TUM Asia

Master of Science
Aerospace Engineering

Technical University of Munich

At A Glance

DEGREE BY
Technical University of Munich (TUM)

TWO-YEAR FULL TIME PROGRAMME
Coursework in Singapore

PRACTICAL KNOWLEDGE
Compulsory Internship & Thesis

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+

6 TUM ranked #6 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.

Master of Science
Aerospace Engineering

TUM Asia's 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

15 **Modules to be completed**
(5 Core Modules, 7 Elective Modules, 1 Non-Technical Elective Module, 1 Lab Course and 1 Business & Technical English Module)

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

7 **Electives across various topics to be chosen by the student**

MASTER DEGREE
Conferred by Technical University of Munich (Germany)

APPLICATION-FOCUSED
Full-time research and application focused programme, inclusive of internship experience and Master Thesis 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
- Core Modules
- Elective Modules
- Non-Technical Elective Module

Year 2
- Elective Modules
- Internship
- Master Thesis at a company, university or research institute

(Supervised by 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

Pre-essential Modules

Business and Technical English
The module aims to teach students the technical writing techniques and to familiarise them with the different business communication styles. Students will learn the international usage of the English language in technical communication especially in academic writing, as well as learn how to make effective presentations and prepare technical or scientific papers.

Numerical Methods & Tools in Aerospace Engineering (Lab Course)
This module provides a comprehensive introduction to the functionality of the software MATLAB / Simulink and explain, for which aerospace engineering problems the tool can be used. Emphasis is on the numerical modelling of technical problems and the engineering interpretation of results. For the dynamic vibration behavior, syntheses will be made with control simulation to show the interaction of several disciplines and to introduce into the field of controlling flexible systems.

Core Modules *(Choose 5 modules)*

Aerodynamics
This module focuses on the basics of the calculation and the analysis of the aerodynamic forces acting on aircraft.

Fundamentals of Aircraft Operations
This module covers a multi-disciplinary range of topics in the field of aircraft operation with focus on commercial air transport. Starting with a review of the history of civil aviation, the module presents important players, operating processes and procedures, and boundary conditions of the air transport system & additionally portrays the future perspectives of new technologies and their potential impact on aircraft operation.

Introduction to Aeronautics
This module will provide a basic overview of the different systems and processes applied in aviation. A general understanding of civil & military aviation will be given to enable basic differentiation of different aircraft configurational layouts. Particularly, the interaction between the different system elements, their relevant requirements and their impact on configuration level will be fundamentally outlined.

Introduction to Flight Mechanics
In this module, topics in flight system dynamics and flight control will be covered. Students will be able to understand relations between aircraft performance and flight control. From this course, students will be able to apply aircraft performance calculations that are required in the preliminary design of aircraft and are able to design basic flight controllers for stabilization and improvement of flight properties.

Flight Propulsion
The module provides basic knowledge about aerospace propulsion systems. The basic governing thermodynamic & aerodynamic equations used in the engine design process, Aero engine and gas turbine cycle and component performance as well as their interaction will be covered.

Structures and Materials
This module covers the essentials of lightweight structures & materials, which provide a basis for structural development including proper material selection. A general view on the basics in elasticity, structural stability, vibrations and strength including fatigue problems are given. Design, numerical analysis and test methods are introduced. On the materials side, metal lightweight alloys and fiber composites are covered.

Elective Modules* *(Choose 7 modules)*

Advanced Flight Control Systems
This module conveys complex control concepts for aircraft. The C*-criterion is derived and modern concepts of adaptive control in aviation is covered.

Aerodynamics Design of Turbomach
This module covers the various types of turbomachinery applications with particular emphasis on compressors. Starting from the fundamental equations in fluid dynamics, the working principle of turbomachinery are derived. Moreover, main components, characteristics and associated flow phenomena are explained. For compressors, design methods and processes, topics of operability and stability enhancement are covered.

Aeroelasticity
This module describes basic aeroelastic phenomena arising from the mutual interaction of elastic, aerodynamic and inertial forces on a structure, with special emphasis on problems related to fixed wing vehicles. Aeroelasticity plays a major role in the design, qualification and certification of flying vehicles, as it contributes to the definition of the flight envelope and affects various performance indicators.

Aerospace Structures
This module introduces the approaches for the development process of lightweight and aerospace structures, including design, simulation, optimization and testing aspects. Current structural design concepts for aerospace applications are shown in the context of goals and requirements to be achieved. Possible future developments are addressed and reasons are discussed.

Aircraft Design
This module covers various current design methods & relevant design tools for the applied design of surface aircraft. With the simultaneous introduction to the aircraft design system, students are enabled to design both individual components of the aircraft with regard to the overall aircraft, and define the overall aircraft configuration so that it complies with the current requirements with regard to safety, safety and security economy, comfort, the environment and the performance of flights.

Boundary Layer Theory
This module covers basic phenomenons present in boundary-layers. Physical models and the derivation of the boundary-layer equations from the Navier-Stokes equations are discussed for flat 2-dimensional cases. Temperature, compressible and 3-dimensional boundary-layers are explained. The stability theory explains the laminar-turbulent transition, turbulent boundary-layers and experimental research methods.

Fibre Composite Materials
This module introduces the main properties & design principles of fibre composite materials and calculation methods. Focusing on Carbon fibre polymers, other types of fibres and matrix materials, failure criteria and behaviour under environmental influences, carbon fibre specific fabrication and manufacturing methods, parameter processing, design and material testing steps will be covered.

Flight Control Systems
This module introduces the basic operating principle of flight controls. Based on the non-linear equations of motion of airplanes and basic control theory principles, control strategies are derived in order to improve the handling qualities or stability of airplanes. In addition, strategies for the implementation of autopilots are presented.

Helicopter Engineering
The content extends over different design requirements and their classification, the sizing process, evaluating the flight performance with respect to power consumption, rotor craft limits and mission design. It also covers tools for the cost & weight estimation of the designed rotorcraft.

Safety & Certificate of Aircraft
This module covers Aviation Safety Principles, Basics in Regulations, Airworthiness Code (CS-27, CS-29), Loads, Stress & Fatigue, Performance Categories, Safety Analysis & Flight Accident Investigation.

Safety & Certification of Avionics & Flight Control Systems
This module addresses the certification process of avionics & flight control systems in commercial aviation. The focus lies in safety analysis methods, taking common approaches of their employment in development projects of safety-critical systems in the industry into account.

Spacecraft Technology
This module covers astronautical & space engineering topics, and relevant theoretical background & engineering design methods to find suitable solutions for spaceflight and spaceflight technology.

Non-Technical Elective Modules *(Choose 1 module)*

Business Administration
The primary purpose of the module is to introduce students to the different areas of business administration with the final objective to give them a basic understanding of how to face decision problems in a company. Most importantly, we will analyse long-term investment decisions, how to set-up strategic planning in a company, how to gather timely information about the current situation of a company, and how to set-up the long-term financial structure.

Innovation and Technology Management
This module presents the dynamics of technological development through innovation and the related management issues, the difference between creating a new product (invention) and improving an existing product/idea (innovation), Start-ups and financing of innovation, Innovation-driven economic cycles and Innovation impact on growth and jobs.

Industrial Marketing
Marketing strategies are developed for a typical commodity and speciality business. Students will work in teams to develop business cases, make their own business decisions and develop marketing concepts based on provided information of a real case study.

Production Planning In Industry
Manufacturers are confronted with special requirements of their production processes. Cycles, by-products, batches and campaigns are difficult to handle by nowadays Enterprise Resource Planning (ERP) software packages. Concepts of material requirements planning, supply chain management (SCM) combined with basics in cost accounting will be explained.

**Disclaimer: 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.*

Admissions Information

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) Statement of Purpose** 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)

TOEFL test score requirements: At least 88 for the Internet-Based Test (TOEFL code: 7368)
IELTS test score requirements: Overall IELTS results of at least 6.5

* The full application process is available on 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 two (2) notarised copies of Official or Provisional Bachelor Degree Certificate, two (2) notarised copies of full, Official Academic Transcript, and two (2) passport-sized photographs when you have accepted the offer of admissions and are being matriculated into our programme.

TO APPLY

Applications open 15 October every year. Apply online at www.tum-asia.edu.sg

FINANCING YOUR STUDIES

APPLICATION	TUITION FEE
SGD 79 is payable for each application per programme	**A total of SGD 38,520⁺** • The tuition fee will be divided into 3 instalments 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, copy right, sports, insurance and medical). These fees will be separately paid by the student.

⁺ The tuition fee stated is accurate as of 1 November 2018. 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.

Studying With Us

"Talents Are Our Assets, Reputation Is Our Return"

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 molecues 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

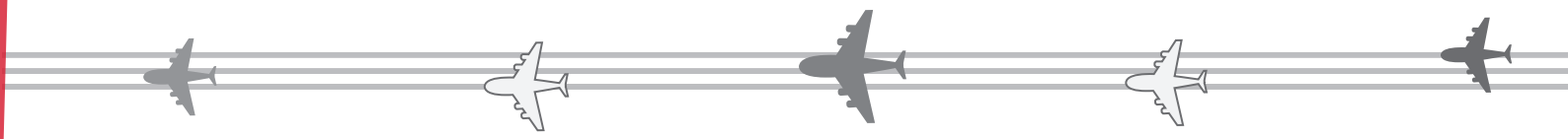
You will be studying with the world's best professors from TUM, as well as experts from the industry. Not only will the student benefit from professors who are actively involved in research, one will also receive a holistic learning experience with the engagement of local lecturers from academia and 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

DID YOU KNOW THAT COMMERCIAL AIRCRAFT ORDER BACKLOG IS AT ITS PEAK OF MORE THAN 14,000, WITH ABOUT 38,000 AIRCRAFT EXPECTED TO BE PRODUCED GLOBALLY OVER THE NEXT 20 YEARS?

Source: 2018 Deloitte Analysis of The Boeing Company and Airbus Group



Outlook 2019: Aerospace Industry

Manufacturers are ramping up production to accommodate growing aircraft demand, and it is expected that aircraft deliveries by end 2018 will be slightly more than 1,600 units, with another 100 aircraft to deliver in 2019. The competitiveness in aircraft efficiency continues, with airlines constantly seeking improved aircraft especially in efficient next-generation wide-bodies. New production programs emerging from outside the United States and Europe, especially from Russia and China, further challenge the current supplier landscape and threaten to disrupt the global supply chain, resulting in new arising opportunities.

Source: 2018 Deloitte Consulting LLP

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.

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.

Our Graduates

- Our graduates in Aerospace Engineering are employed all over the world, with a majority in **Singapore, China** and **Europe.**
- The most commonly accepted positions are **Research Engineer, Project Engineer, Stress Engineer,** and **Mechanical Design Engineer.**
- Others may also choose to continue their academic journey with a doctoral candidate position (PhD).

"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

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+ As rated by Academic Ranking of World Universities (Shanghai Ranking) 2011-2013, 2016 and 2015 QS World University Ranking
^ As ranked in the 2018 Global University Employability Ranking by Times Higher Education
# As ranked by Academic Ranking of World Universities (Shanghai Ranking) 2017 and 2013/2014 QS World University Ranking