

AE-454: INTRODUCTION TO SYSTEMS DYNAMICS & CONTROL

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Time: 13:00-14:30 TUESDAY & THURSDAY, **Room:** 225A TALBOT LABORATORY

This course is structured to introduce the senior undergraduates and junior graduates the fundamental concepts of Lagrangian dynamics, state space representations, Hamiltonian and modern dynamics, stability theory and control of dynamical systems. It covers what constitutes the common core of *dynamics and control theory*. For students intending to pursue a graduate degree in the general area of *dynamics and control*, this course will form the basis for more advanced courses.

- **Lagrangian Dynamics: 7-lectures** (Sri Namachchivaya)
 - Forces, constraints and generalized coordinates* (1-lecture)
 - Virtual displacements, virtual work and D'Alemberts principle* (1-lecture)
 - Lagrange's equations from D'Alemberts principle for holonomic systems* (2-lecture)
 - Lagrange's equations from D'Alemberts principle for non-holonomic systems* (1-lecture)
 - Lagrange's equations from Hamilton's principle for holonomic systems* (1-lecture)
 - Two examples on constraints and Lagrange's equations* (1-lecture)
- **Hamiltonian Dynamics: 8-lectures** (Sri Namachchivaya)
 - Legendre transformation, Hamilton's equations and Poisson Brackets* (2-lecture)
 - Canonical/Symplectic transformations* (2-lecture)
 - Generating functions* (2-lecture)
 - Hamilton-Jacobi equations and action angle variables* (2-lecture)
- **Linear Systems and Stability: 6-lectures**(Voulgaris)
 - Linear vector spaces and state variable description*(1-lecture)
 - Linear dynamical systems: some fundamental results*(1-lecture)
 - Definitions of stability, asymptotic stability, uniform stability, etc*(1-lectures)
 - Lyapunov function, Lyapunov's direct and indirect methods with proofs* (2-lectures)
 - Applications of Lyapunov function*(1-lecture)
- **Control of Dynamical Systems: 8-lectures**(Voulgaris)
 - Concepts of controllability and observability*(2-lectures)
 - Observable canonical forms, controllable canonical forms, poles and zeros*(2-lectures)
 - State feed-back and state estimators*(2-lectures)
 - Frequency domain concepts*(2-lectures)