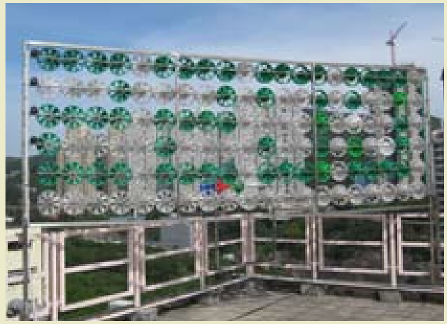
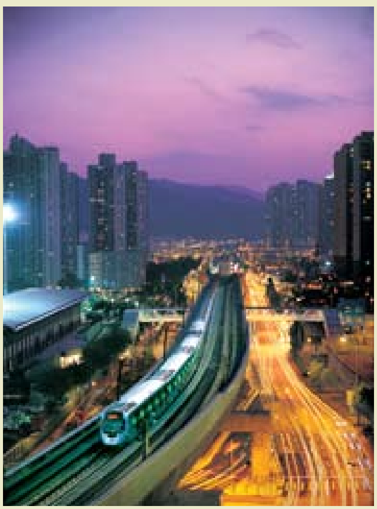
Teaching Areas

Container ships can always be seen in the Hong Kong sea district, which is one of the busiest ports in the world.
(Courtesy of Marine Department, HKSAR Government)



A micro-wind turbine installation on the rooftop of a primary school in Kowloon.

Hong Kong's built environment comprises congested tall buildings.
@Gibbsterr / Dreamtime.com



Ma On Shan Railway (Courtesy of MTRC).

Since early times, mechanical engineers have been responsible for the design, analysis, manufacture and maintenance of mechanical systems such as automobiles, ships, airplanes, heating and cooling systems, industrial equipment and machineries, etc. Over the past few decades, the accelerated growth in scientific knowledge and technology has brought about a significant change in mechanical engineering, both in its education and practice as a profession. For instance, with the rapid advances in computer technology, mechanical engineers are now extensively using computer aided engineering (CAE) tools to undertake design and analysis. To keep pace with the technological advancements, our mechanical engineering degree curricula are structured to bring students quickly to the frontier of knowledge in a wide range of fascinating fields. Our graduates are also imparted with an awareness of the impact of engineering developments on society, professional ethics and the ability to communicate and cooperate with personnel in other disciplines. As a matter of fact, many of our graduates are now assuming very senior technical and managerial positions in a great variety of industries including utility services, building services, manufacturing and environmental consultancy services.

Aeronautical Engineering

(Coordinating staff: Ir Prof. L.X. Huang, Dr. M.X. Huang)

"HOMER" represents the first result of our DBF project.

A typical jet engine mounted on an airliner.

Winglet modification on a Boeing 737 aircraft. (Courtesy of HAECO).

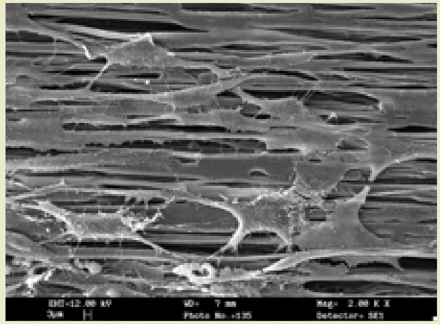
"Stingray" - another model airplane designed and built in the DBF project team.

Aeronautical engineering is the branch of engineering that concerns aircrafts, or the flight of any vehicle heavier than air. Apparently, it originates from ancient human fascination about birds' flight, but serious engineering development took place from 1920s and through war efforts. Further developments in the middle of the last century extend its activity to space flight (aerospace engineering). Modern flight vehicles have to put up with severe conditions such as rapid temperature and pressure changes in the atmosphere during flight, being hit by lightning, impact of birds or even engine failures. They also have to endure heavy structural loads applied upon vehicle components; numerous issues must be taken into account. Consequently, they are products of complex synthesis of various technologies and sciences, including but not limited to aerodynamics and propulsion technology, material sciences, stress analysis, control engineering, avionics and human comfort studies.

Biomechanical Engineering

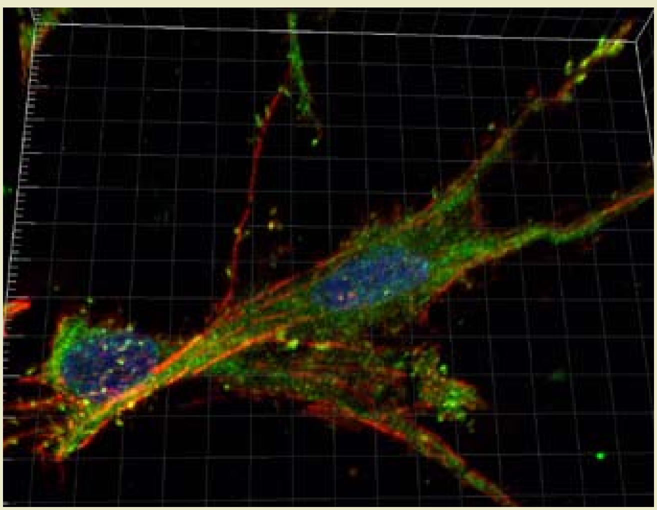
(Coordinating staff: Ir Dr. B.P. Chan, Ir Dr. Y. Lin, Ir Prof. M. Wang)

In vivo investigation: a tissue engineering scaffold is implanted in the muscle of a rabbit.



Contact guidance: osteoblastic cells cultured on aligned electrospun PHBV fibers.

Enhancing cell adhesion: osteoblastic cells cultured on electrospun surface-nanoporous PHBV fibers.



Human bone marrow mesenchymal stem cells in 3D collagen matrix after 9 hours of compression loading.

Red : Actin cytoskeleton;
Green : Arp2/3 (promoting nucleation of actin fiber branching);
Blue : DAPI (nuclear counterstaining);
Yellow : co-localization of actin and Arp2/3 (actin branching).

In recent years, integrating knowledge from engineering and life sciences has received increasing attention both in academia and industry. To prepare our graduates for this challenge, the department is offering a series of Biomechanical Engineering courses. In particular, students will learn (1) fundamentals for understanding and analyzing various mechanical phenomena, such as conformation and dynamics of biomolecules, protein-protein interactions, flow of biofluids, heat and mass transfer, in biological systems on the level of cells, tissues and organs; (2) knowledge of different types of materials widely used for biomedical applications, such as implants and medical devices, technologies for their fabrication and techniques for their characterization and evaluation; (3) how tissue regeneration takes place, what the methods and techniques to regulate or guide this important process are and how to engineer functional tissues for replacement. Basic knowledge in cell biology and biochemistry essential for understanding course topics will be introduced to students as well.

Building Services Engineering

(Coordinating staff: Dr. B.P.L. Ho, Ir Prof. Y.G. Li)

Installation of escalator systems in the atrium of a shopping mall.

Building services distribution systems in a high-rise building.

Lighting design for an airport terminal building.

Building services systems are critical to all the buildings.

Building Services Engineering (BSE) involves the design, installation, operation and management of all the mechanical and electrical systems in the buildings. Examples of BSE systems include air-conditioning, ventilation, electricity, lighting, plumbing, drainage, fire protection, vertical transportation, building automation, communication networks, security and alarms. With the rising standards of modern buildings and the growing importance of energy efficiency, indoor environmental quality and green building design, the role of the Building Services Engineers has become very critical and they are also in high demand in the world with excellent employment prospects.

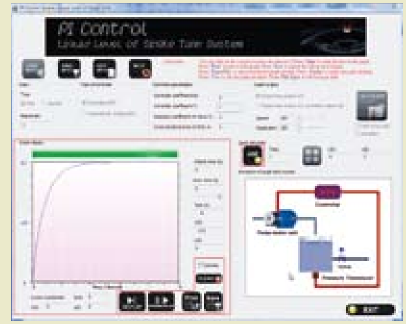
The BSE courses enable the students to acquire transferable skills and knowledge for a professional career. Our courses cover the fundamental theories, basic concepts, technical elements, systems design, code requirements, practical applications, building project and contract management. Students can develop a sound foundation of engineering principles and the ability to apply them effectively to the complex situations in real world.

Control, Automation & Instrumentation

(Coordinating staff: Dr. M.Z.Q. Chen, Dr. K.C. Cheung, Ir Prof. J. Lam)

Wind turbine is a complicated electromechanical system. Its plant room typically houses servo control systems (to align the rotor axis with the wind and to give the blades the optimal angle of attack), gearbox, electric generator and power converter (to interface with the transmission network). (Courtesy of Avantis HK).

Smart grid control



The output page of a computer project on simulation of liquid level controller.

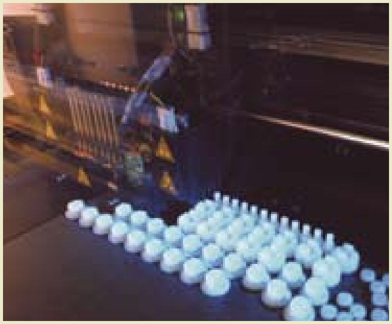
Robots designed and built by students for Asia-Pacific Robot Contest, consisting of microprocessor control boards, optical sensors, laser range finder, d.c. motors, motor drive boards and steering system.

As technologies advance, control, automation and instrumentation are becoming increasingly important. Control systems are now essential in power stations, transportation vehicles, air-conditioning, lifts and even consumer products. These systems use electricity for their operation, because not only it is the most convenient form of energy, but also many electronic devices, ranging from simple encoders to complex microprocessor-based controllers, are built-in within these systems.

In this teaching area, students learn about electrical and electronic engineering at the early stage of the curriculum, which includes topics such as circuit theory, d.c. and a.c. motors, three-phase power supply and power electronics. The foundation of control allows students to gain essential knowledge in control system design. More advanced control and instrumentation topics, such as computer control and hydraulic control systems, will be covered as an optional course to enhance students' knowledge of the subject.

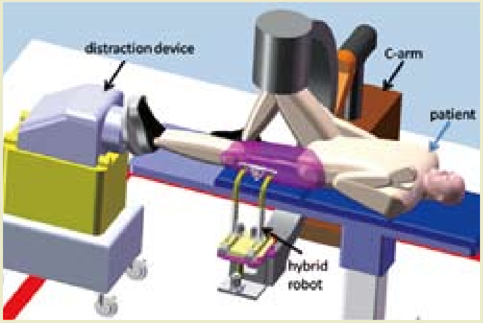
Design & Manufacturing

(Coordinating staff: Dr. C.K. Chan, Dr. Y.H. Chen, Ir Prof. S.T. Tan)

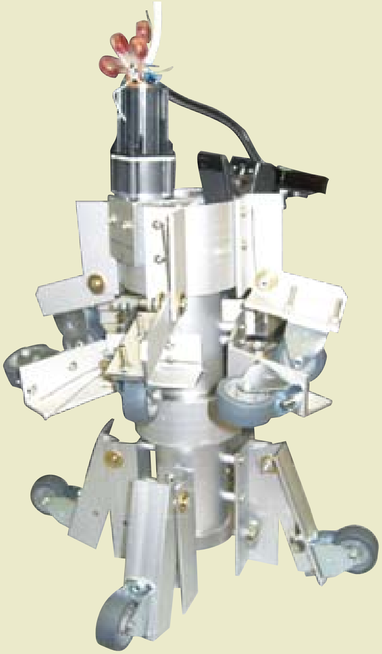


In a collaborative project with our Medical Faculty, artificial blood vessel models were made by using flexible and transparent rapid prototyping material. The models were used for visualizing simulated blood flow and for facilitating pre-surgical planning.

A self-developed testing to simulate the wear condition of artificial finger joints.



The design and development of a robot surgical system.



To extend the service life of underground pipelines, a unique robotic device was developed by a student project group to travel inside a gas pipe for spraying protective coating on its inner surface.

Design and manufacturing is a major element of our mechanical engineering degree curriculum. Related courses are structured to provide students with relevant knowledge and experience in accordance with their study progress. In the early stage, students are equipped with the ability to communicate design and manufacturing information and an understanding of basic manufacturing processes through lectures, assignments and engineering training. Systematic methods and practice for designing engineering components and assemblies are introduced in later years of study. Students are grouped into project teams to handle real-life engineering design problems, some of them are sponsored by industrial companies. At the same time, students learn design methodologies and project management skills in the group project by interacting with the supervising staff and project sponsors. Optional courses are also available for students to strengthen their knowledge in computer-aided design and manufacturing technologies.

Dynamics, Vibration & Acoustics

(Coordinating staff: Ir Prof. L.X. Huang, Dr. K.W. Kwok)

Pneumatic tyres, springs and hydraulic dampers are commonly used in the suspension system of road vehicle. (© Kristy Pargeter I Dreamstime.com)

Sound power measurement for a tunnel boring machine. (Courtesy of Wilson Acoustics Ltd and MTR Corporation Ltd)

The 660 tonnes pendulum used in Taipie 101's major tuned mass damper (photographed by Armand du Plessis).

Aircraft noise is a serious problem for residents near airport and it was once the fatal weakness of the world's only commercial supersonic aircraft "Concorde". Acoustics and vibration is the study that solves these problems. Illustrated here is the noise source distribution on an aircraft. (Courtesy of the Boeing Company)

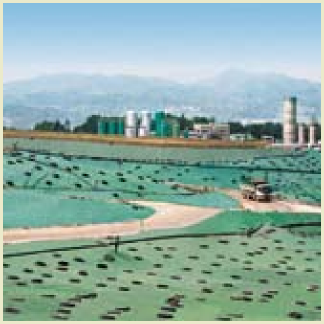
Taipei 101 is the world's second tallest building in 2011. To reduce its vibration induced by earthquake and strong wind, the world's largest tuned mass damper (see the photo at the top right) was suspended from the 92nd to the 88th floor. The vibration energy is transferred to the mass and dissipated by eight hydraulic dampers connecting the lower portion of the mass and the building. (photographed by Gaurav Gupta)

Dynamics concerns the motion of objects under the action of forces. The "objects" range from particles, rigid bodies, interconnected rigid parts found in gears, force and motion transmission systems, to complete vehicles, such as double-decker buses travelling on hilly roads or spacecrafts under the influence of maneuvering astronauts. If the objects are relatively flexible, forces can also cause vibration and severe structural damage, especially when resonance occurs. The study of dynamics and vibration is also closely related to that of automatic control.

In our courses, knowledge for understanding, analyzing and measuring dynamic and vibrating systems will be introduced. A particularly important application area is condition monitoring and fault diagnosis, which involve the use of electronic instrumentation and digital signal processing techniques. Reduction of noise caused by vibration, or other sources is also one of the advanced topics offered at the later stage of the curriculum.

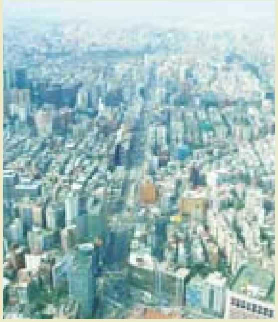
Energy & Environment

(Coordinating staff: Ir Prof. D.Y.C. Leung, Ir Prof. Y.G. Li, Dr. C.H. Liu)

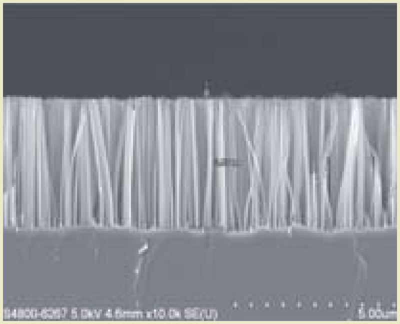


The landfill gas plant in the North-East New Territories Landfill at Ta Kwu Ling. The plant is expected to supply over 10,000 m^3/hr of methane in 2015. (Courtesy of Hong Kong and China Gas Co. Ltd.)

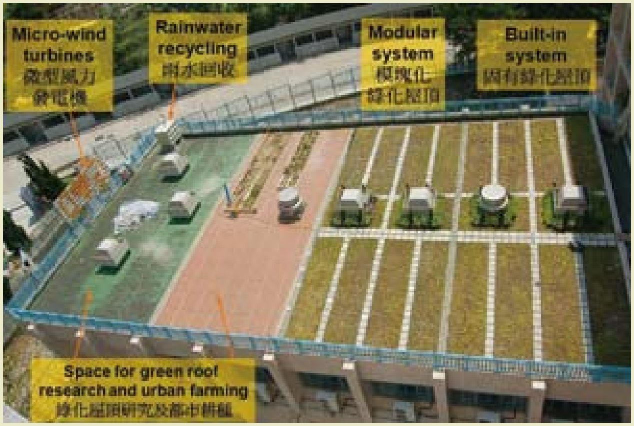
Vibratory membrane recycling system for used oil. The small photo shows oil at different filtering stages. (Courtesy of Dunwell Group)



Rapid urbanization in Asia introduces significant urban climate and environment challenges.



Silicon nanowire developed on silicon substrate for solar cell applications.



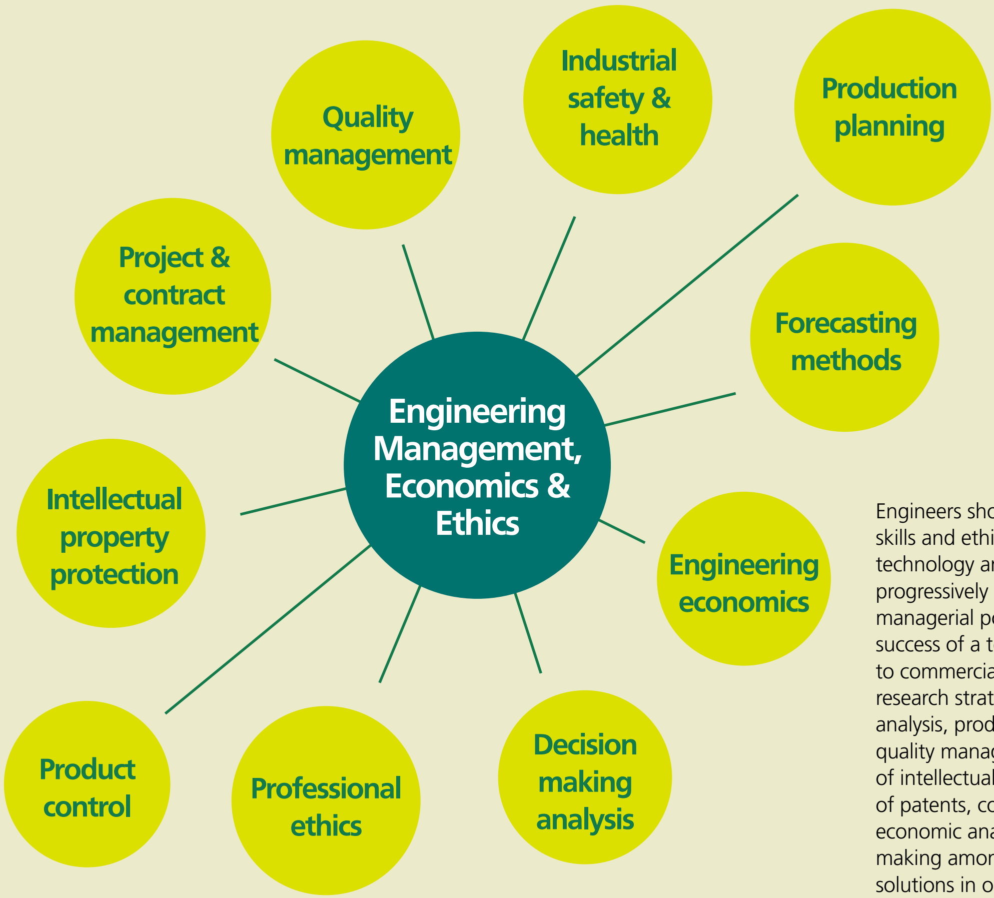
A pilot green roof set-up with the help of our staff in St. Bonaventure Catholic Primary School, Wong Tai Sin.

The prosperity of Hong Kong gives us a high standard of living but, at the same time, brings about many environmental problems. Most pollution is caused by the production of power and consumption of energy, for example, in electric power plants and motor vehicles. The construction of infrastructure may also cause many problems which require solutions by environmental engineers. The Environmental Impact Assessment Ordinance requires all major engineering projects be assessed in all environmental aspects before their commencement. Consequently, our society demands a large number of mechanical engineers who possess the knowledge in various modern energy production and conversion systems, as well as environmental awareness.

Environmental engineering is a broad area and this feature is well-reflected in the offered courses. They cover concepts and measurements of water and air quality, air pollution control, municipal and industrial wastewater treatment, solid and hazardous wastes, noise management, energy efficiency, renewable energy etc. In terms of energy courses, we are offering a variety of courses covering different areas including energy auditing, energy conservation and conversion. Furthermore, as the key element of the courses, green energy and the state-of-art technology in renewable energy will also be covered in the courses. These courses are aimed at training the students to be a professional engineer for resolving the global challenges in the energy and other related issues.

Engineering Management, Economics & Ethics

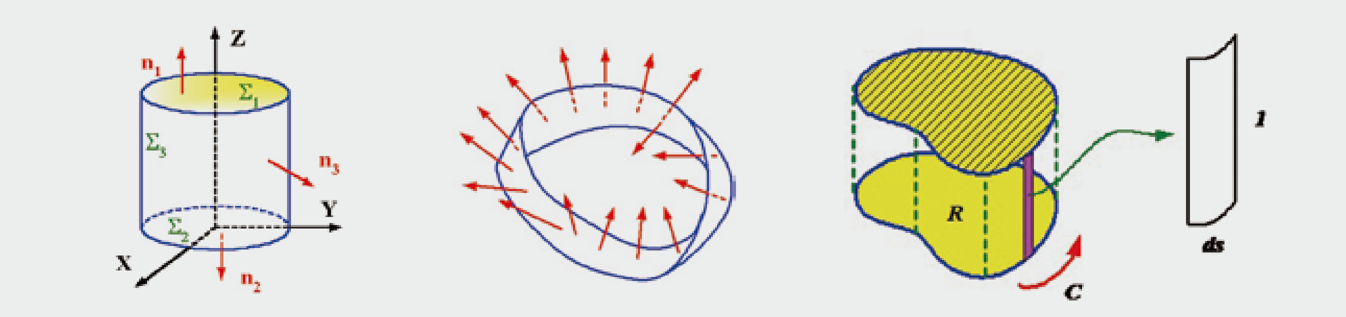
(Coordinating staff: Dr. B.P.L. Ho)



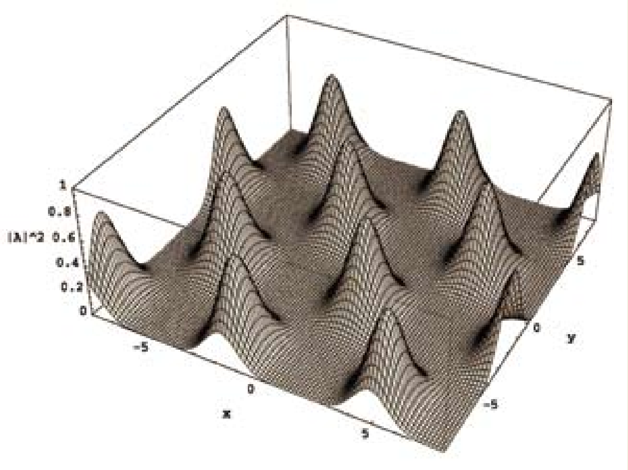
Engineers should possess necessary management skills and ethical quality to bridge the gap between technology and business. These skills become progressively important as they take on senior managerial positions in their professional careers. The success of a technological development from concept to commercial product relies highly on effective research strategy, technology & product life cycle analysis, production planning, project management, quality management and so on. Proper protection of intellectual property should be ensured by means of patents, copyrights or trademarks. Engineering economic analysis should be performed in decision making among feasible alternative engineering solutions in order to maximize the economic benefit.

Engineering Mathematics

(Coordinating staff: Dr. M.Z.Q. Chen, Prof. K.W. Chow, Ir Prof. J. Lam)



Different geometries experienced in engineering contexts are addressed in the Engineering Mathematics courses.



Doubly periodic patterns of water waves governed by the Davey-Stewartson model (amplitude $|A|^2$ versus the spatial coordinates x, y)

Advanced mathematics is an essential tool for describing physical processes. It provides the foundation for scientific analysis and engineering computation. A compulsory sequence of engineering mathematics courses, covering advanced calculus, linear algebra, ordinary differential equations, probability and statistics, will be required for all undergraduates. Subsequently, optional courses involving more advanced mathematical and computational techniques, e.g. integral transforms, calculus of complex variables and methods for solving partial differential equations, will be offered to students with strong quantitative skills.

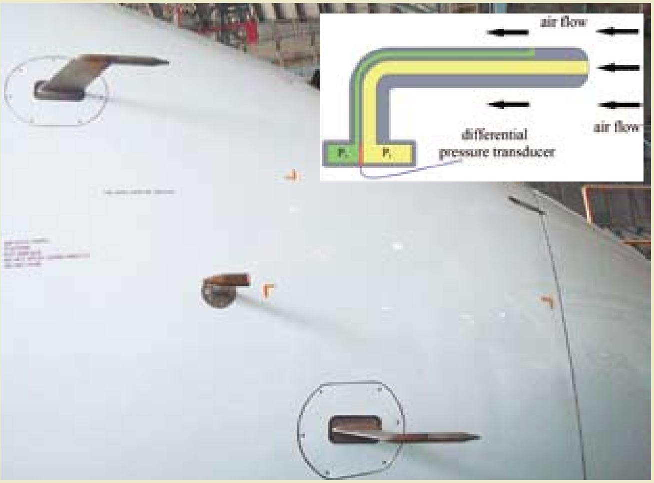
Fluid Mechanics

(Coordinating staff: Prof. K.W. Chow, Prof. C.O. Ng, Dr. A.H.C. Shum)

Aqueduct, a typical example of open channel flow, constitutes the ancient water supply system and is still used in many European countries. (© Peter Szucs | Dreamstime.com)

Fluid flow can be manipulated in small channels for fabrication of useful materials, such as liquid marbles.

Wave motion is related to the transmission of signal and energy, and thus very important in Nature as well as engineering processes. (© Nico Smit | Dreamstime.com)



Pitot-static tubes equipped in a jetliner for flight speed measurement.

Fluid mechanics plays a fundamental role in many core applications of mechanical engineering, e.g., aircrafts and marine vessels, transport of fuel, breakwater and design of harbours. Undergraduates will first learn the basic fluid mechanics from a macroscopic perspective. Basic concepts like momentum theorems will be explained, and forces on structures impinged upon by liquid jets will be computed. Subsequently, analytical techniques will be applied to elucidate the flow configurations arising from sources, sinks and vortices. Open channel flows and the dynamics of rivers and hydraulic pumps will be examined. The concept of a boundary layer is introduced.

In the final year, students may pursue electives specializing in the physics of a viscous fluid. Configurations of critical engineering significance, e.g. flows behind a bluff body, dynamics of airplane wings and the transition from laminar to turbulent regimes, are addressed. Finally, recent developments in microfluidics are discussed.

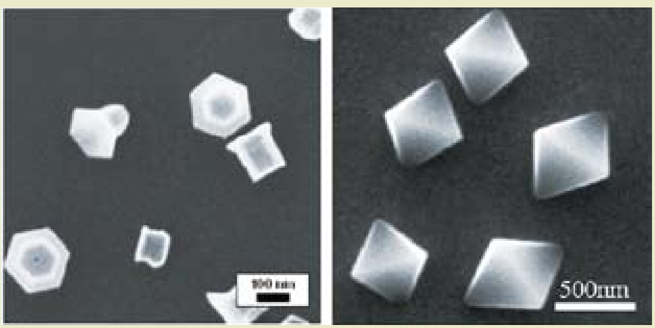
Materials & Nano-technologies

(Coordinating staff: Dr. M.X. Huang, Ir Prof. A.H.W. Ngan, Ir Prof. M. Wang)

Polymeric foam-type materials are extensively used in sports protective gears.

Nano-composite scaffolds for bone tissue engineering made from a selected laser sintering process.

Heat treatment of materials.



Nano-sized materials often exhibit new properties including quantum confinement effects, enhanced catalytic functions and strength.

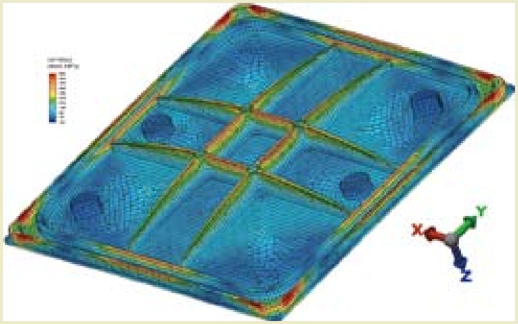
Every piece of engineering design involves materials, and to a large extent, many of the most recent developments in mechanical and other branches of engineering hinge on breakthroughs in materials research. A successful engineer must have a sound knowledge of the behaviour of various types of engineering materials. How materials behave under their service conditions depend not just on the intrinsic properties of the materials but also on the processing treatments they received. Materials engineering is therefore a challenging discipline. In the early stage of the curriculum, our students will study the structures of metals and polymers, as well as the factors that influence their performance in use. In the final year, other materials such as composites, ceramics and high strength alloys will be introduced, and materials behavior under hostile conditions will be dealt with. Students are also provided with the opportunity to enroll in master-level courses on plastics technology and nanotechnology.

Mechanics of Solids

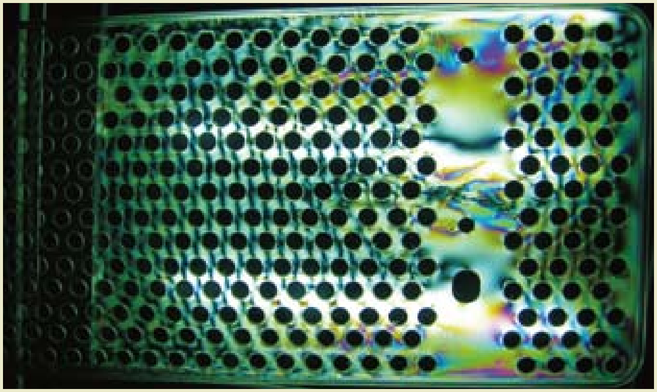
(Coordinating staff: Dr. M.X. Huang, Dr. Y. Lin, Ir Prof. K.Y. Sze)

Our Department conducted computational analyses of an aircraft cabin seat for Hong Kong Productivity Council. The figure shows the stress level when the seat is undergoing 16g deceleration.

Cracks emerging from a rivet hole which can be found in many metallic structures. (© Petr Kastorsky | Dreamstime.com)



Stress analysis for a Class B-125 kN manhole cover. (Courtesy of Dextra Pacific Ltd)



Photoelastic method is used to assess the residual stress, which can be visualized in the form of colourful fringes, in a polycarbonate panel. (Courtesy of Architectural Acoustics)

Mechanics of solids is the branch of mechanics that deals with the behavior of solid bodies under static and dynamic loading. It is different from statics and dynamics, which mostly concern with the external forces and motions associated with particles and rigid bodies. Mechanics of solids deals with deformable bodies by taking their material properties into account. It focuses on the internal force and deformation which are known more technically as stress and strain, respectively. In all engineering products, such as aircrafts, automobiles, mobile phones, electrical appliances and electronic components, mechanical strength is always a critical consideration which cannot be assessed without the knowledge of stress and strain distributions. Through the courses offered in this area, students learn analytical, experimental and computational techniques for analyzing and predicting stress, strain and mechanical strength in load bearing components with and without the presence of stress concentrations such as holes, notches and cracks.

Thermal Engineering

(Coordinating staff: Ir Prof.Y.G. Li, Dr. C.H. Liu, Prof. L.Q. Wang)

Heat sinks used in PC dissipate heat efficiently by using a large surface area to volume ratio.

A power plant generates electricity based on a number of sophisticated thermodynamics processes, including fuel combustion, steam generation in boiler and its expansion through turbine, etc. . (Courtesy of HK Electric)

In large hotels, heat pumps are installed to extract the heat dissipated by air-conditioning systems to warm up tap water for sanitary use. The photo shows a small heat pump designed by our department under the sponsorship of Environment & Conservation Fund and Woo Wheelock Green Fund. The heat pump can be adopted in residential flats in which split-unit air-conditioners are used.

Engineering thermodynamics deals with energy and its conversion during a process. For example, the temperature increase due to rapid strokes of air pumped into a soccer ball can be explained by thermodynamic principles. Practical engineering applications of thermodynamics include steam power plants, internal combustion engines, jet engines, air-conditioning systems, refrigeration systems, etc. Understanding thermodynamics principles enables us to analyze a thermodynamic process, to design effective systems and to optimize their energy efficiency.

Heat transfer seeks to predict and control the energy transfer that takes place in/between material bodies as a result of a temperature difference. It studies how heat is transferred and how the transfer rate can be predicted and controlled. Common modes of heat transfer include conduction, forced convection, natural convection, boiling condensation and radiation. Our students will learn fundamental principles and applications of engineering thermodynamics in their first two years and heat transfer in their final year.