# ENGINEERING SYSTEMS AND DESIGN

## PILLAR OVERVIEW

The focus of the Engineering Systems and Design (ESD) pillar is the study of large scale complex systems whose performance and function depend both on their technology and on the socio-economic context within which they operate. Examples include supply chains and logistics, financial services, health care delivery systems, transportation systems, security and defense systems, energy production and distribution systems, and many more.

The ESD pillar offers a highly innovative undergraduate programme, with a unique emphasis on design and active learning. In addition to providing for a strong foundation in the fundamentals of mathematics, science and engineering, the ESD pillar undergraduate curriculum provides students with a significant exposure to the social sciences, including management, economics, and public policy, with an added emphasis on the soft skills, including communication, team work, entrepreneurship and ethics. The ESD pillar curriculum is modular and flexible, with a mix of half and full term subjects and a wide range of technical electives, allowing students to gain more depth in one of several application tracks.

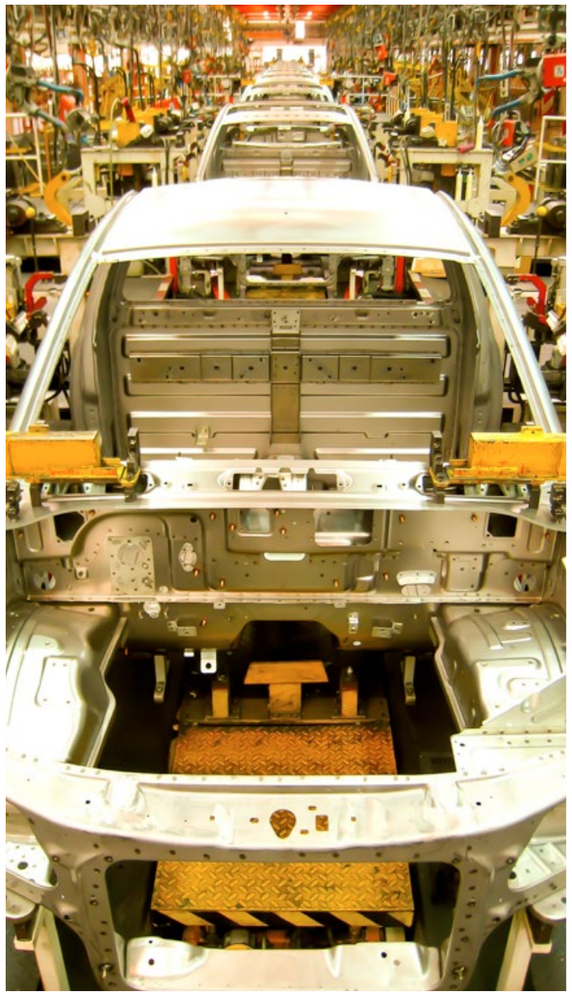
ESD pillar graduates will be prepared for a wide range of engineering and management careers in a variety of industries in the private and public sectors, such as:

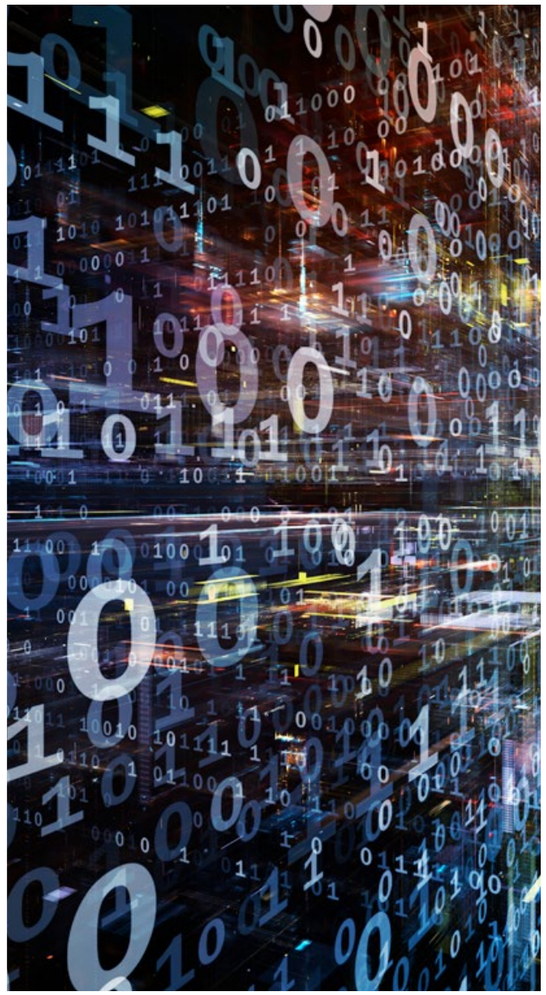
- Consultancy
- Energy and the Environment
- Entertainment
- Financial Institutions
- Healthcare
- Hospitality
- Manufacturing
- Supply Chains and Logistics
- Transportation/Aviation
- Academia

All SUTD students are required to take foundational subjects in humanities and the sciences as part of their curriculum. They go through a rigorous curriculum that is focused on design and on a modern pedagogical approach where students learn how to solve complex problems in interdisciplinary teams.

The ESD undergraduate degree delivers a programme that is broad, with opportunities for acquiring in-depth knowledge in specific application areas. The ESD core consists of rigorous methodology courses, which provide the technical foundation necessary to model, analyse, and manage large-scale complex systems. Students supplement this core by choosing from a variety of elective subjects depending on their interests. Students may also specialise in a specific focus track by choosing elective subjects related to the track.

Refer to the ESD Curriculum Chart which illustrates the ESD programme curriculum structure. The diagram depicts the typical sequence of subjects in the ESD curriculum. Each major row indicates a calendar year with columns representing the Jan-Apr, May-Aug, and Sep-Dec terms ordered from left to right.





**ESD PILLAR CORE SUBJECTS**
The ESD core is composed of subjects focused on various methods for analysis and modelling of engineering systems. These subjects, shown in green, are offered every year in Terms 4, 5 and 6. Full-term subjects are 12 credits and half-term subjects are 6 credits, corresponding to the number of weeks of instruction.

ESD Core Subjects:
- Engineering Systems Design
- Probability
- Optimisation
- Operations Management
- Statistics
- Stochastic Modelling
- Network Modelling
- Decision Analysis
- Quality & Reliability
- Simulation
- System Dynamics

**Electives**
Electives, shown in blue in the diagram, provide the opportunity for students to customise the ESD degree according to their interests and future careers. Electives comprise 60 credits of the ESD undergraduate programme, from which at least 24 credits must come from ESD subjects and at least 12 credits from subjects outside ESD (from ASD, EPD, ISTD, TECH). ESD offers a diverse set of electives, some are full term (12 credits) and some are half term (6 credits) subjects. Pursuing one of ESD's focus tracks can optionally help to guide the selection of these electives.

**Technical Application (TECH) Electives**
All engineering pillars also have a set of elective subjects associated with different applications streams, which permit greater focus and depth in applying their knowledge and offer students an important context to promote inter-pillar interactions and synergies. Students will be able to take technical electives in one of the four focused areas: Global Issues, Transportation, Manufacturing Systems and Enterprise Systems.

**HASS**
Humanities, Arts and Social Sciences (HASS) are an essential component of an SUTD degree. HASS subjects, shown in orange, are required in all but one term of study.

There are a variety of HASS subjects that are a particular relevance to ESD. In particular, ESD students are required to take Microeconomics, offered in Term 4.

**Capstone**
The capstone is a culminating project that allows students to use the skills they have learned in ESD in a real world industry or research project. The capstone projects often focus on interdisciplinary applications, solved by a team of students chosen appropriately from different pillars.

**TRACKS[1]**
The ESD undergraduate programme has been designed with flexibility in

mind, so that students can customise their tracks to suit their interests and future careers. Students may choose to follow one of six tracks. These tracks provide exposure to specific industries and are composed of three elective subjects usually taken in Terms 6, 7 and 8. Students who complete a track will have it indicated on their transcript so that future employers can recognise this expertise. Choosing a track is optional and students are expected to discuss their elective choices with their faculty advisor.

**SUPPLY CHAIN & LOGISTICS**
The supply chain and logistics track is concerned with the movement of raw materials into an organisation, the internal processing of materials into finished goods, and the distribution of finished goods to the end consumer. This track will cover the design and management of products, information, and financial flows that are associated with supply chains in a wide range of industries.

Track Subjects:
- Supply Chain & Logistics
- Manufacturing Systems
- Transportation Systems

**BUSINESS ANALYTICS INTERDISCIPLINARY TRACK WITH THE ISTD PILLAR**
The business analytics track is offered by the ESD pillar in conjunction with the ISTD pillar and focuses on data-driven decision-making. Students will learn how to identify, collect and analyse data to solve real business problems. This includes analysing trends, making predictions and building prescriptive models. Students will be equipped with the latest techniques in optimisation, statistics and machine learning to aid in making better decisions.

Track Subjects:
- Business Analytics
- Introduction to Algorithms
- Machine Learning

**FINANCIAL SERVICES**
The financial services track is designed for students who are interested in careers in the securities,

banking, and financial management and consulting industries, or as quantitative analysts in corporate treasury and finance departments of general manufacturing and service firms. The track-specific subjects will cover portfolio theory, derivatives valuation, and financial risk analysis, complementing the core subject in stochastic processes, optimisation, simulation and statistics.

Track Subjects
- Finance Theory
- Financial Markets
- Mathematical Finance
- Finace Lab
- Financial Decision Making

**International Trading Institute @ SMU / SUTD Trading Associate Programme**
ESD has partnered with the Singapore Management University to deliver a certification programme in trading.

- Trade Finance
- Shipping Business
- Agro-Commodity Trading
- Oil & Petrochemical Trading

**ENERGY & THE ENVIRONMENT**
The energy and the environment track highlights sustainability assessment of new technologies through analytical tools and methods. Subjects will introduce methods to evaluate the life-cycle impact and cost of a product, service, or process, yielding its net effect on the environment. We cover the relevant policy issues, such as trade-and-cap emission rules, and social trends that are intimately tied with our scenario projections of the future as well as the economic impact of energy and environmental regulations.

Track Subjects
- Energy Systems in the Developing World
- Energy & Environmental Systems
- Industrial Ecology

**HEALTHCARE**
The healthcare track takes a systems view to improve the efficiency of healthcare delivery. We review topics from operations and inventory theory that can be used to streamline the supply chains involved in hospital management. Risk assessment between different treatments as well as the interaction of government requirements on patient service brings aspects of ethics and policy into the curriculum.

Track Subjects
- Global Health Technologies
- Healthcare Systems
- Service Operations

**TELECOMMUNICATIONS**
The telecommunications track emphasises the design of wireless and wired systems that are cost-effective, scalable, intelligent, and meet emerging needs for high data-rate and reliable communications. Resource allocation will be optimised across multiple layers, and technical and economic viability of various communication systems will be jointly investigated. This track crosses multi-disciplinary boundaries by combining techniques from network optimisation, communication theory, game theory, probability and stochastic process, queuing theory, control theory, and network protocols and algorithms.

Track Subjects
- Network Economics
- Digital Communication Systems
- Discrete Signal Processing

**CREATE YOUR OWN TRACK**
Students have the option of creating their own track. To do so, a student must prepare and submit to the ESD Undergraduate Committee a proposal listing any four subjects from the list of ESD electives and any two subjects from a pillar other than ESD. The undergraduate committee will make a recommendation to the Head of the ESD Pillar, whether or not to accept the proposal. The Head of Pillar makes the final decision.

*Footnote:*
*[1]Tracks offered in a year are subject to changes*

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