



Faculty of Civil and Industrial Engineering
CALL FOR PARTICIPATION - ACADEMIC YEAR 2015/2016

MASTER COURSE OF SECOND LEVEL
In
“Space Transportation Systems: launchers and re-entry vehicles”

Director: Prof. Marcello Onofri

Course Code: 29033

The Rector Decrees the activation, in the Academic Year 2016/2017, of the International Master Course of Second Level in “**Space Transportation Systems: launchers and re-entry vehicles**”, here and in the following denoted as **Master STS**, at the faculty of Civil and Industrial Engineering of the University of Rome “La Sapienza”, in collaboration with the European Space Companies and Agencies.

1. Goals

The main goal of Master STS is the formation by training of highly qualified system engineers, capable to take managerial roles and/or to perform research tasks and technological development in the design, production, and marketing of space launchers and spacecraft. Master STS is also designed and organized in order to harmonize the hiring of new system engineers in industries and European and Italian Space Agencies.

2. Organization and educational activities.

The lectures will be held in English language. The time dedicated to the training activity amount to 1,500 hours of overall workload, with 450 hours dedicated to lectures and 100 hours dedicated to the making of a thesis. The remaining hours will be employed for the following educational activities: internships with Space Companies, Space Industries, European or Italian Research Institutes and Space Agencies; visits to Space Companies and Research Centers; workshops.

The Master’s didactic activities are organized on the basis of weekly Units, which address the main topics in Space Transportation Systems. The following table details the number European Credit Transfer System (ECTS) credits associated with each didactical Unit:

EDUCATIONAL ACTIVITIES	ECTS - CFU
FRONTAL LECTURE	
Module 1 Introduction <u>Contents:</u> Planning of the Lectures, modality of attendance; description of the Master Course and courseworks explanation	1
Module 2 Overview of Launcher Systems <u>Contents:</u> Introduction to Space Transportation Systems (STS); Expendable and reusable launch vehicles, Expendable launcher system and sub-systems; Launcher Elements of the Ariane 5 Family; ESA and ASI Programs in Space Transportation Systems	2
Module 3 Space Program Management & Quality Certification <u>Contents:</u> Programs in Space Transportation Systems; Cost Management of space programs;	3



Organization and management of a system team for launcher development; Space for Security & Defense; Dual Use Programs, COSMO-SkyMed	
Module 4 Mission Analysis <u>Contents:</u> Staging design principles; Trajectory's phases: vertical ascent; pitch-over; gravity turn; coasting; staging; launch base constraints; Launch trajectory optimization; Orbit sensitivity to injection parameters; Software for Launcher/Mission Design; Preliminary mission design; Preliminary design for air-breathing launchers	3
Module 5 Combustion Modeling <u>Contents:</u> Thermochemistry, Kinetics, Flames,; Physics of injection and mixing; Turbulent Combustion Modeling; Introduction to Liquid Propulsion Systems; Liquid Propellants Classification; Combustion Chamber Configurations; Pre-burners; Combustion instability; Measurement Techniques in Thrust Chamber	3
Module 6 Liquid Rocket Engine (LRE) Thrust Chamber <u>Contents:</u> LRE Cycles; Operating envelopes and transients; Engine mechanical design; LRE System Analysis and trade-off criteria; LRE Thrust chamber; Ignition and Ignition Devices; Advanced Combustion Chambers; Thrust Chamber Life; LRE Thrust chamber cooling systems and LRE development testing activities	3
Module 7 Pump-fed Systems <u>Contents:</u> Architectures & typologies; Components design of pumps & turbines; Pump-fed cycle analysis; Cavitation in cryogenic pumps; TP's auxiliary subsystems	3
Module 8 Rocket Nozzles <u>Contents:</u> Design of classical LRE Nozzles, loads, contouring methods, cooling, mechanical design, flow separation and side-loads; Advanced LRE Nozzle Concepts; Dual bell nozzles: results of recent numerical and theoretical studies on the characteristics of dual bell nozzles.	3
Module 9 Aero-thermo-dynamics of launchers and re-entry vehicles <u>Contents:</u> Shock-Shock interferences and Shock-Wave/Boundary Layer Basic Interactions; Experimental and physical aspects of basic aerothermodynamics for launchers and rocket nozzles; Modelling Re-entry Aerothermodynamic Phenomena; Aerothermodynamics of nozzle and after bodies for launchers; Aerodynamic derivatives of the launcher; Launcher Base Drag; The European Project of the Experimental Vehicle IXV; CFD methods for high speed flows	3
Module 10 Solid Rocket Motors <u>Contents:</u> Solid Rocket Motor Internal Ballistic; Solid Rocket Motor Ignition Transient; Pressure and Thrust Oscillations in Solid Rocket Motors; SRM Static Firing Tests and Flights Performance Analysis	3
Module 11 Launcher design <u>Contents:</u> System loop procedure for feasibility study; Design of propulsion systems: lower stage, upper stage, attitude; control systems; stage separation problems; solid propulsion stage design with TVC	3
Module 12 ECOSimpro/ESPSS Library <u>Contents:</u> ECOSimpro/ESPSS Library; overview of the EcosimPro platform and ESPSS transient libraries	3
Module 13 Guidance, Navigation, Control and Avionic Systems <u>Contents:</u> Applied guidance for launchers; Lyapunov control techniques; Launchers navigation principles; Launchers guidance and control principles; Applied TVC control; Data fusion for hybrid navigation; GNC validations and qualification	3
Modulo 14 Structures <u>Contents:</u> Launch vehicle structural dynamics; Coupled load analysis; Seismic excitation in the launch phase on payload: modal coupling and participation, effective modal masses. Techniques for reduced-order models in structural dynamics: static and dynamic condensation; Random Vibrations; Experimental structural dynamics.	3



Modulo 15 Ground segment	3
<u>Contents:</u> Launcher Ground Segment: Vega and Soyuz Mobile Gantry overview; Principles of Launch range design; Ground network support: requirements and operations-- Ground telemetry and tracking systems: Antenna parameters, ACU operational modes, Autotracking, Receivers, Telemetry data transfer; Space Link; Link Budget; Pre-launch Operations and Testing; Lunch Ground Support; Ground Stations	
ANOTHER ACTIVITIES	
Internship at european space agencies and enterprises	10
Keynote Lecture with international manager	4
Training abroad	1
FINAL THESIS	3
TOTAL	60

Examination tests will be held at the end of one or more units to assess the learning progresses attained by the students.

Attendance to all Units provides 60 ECTS credits.

Didactical activities will take place:

- **Standard lectures** (from December 12 until December 22, 2016; and from January 9 to April 28, 2017) will be held in Rome at Palazzo Baleani, Corso Vittorio Emanuele II, 244, room 4, and at the Faculty of Civil and Industrial Engineering, Via Eudossiana, 18.
- **Advanced lectures** (from May to June) will be held at European industries, research centers, and space agencies. (At CIRA in Capua, DLR in Lampoldshausen, CNES-ONERA-SNECMA in Paris, ESA ESTEC in Noordwijk, ISAE-ONERA in Toulouse, VKI in Bruxelles).

The **internships** (from June/July to December) will take place at the following entities:

- a) Italian Companies (Aerosekur, AVIO, Carlo Gavazzi Space, ELV, Thales Alenia Space, Vitrociset,...);
- b) European companies and Research Institutes (CNES, Airbus, ...)

The lectures will start 12th of December and will end in April.

Attending the educational activities is mandatory; the daily signature of each student certifies attendance. Absences for more than 15% of the total number of hours prevent the award of the Master Course Degree. In case of no-attendance, poor profit, or improper conduct, the Scientific and Teaching Committee Board may suspend or exclude the participant. In these events, the paid fees are not refunded.

3. Duration of the course and number of available places.

The Master course duration is one year. The course has a limited number of positions available. The maximum number of positions open for this academic year is 20, while the minimum number of admitted students required to activate the course is 10.

4. Requirements for admission

Any holder of a **University Master Degree** included in the following list of classes of degree can apply for the admission to the Master STS:

DENOMINATION OF CLASS OF DEGREE	CODE OF CLASS OF DEGREE
Aerospace and Aeronautic Engineering	(25/S e LM-20)
Mechanical Engineering	(36/S e LM-33)



Robotic Engineering	(29/S e LM-25)
Telecommunication Engineering	(30/S e LM-27)
Electric Engineering	(31/S e LM-28)
Electronic Engineering	(32/S e LM-29)
Computer Science Engineering	(35/S e LM-32)
Energy and Nuclear Engineering	(33 / S and LM - 30)
Biomedical Engineering	(26 / S and LM - 21)
Chemical Engineering	(27 / S and LM - 22)
Civil Engineering	(28 / S and LM - 23)
Engineering Management	(34 / S and LM - 31)
Marine Engineering	(37 / S and LM - 34)
Engineering for the environment and the territory	(38 / S and LM - 35)

Holders of any equivalent degree obtained from pre-existing university curricula in the above list of classes of degree can also apply for the admission to the Master STS.

Note that: a Bachelor degree is not considered eligible for applying to the Master STS.

4.1- Admission of foreign students

Students holding degrees conferred by foreign Universities can also apply for the admission to the Master STS if their degree:

- is deemed culturally coherent with the Master STS goals after a preliminary exam of the Scientific and Teaching Committee Board of the Master STS, and / or,
- is included in existing agreements for inter-university cooperation and mobility.

Foreign students can apply for the admission only if the conferment date of their Degree is antecedent the deadline of the application for selection. It is also mandatory to include with the application a "Declaration of Value" ¹of their Degree, and the translation of all their diplomas.

4.1.1 - Admission of EU citizens, Italian citizens in possession of qualifications obtained abroad, and non-EU citizens legally staying in Italy

EU citizens, wherever resident, Italian citizens in possession of qualifications obtained abroad, and non-EU citizens legally staying in Italy, must apply for the admission directly to the University of Rome "La Sapienza"; they need to include their own graduation document with the application form, together with its Italian translation, and the **Declaration of Value** of their Degree, conferred by an Italian diplomatic representative in the Country where the degree was issued.

The declaration of value is required at the time of application, on penalty of disqualification

4.1.2 – Admission of non-EU citizens resident abroad.

Non-EU citizens resident abroad can apply for the admission exclusively by sending an application to the Italian diplomatic office in their Country, which will arrange for the submission to Sapienza University. The application should comply with all the requirements described here above.

¹ **NB:** The Declaration on Value is an official copy the Diploma, duly translate in Italian by a an official translator. The list of these translators is usually available at the Italian Consulate in foreign country. Then the translate diplomas must be sent (via regular mail) to the "Academic Qualification Office", (Ufficio titoli di studio) of the Italian General Consulate in the country of the foreign students that want apply for this call.



5. Incompatibility.

The simultaneous enrollment at other courses of study is forbidden, including courses of different level, at Italian or foreign Universities, or coequal Institutes. Training courses or High Education Courses are compatible.

6. Submission rules for the selection procedure

All candidates must comply with the steps indicated here below to be admitted to the selection procedure to the Master STS:

- i. Registration;
- ii. Payment of the "admission test fee" and of the "stamp duty"
- iii. Submission of application for admission

For the enrollment at the selection please follow the indications that you can find there:

The envelope including the application form and all the relevant enclosures, must

- i. be sent by certified mail (with acknowledgement of receipt) and **received not later than November 24, 2016** at the following address:

Director of the Master STS, Prof. Marcello ONOFRI
Department of Mechanical Engineering and Aerospace (DIMA), Via Eudossiana 18, 00184
Rome, Italy

- ii. and via e-mail to mastersts@uniroma1.it

Non-Italian applicants can get help to finalize the procedure by sending an e-mail request to this Master STS address: mastersts@uniroma1.it, or by calling this phone number: +39644585882, Monday through Friday, from 10:00 am to 18:00pm.

7. Selection timing and criteria

Admission to the Master Course is done after a preliminary scrutiny of Sapienza University aimed at verifying the compatibility of the University/College Degree with the Master Course, as indicated in Art 4.

Participation at the Master is not allowed to candidates without a university degree level equivalent to the level of Master; for Candidates with qualifications obtained abroad, **the degree must be declared as equivalent through the "Declaration of Value" for the sole purpose of enrollment to the Master.**

The admission requirements must be held at the time of the application deadline and the Declaration of Value of previous qualifications abroad must, by law, be enclosed with the application.

The selection procedure is scheduled for the 30th November 2016 at the Department of Aerospace and Mechanical Engineering in the "Auletta del Chiostro" from 9am until 16pm.

The selection day includes an written test and/or interview aimed at assessing the level of scientific knowledge, attitudes and motivations of the candidates in the field of Space Transportation Systems, as well as on the verification of their level of proficiency in English.

The Teaching and Scientific Committee Board will grade each interviewed candidate, and will rank the candidates in descending order by the overall grade attributed to each applicant. This ranking will be published and / or posted on December 2, 2016, at the Department of Aerospace and Mechanical



Engineering, and will also be published on the website www.stsmastercourse.eu. The publication has the value of an official communication; therefore, no personal communication will be sent to the candidates.

8. How to enroll for the Master

Only the candidates who successfully passed the selection procedure can proceed to the enrollment to the course. For the enrolment procedure, please contact the Secretary at mastersts@uniroma1.it.

9. Loans and / or scholarships

Any special funding made available to the Master STS from the Financial Bodies will be used to cover in full or in part the registration fee for the Master of a number of student chosen in accordance with the ranking obtained during the selection procedure (the best students will be considered first). The companies Avio-Group, Aerosekur, Avio-Aero, Carlo Gavazzi Space SpA, ELV; Thales Alenia Space and Vitrociset have made available a number of scholarships, which will be used to cover an equal number of tuition fees. Additional scholarships will also be available so as to cover about 40% of the registration fee.

10. Waiver

Candidates admitted to the Master who wish to renounce their participation, must send a written communication to the Director of the Master. Any registration fee already paid will not be refund.

11. Award of the title of the graduation of the master

At the end of the course, there will be a final exam for graduation. The final examination consists of an oral presentation of the project worked out during the stage.

To be eligible for the final exam, the student must

- a) have attended the Master,
- b) having acquired the necessary number of academic credits (CFUs), including credits corresponding to the various training activities carried out,
- c) be compliant with the payment of the Registration and fee for the final exam,
- d) having completed the questionnaire and have sent the AlmaLaurea receipt to the secretary of the Master teaching.

The final work will be presented and discussed with the examination board of the Master, which will state the final grade in parts of 110; the board can award the "cum laude" honors. The minimum grade to pass the final test is 66/110 (sixty-six / one hundred tenths).

The Master's degree is awarded by the University of Rome "La Sapienza", only after verification of the regularity of the position of the student.

The document of Master Course Diploma will be delivered by Director of the Master; it does not report the final grade awarded to the student, it only states that the student has been awarded the Diploma, and if applicable that he received the "cum laude" honors.

13 - Information

Teachers Reference:

Prof. Marcello Onofri – Director
Prof. Mauro Valorani – Coordinator

Secretary:

Dr. ssa Linda Manzone



Address:

Department of Aerospace and Mechanical Engineering, Via Eudossiana, n.18 - 00184 Rome

Phone number: +39 06 44585882

Fax: +39 06 44585246

E-mail: mastersts@uniroma1.it

Web Site: www.stsmastercourse.eu



Annex 1

CALL FOR PARTICIPATION
to the Master of SECOND Level in
"Space Transportation Systems: launchers and re-entry vehicles"
Academic Year 2016/2017

To: Director of the Master STS
Prof. Marcello Onofri – DIMA
AREA PROPULSIONE
Via Eudossiana 18
00184, ROME, ITALY

I undersigned _____

Registration Code Number _____

Tax code _____

Born _____ On _____ Nationality _____

Resident at _____

Street _____ Zip Code _____

Phone number ____ / _____ Fax ____ / _____

mobile _____ / _____

e-mail _____

Hold the following University

degree: _____

obtained on date _____ at the University / Institute _____ with the following
grade _____

request to be admitted

to the Master of SECOND Level in "Space Transportation Systems. launchers and re-entry vehicles"
established at the **Faculty of Civil and Industrial Engineering**, University of Rome "La Sapienza", in
the academic year 2016/2017.

To this end, I enclose to this form the following documentation:

- Copy of a valid identification document, duly signed and clear to read (e.g., Driving License, Passport);
- Copy of the Tax Code;
- Copy of the receipt of payment of the fee for admission test;
- Copy of the university degree certificate including the grades of each exam;
- Copy of "Declaration of Value" (for those who obtained a university degree abroad);
- Curriculum Vitae et Studiorum;
- Declaration of consent for handling personal data (Annex 2);
- Any further qualifications for the purposes of the score of merit.

I undersigned declares:

1. to have read and approved in full the Call for Participation to the Master,
2. to be in possession of all the requirements set here, and
3. be aware that, under the law D.Lgs. N.445/2000, the act of giving incomplete or false information is a criminal offense.

Handwritten signature of the applicant



Annex 2

Declaration of consent for handling personal data

(pursuant to D.Lgs.N. 196/2003)

According to D.Lgs.N. 196/2003, I take notice that the admission to the Master of SECOND Level in "Space Transportation Systems: launchers and re-entry vehicles" requires both (i) the handling of personal data by the University of Rome "La Sapienza", and (ii) their possible transmission to other institutions either public or private, both in Italy and abroad. I also take notice that the University of Rome "La Sapienza" will use my personal data for aims solely related to the purpose for which they were provided, and in any instance, under the full compliance with the current legislation on personal data protection. Therefore, I hereby declare that:

1) being aware that the University is not allowed to process my admission request to the Master of SECOND Level in "Space Transportation Systems" without my consent for the handling of my personal data

I consent

I do not consent

2) As for the handling of my personal data to inform and promote cultural initiatives of the University, or of third parties, by means of announcements distributed to all participants:

I consent

I do not consent

3) As for the handling of my personal data by the University or others, in view of market research or customer satisfaction survey of the participants on the quality of the services rendered and the activities brought forth by the University:

I consent

I do not consent

Signature
