Mechanical and Automation Engineering Programme

4-year Curriculum

Required Courses:

MAEG2020 Engineering Mechanics

MAEG2030 Thermodynamics
3 Units; 2nd term

MAEG3010 Mechanics of Materials
3 Units; 1st term

MAEG3020 Manufacturing Technology
3 Units; 2nd term
Overview of manufacturing engineering, engineering materials, metal forming processes, machining processes, plastic injection molding processes, and assembly. Hands-on experiments / projects.

MAEG3050 Introduction to Control Systems
3 Units; 1st term

ELEG2202 Circuits and Devices I
3 Units; 2nd term
Basic circuit laws and theorems; mesh and nodal analysis, superposition and source transformation. Phasor, impedance and AC analysis. Introduction to three-phase circuits. P-N junction diode, bipolar transistor and MOS transistor: terminal I-V characteristics and circuit models; diode rectifiers; single-stage transistor amplifiers: biasing and small signal analysis. Operational amplifier and its applications.

ENGG4010 Final Year Project I
The course is designed to provide students with an opportunity to carry out, under the supervision of an academic staff, an independent project with research elements in engineering.

ENGG4020 Final Year Project II
The course is designed to provide students with an opportunity to carry out, under the supervision of an academic staff, an independent project with research elements in engineering.
Major Electives:

ENER2010 Energy Technologies and the Environment
3 Units; 1st term
In a modern society, our living standard strongly correlates with our energy consumption rate. The rapid rise of energy use after WWII has caused the degradation of our environment as well as adverse health effects in human populations. Furthermore, the steady rise of recent global average temperature and its correlation with the atmospheric CO2 concentration is particularly alarming. This course provides an overview of the present energy industry and their environmental impact. Fossil fuel is our main energy source today. Therefore, coal, petroleum and natural gas are emphasized. Their formation, exploration, reserve distribution, production, transport, refinement, final consumption, waste disposal and the carbon cycle are studied. The mechanical structure, configuration and efficiency of various fossil-fueled power plants and automobile engines are described. The life cycle assessment method is used to evaluate their requirement on water withdraw and consumption, carbon footprint and their relationship to global warming. Nuclear power plants provide approximately 20% of our electricity without producing greenhouse gases. Their operating principle, the biological effects of ionizing radiations, the radioactive waste problem, the nuclear weapon proliferation concerns, the risk of large scale accidents like Chernobyl (1986) and Fukushima (2011), and different nuclear policies adopted by various governments are discussed. These lead to the need of renewable energy sources for sustainable developments. The current status of solar, wind, biomass, hydropower, and geothermal energies are briefly presented as an introduction to the next course on renewable energy technologies.
Note: Calculus is NOT a prerequisite. However, high school level of physics, chemistry and mathematics are required.
or

ENGG1500 Introduction to Energy and Environment
3 Units; 1st or 2nd term
Introduction to the power generation and energy resources: including fossil fuels, nuclear power and renewable energy (such as hydro power, solar power, wind power, biomass and biofuels, and geothermal power). Energy supply, utilization and sustainability. Impact on the environment.

ENER3010 Renewable Energy Technologies
3 Units; 1st or 2nd term

ENER4010 Kinetic Energy Harvesting Devices and Systems
3 Units; 1st or 2nd term

ENER4020 Solar Energy and Photovoltaic Technology
3 Units; 1st or 2nd term
Introduction to solar energy technologies; semiconductors for photovoltaics; working principle and performance evaluation of photovoltaic cells (PVs); photovoltaic technologies (crystalline PVs, thin-film PVs, and organic and nanostructure based PVs); solar panel system design; cost aspects, market development and environmental impact of photovoltaic industry.
ENER4030 Nuclear Energy and Risk Assessment
3 Units; 1st or 2nd term
Nuclear physics - elementary quantum theory; nuclear forces; shell structure of the nucleus; alpha, beta, and gamma radioactive decays; nuclear reactions; fission and fusion. Nuclear power plant design - nuclear power plant layout; reactor dynamics; reactor start up and process control, waste treatment. Risk management - assessment and management of nuclear safety; radiation, exposure and environment; safety assessment.

ENER4030 Energy Storage and Distribution
3 Units; 1st or 2nd term
Introduction to energy storage technologies: electrical energy storage (battery, supercapacitor etc.), thermal energy storage (phase change), mechanical energy storage (flywheel and compressed air energy storage), hydrogen storage for fuel cells. Infrastructure for energy distribution; smart grid; charging systems for electrical vehicles and fuel cell vehicles.

MAEG1010 Introduction to Robot Design
3 Units; 1st or 2nd term

MAEG2010 Computer-Aided Drafting
2 Units; 1st term
Introduction to concepts and skills needed to sketch and create 2D drawings and 3-D models. Introduction to CAD systems. A series of projects for students to learn and practice using various CAD packages for modelling, engineering drawing, animation and analysis.

MAEG2020 Engineering Mechanics
3 Units; 1st term

MAEG3030 Fluid Mechanics
3 Units; 2nd term

MAEG3040 Mechanical Design
3 Units; 2nd term

MAEG3060 Introduction to Robotics
3 Units; 1st term
MAEG3070 Fundamentals of Computer-Aided Design 3 Units; 1st or 2nd term
Elements of interactive graphics in CAD/CAM. Mathematical bases and manipulation of curves and surfaces: parametric cubic curve, Bezier and NURBS curve, ruled surface, sweep surface, Coon’s bilinear surface, Hermite surface, Bezier and NURBS surfaces. Introduction to geometric and solid modeling: constructive solid geometry, boundary representation. Visualization for engineering simulation. Applications in design and manufacturing.

MAEG3080 Fundamentals of Machine Intelligence 3 Units; 1st or 2nd term

MAEG3110 Engineering Materials
Atomic bonding; crystal structures; mechanical behaviors of materials; phase diagrams; overview of metals, alloys, ceramics, polymers, and composites; electrical, optical, magnetic, and thermal properties of materials; semiconductive materials and fundamentals of solid state physics.

MAEG3920 Engineering Design and Applications 3 Units; 2nd term
The course includes a project for students to practise the following topics: engineering design process, innovation and design basics, CAD and CAE tools and applications, prototyping (mechanical workshop), prototyping (electronics workshop), quality and inspection.

MAEG4010 Computer-Integrated Manufacturing 3 Units; 1st or 2nd term

MAEG4020 Finite Element Modelling and Analysis 3 Units; 1st or 2nd term

MAEG4030 Heat Transfer 3 Units; 1st or 2nd term

MAEG4040 Mechatronic Systems 3 Units; 1st or 2nd term
MAEG4050 Modern Control Systems Analysis and Design 3 Units; 1st or 2nd term
Continuous and discrete domain state space representations: transition matrix; stability; controllability and observability; pole placement control; state estimator. Emulation designs. Discrete design. Case studies.

MAEG4060 Virtual Reality Systems and Applications 3 Units; 1st or 2nd term

MAEG4070 Engineering Optimization 3 Units; 1st or 2nd term

MAEG4080 Introduction to Combustion 3 Units; 1st or 2nd term
Fundamentals of combustion science: combustion kinetics; thermochemistry; flame dynamics and stability; pollutant formation. Internal combustion engine: operation of internal combustion engines; combustion theory for engine design; engine performance; fuel requirements; heat transfer; frictions; fuel properties; environmental impact.

MAEG5010 Advanced Robotics 3 Units; 1st or 2nd term
Lagrange formulation of robot dynamics, Newton-Euler equations; motion control, force control, visual servoing, grasping analysis, object manipulation; sensors and sensor networks, advanced topics in recent development of robotic theory and applications.

or

ENGG5402 Advanced Robotics 3 Units; 1st or 2nd term
Lagrange formulation of robot dynamics, Newton-Euler equations; motion control, force control, visual servoing, grasping analysis, object manipulation; sensors and sensor networks, medical robotics, advanced topics in recent development of robotic theory and applications. Equivalent to MAEG5010 or BMEG5100. (Not for students who have taken MAEG5010 or BMEG5100)

MAEG5020 Topics in Linear Control Systems 3 Units; 1st or 2nd term
Advanced topics in recent development of linear control theory and its applications. The detailed course contents may be changed from year to year depending on the current development.

or

ENGG5403 Linear System Theory and Design 3 Units; 1st or 2nd term
Review on linear algebra; Linear system model and properties; State space representation: equivalent systems, canonical forms, realization, discrete-time systems; Stability: definitions, Lyapunov Theorem; Controllability and Observability: Grammians, canonical decomposition, sampling effects; Minimal realizations; State-Feedback and State-estimators: regulation and tracking, state estimator feedback, reduced-order estimator, multivariable system; Pole placement and Model Matching. Equivalent to MAEG 5020. (Not for students who have taken MAEG5020 or MAEG5725)
MAEG5030 Topics in Computer-Aided Geometric Design  
Advanced topics in recent development of computer-aided geometric design. The detailed course contents may be changed from year to year depending on the current development.

MAEG5040 Machine Vision  

MAEG5050 MEMS and Nano-Robotics  
or
ENGG5404 Micromachining and Microelectromechanical Systems  
Broad overview of microfabrication and microelectromechanical systems. Micromachining techniques such as photolithography, wet etching, dry etching, physical and chemical vapor deposition, electroplating, metrology, and MEMS device testing and characterization. Review of microsensors, microactuators, micropumps, and microstructures. Important topics include accelerometers, pressure sensor, optical switches, cantilever beams, and microfluidic devices. Fundamentals of central dogma of molecular biology, cell and tissue biology. Principles of transduction and measurements of molecules, cells and tissues. (Not for students who have taken BMEG5120, MAEG5050 or MAEG5750)

MAEG5060 Computational Intelligence  
Concepts, models, methods, and applications of computational intelligence. Topics include neural networks, support vector machines, fuzzy systems, simulated annealing, genetic algorithms, and their applications to control, robotics, automation, manufacturing, and transportation.

MAEG5070 Nonlinear Control Systems  

MAEG5080 Smart Materials and Structures  
Overview of smart materials technology. Characteristics of smart materials such as piezoelectric materials, magnetorheological fluids, and shape memory alloys. Smart actuators and sensors. Structural modeling and design. Dynamics and control for smart structures. Integrated system analysis. Applications in biomedical devices, precision machinery, transportation, and buildings.

MAEG5090 Topics in Robotics  
One or more of the following topics will be discussed in the class. Advanced robot control: adaptive control; cooperative robot control; underactuated robot control; multi-finger hand control. Mobile robot: obstacle avoidance; learning; control; and mobile manipulators. Space robotics: dynamics; control;

**MAEG5100 Advanced Engineering Design and Optimization**  
3 Units; 1st or 2nd term  
To provide in-depth understanding of the principles and tools of engineering system design, statistical optimization methods, Design for Six Sigma (DFSS), TRIX, and complex system design.

or

**ENGG5404 Theory of Engineering Design**  
3 Units; 1st or 2nd term  
Introduction of engineering design and design procedure, design innovation and TRIZ, axiomatic design, nature’s design and complex systems, design analysis (modeling and simulation), statistical analysis, design optimization, statistical design optimization, Design for Six Sigma (DFSS). Practical examples of design and applications, such as pendulum, bicycle, windmill and propulsion. Equivalent to MAEG5100.  
(Not for students who have taken MAEG5100)

**MAEG5110 Quantum Control**  
3 Units; 1st or 2nd term  
Mathematics foundation: Hilbert spaces; manifolds; groups; Lie groups and Lie algebras. Physics foundation: quantum phenomena; states and operators; observables and measurement; quantum dynamics. Quantum control systems: modelling; controllability and observability; optimal quantum control.