



Other Departments potentially interested:

DIETI (Dipartimento di Ingegneria Elettrica e delle Tecnologie dell'Informazione), DIST (Dipartimento di Strutture per l'Ingegneria e l'Architettura), DICEA (Dipartimento di Ingegneria Civile, Edile e Ambientale)

MODEL-BASED APPROACHES FOR MONITORING MECHANICAL SYSTEMS

Ph.D. *Ciro Tordela*

CFU: 3

NUMBER OF LESSONS: 4 (12 HOURS)

DATES AND LOCATION: 06/10/2025 - 07/10/2025 – 09/10/2025 – 10/10/2025 (from 14:00 to 17:00) – Via Claudio 21, 80125, Naples – Building 4; first floor; 48-seat classroom or multimedia classroom.

Complex systems have mechanical ones as components, and those latter are intrinsically complex. Indeed, the growth in technology allowed the transformation from purely mechanical systems to mechatronics ones with many advantages in terms of interfacing with other systems, the external environment, and humans. Unfortunately, higher maintenance of components integrated into new mechanical systems, typically subjected to degradation, is required. The possibility of introducing the condition-based approach to maintenance activities is crucial for avoiding early replacements of components in good functioning or late intervention on them in faulty conditions. Different techniques for monitoring mechanical systems in real-time can be employed for realizing the condition-based maintenance. The present course proposes an overview on model-based estimators, constituted of Kalman Filters and other forms of state observers, which can be adopted for monitoring mechanical and mechatronic systems. Furthermore, generalities regarding different applicable approaches to the diagnostic and monitoring of mechanical and mechatronic systems, functional for condition-based maintenance, are provided. The following three case studies are proposed: the railway vehicle, the road vehicle, and Curved Surfaces Sliding Isolators. Anti-yaw suspension components, which constitute a part of the railway secondary suspension, are monitored to identify possible faults that cause stability and safety reduction in railway vehicles. The tire-road conditions and the sideslip angle related to road vehicles are monitored for managing their performances and to ensure safety requirements. The frictional behaviour related to both surfaces of Curved Surfaces Sliding Isolators is characterized through the proposed model-based approach, which is also suitable for monitoring the wear conditions of isolators during their operations. The suitability of the model-based monitoring approach is confirmed by results obtained for each class of previously mentioned mechanical systems, allowing for real-time applications in hardware equipment integrated onboard them.

At the end of the course, there will be a final test aimed at the recognition of 3 CFU.

SUMMARY:

- MODEL-BASED MONITORING OF MECHANICAL SYSTEMS: CONTEXT OF APPLICATIONS
- OVERVIEW ON APPROACHES FOR MONITORING MECHANICAL SYSTEMS (Monitoring methodologies; Kalman filters; Sliding-mode observers).
- DEVELOPMENT OF ESTIMATOR DESIGN MODELS FOR MODEL-BASED MONITORING SYSTEMS (Estimator design model for monitoring railway anti-yaw suspension components; Estimator design model for vehicle and tire-road monitoring with no interaction modelling; Estimator design model for monitoring the surfaces of sliding seismic isolators).
- IMPLEMENTATION OF THE EXTENDED KALMAN FILTER FOR VEHICLE AND TIRE-ROAD MONITORING IN THE MATLAB/SIMULINK ENVIRONMENT.

NOTE: the course will be held in presence; if all the learners speak Italian, it will be held in Italian.

!!!ALL INTERESTED PARTIES ARE INVITED TO SEND AN EMAIL TO THE TEACHER (ciro.tordela@unina.it)!!!