

Operating Rules of Course MEC-E6004

Non-Destructive Testing (D)

Master Degree in Mechanical Engineering 2023/2024

Responsible Professor: Professor Pedro Vilaça (pedro.vilaca@aalto.fi)

Period II (Autumn term); Credits: 5; Language: English

All course Theory Seminars and Laboratory Sessions are (only) presential

Zoom session will be used for online exam: (meeting ID = 478 439 5526; host key = 992021)

<https://aalto.zoom.us/j/4784395526?pwd=eTJ5UDlIwand2cXVmVlFjbkREUVphUT09>

Date	Theory Seminar Content	Time and Place
Seminar 1 24/10 (Tuesday)	Presentation of course contents and general information Introduction to NDT technology: <ul style="list-style-type: none"> • Historical and industrial scope • Classification of defects for different components 	14h15-16h00 R9 (309) Rakentajanaukio 4
Seminar 2 25/10 (Wednesday)	Introduction to NDT technology (cont.) → Essay 1 <ul style="list-style-type: none"> • Introduction to NDT techniques • Introduction to reliability assessment 	8h15-10h00 R9 (309), Rakentajanaukio 4
Seminar 3 31/10 (Tuesday)	Fundamentals of NDT techniques → Essay 2 <ul style="list-style-type: none"> • Visual Testing • Dye/Liquid Penetrant Testing 	14h15-16h00 R9 (309) Rakentajanaukio 4
Seminar 4 01/11 (Wednesday)	Fundamentals of NDT techniques (cont.): → Essay 3 <ul style="list-style-type: none"> • Magnetic Testing 	8h15-10h00 U1 (R001/U154)
Seminar 5 07/11 (Tuesday)	Fundamentals of NDT techniques (cont.): <ul style="list-style-type: none"> • Eddy Current Testing (session 1 of 2) 	14h15-16h00 R002/266 Rakentajanaukio 4
Seminar 6 08/11 (Wednesday)	Fundamentals of NDT techniques (cont.): → Essay 4 <ul style="list-style-type: none"> • Eddy Current Testing (session 2 of 2) 	8h15-10h00 U1 (R001/U154)
Seminar 7 14/11 (Tuesday)	Fundamentals of NDT techniques (cont.): <ul style="list-style-type: none"> • Radiographic Testing (session 1 of 2) 	14h15-16h00 R002/266 Rakentajanaukio 4
Seminar 8 15/11 (Wednesday)	Fundamentals of NDT techniques (cont.): → Essay 5 <ul style="list-style-type: none"> • Radiographic Testing (session 2 of 2) 	8h15-10h00 U1 (R001/U154)
Seminar 9 21/11 (Tuesday)	Fundamentals of NDT techniques (cont.): <ul style="list-style-type: none"> • Ultrasonic Testing (session 1 of 2) 	14h15-16h00 R002/266 Rakentajanaukio 4

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Date	Theory Seminar Content (continuation)	Time and Place
Seminar 10 22/11 (Wednesday)	Fundamentals of NDT techniques (cont.): → Essay 6 <ul style="list-style-type: none"> Ultrasonic Testing (session 2 of 2) 	8h15-10h00 U1 (R001/U154)
Seminar 11 28/11 (Tuesday)	<i>Invited seminar by Aalto's Professor Sven Bossuyt, on Advanced methodological approaches for NDT:</i> <ul style="list-style-type: none"> Inverse problems approach Camera based testing methods (including DIC and Thermography) 	14h15-16h00 R002/266 Rakentajanaukio 4
Seminar 12 29/11 (Wednesday)	<i>Invited seminar by Tuomas Koskinen (Trueflaw and Aalto's DSc student), on Reliability Analysis in NDT:</i> <ul style="list-style-type: none"> Relative Operating Characteristic (ROC) Probability of Detection (POD) Machine learning for automated flaw detection 	8h15-10h00 U1 (R001/U154)
Seminar 13 05/12 (Tuesday)	Preparation for Exam: <ul style="list-style-type: none"> Exam structure Open session for questions by students 	14h15-16h00 R002/266 Rakentajanaukio 4

Laboratory Session Content	Session	Date and Time Local: NDT lab @ K2
Lab. Session 1 Introduction to NDT laboratory facilities, equipment, safety and good practices Presentation and experience with NDT technique: <ul style="list-style-type: none"> Visual Testing Magnetic Particles Testing 	Shift Thursday	02/11 (Thursday) 10h15-12h00 (Lab Report #1)
	Shift Monday	06/11 (Monday) 12h15-14h00 (Lab Report #1)
Lab. Session 2 Presentation and experience with NDT technique: <ul style="list-style-type: none"> Dye Penetrant Testing 	Shift Thursday	09/11 (Thursday) 10h15-12h00 (Lab Report #2)
	Shift Monday	13/11 (Monday) 12h15-14h00 (Lab Report #2)
Lab. Session 3 Presentation and experience with NDT technique: <ul style="list-style-type: none"> Eddy Current Testing: Absolute and Differential 	Shift Thursday	16/11 (Thursday) 10h15-12h00 (Lab Report #3)
	Shift Monday	20/11 (Monday) 12h15-14h00 (Lab Report #3)
Lab. Session 4 Presentation and experience with NDT technique: <ul style="list-style-type: none"> Ultrasonic Testing: Conventional; PA and EMAT 	Shift Thursday	23/11 (Thursday) 10h15-12h00 (Lab Report #4)
	Shift Monday	27/11 (Monday) 12h15-14h00 (Lab Report #4)
Lab. Session Extra To recover any lost subject (only if needed) <ul style="list-style-type: none"> Any NDT technique 	Shift Thursday	30/11 (Thursday) 10h15-12h00

Learning pre-requisites of course MEC-E6004:

↳ Completed courses on:

- *Mandatory*: Fundamentals of Physics (with electromagnetism) and General Chemistry; Material Science; Mechanics of Materials.
- *Recommendable*: Welding Technology; and Casting Technology.

Evaluation:

Final Grade = 0.5 x max (**Final Exam** grade) +

0.2 X **continuous evaluation** grade from **answers to theory seminar questions** +

0.3 X **continuous evaluation** grade from **laboratory reports**

- All tasks (Final Exam/Questions/Lab Report) are evaluated in a scale of [0..100]
- **Final Grade** [0..5] = (Final Grade [0..100] - 23)/14 , i.e.:
0 (not approved) = [0%..30%]; 1 = [30%..44%]; 2 = [44%..58%]; 3 = [58%..72%];
4 = [72%..86%]; 5 = [86%..100%]
- Participation in the **Final Exam** is mandatory
- **Final Exam** grade $\geq 30\%$ is minimum requirement to pass, if **Final Grade** = [1..5]
- **Final Exam**:
 - a) **1st Final Exam on Thursday, 7th December 2023.**
Time: 09h00 to 12h00 via MyCourses and using the following zoom link for communication: (meeting ID = 478 439 5526; host key = 992021)
<https://aalto.zoom.us/j/4784395526?pwd=eTJ5UDlwand2cXVmVlFjbkREUVphUT09>
 - b) **2nd Final Exam** (date, time and place to be announced)

Note: “**Special Project**”, to be approved case-by-case, may replace the exam.

Theory Seminars:

The seminars will be implemented in slots with duration of 1h45 with the following typical implementation plan:

- ↳ Welcome and start with \approx **45 min 1st leg seminar** by professor +
+ **5 min** (to **relax**, but open-feedback is welcome) +
+ \approx **45 min 2nd leg seminar** by professor (adjustable leg of the seminar) +
+ **5 min** of autonomous student’s discussion to identify the seminar issues demanding clarification to answer the ESSAY (e.g. groups of 3 students randomly selected) +
+ **5 min** to **go-around on the less clear seminar’s issues** identified during autonomous student’s discussion: Professor will answer questions.
- ↳ Note: The plan will be adjusted to each seminar learning objectives and fine-tuned considering the students’ feedback and convenience of the learning process.

Continuous Evaluation:

a) Answer to the questions from theory seminars (**Essay #1 to #6**):

- ↪ A set of questions will be established, per key subject, at the end of the theory seminars (excluding subjects from invited seminars);
- ↪ 6 Essays are planned;
- ↪ Essays may include schematic representations and **are meant to be 2 to 3 pages long**, and cannot be larger than 4 pages;
- ↪ Answer to the questions from the theory seminar should be submitted in MyCourses in the correspondent “Assignments” sub-section, as one document identified as: **“Firstname_Surname_Essay#.pdf”**;
- ↪ **The deadline to submit the answers of both theory seminars, on Tuesday and Wednesday, is the end of Wednesday in the same week (23h59)**;
- ↪ The final grade of continuous evaluation [0..100] is obtained from the average of the grades [0..100] from ALL the 6 Essays.

b) Operation of NDT laboratory sessions (**Lab Report #1 to #4**):

- ↪ 4 NDT laboratory sessions are available with **two Shifts, requiring pre-registration**;
- ↪ The students should distribute themselves as uniform as possible among the 2 available laboratory shifts (**Shift Thursday** and **Shift Monday**) to minimize health-related hazards and benefit from more time of hands-on experience;
- ↪ Registration is done in MyCourses in the “Registration for NDT Laboratory Shifts” sub-section.
 - Registration is open until 27th October (Friday)
Maximum number of participants per group is 15. Note that for over 8 students per NDT Laboratory Shift, there maybe the need to set sub-groups to enable fruitful hands-on experience.
- ↪ Only pre-registered students in the laboratory Shifts are allowed to participate;
- ↪ Students can only participate in the laboratory Shift where they are registered;
- ↪ 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 each of the reports is the start of the next laboratory session, for each of the shifts**;
- ↪ The final grade of laboratory sessions [0..100] is obtained from the average of the grades [0..100] from ALL the **4 laboratory sessions**.

Professor Pedro Vilaça - Timetable to Support Students:

- Wednesday 12h00 to 14h00 (send email to: pedro.vilaca@aalto.fi for confirmation)

Course Assistants:

- Main laboratory assistant: **Gonçalo Sorger** (email to: goncalo.sorger@aalto.fi)
- Laboratory co-assistant: **Maria Silva** (email to: maria.santossilva@aalto.fi)
- Laboratory co-assistant: **Samuel Akinwamide**: (email: samuel.akinwamide@aalto.fi)
- Essay's assistant: **Koshta Eklavya** (email to: eklavya.koshta@aalto.fi)

References:

Main books:

- ASM Handbook, "Nondestructive Evaluation and Quality Control", Volume 17, ASM Handbook.
- Hand Charles J. Hellier, "Handbook of Nondestructive Evaluation", McGraw-Hill

Other literature references:

- J. Krautkrämer, H. Krautkrämer, "Ultrasonic Testing of Materials", Springer-Verlag
- Louis Cartz, "Non-destructive Testing", ASM International
- David C. Jiles, "Introduction to the Principles of Materials Evaluation", CRC Press
- I. N. Prassianakis, "NDT Means Economy and Safety in a Contemporary, Free, Peaceful and Democratic Society", proceedings of 4th International NDT Conference of the Hellenic Society of Non Destructive Testing, Creete, 2007.

Internet sites:

- European Federation for NDT (EFNDT), "Overall NDT Quality System", EFNDT Guidelines, 2008. Available at: <http://www.efndt.org>
- American Society for NDT (ASNDT). Available at: <http://www.asnt.org>
- NDT Resource Center. Available at: http://www.ndt-ed.org/index_flash.html

Scientific content journal on NDT and general search databases:

- NDT & E International: <https://www.journals.elsevier.com/ndt-and-e-international>
- Scopus: <https://www.scopus.com>
- Google Scholar: <https://scholar.google.fi>

Major industrial equipment suppliers:

- Olympus site: <http://www.olympus-ims.com/en/ndt-instruments/>
- GE site: <https://www.gemeasurement.com/inspection-ndt>