D.R. n. 2244

Faculty of Civil and Industrial Engineering

CALL FOR PARTICIPATION – ACADEMIC YEAR 2017/2018

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 2017/2018, 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 training of highly qualified system engineers, capable to take on 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 to promote and coordinate the employment of new system engineers in industries and European and Italian Space Agencies.

2. Organization and educational activities

All lectures will be held in English language.
The **overall workload** dedicated to **training activities** amounts to 1,500 hours, with 300 hours dedicated to lectures and 75 hours to the writing of a thesis.
The remaining hours will be dedicated to the following educational activities: internships in Space Companies, Space Industries, European or Italian Research Institutes and Space Agencies; visits to Space Companies and Research Centers; workshops.

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

ACADEMIC ACTIVITIES	**ECTS - CFU**
FRONTAL LECTURE	
Unit 1 Introduction Contents: Lecture Timetable, attendance requirements; description of the Master Course and coursework introduction	1
Unit 2 Overview of Launcher Systems Contents: 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

Unit 3 Space Program Management & Quality Certification Contents: Programs in Space Transportation Systems; Cost Management of space programs; Organization and management of a system team for launcher development; Space for Security & Defense; Dual Use Programs, COSMO-SkyMed	3
Unit 4 Mission Analysis Contents: Staging design principles; Trajectory 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
Unit 5 Combustion Modeling Contents: 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
Unit 6 Liquid Rocket Engine (LRE) Thrust Chamber Contents: LRE Cycles; Operating envelops 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
Unit 7 Pump-fed Systems Contents: System architectures & types; Components design of pumps & turbines; Pump-fed cycle analysis; Cavitation in cryogenic pumps; TP's auxiliary subsystems	3
Unit 8 Rocket Nozzles Contents: 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
Unit 9 Aero-thermo-dynamics of launchers and re-entry vehicles Contents: 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
Unit 10 Solid Rocket Motors Contents: 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
Unit 11 Launcher design Contents: 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
Unit 12 ECOSimpro/ESPSS Library Contents: ECOSimpro/ESPSS LIbrary; overview of the EcosimPro platform and ESPSS transient libraries	3
Unit 13 Guidance, Navigation, Control and Avionic Systems Contents: 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

Unit 14 Structures Contents: 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
Unit 15 Ground segment Contents: 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	3
OTHER ACTIVITIES	
Internship program at European space agencies or companies	10
Keynote Lecture	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 knowledge level and proficiency of the students.
Attendance to all Units provides 60 ECTS credits.

Academic activities will take place in the following venues:

- **Standard lectures** (from December 11 until December 22, 2017; and from January 8 to April 30, 2018) 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 2018) 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 at Redu in Belgium, ISAE-ONERA in Toulouse, VKI in Bruxelles).

The **internships** (June/July through December 2018) will take place at the following companies/institutions:

a) Italian Companies (Arescosmo, AVIO, OHB Italia, ELV, Thales Alenia Space, Vitrociset, …);
b) European companies and Research Institutes (CNES, AIRBUS, …)

The Master's organization, by virtue of agreements between Rome residences and the University, can provide accommodation for the students. For all interested students, Master STS will pay an economic contribution covering part of the cost of the stay.
Such contribution will be as follows:

- A maximum of € 600,00 for Italian students;
- A maximum of € 1,200.00, for foreign students.

The contribution will be paid in a single transfer for all students enrolled and will be paid directly to the Residence. Contributions paid to students refer to shares for the entire stay in a single or double room, depending on the availability of the selected accommodation agencies.
Charges, overheads, meals and transport remain the responsibility of the student, as well as the balance of the agreed cost with the residence.

Academic activities (frontal teaching) are planned to begin no later than 11 December 2017 and their conclusion is scheduled for 30 April 2018. The deadline for other training activities is scheduled for December 2018.

At the end of the frontal teaching phase, the most deserving students will be engaged in **experimental and theoretical training courses** that will be hosted by European Research Centers.
For all those teaching activities that will take place outside the Master STS headquarters, in Europe or in Italy (excluding Rome and the province), travel and overnight accommodation will be covered by the organization of the Master. Students eligible for such benefits will be chosen based on their academic performance. The costs of urban transport, food and accommodation and all other costs will be covered by the students.
For all students who will not take part in the training period, replacement activities will be provided, including the involvement in the ASTRI international program.

The daily attendance of the Master course is mandatory and must be certified by the signatures of the students; an absence rate over 20% will compromise the achievement of the title. Specifically, an absence rate greater than 10% on lectures and greater than 10% for other training activities will result in the impossibility of achieving the Master's degree and the suspension of the internship.

In the event of non-attendance, low profit, failure to reach the minimum level in the mid-term test and / or non-achievement of the minimum training objectives set by the teachers or behaviors that are censurable or likely to compromise the quality of the lessons and study visits, the Master's Academic Council may decide to suspend or exclude the participant. In such cases, the registration fees will not be refunded.

As far as the internships are concerned, the locations where they will take place will be communicated directly to the students in due time.

A limited number of scholarships will be funded by the Italian Space Agency for total and / or partial participation in the Master STS training course. These full and / or partial Master STS scholarships will be granted by ASI under the Asi Malindi-Dima Agreement, and will be directed exclusively to Kenyan students selected to attend the Master STS training course.

An extremely limited number of participants of the Master STS could be assigned to an “ad hoc” study program related to the international ASTRI program, that has recently started in the Department of Mechanical and Aerospace Engineering.

3. Duration of the course and number of available positions

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 can apply for the admission to the Master STS:

DENOMINATION OF CLASS OF DEGREE	CODE OF CLASS OF DEGREE
Aerospace and Aeronautical 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)
Energy and Nuclear Engineering	(33/S e LM-30)

Computer Science Engineering	(35/S e LM-32)
Civil Engineering	(28/S e LM-23)

Holders of any equivalent degree obtained from pre-existing university curricula in the above list 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

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

a) 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,

b) 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 for foreign students to include with the application a "Declaration of Value"[1] of 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.

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:

[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.

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 no later than November 24,** 2017 at the following address:

Director of the Master STS, Prof. Marcello Onofri
Department of Mechanical and Aerospace Engineering (DIMA), Via Eudossiana 18, 00184 Rome, Italy
ii. and via e-mail to mastersts@uniroma1.it

Non-Italian applicants can get support 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 1st December 2017 at the Department of Mechanical and Aerospace Engineering in the "Sala del Consiglio della Presidenza" from 9am until 16pm.
The selection day includes a written test and/or an 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 7, 2017, at the Department of Mechanical and Aerospace Engineering.

8. How to enroll for the Master

Only the candidates who have successfully passed the selection procedure can proceed to the enrollment to the course. For the enrollment 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 students chosen in accordance with the ranking obtained during the selection procedure (the best students will be considered first). The companies Avio-Group, Arescosmo, Avio-Aero, OHB Italia SpA, ELV, Thales Alenia Space and Vitrociset have made available a number of scolarships, 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 to their participation, must send a written communication to the Director of the Master. Any registration fee already paid will not be refunded.

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 students 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.

12. Information

Teachers Reference:

Prof. Marcello Onofri – Director
Prof. Daniele Bianchi – Coordinator

Secretary:

Master STS Secretariat:
Address: Department of Mechanical and Aerospace Engineering, Via Eudossiana, n.18 - 00184 Rome
Phone number: +39 06 44585882
E-mail: mastersts@uniroma1.it
Web Site: www.stsmastercourse.eu

Annex 1

OBJECT: **CALL FOR PARTICIPATION**
to the Master of SECOND Level in

"Space Transportation Systems: launchers and re-entry vehicles"

Academic Year 2017/2018

To Director of the Master STS
Prof. Marcello Onofri
University of Rome "La Sapienza"
DIMA AREA PROPULSIONE
Via Eudossiana, n. 18
Cap 00184, ROMA (RM)

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 2017/2018.

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.

Place and e date_____ Handwritten signature of the applicant_____

Annex 2

AUTHENTIC CERTIFICATION ACCADEMIC TITLE

To Director of the Master STS
Prof. Marcello Onofri
University of Rome "La Sapienza"
DIMA AREA PROPULSIONE
Via Eudossiana, n. 18
Cap 00184, ROME (RM)

The undersigned _____ born _____ on_____,

in accordance with Articles 46 and 47 of D.P.R. n. 445/2000 and subsequent amendments, aware of the penal sanctions provided for by art. 76 of the same D.P.R., for the hypothesis of falsehood in acts and misrepresentation given therein,

DECLARES
Having obtained the degree (specify whether three-year, master's / specialist or old-fashioned) _____ in (denomination) _____
on date _____ (a.a. xxxx / yyyy) at the Faculty of _____ _____ with the following vote _____ and submitting the thesis from the following title "_____" Rapporteur _____.
(in case of graduate)
which is expected to complete the degree (specify whether a three-year, a master's degree or a specialization course) _____in (denomination) _____ on date _____ (aa xxxx / yyyy) at the Faculty of _____ of the University _____ and submitting the thesis from the following title "_____ "- Rapporteur _____.
In both cases, the master's qualification must be obtained no later than the last useful session of the aa. 2016/2017.

For certificates obtained abroad, this self-certification is replaced by the Diploma Supplement or Declaration of Value.

Place and e date_____ Handwritten signature of the applicant_____

Annex 3

Information pursuant to Legislative Decree 196/2003 - Personal Data Code

Purpose of treatment
Pursuant to Article 13 of Legislative Decree no. n.196 / 2003 the data you provide will be dealt with in the indispensable measure and for the purposes associated with the enrollment and attendance of the Master.

Treatment mode and subjects concerned
The treatment will be carried out both manual and computerized.
Data may be communicated to institutions or public and private bodies if it is strictly necessary for the purpose of carrying out the teaching activities of the course.

The nature of the data transfer and the consequence of a possible refusal
The provision of data is compulsory, and any refusal to provide such data implies the inability to enroll in the course and the management of related procedural activities, as well as didactic activities.

Owner and responsible for data processing
The data controller is the University of Rome in the person of his legal representative, the Magnificent Rector, who is domiciled for office at the university.
Responsible for data processing is the Director of the Training / Higher Education / Master course.

Rights under art. 7 of Legislative Decree 196/2003 Right of access to personal data and other rights
The person concerned has the right to obtain confirmation of the existence or not of personal data concerning him, even if they are not yet registered, and their communication in an intelligible form.

The person concerned has the right to obtain the indication:
(a) the origin of the personal data;
b) the purposes and methods of processing;
c) the logic applied when processing by means of electronic instruments;
d) the identification details of the holder, the persons responsible and the designated representative within the meaning of Article 5, paragraph 2;
(e) the subjects or categories of persons to whom the personal data may be disclosed or who may become aware of them as designated representatives in the territory of the State, of persons in charge or in charge.
The person concerned has the right to obtain:
(a) updating, rectification or, where relevant, integration of data;
b) cancellation, transformation into anonymous form or blocking of data processed in violation of law, including those that are not necessary for storage in relation to the purposes for which the data was collected or subsequently processed;
(c) the attestation that the transactions referred to in points (a) and (b) have been made known, including their content, to those to whom the data have been communicated or disseminated, except where such fulfillment is reveals it impossible or involves the use of means manifestly disproportionate to the protected right.
The person concerned has the right to oppose, in whole or in part:
(a) for legitimate reasons for the processing of personal data concerning him, even though relevant to the purpose of the collection;
b) the processing of personal data concerning him for the purpose of sending advertising material or direct sales or for the purpose of market research or commercial communication.

Place and e date_____ Handwritten signature of the applicant_____