ME152 "Digital Twins" (4 cr. with labs)

Fall 2024 offered as ME190 ST in ME (Digital Twins)

http://mechatronics.ucmerced.edu/digital-twin

Synopsis (why bother and who cares?):

In the era of **digital transformation** driven by **internet of things, big data, edge/cloud computing, artificial intelligence/machine learning, cyber-physical human systems** etc., digital twins are becoming a core technology that a modern engineer should have. *A digital twin (DT) is a digital representation of the physical asset or process with its behavior matched to and information exchanged with its physical counterpart.* Digital twin enables awareness of performance and health of the physical twin so that the physical system can **become smarter than before**. This course will prepare engineering undergraduates with digital twin basic concepts, digital twin fundamentals (modeling and system identification, optimization, machine learning, behavior matching), digital twin construction framework and deployment methods, digital twins enabled capabilities (performance and health monitoring). *This course is **lab-intensive**. 150 min. lectures per week (two 75 min. lectures) and 3 hours lab session per week. 6 extra hours for self-study (book reading, homeworks, literature review, report writing etc.)*

Prerequisites by Topic:

ME140: Vibration and Control, Unit 4; or, ME141: Introduction to Control Systems, Unit 3 or, EE 145: Signal Processing and Linear Systems, Units: 4; or by Instructor Approval

Catalog Description:

ME152: Digital Twins [4cr]. Introduction to digital twin that is a digital representation of the physical asset or process with its behavior matched to and information exchanged with its physical counterpart. This course covers digital twin basic concepts, digital twin fundamentals (modeling and system identification, optimization, machine learning, behavior matching), digital twin construction framework and deployment methods, digital twins enabled capabilities (performance and health monitoring).

Course outline:

Part 1: DT concepts (What is and is not a DT, DT components/applications/industrial examples) (weeks 1-2)
Part 2: Math foundations for DT (LA/DE, SVD/PCA, optimization/machine learning/dynamic fitting) (Weeks 3-6)
Part 3: Dynamic systems modeling and analysis, simulation and system identification (weeks 7-10)
Part 4: DT constructions from edge to cloud (weeks 11-13)
Part 5: DT enabled capabilities and smart systems (weeks 14-16)

Instructor:

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Textbook: none; Reference texts: Two, both free to all:
https://doi.org/10.1007/978-3-031-22140-8 and https://doi.org/10.1137/1.9781611976977