Master of Science
Aerospace Engineering

At A Glance

DEGREE BY
Nanyang Technological University (NTU)

TWO-YEAR FULL TIME PROGRAMME
Coursework in Singapore

PRACTICAL KNOWLEDGE
Compulsory Internship & Dissertation

GLOBAL PROSPECTS
Internationally Recognized Degree

INTAKE
August Every Year

TO APPLY
Apply online from 15th October at www.tum-asia.edu.sg

1 TUM is ranked as the #1 University in Germany

8 TUM ranked #8 in the Global Employability Survey

17 Scientists and alumni of TUM have received the Nobel Prize

50 TUM is ranked among the world’s Top 50 Universities
TUM Asia

TUM Asia was set up in 2002 as the first academic venture abroad by a German university. The first joint-degree between TUM and the National University of Singapore (NUS) was established in 2002, with several joint programmes with Nanyang Technological University (NTU) added in the following years.

The specialized Master programmes aims to be in pace with industry trends and needs, while constantly challenging the worldview of students with an Asian-European curriculum. Lecturers and professors come from as far as Germany and their wealth of knowledge from various fields provide a spectrum of experience for the students to glean from. Towards the end of the programme, students complete their Master thesis and internship in any country in the world.

By 2017, more than a thousand students have come through the doors of TUM Asia and now ply their trades in top research institutes and companies across the globe.

Technical University of Munich (TUM)

The Technical University of Munich (TUM) is one of Europe’s leading research universities, with around 550 professors, 41,000 students, and 10,000 academic and non-academic staff. Its focus areas are the engineering sciences, natural sciences, life sciences and medicine, combined with economic and social sciences.

TUM acts as an entrepreneurial university that promotes talents and creates value for society. In that it profits from having strong partners in science and industry. It is represented worldwide with the TUM Asia campus in Singapore as well as offices in Beijing, Brussels, Cairo, Mumbai, San Francisco, and São Paulo.

Nobel Prize winners and inventors such as Rudolf Diesel, Carl von Linde, and Rudolf Mößbauer have done research at TUM. In 2006 and 2012 it won recognition as a German “Excellence University.” In international rankings, TUM regularly places among the best universities in Germany.
The joint TUM-NTU Master of Science in Aerospace Engineering (MSc in AE) is a programme that caters to highly qualified engineers to meet the ever-increasing demand from a growing aerospace sector in Singapore and the world.

**MODULE REQUIREMENTS**

- **19** Modules to be completed
  - (7 Core Modules, 9 Elective Modules & 2 Cross Discipline Modules, 1 Business & Technical English Module)

- **10** Contact hours for every Cross Discipline Module

- **45** Contact hours for every Core and Elective Module

**MASTER DEGREE**
Conferred by Technical University of Munich (Germany)

**APPLICATION-FOCUSED**
Full-time research and application focused programme, inclusive of internship experience and Master Dissertation writing

**INDUSTRY RELEVANCE**
Our professors are actively involved in research and teaching, allowing them to base the curriculum around the latest technological trends and knowledge

**GLOBAL OPPORTUNITIES**
You are able to complete your Internship and Thesis in Singapore or anywhere in the world with a company, university or research institute and look for job opportunities globally

Programme Timeline Overview

- **July**
  - Arrival in Singapore

- **Year 1**
  - Laboratory Modules
  - Core Technical Elective Modules
  - Specialization Technical Elective Modules
  - Non-Technical Elective Modules

- **Year 2**
  - Non-Technical Elective Modules
  - Internship
  - Master Thesis at a company, university or research institute (Supervised by a NTU or TUM professor)

- **Graduation**
  - End of Programme

Note: This outline is a general reference to the duration of study. A student’s actual duration of study may or may not follow this general reference. This outline is subject to change during the course timetable.
Module Synopsis

Core Modules

Aerodynamics\(^a\)
Introduction, Governing equations, Inviscid & incompressible flows, Viscous boundary layers, Airfoil & wing characteristics, Incompressible flow around airfoils and wings, Dynamics of compressible flow fields, Compressible subsonic flows, Transonic flows, Supersonic flows, Hypersonic flows, Aerodynamic design considerations.

Flight Performance and Dynamics\(^a\)
Basic fixed-wing aircraft performance, Aircraft stability and control, Fundamentals of airplane aerodynamics and propulsion, Performance consideration and handling qualities on aircraft design.

Structures and Materials\(^a\)
Appropriate structural design and selection of materials, Various structural components of aircraft assembly, Typical loads during flight and structural vibration problems, Various characteristics of aerospace materials and deployment in aerospace structures and aircraft systems.

Propulsion

Aircraft Design
Current design methods and basic design tools for the conceptual design and analysis of different types of aircraft. Students will acquire knowledge of systematic procedure of the aircraft design process and will be able to design assemblies with focus on the overall aircraft design. Due to that, the required aircraft performance, current safety, economic efficiency, comfort and environmental requirements are the basics of the design process. The connection between requirements and their impact on configuration level will be outlined.

Aerospace Lab\(^b\)
Students will undergo a series of lab exercises from all disciplines of aerospace engineering; Wind tunnel measurements, flight simulator, structures and materials and computational methods.

Design Lab\(^b\)
Students will be given an aerospace related design task. Under the guidance of the lab supervisors, the entire design process will be completed and presented in a final presentation.

Cross Discipline Modules (Choose 2)
- Aspects of Asian and European Relations Today
- Cultural, Social & Economical Aspects of Globalisation
- International Intellectual Property Law
- Selected Topics in Business Administration
- Selected Topics in Business Management

Elective Modules* (Choose 3 from your Primary Focus Area, 2 from your Secondary Focus Area, 2 modules from any unselected modules as your Free Choice modules, 2 modules from any unselected modules as Elective modules)

Focus Area 1: Aerodynamics and Propulsion* Computational Fluid Dynamics

Turbulent Flows\(^a\)

Boundary Layer Theory
Derivation of the boundary-layer equations from the Navier-Stokes equations, Incompressible boundary-layer equations (flat, 2-dimensional flows), Temperature boundary-layers, Compressible boundary-layers, 3-dimensional boundary-layers, Stability theory, Laminar-turbulent transition, Turbulent boundary-layers, Experimental boyle boundary-layer.

Turbo Compressors

Focus Area 2: Structures, Materials and Systems* Plates and Shells
Fundamentals of plate and shell theories, Contemporary analytical methods and powerful numerical techniques for solving challenging plate and shell problems, Fibre-composite materials.

Fracture Mechanics and Non-Destructive Testing\(^a\)
Basics of the metal high and low cycle fatigue methodology, Flaw and damage tolerant approaches, Analysis of aircraft metal components, FAA/JAR requirements, Fracture Mechanics for defect assessment, Several Non Destructive Testing Techniques.

Carbon Fibre Composite Materials
Typical carbon fibre composite materials and structures in military & civilian aircraft, Unidirectional, orthotropic, anisotropic & quasi-isotropic behavior; Classical laminate plate theory; Hysterothermal effects; Introduction to failure criteria; Basics of materials processing; Parameter studies and design steps.

Aero-systems\(^a\)
Fuel and fuel systems, Environmental control system (ECS), Bleed air and avionics cooling, Landing gear and hydraulics, Flight control mechanisms for fixed and rotary wings aircraft, Helicopter power transmission system and other miscellaneous systems.

Lightweight and Aerospace Structures
Overview on actual aerospace structures, Essentials of typical materials, Requirements for aircraft structures, Current and future design concepts for fuselage and wing structures, Current and future space structures concepts, Design optimisation techniques.

Failure Analysis, Diagnostics and Prevention in Aerospace Engineering
Principles of Failure Analysis, diagnostics and the means to treat/ prevent these failures in an interactive manner. The course is specifically targeted to the Aerospace Industry by the inclusion of aerospace-related case histories and materials, including failures in composite materials. A balanced mix between the theoretical fundamentals and the practical aspects to failure analysis is taught using lectures. Real cases of aerospace failures will be discussed.

Focus Area 3: Flight Mechanics and Control* Advanced Flight Dynamics\(^a\)
Advanced treatment of flight dynamics. Linear and nonlinear aircraft equations of motion, Detailed longitudinal and lateral/directional dynamics. Numerical approaches and the application of linear system theory for studying the dynamical properties of flight.

Flight Control Systems
Principles of control/stability augmentation systems and autopilots used in modern airplanes, Fundamentals of classical control theory analysis and design, Basic properties of airplane dynamic properties, Control strategy for various augmentation systems and autopilots.

Advanced Control of Flight Systems
Application of modern control techniques in flight systems, Multivariable state-space and aircraft system representations, Various modern control techniques with applications and implementations.

Spacecraft Technology 1

Helicopter Engineering
The helicopter design process, applicable requirements and design objectives, helicopter flight physics model, practical dimensioning techniques, engine characteristics, evaluation of helicopter configurations regarding expectable flight performance, structural architecture and design.

Disclaimer: Focus Areas and Elective modules available for selection are subject to availability. Unforeseen circumstances that affect the availability of the module include an insufficient number of students taking up the module and/or the unavailability of the professor. TUM Asia reserves the right to cancel or postpone the module under such circumstances. All students are required to have a number of mandatory modules set by both universities. Module selection choices will be subject to this rule.

*These modules are offered by NTU, with the rest being offered by TUM.
**ADMISSION CRITERIA**

- You may apply to our programme if you have completed your Bachelor Degree Programme, or if you are in your final year of Bachelor Degree studies.
- Hold or currently enrolled in a Bachelor Degree (completed in at least three years, depending on factors such as the rest of your education background) in **Aerospace or Mechanical Engineering** or a closely related discipline.
- Submit one (1) **notarised copy of Bachelor Degree Certificate or Enrolment Letter** (if you have not completed your Bachelor Degree) and one (1) **notarised copy of Academic Transcripts or Mark Sheets**.
- Submit two (2) **Recommendation Letters** from two (2) different Professors or Employers.
- Submit one (1) **Letter of Motivation** that indicates the reason(s) you are interested in the programme you applied for.
- Submit one (1) **Curriculum Vitae / Resume**.
- Submit **TOEFL / IELTS test score** taken no more than two years ago from date of submission of online application.
- Submit **Akademische Prüfstelle (APS) certificate** (Required for applicants who hold a degree from China, Vietnam, or Mongolia).

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<th>TOEFL test score requirements: At least 88 for the Internet-Based Test (TOEFL code: 7368)</th>
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<td>IELTS test score requirements: Overall IELTS results of at least 6.5</td>
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* The full application process is available on [www.tum-asia.edu.sg/application-process](http://www.tum-asia.edu.sg/application-process).

** Documents which are not in English must be translated by a certified translator. All applicants are also required to submit an additional of three (3) notarised copies of Official or Provisional Bachelor Degree Certificate, two (2) notarised copies of full, Official Academic Transcript, and three (3) passport-sized photographs when you have accepted the offer of admissions and are being matriculated into our programme.

**TO APPLY**

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**FEES**

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<th>APPLICATION FEE</th>
<th>TUITION FEE</th>
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<tr>
<td><strong>SGD 79</strong> is payable for each application per programme</td>
<td><strong>A total of SGD 38,520</strong></td>
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- The tuition fee will be divided into 4 installments for payment and may be further divided into SGD and EUR amounts.
- The tuition fee includes teaching fees, laboratory expenses and cost of mandatory events.
- The tuition fee does not include airfare, accommodation, living expenses, and miscellaneous fees (inclusive of registration, IT facilities, matriculation, examination, amenities, copyright, sports, insurance and medical). These fees will be separately paid by the student.

* The tuition fee stated is accurate as of 1 November 2017. All fees are subject to revision due to currency fluctuations, at the discretion of TUM Asia. All fees quoted are inclusive of 7% Singapore’s Government Goods & Services Tax. Please refer to our website for fee updates.
Entrepreneurial Thinking and Engagement
Globalization is now an inevitable force that is here to stay. At TUM Asia, our classroom reflects this diversity with an enrolment of over 28 nationalities. This means that we foster a vibrant learning environment where the student learns not only from the textbook but also through the lives of their counterparts. Classroom ideas are synthesized across the diverse economic realities and students learn to see from multiple vantage points, creating a capacity to solve problems in creative ways. The unique joint degree programme not only equips the student with technical and scientific knowledge, but with an enriched curriculum consisting of business and cultural modules.

TUMCREATE
TUM is known for its research capabilities and strength in innovation. As such, TUM Asia spearheaded the set up of TUMCREATE as a base of research in Singapore. TUMCREATE is a joint programme between Technical University of Munich (TUM) and Nanyang Technological University (NTU). The electromobility institute brings together the expertise and innovation of Germany and Singapore, to drive innovation to shape the future of sustainable mobility by tackling issues ranging from the molecules to the megacity. Graduates from the TUM Asia Master programmes have the opportunity to apply for positions at TUMCreate, especially if your interest lies in the area of transportation and mobility research.

Highest International Standards
You will be studying with the world’s best professors from TUM, as well as experts from the industry. Not only will the student benefit from professors who are actively involved in research, one will also receive a holistic learning experience with the engagement of local lecturers from academia and industry. Our TUM modules are covered by professors who fly in from Germany on an exclusive teaching basis, to ensure that students get the undivided attention of their lecturers.

Engineering is not just about learning facts, but being able to understand complex systems and methods, as well as being able to develop original strategies and solutions. The TUM Aerospace Master programme aims at just that. Become one of the people driving progress in the aerospace industry - Don’t be driven by routine tasks.

Prof. Dr.-Ing. Florian Holzapfel
Professor, Technical University of Munich
Institute of Flight System Dynamics

Studying With Us
“Talents Are Our Assets, Reputation Is Our Return”
DID YOU KNOW THAT SINGAPORE TOPS IN ASIA FOR AEROSPACE MAINTENANCE, REPAIR, AND OVERHAUL (MRO), LAYING CLAIM TO 25% OF THE ASIAN MRO MARKET?

Singapore: Asia’s Aerospace Hub

Singapore has become the leading aviation hub in Asia Pacific today, contributing over a quarter share of the region’s Maintenance, Repair, and Overhaul (MRO) output. Despite global uncertainties, the demand for air travel in Asia Pacific countries continues to grow, creating vast opportunities in the region for the aerospace industry. Singapore is well-equipped to capture the demand for aviation related services, while leveraging off existing capabilities in precision engineering and electronics, to support the production of complex aero-engine components.

The Aerospace Industry in Singapore

The phenomenal growth of the aerospace industry worldwide and in South-East Asia in particular, has greatly increased the number of aerospace design and manufacturing operations in Singapore. On top of that, Singapore is backed by over 100 aerospace companies. Aircraft manufacturers projected that over a third of worldwide deliveries will go to Asia in the next two decades, with Asia Pacific’s fleet tripled to 13,500 aircrafts.

Our Graduates

Our graduates in Aerospace Engineering are employed all over the world, such as in Singapore (80%), Europe (20%).

The most commonly accepted positions are Research Engineer, Project Engineer, Stress Engineer, and Mechanical Design Engineer.

1 Singapore is #1 in Asia for MRO. It is also the most comprehensive MRO in Asia.

8.7 In 2012, Singapore’s Aerospace industry achieved an output of over S$8.7 billion.

10 Singapore’s Aerospace industry has grown at a compounded annual growth rate of over 10% since 1990.

19 Singapore is quickly establishing itself as a Research & Development Hub. 19 Aerospace companies have made commitments to partner Singapore’s A*STAR and its research institutes to jointly conduct Aerospace research.

90 The Aerospace industry employs close to 19,900 workers today, of which 90% are skilled.

100 Today, Singapore is home to over 100 international companies carrying out MRO activities in Singapore.

The TUM Aerospace programme has provided me with the technical knowledge to solve engineering problems in a structured way and find the best possible solution. I have built up a great network while living abroad and a strong foundation in the field of Aerospace Engineering.

Jannik Pötzl
Alumni, Master of Science in Aerospace Engineering