Master of Science
Aerospace Engineering

At A Glance

JOINT DEGREE BY
Technical University of Munich (TUM)
Nanyang Technological University (NTU)

24 MONTHS 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++

1 NTU is ranked #1 in Asia for Engineering**

1 NTU is ranked #1 in the world for industry income and innovation*

8 TUM ranked #8 in the Global Employability Survey^*^*

50 Both TUM & NTU# are in the world’s Top 50 Universities

© AIRBUS 2006 / Photo by S. RAMIDIER

TUM is ranked as the #1 University in Germany+
NTU is ranked #1 in Asia for Engineering**
NTU is ranked #1 in the world for industry income and innovation*
Both TUM & NTU# are in the world’s Top 50 Universities
Technical University of Munich (TUM)

Technical University of Munich (TUM) is one of Europe’s leading research universities, with around 500 professors, 10,000 academic and non-academic staff, and more than 37,000 students. Its focus areas are the engineering sciences, natural sciences, life sciences and medicine, reinforced by schools of management and education.

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 a campus in Singapore as well as offices in Beijing, Brussels, Cairo, Mumbai, and São Paulo.

Nobel Prize winners and inventors such as Rudolf Diesel and Carl von Linde 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.

Nanyang Technological University (NTU)

Inaugurated in 1991, Nanyang Technological University (NTU) has grown to become a full-fledged research university, and is ranked as one of the fastest-rising Asian universities in the world’s top 50**. Hailing from more than 70 countries, NTU’s 3,800 strong teaching and research staff contribute their dynamic perspectives and years of solid industry experience.

NTU’s academic and research programmes, with real-world relevance, have reaped dividends in the form of strong support from major corporations and industry leaders, in terms of both research funding and partnerships as well as global internship opportunities for our students.

As the main Science and Technology university in Singapore, NTU has made substantial contributions to Singapore’s drive for research and innovation, with the 2014 Quacquarelli Symonds (QS) ranking NTU at 10th in the World for Electrical & Electronic Engineering.

**As rated by 2013/2014 QS World University Ranking
Master of Science
Aerospace Engineering

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

Duration of the Programme: 24 months

July

4 Months

• Arrival in Singapore

• Business & Technical English
  • 7 Core Modules

6 Months

• Elective Modules
  • Cross Discipline Modules

2 Months

Break

4 Months

• Elective Modules
  • Cross Discipline Modules

2 Months

Internship

2 Months

6 Months

• 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

Aerodynamics¹
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 Dynamics⁴
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 Materials⁵
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 Lab⁴
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 Lab⁴
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 Modules⁴ (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 Propulsion⁴
Computational Fluid Dynamics

Turbulent Flows⁵

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 data on boundary-layer.

Focus Area 2: Structures, Materials and Systems⁷
Plates and Shells⁷
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 Testing⁶
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 flat plate theory; Hygrothermal effects; Introduction to failure criteria; Basics of materials processing; Parameter studies and design steps.

Focus Area 3: Flight Mechanics and Control⁶
Advanced Flight Dynamics⁸
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.

Turbo Compressors

¹Disclaimer: 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.
²These modules are offered by NTU, with the rest being offered by TUM.
Admissions Information

ADMISSION CRITERIA*

- Hold a minimum 3-year Bachelor Degree in Electrical, Electronics Engineering, or equivalent degree in other relevant disciplines
- Submit one (1) notarised copy of Official or Provisional Bachelor Degree Certificate** and one (1) notarised copy of Official or Provisional Academic Transcript**
- 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 (Required for applicants whose native tongue or medium of instruction from previous studies is not in English)
- Submit Akademische Prüfstelle (APS) certificate (Required for applicants who hold a degree from China, Vietnam, or Mongolia)

| TOEFL test score requirements: At least 100 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 three (3) notarised copies of Official or Provisional Bachelor Degree Certificate, three (3) 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

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

FEES

<table>
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<tr>
<th>APPLICATION FEE</th>
<th>TUITION FEE</th>
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<tr>
<td>SGD 79 is payable for each application per programme</td>
<td>A total of SGD 38,520*</td>
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- The tuition fee will be divided into 3 installments for payment and may be further divided into SGD and EURO 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 NTU 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 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.

Highest International Standards
You will be studying with the world’s best professors from TUM and NTU, 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-NTU 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 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 tripped 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.

Our graduates are expected to be able to find positions with many companies, such as ST Aerospace, ST Electronics, and NTU.

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.

“TUM-NTU is a joint effort between experts from opposite sides of the world. The professors integrate their real world experiences from the industry with the academics and inspire us to perform our best, while helping us to assimilate the ideas and elevate us to their level.”

Mohammed Iqbal
Alumni, Master of Science in Aerospace Engineering PhD Researcher, ThermoPlastic composites Research Center (TPRC) / University of Twente, The Netherlands