark where marking is done by two or more assessors
2. Moderation of a sample of student work near grade boundaries
3. Moderation of all borderline results to confirm standard
4. Moderation of high and low outliers to confirm result

Late assessment

Where the submission of a late assessment is permitted, late penalties will be consistently applied in this unit.

Where a late assessment is permitted for an assessment item or the entirety of the unit (refer to the Assessment Schedule table in this Unit Outline) and the student does not have an approved assessment extension:

1. For assessment items submitted within the first 24 hours after the due date/time, students will be penalised by a deduction of 5% of the total marks allocated for the assessment task;
2. For each additional 24 hour period commenced an additional penalty of 10% of the total marks allocated for the assessment item will be deducted; and
3. Assessment items submitted more than 168 hours late (7 calendar days) will receive a mark of zero.

Where late assessment is NOT permitted for an assessment item or the entirety of the unit (refer to the Assessment Schedule table in this Unit Outline) and the student does not have an approved assessment extension:

1. All assessment items submitted after the due date/time will receive a mark of zero.
Assessment extension

Where an application for an assessment extension is permitted for an assessment item(s) within this unit (refer to the Assessment Schedule table in this Unit Outline):

1. A student who is unable to complete an assessment item by/on the due date/time as a result of exceptional circumstances beyond the student’s control, may apply for an assessment extension on the Assessment Extension Application Form as prescribed by the Academic Registrar. The form is available on the Forms page at https://students.curtin.edu.au/essentials/forms-documents/forms/ and also within the student’s OASIS (My Studies tab – Quick Forms) account.
2. The student will be expected to submit their application for an Assessment Extension with supporting documentation via the online form.
3. Timely submission of this information supports the assessment process. For applications that are declined, delayed submission may have significant ramifications on the possible marks awarded.
4. An application may be accepted up to five working days after the due date/time of the assessment item where the student is able to provide a verifiable explanation as to why they were not able to submit the application prior to the assessment due date/time

Where an application for an assessment extension is NOT permitted for an assessment item(s) within this unit (refer to the Assessment Schedule table in this Unit Outline):

1. All assessment items submitted after the due date/time will be subject to late penalties or receive a mark of zero depending on the unit permitting late assessment submissions.

Deferred assessments

If your results show that you have been granted a deferred assessment you should immediately check OASIS for details.

Deferred examinations/tests will be held from 15/02/2021 to 19/02/2021. Notification to students will be made after the Board of Examiners’ meeting via the Official Communications Channel (OCC) in OASIS.

Further assessment

Further assessments, if granted by the Board of Examiners, will be held between 15/02/2021 and 19/02/2021. Notification to students will be made after the Board of Examiners meeting via the Official Communications Channel in OASIS.

It is the responsibility of the student to be available to complete the requirements of a further assessment. If your results show that you have been granted a further assessment you should immediately check OASIS for details.

Reasonable adjustments for students with disabilities/health circumstances likely to impact on studies

A Curtin Access Plan (CAP) is a document that outlines the type and level of support required by a student with a disability or health condition to have equitable access to their studies at Curtin. Carers for people with disability may also be eligible for support. This support can include alternative exam or test arrangements, study materials in accessible formats, access to Curtin’s facilities and services or other support as discussed with an advisor from AccessAbility Services.

Documentation is required from your treating Health Professional to confirm your health circumstances or carer responsibilities.

If you think you may be eligible for a CAP, please contact AccessAbility Services. If you already have a CAP please provide it to the Unit Coordinator in week 1 of each study period.
Referencing style
The referencing style for this unit is APA 7th Ed.
More information can be found on this style from the Library web site:

Privacy
As part of a learning or assessment activity, or class participation, your image or voice may be recorded or transmitted by equipment and systems operated by Curtin University. Transmission may be to other venues on campus or to others both in Australia and overseas.

Your image or voice may also be recorded by students on personal equipment for individual or group study or assessment purposes. Such recordings may not be reproduced or uploaded to a publicly accessible web environment. If you wish to make such recordings for study purposes as a courtesy you should always seek the permission of those who are impacted by the recording.

Recording of classes or course materials may not be exchanged or distributed for commercial purposes, for compensation, or for any other purpose other than personal study for the enrolled students in the unit. Breach of this may subject a student to disciplinary action under Statute No 10 – Student Disciplinary Statute.

If you wish to discuss this please talk to your Unit Coordinator.

Copyright
The course material for this unit is provided to you for your own research and study only. It is subject to copyright. It is a copyright infringement to make this material available on third party websites.

Academic Integrity (including plagiarism and cheating)

Academic Integrity
Curtin's Student Charter, Academic Integrity Program (AIP), and core Values guide expectations regarding student behaviour and responsibilities. Information on these topics can be found on the Student Essentials Website or the Academic Integrity tab in Blackboard.

Academic Integrity Warnings
An Academic Integrity Warning may be issued to a New-to-Curtin student if they have inadequately acknowledged sources or collaborated inappropriately. The Management of Academic Integrity Warnings for New to Curtin Students Procedures provide further information and explain who is considered to be New-to-Curtin.

Academic Misconduct
Students with an academic breach that do not meet the New-to-Curtin criteria will be managed through the misconduct process. Academic Misconduct means conduct by a student that is dishonest or unfair in connection with any academic work. This includes all types of plagiarism, cheating, collusion, falsification or fabrication of data or other content, and Academic Misconduct Other, such as falsifying medical certificates for extension. More details can be found on the Student Essentials Website or on the Academic Integrity Website.

Staff members are required to report suspected misconduct and an inquiry may take place. If misconduct is determined it will result in penalties, which may include a warning, a reduced or nil grade, a requirement to repeat the assessment, an annulled grade (ANN) or termination from the course. Some penalties may impact on future enrolment.

Academic work under inquiry will not be graded until the process has concluded. If your work is the subject of an inquiry you will be notified by email and Official Communication with an opportunity to respond. Appropriate support will be provided. For more information refer to Statute No.10 Student Discipline and Academic Misconduct Rules.
Information and Communications Technology (ICT) Expectations

Curtin students are expected to have reliable internet access in order to connect to OASIS email and learning systems such as Blackboard and Library Services.

You may also require a computer or mobile device for preparing and submitting your work.

For general ICT assistance, in the first instance please contact OASIS Student Support:

oasisapps.curtin.edu.au/help/general/support.cfm

For specific assistance with any of the items listed below, please contact The Learning Centre:

life.curtin.edu.au/learning-support/learning_centre.htm

- Using Blackboard, the I Drive and Back-Up files
- Introduction to PowerPoint, Word and Excel
Engineers Australia competencies assessed and level of thinking

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>EA Professional competencies assessed ¹</th>
<th>Level of thinking ²</th>
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<tbody>
<tr>
<td>Report</td>
<td>1.3 Specialist knowledge</td>
<td>Application and Analysis</td>
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<td></td>
<td>2.1 Problem solving</td>
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<td>3.2 Communication</td>
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<td>3.4 Information Use</td>
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<td>3.6 Teamwork</td>
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<tr>
<td>Test</td>
<td>1.3. Specialist knowledge</td>
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<tr>
<td>Exam</td>
<td>2.1. Problem solving</td>
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</tbody>
</table>

ENGINEERS AUSTRALIA  Stage 1 competencies and elements of competency assessed in this unit ¹


1. KNOWLEDGE AND SKILL BASE

1.1. Science/Engineering fundamentals: Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.

1.2. Conceptual understanding: Conceptual understanding of the, mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.

1.3. Specialist knowledge: In-depth understanding of specialist bodies of knowledge within the engineering discipline.

1.4. Development & Research: Discernment of knowledge development and research directions within the engineering discipline.

1.5. Context: Knowledge of contextual factors impacting the engineering discipline.

1.6. Engineering, Practice: Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.

2. ENGINEERING APPLICATION ABILITY

2.1. Problem solving: Application of established engineering methods to complex engineering problem solving.

2.2. Use of techniques: Fluent application of engineering techniques, tools and resources.

2.3. Systematic use: Application of systematic engineering synthesis and design processes.

2.4. Project management: Application of systematic approaches to the conduct and management of engineering projects.

3. PROFESSIONAL AND PERSONAL ATTRIBUTES

3.1. Professionalism: Ethical conduct and professional accountability

3.2. Communication: Effective oral and written communication in professional and lay domains.

3.3. Creativity: Creative, innovative and pro-active demeanour.

3.4. Information use: Professional use and management of information.

3.5. Self Conduct: Orderly management of self, and professional conduct.

3.6. Team work: Effective team membership and team leadership.

Levels of thinking 2 (see: http://www.learningandteaching.info/learning/blooms_taxonomy.htm)

Knowledge
Recall of something encountered before but without having to change it, use it or understand it; facts.

Comprehension
Understanding the knowledge that has been acquired without needing to relate it to other information.

**Application**

Use of a learned concept to resolve some situation or solve a new problem in an appropriate way.

**Analysis**

Taking something learned apart into separate components for purposes of thinking about the parts and how they fit together.

**Synthesis**

Generating or creating something different by assembling or connecting ideas in a way that makes a whole.

**Evaluation**

Looking at the particular value of materials, information or methods in characterizing the whole.

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**Enrolment**

It is your responsibility to ensure that your enrolment is correct - you can check your enrolment through the eStudent option on OASIS, where you can also print an Enrolment Advice.

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**Student Rights and Responsibilities**

It is the responsibility of every student to be aware of all relevant legislation, policies and procedures relating to their rights and responsibilities as a student. These include:

- the Student Charter
- Values and Signature Behaviours
- the University’s policy and statements on plagiarism and academic integrity
- copyright principles and responsibilities
- the University’s policies on appropriate use of software and computer facilities

Information on all of the above is available through the University’s “Student Rights and Responsibilities” website at: students.curtin.edu.au/rights.

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**Student Equity**

There are a number of factors that might disadvantage some students from participating in their studies or assessments to the best of their ability, under standard conditions. These factors may include a disability or medical condition (e.g. mental illness, chronic illness, physical or sensory disability, learning disability), significant caring responsibilities, pregnancy, religious practices, living in a remote location, or another reason. If you believe you may be unfairly disadvantaged on these or other grounds please contact the appropriate service below. It is important to note that the staff of the University may not be able to meet your needs if they are not informed of your individual circumstances, so please get in touch with the appropriate service if you require assistance.

To discuss your needs in relation to:

- Disability or medical conditions, contact AccessAbility Services: https://students.curtin.edu.au/personal-support/disability/
- Elite athletes, contact Elite Athlete Coordinator: https://stadium.curtin.edu.au/sport/academy/elite-athlete-program/
- All other grounds, contact the Student Wellbeing Advisory Service: https://students.curtin.edu.au/personal-support/counselling-guidance/wellbeing/
Recent unit changes

Students are encouraged to provide unit feedback through eVALUate, Curtin’s online student feedback system. For more information about eVALUate, please refer to evaluate.curtin.edu.au/info/.

Recent changes to this unit include:

No recent changes were made in this unit, except for some additional learning materials which will be made available to students through unit Blackboard.

To view previous student feedback about this unit, search for the Unit Summary Report at https://evaluate.curtin.edu.au/student/unit_search.cfm. See https://evaluate.curtin.edu.au/info/dates.cfm to find out when you can eVALUate this unit.
<table>
<thead>
<tr>
<th>Week</th>
<th>Begin Date</th>
<th>Lecture (Online)</th>
<th>Pre-readings</th>
<th>Workshop (703.211)</th>
<th>Assessment Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>19 July</td>
<td>Orientation Week</td>
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</tr>
<tr>
<td>1.</td>
<td>26 July</td>
<td>Orientation and Pyrometallurgy Basics</td>
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<td>2.</td>
<td>2 August</td>
<td>Material and Heat Balance</td>
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<td>3.</td>
<td>9 August</td>
<td>Material and Heat Balance</td>
<td>Cu and Ni Pyrometallurgy</td>
<td>Material and Heat Balance</td>
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<td>16 August</td>
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<td>23 August</td>
<td>Material and Heat Balance</td>
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<td>6.</td>
<td>30 August</td>
<td>Metallurgical Thermodynamics</td>
<td>Iron Blast Furnace Process</td>
<td>Metallurgical Thermodynamics</td>
<td>Assessment 1: Mid-Semester Test</td>
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<td>7.</td>
<td>6 September</td>
<td>Tuition Free Week</td>
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<td>8.</td>
<td>13 September</td>
<td>WIL Week 2</td>
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<td>9.</td>
<td>20 September</td>
<td>Metallurgical Thermodynamics</td>
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<td>Assessment 2: Report Topic Released</td>
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<td>27 September</td>
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<td>14.</td>
<td>25 October</td>
<td>Study Week</td>
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<td>15.</td>
<td>1 November</td>
<td>Assessment 3: Examinations</td>
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<tr>
<td>16.</td>
<td>8 November</td>
<td>Examinations</td>
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