



Graduate course

Reliability, Lifetime and System Health

July 9th –10th 2019

**Dynamics based Maintenance Faculty
of Engineering Technology University
of Twente**

General

For any engineering system it is important that it keeps functioning for a certain period of time. This is the case for large macro-scale systems like ships, aircraft, bridges and wind turbines, but also for small scale systems like electronics or micro-electronic devices. This capability can be expressed in terms of reliability, life time or system health. The reliability quantifies the probability of failure within a certain time, the life time quantifies the (expected) time to failure of a system and the system health quantifies the evolution of the system condition from virgin to fully damaged.

Knowledge of these concepts is required both during the design of a system and during its operation. In the design process, the focus will be on realizing a certain minimal reliability or life time. In that stage, understanding, modeling and quantifying the material behavior and associated failure mechanisms is essential. Once the system is in operation, the design cannot be changed anymore, but then the way of operating the system determines the loads on the components, and thus affects the reliability and life time. Being able to calculate the expected time to failure, or to monitor the evolution of the system health will assist in operating and maintaining the system properly.

This course provides an overview of the mathematical and physical concepts and principles required to analyze the reliability, life time and system health. The basic principles will be introduced and applications in both design and operation & maintenance will be shown. Also a practical lab session will be organized, where participants can experience the measurement of the system dynamics to assess the system health.

Local organization

The course is organized by the Dynamics based Maintenance group of the Faculty Engineering Technology at the University of Twente, in collaboration with other research groups within the UT Maintenance Consortium TIME. The local organizing committee is composed of

- Prof. dr. ir. Tiedo Tinga
- Dr. ir. R. Loendersloot
- Debbie Zimmerman (secretary)

Lecturers

- Prof. dr. ir. Tiedo Tinga
- Dr. ir. Richard Loendersloot
- Dr. Alberto Martinetti
- Prof. dr. Marielle Stoelinga

Lecture notes

Lecture notes and course material will be distributed at the start of the course.

Prerequisites

Participants are expected to have basic familiarity with:

- linear continuum mechanics;
- dynamics;
- probability theory.

Contents

The course covers the following topics:

- 1) *Introduction to reliability, life time and system health (Tinga)*
 - a. Definitions and concepts
 - b. Link with design
 - c. Link with operation and maintenance
- 2) *Reliability (Stoelinga)*
 - a. Basics: probability of failure
 - b. System reliability
 - c. Fault trees
 - d. Application in reliability assessment
- 3) *Design for Reliability (Martinetti)*
 - a. Basic concepts
 - b. Applications
- 4) *Life time prediction (Tinga)*
 - a. Physics of failure: fatigue / creep / corrosion / wear
 - b. Failure and damage models
 - c. Link with load variations
 - d. Application: predictive maintenance
- 5) *Structural Health Monitoring (Loendersloot)*
 - a. Dynamic behavior of structures
 - b. Measuring dynamic response
 - c. Assessment of structural health – damage algorithms
- 6) *Condition monitoring (Loendersloot / Tinga)*
 - a. Bearing / gear condition monitoring
 - b. Vibration / oil analysis

In addition to the lectures on these topics, also a **practical session** will be organized. In this session, measurements on a dynamic system will be performed in the dynamics lab and data sets will be processed and analyzed to obtain a health or damage indicator.

Fee/Registration

The course is free for registered members of the graduate school Engineering Mechanics and for the research members of the contributing research groups. The course fee for non EM members is € 100 for students and € 400 for other participants. They will receive an invoice after accepted registration.

Participants need to register by completing the online registration form, which can be found at <http://www.em.tue.nl/events/index.php/2/2019> and returning it **before June 16th, 2019** to the Secretariat of the Graduate School Engineering Mechanics, Eindhoven University of Technology. Members of the Graduate School Engineering Mechanics receive priority in case of over-subscription.

Location/date

The course will take place at the University of Twente on July 9 and 10, 2019. The course language is English. The exact location will be communicated to the participants by e-mail, prior to the course.

Further information

For hotel accommodation on the campus of the University of Twente see <https://www.uparkhotel.nl/>. Participants are required to contact the hotel directly, using registration code "Engineering Mechanics (EM)".

It is requested that at least 50% of the participants brings a laptop with MATLAB installed to perform exercises in small groups.

For more information on the contents of the course, contact: Prof. dr. ir. Tiedo Tinga, UT
E-mail: t.tinga@utwente.nl

Further information about the educational programme and other activities of the Graduate School on Engineering Mechanics can be found at: <http://www.em.tue.nl>.

Assessment

To unify quality assurance for the Engineering Mechanics graduate course program, all courses within the program are closed with a (light-weight) assessment. This assessment is intended to verify active attendance of a student to the course. A student will only receive the course credits if he/she passes the assessment. The assessment (~ 30 minutes) will take place at July 10th at the end of the course, and a student is able to pass if he/she actively participated in the (largest part of) the course.