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MILANO 1863

SCUOLA DI
INGEGNERIA
INDUSTRIALE E
DELL'INFORMAZIONE

Internal double degree in BIOMEDICAL and MATERIALS ENGINEERING AND NANOTECHNOLOGY (DD-BIO_MAT) a.y. 2024-2025

1. Foreword

In the past years, the demand for specialists with more transversal skills and technical competencies has become very challenging. These features cannot be offered by one conventional Master Degree programme.

Starting from the 2011, the idea of joint programmes was introduced at Politecnico di Milano and new roadmaps for joint Double Degrees (DD) have been established in order to combine complementary skills and to culturally widen the current Master Degree programmes.

The general objective of this approach is to fully exploit synergies and complementarities between different Master Degree study plans, to structure an educational offer more flexible and better matching the dynamics of the current industrial world.

2. Overview on the internal Double Degree in BIOMEDICAL ENGINEERING and MATERIALS ENGINEERING AND NANOTECHNOLOGY

The internal Double Degree in Biomedical Engineering and Materials Engineering and Nanotechnology (DD-BIO_MAT) aims at capturing the emerging needs of the Italian and European biomedical industries, which are strategic and relevant in the biomaterials field.

In particular, such sector, in order to compete within international markets, is looking for a new professional figure able to integrate the typical skills of a biomedical engineer with the key technical competencies of a materials science engineer.

Such objective could be achieved by the cultural closeness of the two programmes, which present several commonalities, although showing specific differences that can, nonetheless, be easily compensated through a joint programme.

The focus of *Biomedical Engineering Programme* is to provide students with a solid background in engineering methodologies and technologies applied to medical and biological problems, with particular reference to the analytical description, simulation and analysis of systems and signals of medical/biological interest, to the study of biomechanics, biomaterials, devices and instrumentation for the diagnosis, therapy, substitution and regeneration of tissue or organs, and rehabilitation, to the knowledge of patient management, support structures, IT systems and the relevant ethical criteria. In particular, the Master degree is organized in 5 tracks:

- Biomechanics and Biomaterials,



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- Cells, Tissues and Biotechnologies,
- Clinical Engineering,
- Information Bioengineering,
- Technologies for Electronic.

The mission of the *Materials Engineering and Nanotechnology Programme* is to develop professional skills in the areas related to the development of new production processes of materials and/or parts, the development of surface treatment processes, the development of engineering applications of polymers and composites, the development of technologies, products and applications at the micro- and nanoscale, and technical direction of industrial plants and products. The student of the Master Degree programme in Materials Engineering and Nanotechnology can choose among the following study tracks:

- Surface Engineering,
- Polymer Engineering,
- Nanomaterials and Nanotechnology,
- Engineering Applications,
- Sustainability Engineering;
- Micro and Nano Systems.

The track of Biomaterials and Biomechanics of the Biomedical Engineering Master course presents many common methodological and applicative aspects with the Materials Engineering and Nanotechnology programme.

The DD-BIO_MAT offers a unique opportunity to exploit the main benefits from both approaches, thus filling the existing gaps in the two specific programmes.

The integration of Biomedical Engineering and Materials Engineering and Nanotechnology programmes stems from such requirements, thus aiming at developing professional experts, with a solid materials science background, well matched with a biomedical vision, thus being really appealing for the biomedical industries that develop products in the field of biomechanics and biomaterials with all their applications in biomedical field.

3. Learning objectives (DD-BIO_MAT)

The study plan of the Master Degree in Biomedical Engineering is aimed at producing an advanced professional profile for an expert in biomaterials and biomechanics with specific reference to design, production, personalization and maintenance of biomechanical systems, life support systems, prosthetic devices, and structure for regenerative medicine applications. The above settings are grounded on methods, which include mechanics, thermofluidic-dynamics, materials sciences and materials engineering. This latter is of particular interests with reference to biocompatibility, device effectiveness and device/biological environment interface. The study plan of the Master Degree in Materials Engineering and Nanotechnology is aimed at producing professional profiles for experts in diverse areas including production, properties of materials and/or parts, surface treatment processes, engineering application of polymers and composites as well as technologies of micro- and nanoscale applications.



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On the basis of the two distinct professional profiles, the DD programme in the Biomedical Engineering - Materials Engineering and Nanotechnology is aimed at forming engineers with a new integrated profile of professionals with expertise in the biomechanical fields with materials and nanotechnology education and vice-versa.

Many Italian companies operating in the field of biomedical devices already recruit both biomedical and material engineers for their products development. The main purpose is to design advanced devices with suitable biomechanical functionality using biomaterials with improved properties matching the specific requirements by means of a knowledge-based selection of materials and surface treatments. The new BIO_MAT engineer would collect in one single professional figure the required knowledge to achieve the company's purposes. In addition to the industrial setting, also research and development departments, both in industry as well as in research institutions would benefit of this new integrated educational programme.

4. The study plan

A total of 180 credits over three years must be gained to obtain the DD in Biomedical Engineering and Materials Engineering and Nanotechnology. In comparison to the standard Master programme (with 120 CFU), in the Double Degree programme students have to select additional 60 CFU. The applicants have to enrol in the M.Sc. in Biomedical Engineering (PSPA Biomechanical and Biomaterials or PSPA Cells, Tissues and Biotechnologies) or in the M.Sc. in Materials Engineering and Nanotechnology, and then present a formal individual study programme.

Considering the current study plans of the individual Master Degree courses and the specific requirements set by the Degree Classes of the Italian Ministry of Education, it is expected that the students coming from one of the two individual study plans would develop a multidisciplinary graduation thesis covering topics that are typical of both the study programmes at the end of the second year and during the third year. Once all the 180 credits will be gained, the students will achieve the Master Degree by discussing their thesis in the course of first enrolment.

The overall DD-BIO_MAT study plan should be considered as a set of purposely selected subjects aimed at supplying to a Materials Engineering and Nanotechnology the fundamental knowledge required for an additional master degree in Biomedical Engineering (MAT-BIO track) and to a Biomedical Engineer those required for an additional master degree in Materials Engineering and Nanotechnology (BIO-MAT track).

The development of an interdisciplinary thesis to be performed at end of the second year and during the third year, has to be considered as a joint activity, so that competences acquired in the first two year of DD-BIO_MAT programme can be joined. The project should address topics related to both fields of Biomedical Engineering and Materials Engineering and Nanotechnology, and will be supervised by two professors from the two Master degree courses.

5. Structure of the study plan

The study plan is developed and specifically customized for Biomedical Engineering students desiring to grow their expertise in Materials Engineering and Nanotechnology (BIO-MAT track)



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and for Materials Engineering and Nanotechnology students with specific interests in Biomedical Engineering (MAT-BIO track).

The structure of the study plan is explained in detail in the table reported at the end of the document.

6. Application and admission

The DD programme BIO_MAT is open to students, that earned the Bachelor Degree in Biomedical Engineering or Materials Engineering and Nanotechnology at Politecnico di Milano or other Italian universities. Students with a bachelor from other Italian universities will be considered for the admission after the evaluation of the bachelor curriculum studiorum.

The application for admittance to the DD-BIO_MAT programme shall be presented before August 28th, after attaining the Bachelor Degree in the July session or going to discuss the Bachelor Thesis in September session.

The applications shall be sent by e-mail to Prof. Silvia Farè (silvia.fare@polimi.it) with cc to Prof. Luca Mainardi (luca.mainardi@polimi.it) for students to be enrolled at the Master Course in Biomedical Engineering or to Prof. Pasquale Vena (pasquale.vena@polimi.it) with cc to Prof. Giovanni Dotelli (giovanni.dotelli@polimi.it) for students to be enrolled at the Master Course in Materials Engineering and Nanotechnology, with the following e-mail subject: Application for Internal Double Degree DD-BIO_MAT.

The following information shall be provided as attached documents to the e-mail:

- short motivation letter (max 500 words);
- Curriculum Vitae with indication of other competencies (beside the Curriculum Studiorum), like software skills and/or professional experiences;
- bachelor official academic transcript.

The DD BIO_MAT programme is a course with a restricted access (no more than 20 students, 10 from Materials Engineering and Nanotechnology and 10 from Biomedical Engineering, will be admitted). The average grade achieved in the Bachelor exams will be considered to define the ranking of admitted students. A minimum average grade of 23/30 shall be required for admission.

Notice of admission will be given on **September 6th**.

Students who apply for the DD-BIO_MAT program must apply before **August 28th in the M.Sc of the path of origin, M.Sc. in Biomedical Engineering or in the M.Sc. in Materials Engineering and Nanotechnology**. If admitted to the DD program, they will be automatically recognized as belonging to the internal Double degree program.

Contacts

Supervisors for M.Sc. in Biomedical Engineering:

- Prof. Silvia Farè (silvia.fare@polimi.it)
- Prof. Luca Mainardi (luca.mainardi@polimi.it), coordinator of Biomedical Engineering Course



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Supervisors for M.Sc. in Materials and Nanotechnologies Engineering:

- Prof. Pasquale Vena (pasquale.vena@polimi.it)
- Prof. Giovanni Dotelli (giovanni.dotelli@polimi.it), coordinator of Materials and Nanotechnologies Engineering Course

		Students from MAT bachelor degree	CFU	Students from BIO bachelor degree	CFU
first year – I semester	compulsory	096240 Mathematical methods for materials engineering MAT/07	5	059073 Fundamentals of materials science ING-IND/22	5
		054191 Mechanical behaviour and failure of metals ING-IND/14	10	093698 Introduction to Nanoscience FIS/03	5
		054286 Bioingegneria chimica [2] ING-IND/34 096236 Mechanics of biological structures ING-IND/34 098454 Strutture bioartificiali e biomimetiche ING-IND/34	1x5	096240 Mathematical methods for materials engineering MAT/07	5
		054284 - Biomeccanica ING-IND/34 083122 Progettazione di endoprotesi [C.I.] ING-IND/34 096253 Fenomeni di trasporto nei sistemi biologici ING-IND/34	1x10		
			083122 Progettazione di endoprotesi [C.I.] ING-IND/34 096253 Fenomeni di trasporto nei sistemi biologici ING-IND/34	1x10	
			096236 Mechanics of biological structures ING-IND/34 098454 Strutture bioartificiali e biomimetiche ING-IND/34	1x5	
first year – II semester		054335 Surface engineering ING-IND/23	5	054335 Surface engineering ING-IND/23	5
		089726 Micromechanics ING-IND/34	5	089726 Micromechanics ING-IND/34	5
		089473 Solid state physics FIS/03 085888 Fisica dello stato solido FIS/03	1x10	089473 Solid state physics FIS/03 085888 Fisica dello stato solido FIS/03	1x10
		082746 Fondamenti di informatica ING-INF/05	10	054296 Medical informatics ING-INF/06	10

second year – I semester		054186 Instrumental methods for materials analysis ING-IND/22 054185 Chemistry of materials CHIM/07	1x5	054186 Instrumental methods for materials analysis ING-IND/22 054185 Chemistry of materials CHIM/07	1x5
		054187 Principles of polymer chemistry ING-IND/22 054188 Principi di chimica dei polimeri ING-IND/22	1x5	054187 Principles of polymer chemistry ING-IND/22 054188 Principi di chimica dei polimeri ING-IND/22	1x5
		052517 Mechanical behaviour and durability of polymers ING-IND/22	10	052517 Mechanical behaviour and durability of polymers ING-IND/22	10
		054339 Corrosion engineering of metals and ceramics ING-IND/22	10	054339 Corrosion engineering of metals and ceramics ING-IND/22	10

second year – II semester	083047 Biomateriali [C.I.] ING-IND/34 054297 Life support systems ING-IND/34 083061 Costruzioni biomeccaniche ING-IND/34	2x10	083047 Biomateriali [C.I.] ING-IND/34 054297 Life support systems ING-IND/34 083061 Costruzioni biomeccaniche ING-IND/34	2x10
	053464 Advanced numerical methods for coupled problems MAT/o8 056926 Polymer technologies for circular economy ING-IND/22 091605 Principles of polymer processing ING-IND/22 056863 Certificazione e attività regolatorie per dispositivi medici ING-IND/34, ING-INF/o6 089724 Composite materials for structural applications ING-IND/22 + ICAR/o8 058013 Nanomedicine and pharmaceutical innovation ING-IND/23 099300 Soft matter: the structure and rheology of complex fluids FIS/o3	1x5	053464 Advanced numerical methods for coupled problems MAT/o8 056926 Polymer technologies for circular economy ING-IND/22 091605 Principles of polymer processing ING-IND/22 056863 Certificazione e attività regolatorie per dispositivi medici ING-IND/34, ING-INF/o6 089724 Composite materials for structural applications ING-IND/22 + ICAR/o8 058013 Nanomedicine and pharmaceutical innovation ING-IND/23 099300 Soft matter: the structure and rheology of complex fluids FIS/o3	1x5
	056881 Biomachines (with laboratory) ING-IND/34 056880 Computational biology of the heart ING-IND/34	1x5	056881 Biomachines (with laboratory) ING-IND/34 056880 Computational biology of the heart ING-IND/34	1x5
third year – I semester	091584 Advanced materials ING-IND/22	10	091584 Advanced materials ING-IND/22	10
	083042 Bioingegneria cellulare ING-IND/34 055768 Tecnologie per la medicina rigenerativa [C.I.] ING-IND/34 096253 Fenomeni di trasporto nei sistemi biologici ING-IND/34 083122 Progettazione di endoprotesi [C.I.] ING-IND/34 099281 - Advanced modeling approaches for cardiovascular surgery [I.C.] ING-IND/34	1x10	083042 Bioingegneria cellulare ING-IND/34 055768 Tecnologie per la medicina rigenerativa [C.I.] ING-IND/34 096253 Fenomeni di trasporto nei sistemi biologici ING-IND/34 083122 Progettazione di endoprotesi [C.I.] ING-IND/34 099281 - Advanced modeling approaches for cardiovascular surgery [I.C.] ING-IND/34	1x10
	098454 Strutture bioartificiali e biomimetiche ING-IND/34 096236 Mechanics of biological structures ING-IND/34	1x5	098454 Strutture bioartificiali e biomimetiche ING-IND/34 096236 Mechanics of biological structures ING-IND/34	1x5
	054302 Biomaterials and instrumental analysis laboratory ING-IND/34 052379 Laboratorio di caratterizzazione dei tessuti ING-IND/34 052376 Laboratorio di biofluidodinamica ING-IND/34 052375 Computational biomechanics laboratory ING-IND/34	1x5	054302 Biomaterials and instrumental analysis laboratory ING-IND/34 052379 Laboratorio di caratterizzazione dei tessuti ING-IND/34 052376 Laboratorio di biofluidodinamica ING-IND/34 052375 Computational biomechanics laboratory ING-IND/34	1x5
third year – II semester	085836 Applicazioni biotecnologiche e bioreattori [C.I.] ING-IND/34 083047 Biomateriali [C.I.] ING-IND/34 054297 Life support systems ING-IND/34	1x10	085836 Applicazioni biotecnologiche e bioreattori [C.I.] ING-IND/34 083047 Biomateriali [C.I.] ING-IND/34 054297 Life support systems ING-IND/34	1x10
	Multidisciplinary thesis work	20	Multidisciplinary thesis work	20