ATTACHMENT 23-DISS-M1-202

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Art. 1 - Typology of Post-graduated Master's course

The University of Pavia has activated a **first-level** Post-graduated Master's course in "**Design and Development of Vehicle Dynamics**" at the DEPARTMENT OF OF ELECTRICAL, COMPUTER AND BIOMEDICAL ENGINEERING, for the 2023/2024 academic year.

Edition: 4

Disciplinary area: SCIENTIFIC-TECNOLOGICAL AREA

Art. 2 - Educational aims, professional opportunities and course appeal

The Post graduated Master's course is aimed at **training highly qualified professionals, providing students with a solid preparation in the field of vehicle dynamics design so that they are able to work in all phases of vehicle setup and development**, from dynamic simulation to the testing of prototypes right up until the realization of the pre-series vehicle.

Specific competence will be acquired by the Course's students in techniques of testing and in the trial of vehicles, both virtually, by means of CAE systems, in particular through the use of driving simulators, both experimentally by working directly on a vehicle (on the test circuit and on the road).

An absolutely innovative element of the training course, alongside the lectures, **are testing sessions on the circuit of ASC (Automotive Safety Centre) – Quattroruote**, during which the participants will be personally involved in learning the techniques and methodologies that are used in the testing, control and fine tuning of the dynamic behaviour of vehicles. For all participants, a specially designed advanced driving course is planned at the introductory level and oriented towards the successive phase of trials and testing on the track.

The Post graduated Master's course is supplemented by **targeted training to the use of the compact VI-grade CarRealTime**, **Hezagon MSC Adams and software CFD simulator**, a **special module of training on static simulator and a working session on dynamic simulator** at the VI-Grade centre of Tavagnacco (UD) or at the Danisi Engineering company of Nichelino (TO), partner companies of the program.

Qualified postgraduates of the Course can find employment with all those industrial groups which, in various capacities, operate in the field of design, development and the production of vehicles and more generally in the automotive sector. In particular, **the skills acquired during the Master's course are of fundamental importance in the design, testing and development phases of the dynamic behaviour of new thermal, hybrid or electric vehicles**. This role of the professional design test engineer, urgently required by the market, is not available on the current panorama of academic training and is sought after both by mature markets like that of Italy and by markets that are just emerging from the point of view of the automotive industry. In addition, the Post graduated Master's course, in what is a world first, contributes towards the training of a completely new professional position, which can be defined as a "Certified" CAE Driving Simulator Engineer, reserved for those students involved in internship activities who are specifically oriented towards in-depth training and the development of projects using the simulator.

The Post graduated Master's course in "Design and Development of Vehicle Dynamics" is aimed at young engineers passionate about the automotive world and is offered to international students.

Affiliated with the programme are firms such as ASC, VI-grade, Hexagon MSC, Danisi Engineering, Seat, Maserati, Alfa Romeo, Magneti Marelli, FCA, Abarth, Megaride, Michigan Scientific, Skydrive, Harp Racing, Pirelli, CD Adapco/Siemens, Thyssen Presta, ZF-TRW, Ycom, Brembo, Lamborghini, Continental, JAS Motorsport, Tatuus, Autotecnica Motori, Michelin, Oreste Berta, PCB, Kistler.

The current context of crisis in the automotive sector, also due to the pandemic in progress, can find a way to relaunch also thanks to the acquisition of highly trained human resources not only from a theoretical and methodological point of view but also on the most innovative design techniques and experimentation currently available and which constitute the main area of specialization of the Course.

The institutional location of the Course is at the Faculty of Engineering where the lectures and computer exercises are held. Seminars and meetings with companies are held at Palazzo Vistarino, headquarters of the Alma Mater Ticinensis Foundation.

In the past editions, Palazzo Vistarino has proved to be the ideal and truly unique venue for the Master's programme, as it has characteristics that cannot be found, all together, in other areas of the University. In particular:

- is a highly qualified location, with historical large rooms equipped according to the number of students
- allows an exclusive and continuous use of the spaces
- thanks to the guesthouse, it allows to offer a residential course, in which Italian and international students can dialogue with teachers and professionals in informal moments of meeting, in a process of continuous training and dialogue.

Art. 3 - Programme

The Master's course has a duration of **1 year** and provides a total of **1,500 hours**, divided according to the table below.

All the training activities provided correspond to the acquisition by the members of **60** university credits (CFU).

The teaching modules are organized as follows and will be taught in English:

Module	SSD	Language	L(h)	STD(h)	DAD(h)	EX(h)	Tot(h)	CFU
DESIGN OF THE VEHICLE DYNAMICS								
1) Total Vehicle Design	ING-IND/13 | MECCANICA APPLICATA ALLE MACCHINE	English	60	90	0	0	**150**	**6**
	Contents: • International Scenario and methodology process; • Total vehicle benchmark Analyses; • Methodology processes for total vehicle Design; • Aerodynamics for Dynamics performances improvement and fuel consumption control; • Integration between Aerodynamics and Style.							
2) Fundamental Driving Dynamics	ING-IND/13 | MECCANICA APPLICATA ALLE MACCHINE	English	40	60	0	0	**100**	**4**
	Contents: • The role of K&C Rig Testing with CAE models; • Chassis subsystem modeling for R&H; • Full vehicle virtual prototypes for Handling and Ride-Comfort; • Road loads data prediction; • Multi-attribute balancing; • Coordinating with Control system development; • Advanced experimental body modal contribution techniques; • Integrated Engineering development process; • Advanced driver assistance systems and autonomous driving.							
3) Virtual Dynamics Design and Simulation	ING-IND/13 | MECCANICA APPLICATA ALLE MACCHINE	English	8	60	0	32	**100**	**4**
	Contents: • Multibody analyses introduction; • Adams Car. Real-time analyses; • From real-time virtual Dynamics to Dynamic driving simulator.							
MATERIALS, PROPULSION AND CONTROL								
4a) Materials	ING-IND/21 | METALLURGIA	English	20	30	0	0	**50**	**2**
	Contents: • Materials for the Automotive sector; • Technologies, Processes; • Features.							
4b) Structural resistance	ICAR/08 | SCIENZA DELLE COSTRUZIONI	English	20	30	0	0	**50**	**2**
	Contents: • Methods of topological optimization for verifying the body and components.							

5a) Propulsion: ICE	ING-IND/08 | MACCHINE A FLUIDO	English	10	15	0	0	**25**	**1**
	Contents: • Internal combustion engines; • Principal characteristics and features; • Architecture. Consumption.							
5b) Propulsion: Hybrid, Electric	ING-IND/32 | CONVERTITORI, MACCHINE E AZIONAMENTI ELETTRICI	English	10	15	0	0	**25**	**1**
	Contents: • Electric Motors; • Generators; • Accumulation Systems; • Power supply; • Recharging; • Connection Systems; • Wiring; • Protocols; • Diagnostics.							
6) Vehicle Dynamic Control	ING-INF/04 | AUTOMATICA	English	10	15	0	0	**25**	**1**
	Contents: • Introduction to the main regulators; • Braking control systems, stability, traction, and vector control; • Classical problems; • Vehicle dynamic control; • Measurements, sensors and observers.							
VEHICLE TESTING AND PILOT/VEHICLE INTERACTION								
7) Total Vehicle Testing and Development	ING-IND/13 | MECCANICA APPLICATA ALLE MACCHINE	English	12	90	0	48	**150**	**6**
	Contents: • Total vehicle development process, experimental and CAE; • Standardized subjective and objective experimental tests to develop and evaluate Dynamic and Ride Comfort behaviour Driving course to learn Experimental Development Process: from test results to problem solving; • Methodology to recognize problems and to approach problem solving; • Failure Mode and Effect Analyses.							
8) Human/vehicle interaction	ING-IND/34 | BIOINGEGNERIA INDUSTRIALE	English	14	105	0	56	**175**	**7**
	Contents: • Methodology and tools for the evaluation of driver/vehicle interaction; • Comfort and features; • Integrated system of measurement and monitoring; • Driver physiology; • Psychophysical stress and physiological adaptation; • Environmental factors.							
						PARTIAL	**850**	**34**
Internship/Stage		English					**600**	**24**
Final exam							**50**	**2**
						TOTAL	**1500**	**60**
L Lectures; STD Study; DAD Online lessons; EX Exercises, practical activities.								

Lectures and seminars will be held by researchers from the University of Pavia, by researchers from other universities including University of Naples Federico II, University of Pisa, Politecnico di Milano, Sheffield Hallam University, University of Padova, Stanford University **and by experts from companies** such as FCA, Abarth, VI-Grade, Pirelli, Seat, CSI, MegaRide, Brembo, Danisi Engineering, Alfa Romeo, Maserati, CSI, Kistler, PCB.
There will be **technical visits** to the Balocco (FCA) experimental center, the *Driving Simulator Centre* of Danisi Engineering, the CSI center and the Pirelli laboratories. **Unique and very innovative seminars and workshop** will be offered:

1. **Theoretical and practical seminar on ADAS systems (Advanced Driver Assistance Systems) conducted by ASC technical staff**; during the two-day seminar, the main issues concerning the technical characteristics and the evaluation of the effectiveness and efficiency of the ADAS systems currently used on road vehicles will be addressed. The experimental seminar will be conducted with the exclusive "UFO" (UltraFlat Overunnable robot) instrumentation supplied to the ASC centre
2. **Experimental seminar on vehicle dynamics** designed in collaboration with FCA
3. **Seminar on experimental aerodynamics**
4. **Seminar on vehicle instrumentation** with a view to dynamics, *durability* and comfort.

Students attendance to the various training activities is structured as follows:

- internship activities, practical and laboratory exercises: compulsory attendance
- teaching activities: compulsory for at least 75% of the total number of hours.

The training period may not be suspended.

Transfers to similar Master's courses at other universities are not allowed.

Art. 4 - In-course assessment

Learning is assessed during the course, by the teachers who hold the lessons and exercises, carry out the seminars and practical tests and follow the work of the students. There is no specific mark for course examinations and the final exam.

Art. 5 - Final exam and achievement of qualification

The final exam will consist in the **presentation and discussion of a written thesis on the internship** carried out by the students.

The final exam does not result in a vote or judgment on merit.

At the end of the Course, participants who have carried out all the activities and fulfilled the obligations, upon passing the final exam will be awarded the **first-level Post-graduated Master's course Diploma in "Design and Development of Vehicle Dynamics".**

Art. 6 - Faculty

Teaching will be carried out by faculty from the University of Pavia and from other universities as well as by highly-qualified outside experts.

Art. 7 - Admission requirements

The Course's programme is aimed at students who possess a degree in accordance with DD.MM. (Ministerial decrees) 509/99 and 270/04:

- (L-9) Class of degrees in Industrial engineering
- (10) Classe delle lauree in ingegneria industriale

and degree in accordance with the previous regulations.

Withing the above degree classes, the following qualifications will be preferential:

- Mechanical engineering
- Electrical engineering
- Industrial engineering
- Nuclear engineering
- Aerospace engineering

- Materials engineering.

Moreover the following academic titles belonging to classes of degrees in accordance with DD.MM. 509/99 and 270/04, will be evaluated:

- Aerospace and Aeronautical engineering – 25/S, LM-20
- Automation engineering – 29/S, LM-25
- Electrical engineering – 31/S, LM-28
- Energy and nuclear engineering – 33/S, LM-30
- Mechanical engineering – 36/S, LM-33
- Material sciences and engineering – 61/S, LM-53.

The maximum number of enrolment is **14**.

The minimum number of participants to activate the course is **7**.

The Academic Board will also be able to assess whether the conditions for expanding the maximum number of participants are met.

If the number of applicants exceeds the maximum number called for, a Committee made up of the Coordinator and two members of the Master's Academic Board will determine a ranking based on merit (expressed in **hundredths**), which takes into account the following evaluation criteria:

1) Up to a maximum of 30 points for the graduation mark as follows:

- 10 points for a graduation mark < than 100/110
- 11-21 points for graduation marks from 100/110 to 110/110 (for a mark of 100 points, 11 points are awarded, and the score is increased by one point for every additional mark achieved)
- 30 points for marks of 110/110 "cum laude".

2) Up to a maximum of 70 points for an interview in Italian or English, whose aim is to evaluate the competencies, capacities and motivations of the candidate regarding the content and specific objectives of the Course's programme. Special recognition will be given for any work experience in the automotive sector – such as scientific publications related to the topic area of the Master's – and for knowledge of specific development software such as Matlab, Simulink, Adams, etc. The interview is considered passed with a score of **at least 42/70**.

In case of a tie in the rankings, the younger candidate will be given preference.
In the event of the resignation of one or more candidates, the available places will be made available again according to the ranking of merit, fino to exhaustion of the places themselves.

AUDITORS

For the admission of auditors the following criteria are required:

auditors, business partner employees or professionals, must have proven experience in the automotive industry and can participate in up to 5 modules.

Fees including € 32 (stamp duty tax) and € 142 (administrative fees), are as follows:

- Module 1 (60 hours, classroom) - € 3.500
- Module 2 (40 hours, classroom) - € 2.500
- Module 3 (40 hours, classroom) - € 2.500
- Module 7 (60 hours: ASC driving course + ASC Vairano track activity) - € 7.174
- Module 8 (70 hours, classroom and experimental) - € 4.000.

The activities of module 7 take place exclusively on the ASC slope in Vairano.

Art. 8 - Deadline for admission application

Applicants must submit their application for admission in accordance with the procedures, set out in the Call for Admission, **from 28 of April 2023 and by the deadline of 29 of September 2023**.
The requirements of the Call fo admission and this Attachment, must be held by the deadline for application.

Art. 9 - Attachments to the online application

Candidates must attach, during the online application procedure to the Course, the scan of the following documentation:

1) **application form** (the form is at the end of this Attachment)
2) (front-rear) **personal identification document i**nserted during registration
3) **reference letter**
4) **motivational letter**
5) **curriculum vitae** listing also professional experiences in working environments pertaining the above Master, if any.

Only for whom have an Italian academic title:

6) **self-declaration** of the passed exams during the academic career reading relevant marks

Only for whom achieved a foreign academic title:

6) **academic qualification** required for admission in **Italian or English**
7) "**Declaration of value**" issued by the Italian Embassy/Consulate in the State where the academic title had been released (only if already available)

***As an alternative** to the "Declaration of value on site", the University recognizes the following documents as valid:*

- ***Diploma supplement** (if the admission qualification to the Master is issued by a European University)*
- ***Certificate of comparability** issued by Naric/Cimea*

8) **degree certificate in Italian or English** with the taken exams and the relative marks (**transcript of records**).

Please note that as indicated in art. 3 of the Call for Admission, **applicants holding a qualification obtained abroad must**, **by the deadline for enrolment or, at least, by the deadline of 11 of January 2024**, deliver the above mentioned documentation in original to Servizio Post Laurea - Ufficio Master (via Ferrata, 5 - 27100 Pavia).

Art. 10 - University tuition and fees

Enrolment

Those enrolled in the Course must pay the sum of **€ 15.000** inclusive of: € 16 (stamp duty tax) and € 142(administrative fees) for the 2023/2024 academic year.

This amount must be paid in **2 instalments:**

- 1° instalment of € **10.000** to be paid **upon enrolment**
- 2° instalment of € **5.000** to be paid **by 11 of January 2024.**

Bodies or national or international subjects can contribute to the functioning of the Master's course by providing scholarships aimed to enrollment/internships attendance. In the event of finalization of these agreements, they will be advertised on the website of the Master's course with the eventual award criteria.

Final exam

To be admitted to the final exam, candidates must submit a specific application form along with the payment of € 116 as a fee for the issuance of the Master's course Diploma (including n° 2 stamp duty tax paid virtually: one for the parchment and one for the application).

Art. 11 - Web site and Organizational Secretary

Any communication to candidates will be published on the following website:
http://vehicledynamics.unipv.it

For information on the organization of the course:

Organizational Secretary

The Organizational Secretary will be located at:

Dipartimento di Ingegneria Industriale e dell'Informazione

Via A. Ferrata, 5 - 27100 Pavia (PV)

E: info.vehicledyn@unipv.it

T: 0382.6992201

The referral persons are: Prof. Carlo E. Rottenbacher - Sig.ra Laura Pecoraro.

UNIVERSITÀ DI PAVIA | Servizio Post laurea

APPLICATION FORM

to I level POST-GRADUATED MASTER'S COURSE: DESIGN AND DEVELOPMENT OF VEHICLE DYNAMICS

(this form, duly filled in, must be uploaded in the on-line procedure of admission to the Post-graduated Master's course as per issue n°9 of the annex to the relevant call for admissions)

The undersigned (FORENAME, SURNAME) ……

Date of birth …… City …… State ……

State of residence …… Permanent address ……

E-mail ……

APPLIES

for admission to the aforementioned Post-graduated Master's course

and **ATTACHES**

to the formal admission form, the following papers **to be submitted mandatorily for the application evaluation**:

1) front-back of the personal ID document/passport uploaded during the on-line registration procedure

2) reference letter

3) motivational letter

4) CV listing also professional experiences in working environments pertaining the above Master, if any

Only for whom have an Italian academic title:

5) self-declaration of the passed exams during the academic career reading relevant marks

Only for whom achieved a foreign academic title:

5) Academic qualification required for admission in Italian or English

6) "Declaration of value" issued by the Italian Embassy/Consulate in the State where the academic title had been released (only if already available)
   As an alternative to the "Declaration of value on site", the University recognizes the following documents as valid:
   - *Diploma supplement (if the admission qualification to the Master is issued by a European University)*
   - *Certificate of comparability issued by Naric / Cimea*

7) Degree certificate in Italian or English with the taken exams and the relative marks (**transcript of records**).

Date …… Signature ……