Introduction to Space Vehicles and Dynamics

1. TIMETABLE

The course contents will be imparted in online classes through Google Meets during the month of July. Four additional classes will be given at the end of August and beginning of September to answer doubts on the subject before the final exam. A detailed schedule is provided below. Any modification of it will be promptly communicated to the students.

July: Mechanics (8), Fluid dynamics (5), Structures (3), Quiz (1)

Day	Room	Topic
01/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
02/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
03/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
06/07*	Online: https://meet.google.com/gtm-jjte-zgz	Structures
07/07*	Online: https://meet.google.com/uho-buyr-okx	Fluid dynamics
08/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
09/07*	Online: https://meet.google.com/uho-buyr-okx	Fluid dynamics
10/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
13/07*	Online: https://meet.google.com/gtm-jjte-zgz	Structures
14/07*	Online: https://meet.google.com/uho-buyr-okx	Fluid dynamics
15/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
16/07*	Online: https://meet.google.com/uho-buyr-okx	Fluid dynamics
17/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics
20/07*	Online: https://meet.google.com/gtm-jjte-zgz	Structures
21/07*	Online: https://meet.google.com/uho-buyr-okx	Fluid dynamics
22/07*	Online: https://meet.google.com/uho-buyr-okx	Mechanics

*Class will be held from 11:30 to 13:00 CEST

September:

Day (time)	Room	Topic
31/08 (9:00-10:30)	On-site: 2.0.C03	Mechanics
31/08 (10:45-12:15)	On-site: 2.0.C03	Fluid dynamics
01/09 (9:00-10:30)	On-site: 2.0.C03	Mechanics
01/09 (10:45-12:15)	On-site: 2.0.C03	Structures

2. EVALUATION

The final mark will weight for a 40% the midterm quiz mark to be hold in July (online) and for a 60% the final exam to be hold on-site in September.

Midterm Quiz (40% final mark)

Day	Room
TBD	Online quizzes.

Final Exam (60% final mark)

Day (time)	Room
04/09 (9:00-13:00)	On-site: 2.0.C03

3. COURSE TOPICS

Point particle and rigid body mechanics, and basic orbital dynamics
(Teacher: Alberto Marín, email: almarinc@pa.uc3m.es)

- Point particle kinematics: reference frames, position velocity and acceleration; coordinates systems; working with multiple vector bases; time derivative of a vector; omega definition; Coriolis theorem; velocity and acceleration in a moving reference frame.
- Point particle dynamics: force, linear momentum and kinetic energy; Newton's laws; equations of motion (EOM); power, work and potential energy; conservation of mechanical energy; angular momentum and torque; central force motion.

- Orbital mechanics: Kepler's problem; conservation of specific mechanical energy; conservation of specific angular momentum; perifocal reference frame; trajectory equation; Conic sections; Trajectory types; velocity components and flight path angle; vis-viva equation and fundamental velocities; classical orbital elements.
- Rigid body kinematics: body-fixed reference frame; velocity and acceleration fields; instantaneous axis of rotation and slip; general rigid body motion; points of a rigid body; Euler angles, omega, alpha; degrees of freedom (DOF) of a rigid body.
- Geometry of masses.
- Rigid body dynamics: linear momentum; angular momentum; kinetic energy; EOM of rigid body; Euler's equations in the principal axes of inertia; equilibrium; conservation of mechanical energy.

Fluid mechanics and thermal engineering
(Teacher: Alberto Marín, email: almarinc@pa.uc3m.es)

- Fundamental concepts: control mass and volume. Thermodynamic state, properties, processes.
- Conservation of mass and momentum.
- First Law: heat and work, stored energy, internal energy, the energy equation for a control volume, enthalpy, specific heats.
- Second law: entropy and irreversibility. Thermodynamics cycles.
- 1D flow model.
- Nozzles.
- Heat transfer mechanisms: conduction, convection, radiation.

Solid mechanics and structural engineering
(Teacher: Gabriele Dessena, email: gdessena@ing.uc3m.es)

- Introduction to solid mechanics and linear structures.
- Deformation and stress in a material. Elasticity. Constitutive relations.
- Loads and stress types: compression/tension, shear, torsion, bending…
- Resistance: ultimate stresses. Safety factors in a structure.