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Space Exploration and Development Systems

V Edition 2009/2010



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The International Post Graduate Master Course (Italian: *Master Universitario di II livello*) in "**Space Exploration and Development Systems**" (5th edition 2009-2010) has been established by Politecnico di Torino (Italy) in collaboration with ISAE/Supaero Toulouse (France) and is managed in Torino by COREP. COREP – Consortium for the Research and Permanent Education – is a no-profit consortium created in 1987 on the initiative of the three Piedmont Universities – Polytechnic of Turin, University of Eastern Piedmont "A. Avogadro" – local bodies and important Italian industries and associations. One of the main goals of COREP is to provide high qualifying training services to young graduates in order to facilitate their entrance in the labour market, promoting the cooperation between universities and socio-economic actors. As a garanty of reliability and professionalism, some COREP's branches are certified for education and training activities by Regione Piemonte.

The Master is sponsored or endorsed by:

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In partnership with:





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Prof. Gianfranco Chiocchia, Department of Aerospace Engineering, Politecnico di Torino

Educational Project Manager:

Prof. Ernesto Vallerani, Former President of Alenia Spazio and Former Vice Chairman of the International Academy of Astronautics (IAA)

Chief Project Work Tutor:

Mr. Enrico Beruto, former System Engineer Manager, Alcatel Alenia Space

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1. WHY THIS MASTER?

Thanks to its innovative programme, SEEDS aims to meet the request emerging from the European Space Industry of a new generation of high level specialists, whose main characteristics are to be educated in an international environment and to have gathered an experience in working on advanced projects in some of the most renowned Space Centres, Agencies and Companies of the European Union.

To fulfil these objectives, SEEDS was originated by the collaboration of three European universities, namely an Italian (Politecnico di Torino), a French one (Supaero Toulouse, now ISAE) and a German one (Bremen Universität), all located in towns whose common feature is that of hosting industries and research centres linked to one another by a long-standing tradition of co-operation in space.

The main object of SEEDS is the exploration of the space and the development of the related systems. It deliberately differs from the utilization of the space, which forms the object of other existing master courses (most of them on national bases). Selecting the **space exploration** as its principal theme, SEEDS aims to harness the most recent development lines emerging in the space strategies of both the European Union and the USA and, according to these strategies, to prepare the specialists who will be required in the near future.

2. JOB OPPORTUNITIES

Being focused on the Engineering of the Space Systems for Exploration and Development, the SEEDS Master Course is perfectly phased with the National, European and International projects on Exploration such as the ESA Aurora Programme and the NASA Constellation Programme (see <u>www.esa.int</u> and <u>www.nasa.gov</u>).

SEEDS looks at the major European Space Agencies and Companies involved in Exploration projects, such as the European Space Agency (ESA), the Italian, German and French Space Agencies (ASI, DLR and CNES), the ASTRIUM, Thales Alenia Space, OHB System Companies and other establishments. These organizations are strongly interested to the SEEDS Master initiative since its main focus lies on the training of engineering resources oriented to the specific Exploration system products, prepared to work in an international context and trained *on the job* by using modern and company oriented engineering methodologies.

It is expected that the students successfully completing the SEEDS courses and associated Project Works will be employed by the partner organizations at the proper level in their Engineering Teams working on the Space Exploration projects. The employment rates of the graduates from the three first SEEDS editions (the only ones concluded at present, the fourth being still running) fully confirm these expectations: **33 out of the 35 graduates from the 2005/06 edition to the 2007/2008 are presently working on space activities in Europe.**

3. ADMISSION REQUIREMENTS

A **Bac+5 level degree** (e.g.: French Diplôme d'Ingénieur, Italian Laurea Magistrale or former 5-year Laurea, German Diplom or equivalent degree at MSc level) in Industrial Engineering (Aerospace, Mechanical, Thermal, Nuclear, Electronics ...), in Information and Communications Technologies or in Physical Sciences is required. BSc or MEng degrees at a minimum level of Bac+4 may also be considered for admission. A good knowledge of English is required to the participants.

A maximum number of **15 participants is foreseen in Torino**.

N.5 places will be reserved to foreign candidates belonging to the following countries:Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Luxemburg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and Canada.

N.3 places will be reserved to foreign candidates belonging to the following countries: Hungary, Romania, Poland.

Selection

The selection is based on the curricula of the applicants and oral interviews.

The oral interview for other participants will take place from the 5th to the 9th of October 2009.

A Selection's Board, made up of the Director, the COREP Organizational Coordinator and a few representatives of the Academia or the Space Industry, will examine all submitted application forms and curricula and reject those not complying to the general requests to be enrolled in the SEEDS Master Course.

The selected applicants will then be admitted to an oral interview in English. During this interview, knowledge about Informatics (Internet, E-mail, Windows, Word and Excel), if not certified by given exams, will be tested.

For applicants from outside Italy a videoconference or webcam interview mode can also be applied.

At the end of the selection process a ranking list of the successful applicants will be produced. These will be enrolled in the SEEDS Master Course according to the position in the list and to the number of available places.

Selection Committee:

SELECTION COMMITTEE		
		Prof. Gianfranco Chiocchia
6 OCTOBER		Ing. Enrico Beruto
	15.30-19.00	Ing. Piero Messidoro
		COREP
		Prof. Gianfranco Chiocchia
7 OCTOBER		Ing. Enrico Beruto
	9.00-13.00	Ing. Claudio Ferro
		COREP
		Prof. Gianfranco Chiocchia
		Ing. Enrico Beruto
	14.30-16.30	Ing. Piero Messidoro
		COREP

Oral interview: 6th -7th -19th -20th October 2009 at COREP, Corso Trento 13, Torino.

Each candidate must confirm to the Master Secretariat (+39-011/19742401 - iscrizioni@corep.it) his/her participation to the oral interview.

At the end of the selection procedure, a final ranking list will be published in the SEEDS web site (www.formazione.corep.it/seeds) on the **22**th of October 2009.

Admitted candidates, with respect to the maximum number of participants possible, will have to confirm their participation to the master course by the 26th of October 2009.

If an admitted candidate renounces to partecipate to the course, the Master Secretariat will contact other candidates following the order of the ranking list, starting from the **26**th of October 2009 at 12.00 a.m. In this case, candidates will have to confirm their participation to the Master course by the **28**th of October 2009 at 12.00 a.m.

Candidates confirming their participation to the Master Course should pay the first instalment of the tuition fee by the **28**th of October 2009, according to the modalities that will be comunicated after the publication on the web site of the final ranking list.

4. PERIOD/VENUE

The Course will be held from **2 November 2009** to **December 2010** and will start on the first week of November 2009.

The course attendance is mandatory and implies full time engagement from Monday to Friday (9.00-13.00;14.00-18.00).

The first 6 months of lectures and exercises in Torino will be held at COREP, C.so Trento 13.

The SEEDS Project Work activity will then start with an Introduction lasting from two to three weeks, to be partly spent either at the Space Centre ALTEC or in the Thales Alenia Space premises. Then the three main Project Work phases follow. In the first four SEEDS editions these have been sequentially performed in Toulouse (with tutors from CNES, EADS Astrium, TAS-F ...), Bremen (tutors from Astrium ST, OHB Systems...) and Torino (tutors from Thales Alenia Space, ALTEC ...) under the supervision of senior experts from the quoted local Space Industries and of the general Project Work co-ordinator. The reported sequence may be modified each year according to the educational and organizational needs and to the availability of the local partners. It is expected that – as in the first four editions – the final Project Work discussion will be held at the ESA ESTEC Space Centre in Noordwijk (The Netherlands) or in another European space establishment.

Information on the European SEEDS structure and also on the ISAE-Supaero academic partner can be found in the European SEEDS website: <u>www.seeds-master.eu</u>

5. PROGRAMME

The courses working language will be English.

The 2009/10 training programme will have an overall duration of 14-15 months for a total amount of **1792** hours and 90 credits.

Course attendance is mandatory and implies full time engagement **from Monday to Friday** (9.00-13.00; 14.00-18.00). The average class workload is almost 36 hours/week.

The **first 6 months** (about 742 hours) may be spent either at Politecnico di Torino (SEEDS programme) or at ISAE-Supaero (TAS-Astro programme, see the SEEDS European website for details on the local application conditions) and will mainly consist of **class lectures and exercises** providing the general foundations of the various disciplines related to Space Exploration. Visits to National or European facilities as well as conferences and lectures of distinguished personalities may be foreseen throughout this phase. The planned average class attendance is almost 36 hours/week.

The main subjects taught in Torino may divided in two categories. They are:

- Understanding Space: Introduction to Space Basic Concepts

Space and planetary environment; Orbits and astrodynamics; Entry, descent, landing and ascent; Mission analysis; Space human engineering - Crew safety; Space utilization; Space system engineering I; Space programme management; Product and quality assurance; Planetary aerothermodynamics.

- Learning about Space Systems: Fundamentals of Space Engineering

Space System engineering II; Space robotics; Space propulsion; Attitude determination, guidance and control; Environmental control - Life support; Thermal control; Space telecommunication; Power generation; Space materials and structures; Space avionics; Costs estimation; Launchers.

Learning assessments on all subjects are foreseen at the end of any lecture phase, possibly grouped to homogeneous clusters to be evaluated as a whole.

In the following **9 months** (960 hours) the students perform the **Project Work Activities** by extensively developing the **SEEDS Project Work** under the guide of experienced senior tutors. Thanks to its extension this Project Work is one of the main characteristic features of SEEDS. It is divided into three phases, each one dedicated to a special aspect of the space exploration. A specific theme is identified every year (e.g. the preliminary design of a lunar outpost and that of a lunar permanent basis have been the themes of the first two SEEDS editions). Each Project Work phase lasts about two months and is dedicated to a specific aspect

of the selected theme, taking also into account the locally available competences. The three phases are hosted in a temporal sequence by universities, industries and centres of the associated European towns. During the whole Project Work students from Torino and Toulouse are grouped together and work in crossnational teams. The Project Work itself is an advanced and ambitious activity, intended to lead to scientific reports to be diffused worldwide in the space community. On more than one occasion partial results have been presented by the students to international conferences. The activities performed during the 2006, 2007, and 2008 Project Works are described in the **SEEDS PW Executive Summaries 2006, 2007 and 2008** respectively (see the European SEEDS website for details).

6. SCIENTIFIC COMMITTEE

The Scientific Committee is made up of:

-Prof. Gianfranco Chiocchia, SEEDS Director, Dipartimento di Ingegneria Aeronautica e Spaziale, Politecnico di Torino

-Prof. Ernesto Vallerani, SEEDS Educational Project Manager, Former President of Alenia Spazio and former Vice Chairman of the International Academy of Astronautics (IAA)

-Prof. Bénédicte Escudier, ISAE Suapero, Toulouse

-Mr. Enrico Beruto, SEEDS Chief Project Work Tutor, Former System Engineer Manager, Thales Alenia Space

-Mr. Piero Messidoro – BU Space Infrastructures & Transportation Director Engineering, Thales Alenia Space

7. HOW TO APPLY

In order to apply for the SEEDS Master Course in Torino please fill in the Subscription Form (download: <u>.doc</u> or <u>.pdf</u>) and send it by the deadline in one of the following way:

- by E-mail (iscrizioni@corep.it)
- by fax (+39 011 19742419)
- hand delivered to Master COREP Secretariat (Corso Trento, 13 10129 Turin, ITALY)
- by ordinary mail. Please send a closed envelope to: Segreteria Master COREP (Corso Trento, 13 10129 Turin, ITALY)

The deadline to apply is: **28th September 2009**

For all students who submit an application by 11th September 2009 there is a reduction of 10% on entry fee.

The application is not binding. It only allows to be admitted to the selection.

ALL STUDENTS must provide following documentation in attachment (the list of documents is also provided in Italian at the <u>note¹</u>):

- the Subscription Form (download: .doc or .pdf)
- <u>Copy of the MSc</u> (or MSc equivalent) degree together with the transcript of records of the sustained examinations
- <u>Curriculum Vitae</u> according to the European standard (Europass CV in <u>.doc</u> or <u>.pdf</u> format). It must include the authorization to the treatment of the personal data (Italian DL 196/2003). In any case the curriculum must be sent in electronic format to <u>iscrizioni@corep.it</u>.
- <u>One passport photo</u> with name and surname reported on the back (if the application has been sent by email, the photo is not mandatory, but has to be provided in case of admission.)
- <u>Copy of a passport or identity card valid</u>
- <u>Copy of "Codice Fiscale"</u> (the Italian individual taxpayer's code)
- It may be obtained at the "<u>Agenzia delle Entrate</u>" local office (Italian Internal Revenue Service) by presenting a document of identification (foreigners must present Passport or Residence Permit). Residents abroad can refer also to Italian Consulates. <u>For further information</u>
- <u>Title of the MSc</u> (or MSc equivalent) final project together with a short summary of its contents (max one page)
- <u>Self certification Module</u> (in <u>.doc</u> or <u>.pdf</u> format).
- Form: "<u>Main Professional Condition</u>" (in <u>.doc</u> or <u>.pdf</u> format).

Note 1

- Domanda di iscrizione (in formato <u>.doc</u> o <u>.pdf</u>)
- Certificato di laurea con esami; per laureandi certificato degli esami con voti. È ammessa anche l'autocertificazione (in formato <u>.doc</u> o <u>.pdf</u>);
- Curriculum vitae secondo lo standard europeo (Europass CV in formato <u>.doc</u> o <u>.pdf</u>). Il curriculum dovrà riportare in calce l'autorizzazione al trattamento dei dati personali (D.Lgs.196/2003);
- 1 fotografia formato tessera con indicati nome e cognome sul retro (se la domanda viene spedita in formato elettronico, la fotografia non è obbligatoria, ma deve essere consegnata in caso di selezione);
- Copia di un documento di identità in corso di validità (Carta di Identità o Passaporto)
- Copia del Codice Fiscale
 Chi non possedesse il Codice Fiscale, lo potrà richiedere presentandosi all' <u>Ufficio locale dell'Agenzia</u> <u>delle Entrate</u> con un documento di riconoscimento (gli stranieri devono presentare passaporto o permesso di soggiorno). I residenti all'estero possono rivolgersi anche ai Consolati, se collegati al sistema informativo dell' Anagrafe Tributaria. <u>Per maggiori informazioni</u>
- Titolo della tesi accompagnato da una breve sintesi (massimo una pagina) della medesima;
- Modulo "Condizione Professionale Prevalente" (in formato <u>.doc</u> o <u>.pdf</u>).

STUDENTS WITH AN ITALIAN DEGREE must also enclose:

<u>Abstract of the degree final project and transcript of records of all passed examinations.</u> For students still enrolled in the final year and pending final examination a transcript of records with marks is sufficient. A self declaration ex art. 445/2000, articles 46-47 (<u>.doc</u> or .<u>pdf</u>) is also accepted.

STUDENTS WITH FOREIGN DEGREES must also enclose:

<u>Declaration of value and certificate with the translation of all the passed exams with marks.</u> This
declaration must be requested to the Italian Consulate in the country where the student had the
degree.

EU-citizens may submit certified copies of all documents supporting their qualification together with the Declaration of Value.

Non EU-citizens have to submit originals of all documents supporting their qualification together with the Declaration of Value.

FOREIGN STUDENTS FROM COUNTRIES INDICATED IN THE VISA SYSTEM AND THE ENTRY OF ALIENS INTO ITALY AND THE SCHENGEN AREA (www.esteri.it/visti/home.asp) LIVING IN ITALY must also enclose:

• Entry Visa and residence permit

Incompletes application forms will not be considered as valid.

The COREP Secretariat Office will send an acknowledge of receipt (by phone or by e-mail) of the application in 3 working days. If you don't receive any communications, please contact our Office by phone or e-mail. For more info please call the Info-Point: Tel +39 011 197.42.401. E-mail: <u>formazione@corep.it</u>

CONFIRMATION OF REGISTRATION

The candidates who pass the selection (see below) receive, subject to their position in the ranking list and to the available places, the proposal to be registered to the Master.

The student will regularize the registration through the apposite form ("Confirmation of registration").

Please consider that:

- **STUDENTS WITH AN ITALIAN DEGREE** will have to deliver an original copy of their "Tesi" Degree.
- FOREIGN STUDENTS FROM COUNTRIES INDICATED IN THE VISA SYSTEM AND THE ENTRY OF ALIENS INTO ITALY AND THE SCHENGEN AREA (www.esteri.it/visti/home.asp) must give to the Master Secretariat, within the expiration date, the Visa of entrance for study reason type D with multiple entrances and the residence permit, before confirming the registration with the form "Confirmation of registration". Further information about the documents requested to foreign students is available on the website: www.esteri.it/visti/home.asp

Personal data will be used by COREP according to Italian laws (Article n. 13 Legislative decree n. 196/03).

8. TUITION FEE

The Post Graduate Master Course has been approved and funded by the European Social Fund (Bando Regionale per i Master Universitari di I e II Livello 2009/2010. D.n.349 del 03/07/2009).

In no case the tuition fee for the 5th SEEDS edition will exceed **4000,00 Euro**. This rate is intended for the whole SEEDS course and includes also the university fees. If the financial support received during the last editions (sponsorships, subsidies, EU Social Fund ...) will be confirmed also for 2009/10 the quoted amount will be reduced to a level which could be considerably lower (in the first 4 edition the fee ranged from 3000 to 4500 Euro, depending on the obtained financial support). Consider, however, that the availability of the full support is usually not known before two or three months after the start of the course.

Accommodation and travel costs during the all teaching and Project Work phases are to be sustained by the students.

Thanks to a special support granted by ESA to SEEDS in order to foster its Europeanization by encouraging the enrolment in Torino of non Italian students from the States sitting in the ESA Ruling Council, **the best 5 selected applicants** from the following countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Luxemburg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and Canada will be fully exempted from paying the fee. Additionally, each of them will receive **a grant of 3000,00 Euro** to support the expenses related to the SEEDS mobility across Europe. This grant will be paid just after the start of the Project Work activity.

The same conditions (fee exemption and grant to the Project Work) apply also to **the best 3 selected applicants** from the so-called PECS (*Plan for European Cooperating States*) countries being also ESA Candidate Member States, namely: Hungary, Romania and Poland.

Applicants from the ESA and PECS countries in excess with respect to the quoted numbers can be admitted, if selected, at the same conditions as all other applicants.

In addition n. 3 grants of 1500,00 Euro are available for students from the ESA and PECS countries *enrolled in SEEDS at Supaero (Toulouse)* through the local TAS-Astro Course and joining in Torino the SEEDS Project Work Team to support their mobility during the Project Work.

The course will be activated on condition that also the new edition will obtain the approval and funding by European Social Fund and by sponsors, and if the minimum number of 10 partecipants is reached.

A maximum number of 15 participants is foreseen in Torino.

The above cited grants are the only kind of financial support provided by the SEEDS management to the students but, as specified, they hold only for a limited number of non Italian participants from ESA and PECS countries. No other fellowships are available since, according to its policy, SEEDS utilizes any additional financial income to realize a generalized fee reduction as high as possible rather than to support individual students.

As a consequence, fellowships have to be found by the students themselves. For instance, some Italian Regions support their citizens' attendance of post-degree courses (information can be obtained from the regional offices). Furthermore, all Italian students enrolled in the post-graduate Master Courses managed by COREP can get an **"ad honorem loan" for an amount of 5.000 Euro** per year given by UniCredit Bank. To get the loan it is sufficient to present an Enrolment Certification to the Master, without other requirements. Further information can be asked to the COREP Master Secretariat.

9. CERTIFICATION

A final report ("Executive Summary") followed by a discussion in front of international experts on the Project Work concludes the course and finally leads to the award of the SEEDS "Master Universitario di II livello" degree released by Politecnico di Torino. Additionally, a SEEDS Certificate/label jointly released by Politecnico di Torino and ISAE Supaero will be attached to the National Degree.

In order to be admitted to the Project Work activities students must attend at least 2/3 of the lectures hours (certificated by signature) and to pass all related examinations. Students satisfying this requirement get the SEEDS Master Degree and Certificate after conclusion of the Project Work activities, full completion of the Executive Summary and successful final discussion.

To be entitled to obtain the University Master Degree, the Italian students must comply to the Italian requirements stated by the law on education T.U. of 1933 art. 142 (simultaneous enrolment in other universities courses, doctorates, etc...is not admitted).

10. COURSE ORGANIZATION

Understanding Space: Introduction to Space Basic Concepts - Space and Planetary Environment

Teacher: Ing. LOBASCIO (Thales Alenia Space) Number of lecture's hours: 28 Number of Credits: 2

Contents: Understanding the space environment. Difference with respect to the terrestrial environment. Effects of cosmic radiations. Effects of the vacuum. The gravity. Boundaries of the terrestrial atmosphere. The planetary atmospheres. Impact of micrometeorites and space debris.

Understanding Space: Introduction to Space Basic Concepts – Orbit and Astrodynamics. Entry, Descent, Landing, Ascent

Teacher: Prof. AVANZINI (Polito) Number of lecture's hours: 48 Number of Credits: 4

Contents: Basic concepts of orbital motions. Laws of Newton. The two-body problem. Orbital perturbations. Manoeuvres in space. Transfer of orbit. Rendez-vous. Interplanetary flight. Fly-by effect. The four-body problem, solutions by superposition.

Understanding Space: Introduction to Space Basic Concepts - Mission Analysis

Teacher: Ing. Piras (Thales Alenia Space) Number of lecture's hours: 36 Number of Credits: 3

Contents: Basic concepts of orbital motions. Laws of Newton. The two-body problem. Orbital perturbations. Manoeuvres in space. Transfer of orbit. Rendez-vous. Interplanetary flight. Fly-by effect. The four-body problem, solutions by superposition.

Understanding Space: Introduction to Space Basic Concepts - Space Human Engineering. Crew Safety

Teacher: Prof. QUAGLIOTTI (Polito); Ing. MUSSO (Thales Alenia Space) Number of lecture's hours: 36 Number of Credits: 3

Contents: Environmental effects on human beings. Difference between manned systems and satellites. The extra-vehicular activity. Architecture of the manned systems. Space stations. The lunar base. Human settlements on Mars. The space colonization: basic requisites.

<u>Understanding Space: Introduction to Space Basic Concepts – Space Utilization</u>

Teacher: Prof.VALLERANI; Ing. BERUTO Number of lecture's hours: 40 Number of Credits: 3

Contents: The disciplines of Space Physics: astronomy, planetology, the solar system, plasma physics, microgravity. The disciplines of Life Sciences: space biology, the man in space. The applications: telecommunications, space navigation, observation of Earth.

Understanding Space: Introduction to Space Basic Concepts - Space Programme Management - Costs Estimation

Teacher: Ing. MESSIDORO (Thales Alenia Space) Number of lecture's hours: 30 Number of Credits: 2,5

Contents: Phases of development of a programme. The business plan. Cost analysis. Project monitoring. Integrating the system of the co-producers. The responsibility of the Prime Contractor.

Understanding Space: Introduction to Space Basic Concepts - Product Quality Assurance

Teacher: different teachers Number of lecture's hours: 12 Number of Credits: 1

Contents: Project risk assessment. Procedures to analyse the failure modes. The assurance of quality. The system of the on-ground testing and proofing.

Learning about Space Systems: Fundamentals of Space Engineering - Space System Engineering I - II

Teacher: Prof. CHIESA (Polito) and Ing. FERRO (Thales Alenia Space) Number of lecture's hours: 76 Number of Credits: 6

Contents: The concept of system. Subsystems and components. The system of systems. System integration. Functional analysis. The phases of a project: conception, development, testing, qualification, operations in orbit. Integrated project, use of CAD. Concurrent Engineering processes. Parametric analyses. Optimization methods.

Learning about Space Systems: Fundamentals of Space Engineering - Space Telecommunications

Teacher: Prof. VISINTIN (Polito) Number of lecture's hours: 48 Number of Credits: 3

Contents: The architecture of the communication system: the Earth stations, the centre of control, the satellite, the connecting satellites. Principles of radio-communications. Collecting and processing data. The satellite computers. The communications among the components of the infrastructural system on a planet. Permanent bases and moving vehicles.

Learning about Space Systems: Fundamentals of Space Engineering - Space Propulsion - Launchers

Teacher: Prof. CASALINO (Polito) Number of lecture's hours: 48 Number of Credits: 4

Contents: Principles of space propulsion. Chemical, electrical and nuclear engines. Types of propulsive systems: solid vs. liquid, mono vs. bipropellant. Hybrid engines. Comparison of performances. Optimization of the propulsive system in the ground base and during the mission.

Learning about Space Systems: Fundamentals of Space Engineering - Planetary Aerothermodynamics

Teacher: Prof. D'AMBROSIO (Polito) Number of lecture's hours: 36 Number of Credits: 3

Contents: The re-entry problem. The various atmospheres and the different trajectories. The flight regimes during re-entry. The physical phenomena during the re-entry. Non-reacting compressible flows: the boundary layer, the shock waves. Compressible flows with chemical reactions. Heat transfer into the body wall. Numerical simulations and wind tunnel tests.

Learning about Space Systems: Fundamentals of Space Engineering - Environmental Control and Life Support

Teacher: Ing. LOBASCIO (Thales Alenia Space) Number of lecture's hours: 36 Number of Credits: 3

Contents: Requisites for an environmental control system capable to assure the human presence in space. Management of the available resources. Environmental control: dispersion and processing of waste. Designing closed - cycle systems.

Learning about Space Systems: Fundamentals of Space Engineering - Space Structures and Materials

Teacher: Prof. CARRERA (Polito) Number of lecture's hours: 36 Number of Credits: 3

Contents: Requisites for structures hosting astronauts. Design loads in the various phases of the operating life. Types of structures. Material properties. Dimensioning a pressurized module of a space station. Fracture mechanics. Impact with micrometeorites. Ground testing. Certification and flight qualification.

Learning about Space Systems: Fundamentals of Space Engineering - Thermal Control

Teacher: Ing. SACCHI (Thales Alenia Space) Number of lecture's hours: 36 Number of Credits: 3

Contents: Fundamentals of the thermal control of a space vehicle. Design of the control system. Thermal shields. Passive and active thermal control. Components of a thermal control system. Thermo-mechanical characteristics of the materials. Principles of ablative protection. Thermo – structural optimization. Experimental tests and numerical simulations.

Learning about Space Systems: Fundamentals of Space Engineering - Space Robotics

Teacher: Prof. GENTA (Polito) Number of lecture's hours: 36 Number of Credits: 3

Contents: Base concepts of robotics. Man – robot comparison. Base requisites and employment modes. Principal elements of a design. Remote control. Optimization of a robotic system. Applications to a Moon – Mars mission.

Learning about Space Systems: Fundamentals of Space Engineering - Power Generation

Teacher: Ing. BOARETTO (Thales Alenia Space) Number of lecture's hours: 18 Number of Credits: 1,5

Contents: The generation on necessary power to be operation of a space vehicle.

Learning about Space Systems: Fundamentals of Space Engineering – Attitude Determination, Guidance and Control - Space Avionics

Teacher: different teachers Number of lecture's hours: 36 Number of Credits: 3

Contents: The control of Space vehicle on the Moon and Mars surface.

Equal Opportunities

Teacher: to be confirmed Number of lecture's hours: 26 Number of Credits: 2

Contents: Culture and equal opportunities between man and woman. Equal opportunities legislation.

Project Work Activity – Plenary Session to start Project Work Activity

Teacher: Different experts Number of lecture's hours: 80 Number of Credits: 4

Contents: Illustration of the Project Work concept. Planning the sequential phases. Becoming familiar with the "Concurrent Engineering" methods. Definitions of the working teams.

Project Work (Fixed Segment)- Plenary PWA Activities and Conclusive Plenary Session in Torino

Teacher:Tutors in Torino Number of lecture's hours: 320 Number of Credits: 10

Project Work (Transportation Segment) - Plenary PWA Activities and Conclusive Plenary Session in Bremen

Teacher:Tutors in Bremen Number of lecture's hours: 320 Number of Credits: 10

<u>Project Work (In-Space segment) - Plenary PWA Activities and Conclusive Plenary Session</u> <u>in Toulouse</u>

Teacher: Tutors in Toulouse Number of lecture's hours: 320 Number of Credits: 10