Academic subject: Elements of Advanced Geometry 2				
Degree Class: LM-40 – Matematica		**Degree Course:** Mathematics	**Academic Year:** 2017/2018	
		Kind of class: Mandatory	**Year:** 1	**Period:** 2
			ECTS: 7 divided into **ECTS lessons:** 6 **ECTS exe/lab:** 1	
Time management, hours, in–class study hours, out–of–class study hours lesson: 48 exe/lab: 24 in–class study: 72 out–of–class study: 103				
Language: Italian	**Compulsory Attendance:** no			
Subject Teacher: Francesco Bastianelli	**Tel:** +39 080 5442664 **e–mail:** francesco.bastianelli@uniba.it	**Office:** Department of Mathematics Room 18, Floor II	**Office days and hours:** Monday 16.30-18.30. Please contact the teacher by e-mail to schedule an appointment.	
Prerequisites: Mathematical knowledge which is usually learned during the first two years of a degree of L–35 class. In particular, classical analysis of one and several variables, linear algebra, affine and projective geometry, general topology. Basic theory of differentiable manifolds, which is usually learned during the third year of a degree of L–35 class. In particular, notion of differentiable manifold, tangent and cotangent space to a differentiable manifold at a point, differential forms on a differentiable manifold.				
Educational objectives: Acquiring language and techniques of modern analysis, especially measure theory, L_p spaces, Hilbert spaces, basic complex analysis in one variable.				
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding:** Assimilating fundamental concepts in modern geometry and of elementary algebraic topology. Assimilating the related techniques. **Applying knowledge and understanding:** The assimilated theoretical knowledge is involved in large part of mathematics and its applications. **Making judgements:** Ability to analyze the consistency of the logical arguments appearing in a proof. Ability to choose suitable mathematical tools and techniques for studying complex mathematical objects. **Communication:** Students should learn the mathematical language and formalism necessary to read and comprehend textbooks, to explain the assimilated knowledge, and to describe, analyze and solve problems. **Lifelong learning skills:** Assimilate suitable learning methods, supported by consulting textbooks and by solving the exercises and questions which are periodically proposed during the course.			
Course program **1. Elements of category theory:** categories, isomorphisms, functors. **2. Fundamental group and covering spaces:** homotopy, fundamental group, functorial properties of the fundamental group, covering spaces, liftings, theorem of Seifert–Van Kampen, applications. **3. Complexes, homology and cohomology:** exact sequences of abelian groups, five lemma, chain complexes, morphisms of complexes, homology groups, exact sequences of complexes, induced long exact sequence of homology groups, homotopy of complexes, dual complexes and cohomology. **4. De Rham cohomology:** cochain complexes, cohomology groups, the de Rham complex and its cohomology, Poincaré lemma.				

5. Singular homology and singular cohomology: singular simplexes and singular chains, singular homology, singular cohomology, the Mayer–Vietoris sequence and applications, Stokes theorem.
6. Elements of sheaves theory: presheaves and sheaves of abelian groups, morphism of presheaves, stalk of a presheaf, sheaf associated to a presheaf, exact sequences of sheaves.
7. Cohomology of sheaves: resolutions of sheaves, soft sheaves and canonical resolutions, cohomology groups of a sheaf, acyclic sheaves, de Rham theorem.
8. Introduction to vector bundles: vector bundles, morphisms of vector bundles and exact sequences, locally free sheaves of modules over a sheaf of rings, correspondence between isomorphism classes of vector bundles and locally free sheaves.

Teaching methods:
Lectures and exercise sessions

Auxiliary teaching:

Assessment methods:
Oral exam

Bibliography:

M. ABATE, F. TOVENA, *Geometria differenziale*, Springer.

A. HATCHER, *Algebraic topology*, Cambridge University Press.

C. KOSNIOWSKI, A first course in algebraic topology, Cambridge University Press.

M. MANETTI, Topologia, Springer.

I. MADSEN, J. TORNEHAVE, *From calculus to cohomology*, Cambridge University Press.

E. SERNESI, *Geometria 2*, Bollati Boringhieri.

R. O. WELLS, *Differential analysis on complex manifolds*, Springer.