# POLITECNICO DI MILANO

Protocol number: 127651
Protocol date: 18/12/2014
Register number: 0910-0801

DIPLOMA SUPPLEMENT ATTACHMENT

1 INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION

1.1 Family name(s)
DI STASIO
1.2 Given name(s)
LUCA
1.3 Date of birth (day/month/year)
19/04/1988
1.4 Student identification number or code (if available)
714194

2 INFORMATION IDENTIFYING THE QUALIFICATION

2.1 Name of the qualification and (if applicable) title conferred (in original language)
Laurea in AEROSPACE ENGINEERING
Dottore
2.2 Main field(s) of study for the qualification
L-9 Industrial Engineering
2.3 Name and status of awarding institution (in original language)
Politecnico di Milano (Università statale), Piazza Leonardo da Vinci 32, 20133 Milano

# POLITECNICO DI MILANO

Description of curriculum

## CHEMISTRY A

Code: 060003
Credits: 5.00
Grade: 30 cum laude
Date: 11/02/2008

Subject groups

CHIM/07 FOUNDATIONS OF CHEMISTRY FOR TECHNOLOGIES

The Programme

Basis concepts: elements and compounds, chemical formulae, mole, simple reactions, stoichiometry. Atomic structure: nucleus and electrons. Electronic structure of atoms and the periodic system. The chemical bond: Ionic bonding: crystal structure and properties of ionic compounds. Covalent bonding: molecules and covalent solids. The metallic bond: conductors and semiconductors. States of matter: description of the gaseous state by the ideal-gas equation of state and of solids and liquids by phase diagrams. Chemical thermodynamics: First and second principles of thermodynamics. Enthalpy, entropy and Gibbs free energy state functions, and their application to the calculation of the heat, spontaneity and equilibrium conditions of chemical reactions. Chemical kinetics: reaction rate. The molecular collision model of chemical reactions. Parameters affecting reaction rates. Catalysts. Reactions and equilibria in aqueous solutions: Acids, bases and acid-base equilibria. Autoprotolysis of water and the pH. Red-ox reactions. Electrochemical cells, electromotive force, standard reduction potentials, electrolysis.

## EXPERIMENTAL PHYSICS A + B

Code: 060028
Credits: 10.00
Grade: 27
Date: 07/07/2008

Subject groups

FIS/01 EXPERIMENTAL PHYSICS

The Programme

Physical quantities and their measurement. Kinematics of a particle: frames of reference, position, velocity, acceleration. Dynamics of a particle: Newton's laws and their applications. Work, power, energy and conservation of mechanical energy. Gravitational field. Oscillatory motion. Dynamics of a system of particles (fundamentals): conservation laws, collisions. Coulomb's law, electrostatic field. Gauss' law. Electrostatic potential. Electrostatic properties of conductors, electric capacity, capacitors. Energy of the electric field. Electrostatic phenomenology in dielectric materials. Electric current, Ohm's law, electromotive force. Magnetostatic field. Sources and properties of magnetostatic field, Ampe're's law. Phenomenology of magnetostatic field in matter.

# POLITECNICO DI MILANO

## MATHEMATICAL ANALYSIS B

Code: 060038
Credits: 5.00
Grade: 30 cum laude
Date: 14/07/2008

Subject groups

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|---|---|
| MAT/05 | MATHEMATICAL ANALYSIS |

The Programme

Functions of several real variables (scalar fields): continuity, gradient, differentiability. Maxima and minima. Implicit functions. Lagrange multipliers. Double and triple integrals. Curves in 2-D and 3-D, surfaces in 3-D. Line and surface integrals of a scalar field. Vector fields in 2-D and 3-D: rotation and divergence; line integral of a vector field; potential function and conservative fields; Gauss' and Stokes' theorems. Ordinary differential equations: initial value problems; solutions of first-order equations, of higher-order linear equations, etc.

## MATHEMATICAL ANALYSIS A AND GEOMETRY

Code: 060044
Credits: 10.00
Grade: 30
Date: 03/03/2008

Subject groups

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|---|---|
| MAT/05 | MATHEMATICAL ANALYSIS |
| MAT/03 | GEOMETRY |

The Programme

Logics. Sets. Real numbers. Sequences and series of real numbers. Cartesian coordinates. Vectors in two and threedimensional Euclidean space. Linear subspaces of the Euclidean space. Vector spaces. Scalar product. Linear transformations. Matrices, and determinants. Linear systems. Eigenvalues and eigenvectors. Reduction of a matrix to diagonal form. Comples numbers: operations and representations. Real functions of one real variable. Limits and continuity. Properties of continuous functions on an interval. Derivation. Properties of differentiable functions on an interval. Maxima and minima. Taylor formula. Convex funtions. Study of the graph of a function. Riemann integral. Fundamental theorem of integral calculus. Computation of elementary integrals. Integration methods.

# POLITECNICO DI MILANO

## INFORMATICS C

Code: 060065
Credits: 5.00
Grade: 29
Date: 02/07/2008

Subject groups

ING-INF/05 DATA PROCESSING SYSTEMS

The Programme

Introduction to Informatics: History. Automated solution of problems. Nature and representation of information. Composition and organization of information systems: Structure of computers. Main programming concepts: Introduction to algorithms. Foundation of C programming ? abstraction mechanisms. The concept of program, simple and structured types, control flow instructions. Programming techniques: Subprograms. File management. Specific applications: Production environments and tools. Applications supporting communication and cooperation in the Internet context.

## FUNDAMENTALS OF AEROSPACE ENGINEERING

Code: 060066
Credits: 12.50
Grade: 27
Date: 19/02/2008

Subject groups

ING-IND/04 AEROSPACE CONSTRUCTION AND INSTALLATION
ING-IND/06 FLUID DYNAMICS
ING-IND/15 DESIGN AND METHODS FOR INDUSTRIAL ENGINEERING

The Programme

The course is organized following sequential chapters concerning those arguments that are considered introductory to the degree in aerospace engineering. The chapters are as follows. Environment of aerospace vehicles. Aerodynamics. Architecture of aerospace vehicles. Aerospace propulsion. Mechanics of flight both in atmosphere and in space. Aerospace vehicle model. Loads acting on vehicles. Structural elements in aerospace vehicles. Materials used in the aerospace field. Introduction to the technical drawing. Methods for graphical representation. Methods for manufacturing and control of di pezzi. Precision and finishing specifications. Functionality and morphology of constructive elements. Funzionalita' e morfologia di elementi costruttivi. Aerospace technologies.

# POLITECNICO DI MILANO

## BUSINESS ADMINISTRATION

Code: 060076
Credits: 5.00
Grade: 29
Date: 10/07/2008

Subject groups

ING-IND/35 ENGINEERING AND MANAGEMENT

The Programme

Course introduces to fundamental knowledge of management and to organisational aspects present in the various types of companies that operate in different economic contexts. The principal arguments are: fundamentals of management, accounting and financial statements, managerial accounting, organization theory, strategic management.Company and his objiectives, company and environment, "forme giuridiche d'impresa". Financial statements ( balance sheet and profit and loss statement). Balance sheet ratios. Types of costs and costing tecniques. (job order costing, operation costing, process costing, activity based costing)Strategy: definition and strategic choices. Abell and Porter model. Boston Matrix (BCG):Design of organizational structures: functional, project, matrix. Decisions about investements.

## INTEGRATION OF CALCULUS 2

Code: 084344
Credits: 5.00
Grade: 30
Date: 02/07/2009

Subject groups

MAT/05 MATHEMATICAL ANALYSIS
MAT/03 GEOMETRY

The Programme

Provides the necessary integration and the required credits to adapt curricula of students coming from previous regulamentations. See the program of the main course.

## INTEGRATION OF FUNDAMENTALS OF AEROSPACE ENGINEERING

Code: 084357
Credits: 2.50
Grade: 27
Date: 29/06/2009

Subject groups

ING-IND/15 DESIGN AND METHODS FOR INDUSTRIAL ENGINEERING

The Programme

Provides the necessary integration and the required credits to adapt curricula of students coming from previous regulamentations. See the program of the main course.

# POLITECNICO DI MILANO

## CIRCUITS AND ELECTRONICS

Code: 083266
Credits: 10.00
Grade: 30 cum laude
Date: 30/06/2009

### Subject groups

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|---|---|
| ING-IND/31 | ELECTROTECHNICS |
| ING-IND/32 | ELECTRICAL CONVERTORS, MACHINES AND SWITCHES |
| ING-IND/33 | ELECTRICAL ENERGY SYSTEMS |

### The Programme

The course deals with the basic principles and applications of electrical engineering. The general part of the course is devoted to circuit theory, and therefore it provides the characterization of electrical and electronic components, the methods of analysis for resistive electrical networks, sinusoidal steady-state and dynamical networks, and circuits in the frequency domain. The application-oriented part of the course is devoted to electronics (examples of analysis and design of electronic circuits) and to electromechanical conversion of energy (electromechanical devices and basic principles of the main electrical machines).

## THEORETICAL MECHANICS

Code: 083267
Credits: 10.00
Grade: 30
Date: 18/02/2009

### Subject groups

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|---|---|
| MAT/07 | MATHEMATICAL PHYSICS |

### The Programme

The course on theoretical mechanics aims at providing a general background about the concepts and methods of Classical Mechanics. Starting from the basic notions on Newtonian mechanics which students have already acquired in previous courses, the mechanics of systems of constrained point masses, rigid and deformable bodies is rigorously developed. In the first part of the course, the study of mechanical systems is based on the balance equations for linear and angular momentum and kinetic energy. The concepts and methods of analytical mechanics are presented and applied in the second part of the course. The benefits and drawbacks of the two approaches are discussed. The chapter devoted to analytical mechanics also contains a presentation of the basic tools to study the stability of motion and equilibrium of mechanical systems, as well as an introduction to variational formulations of mechanics.

# POLITECNICO DI MILANO

## FUNDAMENTALS OF AUTOMATIC CONTROL

Code: 083401
Credits: 8.00
Grade: 30
Date: 10/07/2009

### Subject groups

ING-INF/04 AUTOMATICS

### The Programme

After an introduction where the control problem is introduced, the course works out the theory of dynamic systems: the notion of dynamic system in time domain is formalized and fundamental concepts are defined, like state variables, system linearity, motion, equilibrium and linearization around an equilibrium point. Structural properties (stability and some elements on controllability and observability) of dynamic systems are studied.
Laplace and Fourier transforms are then introduced: based on these tools, the description of dynamic systems in terms of transfer functions is addressed. In particular, stability of systems and the relation between zeros and poles of the transfer function and the time responses are discussed. The study of dynamic systems is completed by the analysis of the frequency response, including Bode diagrams plotting.
The study of the tools for simplification of the block diagrams introduces the discussion on feedback control systems, in terms of stability, dynamic and static performance. The design of the controller in the frequency domain is then worked out in detail, with particular reference to industrial controllers (PID). Root locus analysis is discussed as well.
Discrete time systems theory, briefly developed in this course, introduces the last part, where the main properties and the design criteria for digital control systems are discussed. In particular methodologies for the digital implementation of an analogue controller are presented.

## APPLIED NUMERICAL ANALYSIS

Code: 083402
Credits: 10.00
Grade: 30 cum laude
Date: 31/07/2009

### Subject groups

MAT/05 MATHEMATICAL ANALYSIS
MAT/08 NUMERICAL ANALYSIS

### The Programme

The objective of this Course is to introduce some numerical methods for the solution of engineering problems, while growing, at the same time, a sufficient insight with a view to their employment. This aim will be pursued by completing the lectures with hands-on sessions in computer laboratories based on Matlab or Octave.
The topics covered on the Course can be classified in six categories: numerical linear algebra; numerical solution of nonlinear equations and systems; approximation of functions and data; numerical integration and differentiation; ordinary differential equations; boundary-value problems. Moreover some basic issues on partial differential equations will be provided, covering both the theoretical and the numerical aspects.
For all these topics, the corresponding implementation skills as well as some practical exemplifications will be furnished.

# POLITECNICO DI MILANO

## AEROSPACE SYSTEMS

Code: 083404
Credits: 8.00
Grade: 28
Date: 08/09/2009

Subject groups

ING-IND/05 AEROSPACE SYSTEMS

The Programme

Features of most relevant components and their integration in aerospace systems. Layout and preliminary sizing of hydraulic, electrical, pneumatic, fuel, environmental, landing gear and flight control systems. Emergency systems, instruments and avionic systems.

## THERMODYNAMICS AND HEAT TRANSFER

Code: 083795
Credits: 10.00
Grade: 27
Date: 03/02/2009

Subject groups

ING-IND/10 TECHNICAL PHYSICS

The Programme

The course introduces foundations and applications of engineering thermodynamics as well as basic concepts of heat
transfer, and it is aimed to solve simple problems in modeling thermo-fluid-dynamic processes and energy systems.
Main topics: fundamentals of thermodynamics, internal energy, available energy, entropy; properties of substances,
state equations for ideal gases and incompressible liquids, heterogeneous systems; engineering thermodynamics: control
volume, mass, energy and entropy balances, conversion devices (turbines, compressors, pumps, nozzles), cycles and
processes for power and refrigeration plants (Otto, Brayton, Rankine, vapor-compression cycle); heat transfer
mechanisms, the Fourier's equation, the one-dimensional steady-state solution for plane and cylindrical geometry;
electrical analogy and equivalent thermal network; transient conduction (the lumped capacitance method); forced
convection in internal and external flows, dimensionless numbers; thermal radiation, black body, gray surfaces,
radiation exchanges.

# POLITECNICO DI MILANO

FUNDAMENTALS OF STRUCTURAL MECHANICS

Code: 086222
Credits: 10.00
Grade: 30
Date: 23/02/2010

Subject groups

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|---|---|
| ICAR/08 | CONSTRUCTION SCIENCE |
| ING-IND/04 | AEROSPACE CONSTRUCTION AND INSTALLATION |

The Programme

Brief description of the topics

The purpose of the course is to introduce aeronautical engineering students to Structural Mechanics. In the first part, the focus is set on equilibrium of structural systems. Beams are the main object of the analysis, but the generality of the discussed concepts (e.g. for continuum models) is constantly underlined.
Basic concepts of solid mechanics are discussed: stresses, strain and constitutive laws. The general problem of thermo-elasticity is formulated and analytically solved in the case of the De Saint Venant solid, as an example of analytical solution.
Elastic deformability of structural systems is analyzed and some approaches to solve statically undetermined, plane and spatial, problems are presented in conceptual and operative terms. The Virtual Work Principle (VWP) and the elasticity theorems are introduced. The VWP is applied to the solution of simple, elastic, plane and spatial frames.
A special attention is given to the total potential energy theorem and its numerical importance. Beyond the linear elasticity limits, the third part of the course describes basic concepts on instability of elastic structures and strength criteria, introducing the bases of the classic plasticity

# POLITECNICO DI MILANO

## DYNAMICS OF AEROSPACE SYSTEMS

Code: 086223
Credits: 8.00
Grade: 28
Date: 16/02/2010

Subject groups

ING-IND/13 APPLIED MECHANICS FOR MACHINERY

The Programme

The course provides basic modeling capabilities by illustrating how reality can be cast into physical models, which are translated in mathematical models and analyzed to provide approximate answers to the real problems. The foundations of the course are represented by kinematcis and analytical dynamics provided by theoretical mechanics, augmented by basic concepts of hydraulic and electric modeling, provided by aerospace systems and electrotechnics. The principles of control theory are applied to the resulting dynamical systems. Phenomena related to interaction between machinery parts are presented, including friction, tyre rolling and lubrication. The energetic approach to the description of single degree of freedom machines is presented as well. The actuation of coupled systems is analyzed from the point of view of their control. The process of continua discretization is introduced. The dynamics of discrete systems is analyzed from the point of view of small perturbations about a steady configuration, to address stability and response to periodic excitation. Single degree of freedom systems are considered first: free and forced response of damped and undamped systems are analyzed. Multiple degree of freedom systems allow the introduction of the concept of natural frequencies and modes of vibration. The course is concluded by basic notions of stability and response of systems subjected to non-conservative force fields, with applications to aeroelasticity.

# POLITECNICO DI MILANO

## FLUID DYNAMICS

Code: 086224
Credits: 10.00
Grade: 27
Date: 29/06/2010

Subject groups

ING-IND/06 FLUID DYNAMICS

The Programme

The fundamentals of fluid dynamic phenomena and related models are given in this course. In the first part of the course, the laws and the physical and mathematical models governing the dynamics of fluids are derived on the basis of the knowledge supplied by previous courses in the fields of physics, mathematics, theoretical mechanics, numerical methods and applied thermodynamics. Starting from the most general mathematical model of the Navier-Stokes equations, which is analyzed and discussed in details, the classical simplified models of fluid dynamics are derived, based on dynamical approximations criteria, assumptions on the rheological and thermodynamic state equations of the specific fluid and flow conditions, or properties of the flow domain and boundary conditions. Steady and unsteady exact solutions of the Navier-Stokes equations, the Euler equations, the Prandtl's thin layer and the potential flow models are presented, the latter having particular impact on low speed aeronautical applications. The theoretical aspects of fluid dynamics are treated in constant touch with their practical, natural or industrial implications and supported by the physical insight supplied by the still unequalled films of the National Committee for Fluid Dynamics. Fellows will also be introduced to basic experimental techniques and will acquire capabilities in the prediction of the aerodynamic performances of airfoils.

## PRINCIPLES OF AEROSPACE EXPERIMENTATION

Code: 086225
Credits: 6.00
Grade: 29
Date: 27/07/2010

Subject groups

ING-IND/04 AEROSPACE CONSTRUCTION AND INSTALLATION

The Programme

Basics in metrology: Needs for experimentation, The generalized instrument, Standards and requirements.
Measurements methods in aerospace experimentation: fundamental principles in transduction. Fundamental techniques for basics measurements (length, displacement, strain, acceleration, force, pressure, temperature)
Static and dynamic properties of instruments and transducers. Quality properties of instruments. Dynamic modelling of instruments. Basics in signal conditioning (filtering, amplification, partitioning)
Analogic to digital conversion and data acquisition systems: A/D and D/A converter characteristics and performances. Sampling theoreme. Leakage. Acquisition systems layouts
Statistical analysis of experimental data: Basics in probability and statistics. Density distribution. Infinite and finite statistics. Confidence level and interval. Rejection of questionable data. Data fitting.
Design and management of measurement systems: Experimental Uncertainity Analysis. Design of simple measurement systems.

# POLITECNICO DI MILANO

## AEROSPACE PROPULSION

Code: 086416
Credits: 7.00
Grade: 27
Date: 06/07/2010

Subject groups

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|---|---|
| ING-IND/07 | AEROSPATIAL PROPULSION |

The Programme

The course aims to provide the fundamental knowledge of modern aerospace propulsion systems. After an introductory review of the main propulsion systems, for aeronautical and space applications, the system performance parameters are discussed in detail. A review of fundamental topics concerning fluid-dynamic, thermodynamic and energetic aspects of the propulsion systems is given in order to deep air inlets, combustion chambers, nozzles and turbomachines. The final part of the course is devoted to the detailed treatment of airbreathing and rocket motors.

## AEROSPACE TECHNOLOGIES AND MATERIALS

Code: 086419
Credits: 7.00
Grade: 27
Date: 08/07/2010

Subject groups

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|---|---|
| ING-IND/04 | AEROSPACE CONSTRUCTION AND INSTALLATION |
| ING-IND/22 | SCIENCE AND TECHNOLOGY OF MATERIALS |

The Programme

The course of Aerospace Technologies and Materials has the purpose to impart the basic concepts about the materials and the technologies adopted for the construction of aerospace vehicles. To this aim, the material and process selection strategies are preliminarily analyzed, as well as property limit and indices. Then, the main features of the principal families of materials used for aerospace construction are presented, paying special attention to metals, metal alloys and composite materials, as well as to the related technologies for the construction of detached components. Finally, the joining techniques are considered, together with the assembling organization and the overall production management. Besides, post-production issues, like non destructive inspection, repairing and maintenance procedures are dealt as well.

# POLITECNICO DI MILANO

## FUNDAMENTALS OF ATMOSPHERIC AND SPACE FLIGHT MECHANICS

Code: 086422
Credits: 7.00
Grade: 27
Date: 14/07/2010

### Subject groups

ING-IND/03 FLIGHT MECHANICS

### The Programme

The course addresses the basic elements of fixed-wing aircraft flight mechanics and of orbital mechanics. Concerning atmospheric flight mechanics, after the introduction of preliminary notions on the aircraft and the environment of flight, basic aerodynamics and aeronautical propulsion, the course covers the analysis of basic aircraft trim, control, static and dynamic stability, ending with the study of point and integral flight and airfield performances. Concerning space flight mechanics, appropriate mathematical models and equations of motion are introduced, in order to characterize orbital trajectories, analyze orbital maneuvers and interplanetary mission planning. The presentation of the various topics is complemented by the student's implementation and usage of simple numerical algorithms.

## FINAL DEGREE TEST

Code: 086633
Credits: 3.00
Grade: --
Date: 15/09/2010

### Subject groups

ING-IND/03 FLIGHT MECHANICS
ING-IND/04 AEROSPACE CONSTRUCTION AND INSTALLATION
ING-IND/07 AEROSPATIAL PROPULSION
ING-IND/22 SCIENCE AND TECHNOLOGY OF MATERIALS

### The Programme

Unavailable

## INTEGRATION OF FINAL DEGREE TEST

Code: 087393
Credits: 2.00
Grade: --
Date: 15/09/2010

### Subject groups

Unavailable

### The Programme

Unavailable

# POLITECNICO DI MILANO

INTEGRATION OF FINAL DEGREE TEST

Code: 087395
Credits: 4.00
Grade: --
Date: 15/09/2010

Subject groups

Unavailable

The Programme

Unavailable