

# Operating Rules of Course MEC-E6002

## Welding Technology and Design

Master Degree in Mechanical Engineering 2018/2019

**Responsible Professor:** Professor Pedro Vilaça ([pedro.vilaca@aalto.fi](mailto:pedro.vilaca@aalto.fi))

Period V (Spring term); Credits: 5; Language: English; Evaluation: 0 to 5

Date	Theory Seminar Content	Time and Place
Seminar 1 <b>15/04</b> (Monday)	Presentation of course contents and general information Introduction to welding technology (+ allied techniques)	10h15-12h00 U5 / U147 Otakaari 1
Seminar 2 <b>17/04</b> (Wednesday)	Fundamentals of physics of the electric arc and power sources	10h15-13h00 U5 / U147 Otakaari 1
Seminar 3 <b>24/04</b> (Wednesday)	Electric arc welding processes: <ul style="list-style-type: none"> <li>• Fundamentals of SMAW and variants (+ arc-air cutting)</li> <li>• Fundamentals of SAW and variants</li> <li>• Fundamentals of GTAW and variants</li> <li>• Fundamentals of PAW and variants (+ plasma cutting)</li> </ul>	10h15-13h00 U5 / U147 Otakaari 1
Seminar 4 <b>29/04</b> (Monday)	Electric arc welding processes (cont.): <ul style="list-style-type: none"> <li>• Fundamentals of conventional GMAW</li> <li>• Advanced GMAW and FCAW</li> </ul>	10h15-12h00 U5 / U147 Otakaari 1
Seminar 5 <b>06/05</b> (Monday)	High power density welding processes: <ul style="list-style-type: none"> <li>• Fundamentals of electron beam welding and variants</li> <li>• Fundamentals of laser beam welding and variants (+ laser cutting)</li> </ul>	10h15-12h00 12h30-14h00 U5 / U147 Otakaari 1
Seminar 6 <b>08/05</b> (Wednesday)	Oxyfuel welding (+ oxyfuel cutting) Joining by brasing and soldering Fundamentals and variants of resistance welding processes: <ul style="list-style-type: none"> <li>• Spot, seam and projection</li> </ul>	10h15-13h00 U5 / U147 Otakaari 1
Seminar 7 <b>13/05</b> (Monday)	Introduction to welding metallurgy: <ul style="list-style-type: none"> <li>• Fundamentals</li> <li>• Thermal cycle in welding</li> <li>• Welding of steels and low alloy steels</li> </ul>	10h15-12h00 U5 / U147 Otakaari 1

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<b>Date</b>	<b>Theory Seminar Content (continuation)</b>	<b>Time and Place</b>
Seminar 8 <b>15/05</b> (Wednesday)	Introduction of welding metallurgy (cont.): <ul style="list-style-type: none"> <li>• Welding of steels and low alloy steels (cont.)</li> <li>• Welding of stainless steels</li> <li>• Welding of non-ferrous metals</li> </ul>	10h15-13h00 U5 / U147 Otakaari 1
Seminar 9 <b>20/05</b> (Monday)	Solid state welding processes: <ul style="list-style-type: none"> <li>• Flash and stud welding</li> <li>• High frequency welding</li> <li>• Cold pressure welding</li> <li>• Ultrasonic welding</li> <li>• Diffusion welding</li> <li>• Explosion coating and cutting</li> <li>• Friction and friction stir based processes</li> </ul>	10h15-13h00 U5 / U147 Otakaari 1
Seminar 10 <b>22/05</b> (Wednesday)	Design of Welded Structures: (issue not included in exam) <ul style="list-style-type: none"> <li>• Residual Stress and Deformation</li> </ul>	10h15-13h00 U5 / U147 Otakaari 1

<b>Date</b>	<b>Exercise/Laboratory Session Content</b>	<b>Time and Place</b>
Session 1 <b>18/04</b> (Thursday)	Safety and general information about welding laboratory facilities and procedures Demonstration and practice of electric arc welding process (1/3): <ul style="list-style-type: none"> <li>• Practice: Shielded Metal Arc Welding (SMAW or MMA)</li> <li>• Demo: Submerged Arc Welding (SAW)</li> </ul>	Shift A: 10h15-12h00 Shift B: 14h15-16h00 K2 Welding Lab
Session 2 <b>25/04</b> (Thursday)	Demonstration and practice of electric arc welding process (2/3): <ul style="list-style-type: none"> <li>• Practice: Gas Metal Arc Welding (GMAW or MIG/MAG)</li> <li>• Demo: Friction Stir Welding (FSW)</li> </ul>	Shift A: 10h15-12h00 Shift B: 14h15-16h00 K2 Welding Lab
Session 3 <b>02/05</b> (Thursday)	Demonstration and practice of electric arc welding process (3/3): <ul style="list-style-type: none"> <li>• Practice: Gas Tungsten Arc Welding (GTAW or TIG)</li> <li>• Demo: Plasma Arc Welding (PAW)</li> </ul>	Shift A: 10h15-12h00 Shift B: 14h15-16h00 K2 Welding Lab
Session 4 <b>09/05</b> (Thursday)	Demonstration and practice of non-electric arc techniques: <ul style="list-style-type: none"> <li>• Practice: Resistance Welding (RW)</li> <li>• Demo: Oxyfuel Cutting + Plasma Cutting</li> </ul>	Shift A: 10h15-12h00 Shift B: 14h15-16h00 K2 Welding Lab
Session 5 <b>16/05</b> (Thursday)	Application exercises of welding metallurgy	Shift A + Shift B: 10h15-12h00 U5 / U147 Otakaari 1
Session 6 23/05 (Thursday)	Preparation for exam	Shift A + Shift B: 10h15-12h00 K3, Room118

Registration preferential condition:

- ↳ Completed course(s) on the issue(s) of “material science and engineering”.

## Evaluation:

Final Grade = 0.6 X max (final exam grade May; final exam grade September) +  
0.2 X continuous evaluation grade (questions from 11 theory seminars) +  
0.2 X continuous evaluation grade (reports of 4 weld laboratory sessions)

- All exams and continuous evaluation tasks are evaluated in a scale of [0..100];
- Final Grade [0..5] = (Final Grade [0..100] - 23)/14  
0 (insufficient); 1 (sufficient); 2 (satisfactory); 3 (good); 4 (very good); 5 (excellent).
  
- Final Exam:
  - a) 1st Final exam: Monday, 27<sup>th</sup> May 2019 from 13h00 to 16h00  
(room: U1/U154 @ Otakaari 1);
  - b) 2nd Final exam in date, time and room to be announced.
  
- Continuous Evaluation:
  - a) Questions from theory seminars:
    - ↪ A set of questions will be established at the end of each of the 11 seminars;
    - ↪ Answer to the questions from each theory seminar should be submitted in MyCourses in the correspondent "Assignments" sub-section, as one document identified as: "**Firstname\_Surname\_Seminar#.pdf**"
    - ↪ **The deadline to submit the answers is the end of the day of the theory seminar (23h59);**
    - ↪ The grade [0..100] is obtained from the average of the grades [0..100] of each of the 11 theory seminars.
  
  - b) Reports of weld laboratory sessions:
    - ↪ The report is individual (each student will submit his own document), and only the students present during laboratory sessions are entitled to submit it;
    - ↪ Instructions and guidance information for the report of the laboratory activities will be available in a separated document;
    - ↪ Reports cannot be larger than 4 pages;
    - ↪ Reports should be submitted in MyCourses in the "Assignments" sub-section, as one document identified as: "**Firstname\_Surname\_LabSession#.pdf**"
    - ↪ **The deadline to submit the reports is the end of the Sunday immediately after of the laboratory session (23h59);**
    - ↪ The grade [0..100] is obtained from the average of the grades [0..100] of each of the 4 laboratory session reports.

## Registration in laboratory sessions:

- Timetable:
  - Shift A: Thursday 10h15 to 12h00
  - Shift B: Thursday 14h15 to 16h00
- All the students should register at MyCourses, in the "Laboratory Sessions" section, and attend all the sessions in the laboratory shift where they are registered. **The deadline to register is 17.04.2019 (23h59);**
- The welding lab is located @ K2 ground floor.

## **Professor Time Table for Support of Students** (Sähkämiehentie 3, Room 246):

- Thursday 12h00 to 14h00 (send email for confirmation: [pedro.vilaca@aalto.fi](mailto:pedro.vilaca@aalto.fi))

## **Contact of Course Assistant:**

- General issues: Hamidreza Latifi ([hamidreza.latifi@aalto.fi](mailto:hamidreza.latifi@aalto.fi))

## **Contact of Welding Laboratory Operator:**

- Mikko Peltonen ([mikko.j.peltonen@aalto.fi](mailto:mikko.j.peltonen@aalto.fi))

## **References:**

### Basic

- Principles of Welding – Processes Physics, Chemistry, and Metallurgy. Robert W. Messler, Jr. Wiley-VCH. 2004 (ISBN-13: 978-0-471-25376-1)
- Welded Joint Design (3<sup>rd</sup> Edition), John Hicks. Woodhead Publishing Ltd. 1999 (ISBN-1-85573386-2).

### Other

#### General (Welding Processes and Applications):

- ASM Metals Handbook – Vol. 6 – Welding Brazing and Soldering. 1993. ASM International.
- AWS Welding Handbook – Vol. 1 to 4 – 8<sup>th</sup> and/or 9<sup>th</sup> edition. American Welding Society.

#### Electric Arc Physics:

- J. F. Lancaster (1986) The Physics of Welding, 2nd edition, IIW, Pergamon Press

#### Solid state processing:

- Pedro Vilaça, João Gandra, Catarina Vidal, “Linear Friction Based Processing Technologies for Aluminum Alloys: Surfacing, Stir Welding and Stir Channeling”. Chapter 7 of book: “Aluminium Alloys-New Trends in Fabrication and Applications”. pp. 159-197. ISBN 980-953-307-512-4, Intech. Available from: doi: 10.5772/3354.
- Pedro Vilaça, Wayne Thomas, “State-of-the-art in FSW technology”. Chapter 4 of book: “Structural Connections for Lightweight Metallic Structures”. pp. 85-124. ISBN 978-3-642-18186-3, Springer. Available from doi: 10.1007/8611\_2010\_50.

#### Design of Welded Structures:

- Eurocode 3: Design of steel structures. Part 1-1 (General rules and rules for buildings) and Part 1-8 (Design of joints)