



Internal Double Degree in BIOMEDICAL and MECHANICAL ENGINEERING

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1. Foreword

In recent years the demand for professionals with more transversal skills and technical competencies has become very evident. These features cannot be offered by a single conventional master degree programme.

Starting from the year 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 degree programmes.

The general objective of this approach is to fully exploit synergies and complementarities among different master degree study plans, to make educational offer more flexible and better matching the dynamics of the industrial world.

2. Overview on the internal Double Degree in BIOMEDICAL and MECHANICAL ENGINEERING

The internal Double Degree in Biomedical and Mechanical Engineering (iDD-BME) aims at capturing the emerging needs of the Italian and European biomedical industries, which are strategic and relevant in the biomechanical 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 mechanical 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 providing 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 biomaterials, devices and instrumentation for the diagnosis, therapy, substitution of 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 4 tracks:

- Clinical Engineering,
- Electronic Technologies,
- Biomechanics and Biomaterials,
- Engineering for Cells, Tissues and Biotechnologies.

The mission of the *Mechanical Engineering Programme* is to train professionals with a solid foundational base, a good scientific method and broad technical and applicative knowledge. A mechanical engineer, being involved in the design, optimization and management of products, systems and production processes, must reach a sound preparation in design and testing methodologies, numerical simulation, manufacturing processes, automation and control, material properties and related selection criteria, fluid mechanics and transformation of energy in a machinery. The students of the MSc programme in Mechanical Engineering can choose between eight different study plans:

- Production Systems,
- Mechatronics and Robotics,
- Virtual Prototyping,
- Internal Combustion Engines and Turbomachinery,
- Advanced Mechanical Design,
- Advanced Materials and Technologies,
- Ground vehicles,
- Machine Tools and Manufacturing Systems.

The track of Biomaterials and Biomechanics of the Biomedical course, presents many common methodological and applicative aspects with the Mechanical Engineering programme.

The iDD-BME offers a unique opportunity to exploit the main benefits from both approaches, thus fulfilling the existing gaps in the two specific programmes.

The integration of Biomedical and Mechanical Engineering programmes stems from such needs, thus aiming at developing a professional technician, with a solid industrial technical background, well matched with a biomedical vision, thus being really appealing for the biomedical industries that develop products in the field of biomechanics.

3. Learning objectives

The study plan of the Master degree in Biomedical and Mechanical Engineering is aimed at producing an advanced professional profile for an expert in biomechanics.

The Biomedical-Mechanical Engineer coming from the DD programme here described acquires during the three-year course a combination of knowledge featuring a sound background on applied disciplines of engineering, together with wide scientific skills on biomechanics in order to: "know how to design complex systems and manage processes by exploiting at the highest level modern industrial biomechanics".

This new professional figure would be welcome by the industrial world with great favour since in many technical fields, not only those concerned with research and innovation, biomechanical engineers are required with expertise combining mechanical engineering and biomedical science. Figures about employment in recent years, clearly show that in private industry both profiles are highly recognized and it can be reasonably supposed that a professional combining both profiles acquired through the DD programme would be sought and appreciated.

4. The study plan

A total of 180 credits over three years must be gained to obtain the DD in Biomedical and Mechanical Engineering. Students will therefore need to select courses in excess with respect to the standard Master of Science programme (120 credits over two years). The applicants have to enrol in the M.Sc. in Biomedical Engineering or in the M.Sc. in Mechanical Engineering, and then present a – formal – individual study programme comprising the credits that will be gained in the third year.

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 attendance of the third year. The Master

degree titles will be achieved first in the course of enrolment and then in the other course, once 180 credits will be gained.

The overall DD study plan should be considered as a set of accurately customised tracks aimed at supplying to a Mechanical Engineer all the fundamental knowledge required for an additional master degree in Biomedical Engineering (MEC-BIO study plan) and to a Biomedical Engineer those required for an additional master degree in Mechanical Engineering (BIO-MEC study plan).

The development of an interdisciplinary thesis (to be carried out at end of the second year and during the third year) has to be considered as a joint activity. The project should address topics related to both fields of Biomedical and Mechanical Engineering, 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 customised for Biomedical Engineering students wishing to expand their expertise in Mechanical Engineering (BIO-MEC track) and for Mechanical Engineering students with specific interests in Biomedical Engineering (MEC-BIO track).

The structure of the study plan is illustrated in detail in the following table. It consists of 39/40 CFU of grounding courses (depending on the student's Bachelor degree), which are followed by a common track consisting of courses taken both from BIO and MEC M.Sc programmes.

	Students from BIO Bachelor degree (BIO-MEC track)	CFU	Students from MEC Bachelor degree (MEC-BIO track)	CFU
Grounding	086454 - LABORATORIO PROGETTUALE CAD (II sem)	7	060001 - BIOLOGIA E FISILOGIA (II sem)	10
	086453 - MECCANICA DELLE VIBRAZIONI (II sem)	6	083122 - PROGETTAZIONE DI ENDOPROTESI (I sem)	10
	086218 - MACCHINE (II sem)	9	086028 - BIOINGEGNERIA CHIMICA (I sem)/ 086031 - BIOELETTRROMAGNETISMO E STRUMENTAZIONE BIOMEDICA [C.I.] (I sem)	10
	083447 - TECNOLOGIA MECCANICA 1 (II sem)	10	085858 - BIOMECCANICA (I sem)	10
	086468 - IMPIANTI MECCANICI (I sem)	7		
	TOTAL GROUNDING	39	TOTAL GROUNDING	40
	083061 - COSTRUZIONI BIOMECCANICHE (II sem)	10	095841 - MACHINE DESIGN 2 (II sem)	10
	Table BIO	57	Table BIO	55
	Table MEC	55	Table MEC	55
	Master Thesis	20	Master Thesis	20
	TOTAL	181	TOTAL	180

Table BIO

	Title	CFU	Sem	Students from BIO Bachelor degree	Students from MECC Bachelor degree
	096233 - MATHEMATICAL AND NUMERICAL METHODS IN ENGINEERING [I.C.]	12	1	12	--
	083122 - PROGETTAZIONE DI ENDOPROTESI	10	1	20	30
	083149 - VALUTAZIONE FUNZIONALE E RIABILITAZIONE MOTORIA	10	2		
	096253 - FENOMENI DI TRASPORTO NEI SISTEMI BIOLOGICI	10	2		
	083047 - BIOMATERIALI	10	2		
	096236 - MECHANICS OF BIOLOGICAL STRUCTURES	5	1	5	
	073011 - BIOINGEGNERIA DEL SISTEMA MOTORIO	5	1	10	
	096054 - BIOENGINEERING OF THE RESPIRATORY SYSTEM	5	1		
	099278 - BIOMACHINES (WITH LABORATORY)	5	2		
	096055 - BIOENGINEERING OF PHYSIOLOGICAL CONTROL SYSTEMS	5	1		
	091109 - BREVETTI E PROPRIETA' INDUSTRIALE	5	2		
	079795 - LABORATORIO DI CARATTERIZZAZIONE DEI TESSUTI	5	1	10	
	096254 - BIOMATERIALS AND INSTRUMENTAL ANALYSIS LABORATORY	5	1		
	079796 - LABORATORIO DI COSTRUZIONI BIOMECCANICHE	5	2		
	096267 - FUNCTIONAL EVALUATION LABORATORY	5	2		
	097576 - MEDICAL ROBOTICS AND TECHNOLOGIES FOR COMPUTER AIDED SURGERY LABORATORY	5	1		

Table MEC

	Title	CFU	Sem	Students from MECC/BIO Bachelor degree
	095843 - MEASUREMENTS (II sem)	5	2	5
	095838 - APPLIED METALLURGY (I sem)	6	1	6
	095837 - CONTROL AND ACTUATING DEVICES FOR MECHANICAL SYSTEMS (I sem)	9	1	9
	095842 - MECHANICAL SYSTEM DYNAMICS (II sem)	5	2	5
	097499 - FUNCTIONAL MECHANICAL DESIGN	6	2	6
	091106 - MECCANICA DEI ROBOT	6	1	
	097550 - MECHATRONIC SYSTEMS AND LABORATORY B	6	1	6
	094910 - SMART STRUCTURES AND DEVICES	6	2	
	097457 - VISION BASED 3D MEASUREMENTS	6	1	
	097525 - ADVANCED MEASUREMENT TECHNIQUES	6	1	
	097502 - MECHANICAL SYSTEMS RELIABILITY	6	1	6
	097500 - LIGHTWEIGHT DESIGN OF MECHANICAL STRUCTURES	6	2	
	097547 - MODELLING OF MECHANICAL BEHAVIOUR OF MATERIALS B	6	1	
	091088 - MECCANICA SPERIMENTALE E CONTROLLI NON DISTRUTTIVI	6	2	
	095890 - METHODS FOR VIRTUAL PROTOTYPING	6	1	6
	097450 - DESIGN METHODS	6	1	
	097451 - HUMAN MODELLING IN ENGINEERING	6	1	
	097452 - METHODS AND TOOLS FOR SYSTEMATIC INNOVATION B - PROBLEM SOLVING AND INVENTIVE DESIGN	6	1	
	097454 - COMPUTER VISION AND REVERSE ENGINEERING	6	2	
	084843 - METALLI E LEGHE PER APPLICAZIONI AVANZATE	6	2	6
	095120 - MATERIAL ENGINEERING FOR PRODUCT INNOVATION	6	2	
	097620 - ADDITIVE MANUFACTURING B	6	1	
	050870 - ADVANCED MANUFACTURING PROCESSES LAB B	6	1	

Should new contributions be deemed useful for the Internal Double Degree in Biomedical and Mechanical Engineering, proposals for including additional courses in the tables above can be brought any time to the attention of the Coordinators of the BIO and MEC Programmes.

6. Application and admission

The DD programme is open to internal students, namely to students that earned the Bachelor Degree in Biomedical Engineering or Mechanical Engineering¹ at Politecnico di Milano. Only these students will be considered for the admission to the DD programme. With reference to the students coming from the Bachelor in Mechanical Engineering, only those who attended the propaedeutic track can apply for the DD programme. The application for admittance to the DD programme in Biomedical-Mechanical Engineering shall be presented before September 6th, after obtaining the Bachelor Degree in either the July or September sessions of the same year. The applications shall be sent by e-mail to Prof. Manuela Galli (manuela.galli@polimi.it) with cc to Prof. Maria Laura Costantino (marialaura.costantino@polimi.it) for students to be enrolled at the Master Course in Biomedical Engineering or to Prof. Roberto Corradi (roberto.corradi@polimi.it) with cc to Prof. Gaetano Cascini (Gaetano.cascini@polimi.it) for students to be enrolled at the Master Course in Mechanical Engineering, with the following e-mail subject: Application for Internal Double Degree in Biomedical & Mechanical Engineering.

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.

The DD programme in Biomedical-Mechanical Engineering is a course with a restricted access (no more than 20 students, 10 from Mechanical 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 grade of 23/30 shall be required to be considered for admission. In addition, for students coming from the Bachelor in Biomedical Engineering, the average grade achieved in the following exams of the Bachelor degree will be considered: 083118 -Meccanica dei continui e delle strutture, 097534-Meccanica applicata alle macchine, 096202- Biomeccanica and 086028-Bioingegneria Chimica.

Notice of admission will be given on September 25th.

Contacts

Supervisors for M.Sc. in Biomedical Engineering:

- Prof. Manuela Galli (manuela.galli@polimi.it)
- Prof. Giancarlo Pennati (giancarlo.pennati@polimi.it)

Supervisors for M.Sc. in Mechanical Engineering:

- Prof. Monica Bordegoni (monica.bordegoni@polimi.it)
- Prof. Roberto Corradi (roberto.corradi@polimi.it)

¹ Students coming from the Bachelor Degree in Industrial Production Engineering - PPM Track (Lecco Campus) can apply as well for the DD programme, since their background is regarded as equivalent to that of the students having a Bachelor in Mechanical Engineering.