COURSES ACADEMIC YEAR: 2010/2011

SAPIENZA
UNIVERSITÀ DI ROMA

FACOLTÀ DI INGEGNERIA

School of Engineering

- **MECCANICA RAZIONALE**
  (SSD MAT/07 - Fisica Matematica - 6 crediti)
  (Corso di Laurea in Ingegneria Meccanica - Facoltà di Ingegneria.)

- **GEOMETRIA DIFFERENZIALE**
  (SSD MAT/03 - Geometria - 6 crediti).
  (Corso Laurea Magistrale in Ingegneria Meccanica - Facoltà di Ingegneria)

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MECCANICA RAZIONALE

Laurea in Ingegneria Meccanica (BMER)

Synopsis - **The main purpose of this course is to give a mathematical method to mechanical engineering design. In fact, in order to use the actual digital tools, it is necessary have a mathematical education that allows to handle suitable mathematical models. With this respect, the course aims to utilize, and adequately complement, the mathematical education just acquired by the student, in order to be able to work with a mathematical model that is enough versatile to handle also with the next courses in mechanical engineering.**

PROGRAMME

• **BASICS OF DIFFERENTIAL GEOMETRY.** **Algebraic complements. Affine spaces. Differential manifolds. Linear connections. Physical components of geometric objects.**

• **KINETICS.** **Structure of the Galilean space-time. Motion and velocity of motion. Frame and frame velocity. Acceleration and Frenet formulas. Rigid motions and Euler angles. Relative motion. Poinsot cones. Base and roulette.**

• **DYNAMICS AND STATICS.** **Geometry of holonomic and non-holonomic constraints. Geometry of forces. Newton equations. Constraints with and without friction. One body statics. Conservative forces. Fundamental laws of dynamics and conservation laws. Work, kinetic energy and related theorems. D'Alembert principle. Stability in statics. Many bodies systems and cardinal equations. Koenig theorem and generalized Koenig theorem. Virtual works principle. Fundamental theorems on the centre of mass and on moment of inertia tensor. Dynamics and statics of rigid systems and related cardinal equations. Equivalent forces and statics. Lagrangian mechanics for holonomic systems with time dependent constraints. Stability and linearization of the Lagrange equation. Statics and stability in Lagrangian systems with forces that do not necessitate to be conservative.**

References

[1] A. Prástaro, *Elementi di Meccanica Razionale*, Edizione 2010, Aracne Editrice, Roma, 2010, 456 pp.

[2] R. Spiegel, *Vector Analysis and an introduction to Tensor Analysis*, Schaum's Outline Series, Schaum Publishing Co., New York 1959. (Italian translation by McGraw-Hill.)

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GEOMETRIA DIFFERENZIALE

Laurea Magistrale Ingegneria Meccanica

Synopsis - The main purpose is to allow the student to acquire some fundamental geometric differential methods for description and integration of partial differential equations (PDE's), that codify design in Mechanical Engineering. The main goal is to obtain a good operative level to handle PDE types interesting Mechanical Engineering.

PROGRAMME - Differential geometry of manifolds, surfaces and curves. Frenet formulas. Differential connections on fiber bundles and manifolds. Levi-Civita connection on Riemannian manifold.
Geometry of PDE's and characteristic vector fields. Smooth, singular and weak solutions of PDE's.
PDE's of Continuum Mechanics and their integration.

References

[1] A. Prástaro, *Geometry of PDE's and Mechanics*, World Scientific, USA, 1996. (Some sections in Chapter 2).
[2] A. Prástaro, *Elementi di Meccanica Razionale*, Ed. 2010, Aracne, Roma 2010, 456 pp. (Chapter 2; Chapter 3; Some sections of Chapter 10 and Chapter 13).
[3] F. W. Warner, *Foundations of Differential Manifolds and Lie Groups*, Glenview, Ill., 1971.
[4] B. Spain, *Tensor calculus*, Oliver and Boyd, Edinburg and London. New York: Interscience Publishers, A Division of John Wiley & Sons, Inc., Edinburg 1965.