2010-2011
MSC(ENG) IN MECHANICAL ENGINEERING

Programme Objectives

The aim of the programme is to provide advanced postgraduate education in the fields of energy and power; environmental engineering; material technology; theoretical mechanics; marine and offshore engineering; and computer aided design and manufacturing to graduates in engineering or related science.

Course Selection

For full-time mode of study, students need to complete a project and 8 courses of which 3 courses can be chosen from other MSc programmes in the Faculty of Engineering. Furthermore, students following the "Energy and Environment" theme are encouraged to select most of their modules from a recommended list. Each course involves 30 contact hours. Classes are mainly scheduled in weekday evenings and on Saturdays.

General or Theme-related?

Students with a general interest in the broad field of Mechanical Engineering may choose from the wide range of advanced courses available, without following any particular theme. However, some students may wish to concentrate on a coherent set of courses that follow a theme. At the present time, the Department offers the theme "Energy and Environment", and students wishing to follow this theme are encouraged to select courses from a recommended list.

The "Energy and Environment" Theme

Energy and Environment

Worldwide there are increasing problems of pollution associated with energy usage. Therefore, this theme embraces indoor and outdoor environmental pollution, together with the efficient production and use of energy. The core modules are structured to provide students with the engineering knowledge and tools to tackle problems often found in the natural and built environment. The primary emphasis is on mechanical topics, but students interested in other environmental areas may choose to take suitable courses available elsewhere in the Faculty.
Full details of all the courses offered by the Department are given in the Curriculum section. However, students opting for this theme will select most of their courses from the following subset:

Courses for "Energy and Environment"

MECH6007 Project (4 modules)
MECH6009 Renewable energy technology I
MECH6017 Noise and vibration
MECH6018 Atmospheric environment modelling
MECH6019 Sources and control of air pollution
MECH6023 Power plant technology
MECH6024 Applied mathematics for engineers
MECH6026 Computational fluid dynamics
MECH6033 Energy conservation and management
MECH6038 Renewable energy technology II
MECH6041 Energy audit and energy saving measures
MEBS6004 Built environment

MEBS6010 Indoor air quality

Curriculum

A taught Master student will not be permitted to select a course whose contents are similar or identical to any course he/she has previously taken for the purpose of fulfilling the requirements of another degree.

The following list is not final and some courses may not be offered every year.

MECH6007. Project (4 modules)

Students will undertake an assigned and supervised project which will be assessed. The project must relate to the subject matter of the curriculum and be agreed by the Department of Mechanical Engineering.

MECH6001. Advanced design methods and applications *

Engineering design; axiomatic design; creative design; design for human factors; optimization design; design for product lifecycle; design for manufacturability; design for assembly; robust design; reliability design.

MECH6003. Advanced fluid mechanics

Fundamental concepts and equations; hydrodynamic lubrication; boundary layers; turbulent flow; pipe flows; open channel flows.

MECH6009. Renewable energy technology I

Basic energy concepts; present-day fuel use; sustainability problems; solar thermal energy and direct conversion systems; wind turbines; biomass; bio-fuels; energy from refuse; tidal power; wave energy technology; hydrogen energy and fuel cells.

MECH6010. Service behaviour of materials

Creep regimes; creep mechanisms; creep resistant alloys; brittle fracture; ductile fracture; brittle-ductile transition; fracture mechanism maps; fatigue; Basquins and Coffin-Manson Laws; Goodman's relation; Palmgren-Miner rule; corrosion; electrochemical principles; forms of corrosion; corrosion control; case studies; introduction to polymer-matrix composites.

MECH6017. Noise and vibration

Fundamentals of acoustics; noise measurement; human hearing; noise in rooms; sound absorption and transmission through walls; environmental legislation and guidelines; fundamentals of vibration and its measurement; vibration absorption and isolation; control of noise and vibration at the source.

MECH6018. Atmospheric environment modelling

Foundations of atmospheric dynamics; models of winds; atmospheric turbulence modelling; boundary layer climates; air pollution in boundary layer; atmospheric diffusion theories.

MECH6019. Sources and control of air pollution

Basics of air pollution; air pollution transports; sources of air pollutants; control of gaseous pollutants; control of particulate matter; atmospheric dispersion modelling.

MECH6023. Power plant technology

Historical development; energy resources; steam and vapour cycles; boilers; fuels and combustion; steam turbines; gas turbines; principles of nuclear energy; radioactivity; reaction rate and power shape; nuclear reactor thermal-hydraulics; Pressurized Water Reactor power plant and its design limits.

MECH6024. Applied mathematics for engineers

Statistical and numerical methods in engineering; hypothesis testing; estimation of parameters and confidence intervals; correlation coefficient; direct and iterative methods for systems of equations; numerical analysis; finite difference and finite element schemes; wave propagation and vibration; normal modes.

MECH6025. Marine propulsion plant

Machinery systems; design criteria; prime mover efficiency; energy saving methods. Propulsion; fixed and controllable pitch propellers; design procedures; matching of hull, propeller, diesel engine and turbocharger. Marine shafting design; alignment; vibration; thrust and tail shaft bearings.

MECH6026. Computational fluid dynamics

Fundamental concepts and equations of thermal fluid dynamics; finite-difference method for solving partial differential equations (stability, consistency, convergence, accuracy and efficiency, and solution of system of algebraic equations); simplified models for fluid flow (wave equation) and heat transfer (heat equation); grid generation; turbulent diffusion and shear flow dispersion; numerical solution of transport equations (mass; momentum and energy transport); applications involving the built environment, air pollution, atmospheric diffusion and dissipation, power-plant design, land- air- and marine-vehicle design; etc.

MECH6028. Processing and properties of engineering plastics

Viscosity of polymer melts, extrusion; injection moulding; blow moulding; joining; plating; yield criteria; environmental stress cracking; UV degradation; flame retardation; biodegradable polymers; viscoelastic behaviour of plastics; dynamic behaviour; design methods for plastics based on creep data.

MECH6030. Computer control for manufacturing processes

Structure of process control computers; interface; z-transform, sampling theory; discrete-time models; stability analysis; discrete controller design; optimal control; state space representation and controller design; parameter estimation; self-tuning controllers; control applications.

MECH6031. Computer automated inspection

Inspection planning; process capability; control charts; optical gauging and profiling; image acquisition and storage; lighting and optical systems; image processing and understanding; pattern recognition and decision making; coordinate measuring machines (CMM); CAD-based CMM inspection.

MECH6032. MEMS & Microsystems design and manufacturing

MEMS and microsystem products; microsensors; microactuation; multidisciplinary nature of microsystem design and manufacture; materials for MEMS and Microsystems; micromanufacturing; microsystem design; microsystem packaging.

MECH6033. Energy conservation and management

Energy sources and environmental impact; energy in buildings; energy-efficient industrial processes; waste heat recovery; energy storage; energy auditing; economic analysis; energy strategies and management.

MECH6034. Computer-aided product development (CAPD) *

CAD modeling; Haptic shape modeling; reverse engineering; prototyping; product development case studies.

MECH6035. Finite element applications in product design

Concepts in finite element analysis; finite elements in vibration analysis; finite elements in design optimisation; introduction to nonlinear and multi-physics analyses; practical sessions on solving engineering problems by using a state-of-art finite element software.

MECH6036. Engineering stress and strength analysis

Introduction to fracture mechanics and fatigue analysis; design against fracture and fatigue failure; introduction to impact mechanics; design for impact loads; impact testing: charpy; izod; strain gauge method; photoelasticity; moire and interferometric methods; practical sessions.

MECH6038. Renewable energy technology II

Prospects of renewable energy sources; sun-earth trigonometry; beam and diffuse radiation; collector types; solar heating and cooling; system design; tracking; photovoltaics; Wind energy resources; aerodynamics; blades element theory; components and operational characteristics; utility connected wind turbines; off shore wind farms.

Pre-requisite: MECH6009

MECH6039. Biomaterials and tissue engineering

Bioactive bioceramics; bioactive composites; surface modification of metallic biomaterials; blood-contacting biomaterials; advanced testing and analytical techniques for biomaterials; long-term performance of biomaterials; clinical applications of biomaterials; tissue engineering: principles, methods and applications; standards and regulatory issues.

MECH6040. Foundations of nanotechnology

Characteristic length scales, nanomaterials, nanostructures, physical properties of nanostructures, deposition techniques of nanofabrication, high resolution analysis and characterization, scanning probes methods, nanoindentation, deformation of nanostructures, mechanical behaviours of nanocrystalline solids, ultra-high strength of nanostructures, sensors, actuators, MEMS, NEMS, functional nanomaterials, nano-scale devices, modelling and computer-aided designs, bio-nanotechnology.

MECH6041. Energy audit and energy saving measures

Energy audit; energy management opportunity; electrical power quality; HVAC; heat pumps; lighting; industrial equipment; motors; boilers; air compressors; measurement and verification.

MEBS6004. Built environment

External environment: human factors, climatology; internal design criteria; thermal environment (heat): insulation for energy conservation, heat transmission; e.g. solar contribution; visual environment (light): eye and vision, light production, levels of illumination; aural environment (sound or noise): noise criteria for buildings; sources of noise and vibration, noise and vibration control; functional requirement of buildings.

MEBS6010. Indoor air quality

Concept of indoor air quality, health requirements, sick building syndrome, building related illnesses, indoor air quality indicators, types, sources, characterization and heath effects of pollutants, concentration, individual and population exposure, dose-response relationships, measurement and monitoring methods, ventilation, filtration, indoor air quality assessment and control, operation and maintenance, legislation and public policy issues, energy and cost implications.

MECH7002. Advanced topics in fluid flows and transport phenomena research #

Turbulence modeling and measurement, multi-phase flows, non-Newtonian fluid flows, flow visualization, environment aerodynamics, computational fluid dynamics, heat and mass transfer, surface and internal waves, stabilities and dynamics of vorticity, etc. (The topics presented may differ from year to year depending on the needs of the students and the interests of the instructor(s)).

Pre-requisites: Students who have completed MECH 2008 Mechanics of Fluids or the equivalence.

MECH7003. Advanced topics in materials research #

Diffusion and related phenomena, defect theory, physical examination of materials by X-ray and electron microscopy, processing techniques, thermal and mechanical behaviour of materials, introduction to specific classes of new materials, etc. (The topics presented may differ from year to year depending on the needs of the students and the interests of the instructor(s)).

MECH7004. Advanced topics in solids mechanics research #

Mechanics of electromagnetic solids, anisotropic elasticity, complex stress functions for 2-D elasticity, fracture mechanics, finite element methods, phase field methods, etc. (The topics presented may differ from year to year depending on the needs of the students and the interests of the instructor(s)).

MECH7005. Advanced topics in control engineering research #

Control of multivariable systems, linear system theory, limitations of performance, robust stability and performance analysis, LQG, H2 and H-infinity design, robust pole assignment, model reduction, singular systems, state estimation and filtering, for instance. (The topics presented may differ from year to year depending on the needs of the students and the interests of the instructor(s)).

Pre-requisites: Students who have completed MECH 2004 Control or MECH 3004 Automatic Control or the equivalence.

MECH7006. Advanced finite difference/volume methods #

Conservation laws and (partial) differential equations, one-dimensional and multi-dimensional problems, high-order accuracy schemes, explicit or implicit schemes, surface and volume integrals, consistency, convergence and stability, non-linear equations, Navier-Stokes equations, boundary conditions, solution of linear equation systems (e.g. multi-grid, conjugate gradient), parallel computing, unsteady problems, and examples. (The topics presented may differ from year to year depending on the needs of the students and the interests of the instructor(s)).

Pre-requisites: Students who have completed courses on Basic numerical methods.

CIVL6002/CIVL8031. Advanced finite elements #

Equilibrium and virtual work principle; variation principle; numerical integration; computer applications; convergence and error estimate; hybrid and mixed methods for multi-field problems; enhanced and assumed strain method; nonlinear problems.

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* Approved for reimbursement from the Continuing Education Fund (CEF) (applicable to Hong Kong Residents only)

for full-time students only