

MASTER OF SCIENCE

# Aerospace Engineering



## At a Glance

- The best of German engineering, infused with an Asian perspective
- Nurturing aerospace engineers of tomorrow
- Internationally-recognised degree conferred by TUM
- Bright career prospects regionally and worldwide
- Apply online at [www.tum-asia.edu.sg](http://www.tum-asia.edu.sg)

# About TUM

## Technical University of Munich (TUM)

The Technical University of Munich (TUM) was founded in 1868 and is one of Europe's leading technical universities. Serving as an entrepreneurial university that promotes talents and creates value for society, TUM has produced 17 Nobel Prize winners since 1927, most notably Ernst Otto Fischer (Chemistry) and Rudolf Mößbauer (Physics). Its focus areas are engineering sciences, natural sciences, life sciences, medicine, management and political and social sciences.

TUM promotes talents with its network of strong partners in research 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.

In international rankings, TUM regularly places among the best universities in Germany and worldwide. It is the only university to have won recognition as a German 'Excellence University' in every round since 2006.

## Technical University of Munich (TUM) Asia

Technical University of Munich (TUM) Asia was set up in 2002 as the first academic venture abroad by a German university, blending German academic excellence with industry relevance in Asia. Its partnerships with top Asian universities and industry leaders combine German engineering with Asian relevance to equip talents for industry and research sectors in the world.

With the changing needs of the economy, the specialised Master programmes that are offered keep pace with industry needs through an Asian-European perspective. Lecturers and professors hail from as far as Germany to equip students with their rich knowledge and experience.

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.

**NO. 1**  
university

TUM is ranked as the no. 1 University in Germany\*

**NO. 6**  
in employability

TUM ranked no. 6 in the Global Employability Survey<sup>^</sup>

**17**  
Nobel Prize recipients

17 scientists and alumni of TUM have received the Nobel Prize

**50**  
universities

TUM is ranked among the world's Top 50 Universities<sup>#</sup>

\* As rated by QS World Ranking 2015 -2019 and Academic Ranking of World Universities (Shanghai ranking) 2011 - 2013, 2016

<sup>^</sup> As ranked in the 2018 & 2019 Global University Employability Ranking by Times Higher Education (THE)

<sup>#</sup> As rated by Times Higher Education World University Rankings 2020, QS World Ranking 2018 and Academic Ranking of World Universities (Shanghai ranking) 2016 - 2018



# Programme Overview

Awarded by TUM, the **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.

## Programme Structure and Timeline



**15**  
modules

- 5 Core Modules
- 7 Elective Modules
- 1 Non-Technical Elective Module
- 1 Lab Course
- 1 Business & Technical English Module



**45**  
contact hours

for every Core and  
Elective Module

**2 Years**

- Full-time programme
- Coursework in Singapore
- Internationally-recognised degree

**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 a 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.

# Programme Modules

## 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 and Tools in Aerospace Engineering (Lab Course)

This module provides a comprehensive introduction to the functionality of the software MATLAB / Simulink and explains the aerospace engineering problems the tool can be used to solve. Emphasis is placed on numerical modelling of technical problems and the engineering interpretation of results. For dynamic vibration behavior, syntheses will be made with control simulation to show the interaction of several disciplines and to introduce the field of controlling flexible systems to students.

## 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 a 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, it 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 and military aviation will be given to enable basic differentiation of different aircraft configurational layouts. In particular, the interaction among different system elements, their respective requirements and their impact on configuration level will be outlined.

### Introduction to Flight Mechanics

This module will cover topics in flight system dynamics and flight control. Students will be able to understand relations between aircraft performance and flight control. Through this course, students will be able to apply aircraft performance calculations that are required in the preliminary design of aircraft and will be able to design basic flight controllers for stabilisation and improvement of flight properties.

### Flight Propulsion

The module provides basic knowledge about aerospace propulsion systems. The basic governing thermodynamic and 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 and materials, which provide a basis for structural development, including proper material selection. A general view on the basics of elasticity, structural stability, vibrations and strength, including fatigue problems, is 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. How the C\*-criterion is derived and modern concepts of adaptive control in aviation are 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 principles 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, optimisation 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 and reasons for these will be addressed and discussed.

### **Aircraft Design**

This module covers various current design methods and relevant design tools for the applied design of surface aircraft. With the simultaneous introduction to the aircraft design system, students will be able 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 phenomena 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 and 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, rotorcraft limits and mission design. It also covers tools for the cost and 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 and Fatigue, Performance Categories, Safety Analysis and Flight Accident Investigation.

### **Safety & Certification of Avionics & Flight Control Systems**

This module addresses the certification process of avionics and 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 astronomical and space engineering topics, and relevant theoretical background and 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, while the final objective is to give them a basic understanding of how to face decision problems in a company. Most importantly, students 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 its long-term financial structure.

### **Innovation and Technology Management**

This module presents the dynamics of technological development through innovation and 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 Enterprise Resource Planning (ERP) software packages nowadays. Concepts of material requirements planning and 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.

# The TUM Experience



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

## Entrepreneurial Thinking and Engagement

You will formulate and discuss ideas based on the diverse economic realities and learn to see from multiple vantage points. The unique joint degree programme equips you not only with the technical knowledge, but also with the business and cultural aspects of the subject.

## Industry Relevance

Our professors - the world's best - are industry experts and active researchers. This allows you to learn from a curriculum that is built around the latest technological trends and knowledge.

## Highest International Standards

You will receive a holistic learning experience with the 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 you receive their undivided attention.

## Global Prospects

You can choose to complete your internship and thesis in Singapore or anywhere in the world with a company, university or research institute. Your internationally recognised degree and experience is a great boost to your profile for future global job opportunities.

## TUMCREATE

TUMCREATE is a joint programme between the Technical University of Munich (TUM) and the Nanyang Technological University (NTU). The electromobility institute brings together the expertise and innovation of Germany and Singapore to drive innovation and shape the future of sustainable mobility by tackling issues ranging from molecules to the megacity. Graduates have the opportunity to apply for positions at TUMCREATE, especially if your interest lies in the area of transportation and mobility research.

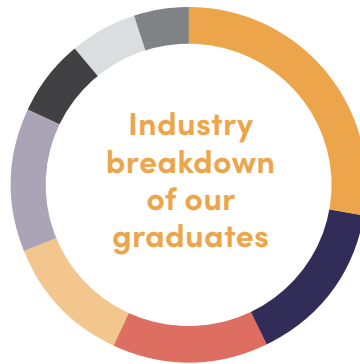
# Industry Outlook

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?

## 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.

Source: gov.sg, Singapore Economic Development Board, The Straits Times



Academic	28%
Engineering (incl. Aerospace Engineering)	15%
Aerospace industry	14%
Research	12%
Industrial and Manufacturing	13%
Automobile and Transport	7%
Technology	6%
Others	5%

Singapore is

**NO. 1**

in Asia for MRO. It is also the most comprehensive MRO in Asia.

Singapore launched the Aerospace Industry Transformation Map (ITM), expecting to achieve a manufacturing value-added of

**\$4 billion**

and introduce 1,000 new jobs by 2020.

The Aerospace industry employs close to

**21,000**

workers today, with the majority in high-skilled job roles.

Today, over

**130**

international companies carry 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).



## Programme Fees

### Processing Fee

SGD79 per application

### Tuition Fee

SGD38,520\*

## Admission Criteria

- **Bachelor Degree in Aerospace or Mechanical Engineering** or a closely-related discipline
- Bachelor Degree certificate or enrolment letter\* (if you have not completed your Bachelor Degree)
- Academic transcripts or mark sheets\*
- **2 Recommendation Letters** from your professors or employers
- **Statement of Purpose** indicating the reason(s) you are interested in this programme
- **Curriculum Vitae / Résumé**
- **TOEFL** test score ( $\geq 88$  for Internet-based test, DI code: 7368) or **IELTS** test score ( $\geq 6.5$  overall) taken no more than two years ago from date of submission
- **Akademische Prüfstelle (APS) certificate** for applicants who hold a degree from China, Vietnam, or Mongolia



The full application process and documents required for submission is available at [www.tum-asia.edu.sg/application-process](http://www.tum-asia.edu.sg/application-process)

Applications open 1 October every year.

\* Tuition fees are to be paid in 3 instalments.

\* 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, and medical insurance). These fees will be separately borne by the student.

\* The tuition fee stated is accurate as of 1 January 2020. 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 (GST). Please refer to our website for fee updates.

\* Documents which are not in English must be translated by a certified translator. All applicants are also required to submit an additional of

- 2 notarised copies of official or provisional Bachelor's Degree certificate
- 2 notarised copies of official academic transcript, and
- 2 passport-sized photographs when you have accepted the offer of admissions and are being matriculated into our programme.



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