MECHANICAL ENGINEERING

Courses

MECH 810 Adv. Top. In Manufacturing Eng Units: 3.00
A topical course in manufacturing engineering which deals with some of today's research issues from both a theoretical and pragmatic approach. Research in areas such as Flexible Manufacturing Systems, Computer Integrated Manufacturing, Statistical Quality Control, Group Technology, Just in Time Concepts, Material Removal and Forming Technology, Design for Assemble, etc. are examined based on recent literature and publications. The specific topics to be addressed each year are selected to match the student's research interest and background. Three term-hours, may be given in any term. J. Jeswiet
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 811 Lasers In Manufacturing Appl. Units: 3.00
Course presents an overview of lasers as they relate to selected manufacturing applications. Topics covered include general principles of laser operation, description of laser types used in manufacturing, and components of laser-based processing systems. Among the applications, laser machining of metals and ceramics, joining of polymers, and laser sintering are examined in greater depth. Analytical and numerical modeling techniques are briefly presented. Students will carry out a survey-based or an experimental project (the latter being subject to instructor¿s approval and availability of resources). Three term-hours, lectures. G. Zak.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 812 Corrosion Units: 3.00
This course presents the fundamental principles of corrosion with applied examples and emphasis on metals in aqueous environments. The main topics considered are: Basics of electrochemistry and charged interfaces; thermodynamics and Pourbaix diagrams; electrochemical kinetics; corrosion measurements; passivity; localized corrosion; high temperature oxidation; microscopy in corrosion analysis.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 816 Energetics & Mechanics Locomotion Units: 3.00
Offering Faculty: School of Graduate Studies

MECH 817 Systematic Review Methodology for Product Evaluation Units: 3.00
This course provides the skills to undertake a systematic literature review as required by the FDA when seeking approval for a device. Drawing on a clinical model, this course will enable the student to define a question using PICO (population, intervention, comparison, outcome), synthesize quantitative evidence and interpret the results. Three term hours.
Offering Faculty: School of Graduate Studies

MECH 818 Functional Morphology Units: 3.00
This course uses dynamics to understand how the musculoskeletal system allows movement and propulsion in animals. Topics include: a review of solutions for terrestrial locomotion, rigid body dynamics, implications of scaling, muscle and tendon dynamics, musculoskeletal lever systems, arthromechanics, and measurement modalities. Students interested in biomechanics, the animal
world, dynamics, and bio-inspired engineering should take this course.
Prerequisite: Permission of the instructor.
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

MECH 821 Adv Dynamics Of Mechanical Sys Units: 3.00
Mathematical modelling of the dynamics of mechanical systems using Newton's Laws, LaGrange's Equation and Hamilton's Equations; linear and non-linear systems; time-domain and frequency-domain solutions; large systems; stability; response to random excitation. Three term-hours, lectures. R.J. Anderson.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 823 Micro-Electro-Mech. Sys.(Mems) Units: 3.00
This course is an overview of the research in MEMS and BioMEMS, particularly including microactuators, microsensors and their applications. Fundamentals of photolithography, wet and dry etching, and surface micromachining will be covered. Design methodologies together with fabrication processes will be emphasised through case studies. A design project will be used to enhance the understanding of the relevant theories that are covered in class. By the end of the course, students will be expected to demonstrate mastery of several different modelling techniques for microsystems and understand the mechanisms of microsystems. Three term-hours, lectures. Y. Lai
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 826 Experimental Vib./Shock Analy. Units: 3.00
Characteristics of vibration and shock and their effects on mechanical systems and people; sensors and systems for measurement of vibratory displacement, velocity, acceleration and force; spectral analysis including applications to machinery vibration diagnostics; vibration test systems; random vibrations; modal analysis; vibration test standards; stress screening; shock testing. Three term-hours, lectures and laboratory. C. Mechefske.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 828 Biomechanics Of Human Gait Units: 3.00
An overview of the research in biomechanics of human motion with particular focus on gait analysis. Topics include measuring and analysis techniques, biomechanical modelling, and data analysis techniques. Applications include the study of normal, able-bodied gait, and the evaluation of gait pattern changes associated with osteoarthritis, and total knee replacements. The course has a laboratory component that is used to give the student the opportunity to apply the theory covered in class. Three term -hours. K. Deluzio.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 829 Tissue Mechanics Units: 3.00
Methods of characterizing biological tissues for the Mechanical Engineer with no previous biology background. Histology of ligament, tendon, cartilage and bone. Viscoelasticity and classical elasticity. Current models of ligament and tendon (Fung's quasi-linear model). Linear anisotropic elastic model for bone and cartilage. Theories for strength and failure mechanisms. Three term-hours, lectures. J.T. Bryant
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 830 Experimental Fluid Dynamics Units: 3.00
A review of measurement theory including: static and dynamic characteristics of signals, spectral analysis with filtering methodologies, response of systems, and statistical/uncertainty analyses. Subsequently the course then provides insight into traditional as well as contemporary measurement techniques in fluid dynamics ranging from single-point scalar/vector measurements through to spatially resolved volumetric reconstructions. To conclude, post-processing and data-manipulation strategies for such contemporary data sets along with a discussion of future concepts will be presented.
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

MECH 831 Convective Heat Transfer Units: 3.00
Convective Heat Transfer
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 832 Combustion Dynamics Units: 3.00
This course begins with a thorough review of the fundamental principles of combustion such as heat of reaction, chemical equilibrium, and chemical kinetics. Combustion aspects related to explosion phenomena such as flame acceleration, detonation wave and blast wave propagation are then covered. Finally, the single degree-of-freedom response of mechanical structures to blast wave loading will be discussed, and explosion damage mitigation techniques will be presented. Three term-hours, lectures. G. Ciccarelli
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 833 Topics in Single Phase Convective Heat Transfer Units: 3.00
This course deals with aspects of Convective Heat Transfer not considered in course MECH-831. The main topics considered are: Introduction to Convective Heat Transfer, Natural Convection, Mixed Convection, Convective Heat Transfer in Porous Media, Enhanced Convective Heat Transfer, Nano Heat Transfer, Convective Heat Transfer in High Speed Flows, Interaction of Convection with Other Modes of Heat Transfer. Three term hours.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 834 Fundamentals Of Solar Energy Units: 3.00
This course presents the fundamental principles of solar energy conversion, storage and distribution. Both photovoltaic and thermal energy conversion systems will be introduced; however the primary focus of the course will be on solar thermal systems for heating and cooling applications. Topics covered include the nature and prediction of the solar resource, solar collector design and performance, thermal storage, heat transport and distribution. The modeling and design of complete solar heating and cooling systems will be studied and exercises completed. Students will be required to complete a major project related to one of the above topics. Course lecture material will be augmented with laboratory exercises. S.J. Harrison.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 835 Introduction to Computational Fluid Dynamics Units: 3.00
Objective of this course is to give students a basic understanding of the potential and limitations of Computational Fluid Dynamics (CFD), learn the fundamentals of CFD codes, find solutions for test problems, and run commercial software in a competent and critical manner. Three term hours; lectures. Prerequisites: Permission of instructor.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 836 Radiative Heat Transfer Units: 3.00
This course covers the following topics related to heat transfer by thermal radiation: fundamentals of thermal radiation, blackbody thermal radiation, radiative properties of real materials, surface to surface exchange of diffuse radiation, numerical solution of diffuse radiation problems, radiation with conduction and convection, radiation in absorbing, emitting and scattering media, gas volume radiation, surface-volume radiation selected applications.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 837 Trans & Kin. In Fuel Cells Units: 3.00
The fundamentals of transport phenomena and reaction kinetics are considered and applied to fuel cells, with a view to a mechanistic understanding of fuel cell operation and limitations. Material covered includes the basic axioms of mechanics (conservation of mass, momentum, energy and charge) presented in indicial notation and applied to porous media. Emphasis is placed on the description of porous materials and the implications of porous media on transport, including the notion of effective transport coefficients. Ion transport in solid and polymer electrolytes due to electrochemical potential differences is considered. Diffusion models covered include Fick¿s law, Stefan Maxwell and Knudsen. Electrochemical reaction kinetics and mechanism are covered including rate-limiting steps, exchange current density and the fundamental definition of overpotential. The course will include individual projects. J. Pharoah
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 838 Civil Aviation & Environment Units: 3.00
Offering Faculty: Fac of Engineering Appl Sci

MECH 839 Introduction to Turbulence Units: 3.00
This course is an introduction to the study of turbulence, covering its mathematical description, its physical features and the modelling of turbulent flows. The course is suitable for MASc and PhD students with a background in advanced fluid dynamics and numerical methods. Three term-hours; lectures. Taught in alternate years. PREREQUISITE: Permission of the instructor.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 840 Selected Topics in Thermal Fluid Systems Units: 3.00
This course is limited to Master¿s students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of heat transfer, fluid mechanics and thermodynamics. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-842*, MECH-843*, MECH-844*
Offering Faculty: Fac of Engineering Appl Sci

MECH 841 Net-Zero Energy Buildings and Communities Units: 3.00
An introduction to what is meant by net-zero energy building or community, to how the net-zero energy state can be achieved, and to the considerations that need to be taken into account in planning and designing a net-zero energy building or community is provided. Building envelopes, building integrated photo-voltaic systems, bore-hole energy systems, day-lighting, ventilation, solar air-conditioning, energy storage, and social and economic factors are considered. Three term hours; lectures.
Offering Faculty: Fac of Engineering Appl Sci

MECH 842 Topics in Manufacturing and Design Units: 3.00
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of dynamics, manufacturing and design. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-843*, MECH-844*
Offering Faculty: Fac of Engineering Appl Sci

MECH 843 Selected Topics in Biomechanical Engineering Units: 3.00
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of biomechanical engineering. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-842*, MECH-844*
Offering Faculty: Fac of Engineering Appl Sci

MECH 844 Selected Topics in Materials Engineering Units: 3.00
This course is limited to Master's students who already have a good background in the fundamental topics related to their areas of study and are interested in other areas not offered in existing graduate courses. Topics will be related to the structure, properties, processing and/or performance of materials. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering
Exclusions: MECH-840*, MECH-842*, MECH-843*
Offering Faculty: Fac of Engineering Appl Sci

MECH 846 Fluid Systems Analysis Units: 3.00
This course provides an introduction to analysis of fluid flows at the masters level. Derivation of the transport equations is completed for arbitrary control volumes in both vector and tensor forms. Inviscid flows are explored to illustrate the separate effects of inertial and viscous forces, including development of Joukowski airfoil models. Exact and approximate solutions are developed for steady and unsteady laminar flows. Boundary Layer solutions are developed by differential and integral analysis. The similarity of transport equations for thermal energy and concentration are illustrated. On completion of the course, students will be well prepared for specialized courses in convective heat transfer, turbulence, and computational fluid mechanics.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 847 Energy & Society Units: 3.00
This course is a discussion course focused on fundamental ideas in energy and the social context of energy. It will feature an introduction to Energy Systems and fundamental thermodynamic tools to analyze these systems. Of particular emphasis will be the social context of energy: how societies emerge, organize and thrive or fail according to their energy supply. Factors which contribute to societal responses to changing contexts will also be discussed. In class participation is an essential element of this course.
PREREQUISITE: Permission of the instructor
Offering Faculty: Fac of Engineering Appl Sci

MECH 848 Measurement Systems I Units: 3.00
This course focusses on practical measurement systems for Masters student's in mechanical engineering. On completing this course students will be able to: Select, install, test, and program a micro controller system for data acquisition and control; Select, analyze the performance of, and apply transducers for temperature; pressure; stress, strain and force; position, velocity and acceleration; Apply basic signal conditioning in analog and digital domains; Analyze data to draw conclusions from measurements and uncertainty analysis. Conceive, Design, Implement and Operate a complete measurement system as part of a course project. The course will require a small equipment expenditure (< $100 / student) for components that will be reusable in subsequent years.
Offering Faculty: Fac of Engineering Appl Sci

MECH 851 Materials Characterization Units: 3.00
This course covers the theory and practice of materials characterization by X-ray and electron microscopy techniques. Theory includes interaction of materials with X-rays and electrons, diffraction and image formation. The following topics are discussed and illustrated by laboratory investigations: determination of crystal structure, microchemical analysis, characterization of lattice defects, determination of texture and measurement of residual stresses. Three term-hours, lecture and laboratory; R. Holt.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 852 Mechatronics for Automation Units: 3.00
This course covers the tools and techniques needed to design and control assembly automation machines and their machine vision-based inspection systems. The issues that arise when interfacing different components to form complex mechatronic systems are studied. Course content will be reinforced with an individual project and group laboratories.
Offering Faculty: Fac of Engineering Appl Sci

MECH 857 Robotics Units: 3.00
This course will cover kinematics of serial and parallel architecture robots; as well as the geometric, kinematic, static and dynamic criteria required for designing robot manipulators. The course will also include projects on advanced robotics topics and will conclude with the presentation of these projects, at least two presentations per student. Three term-hours, lectures and seminars. L. Notash.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 858 System Dynamics and Control Units: 3.00
The course will include ¿a review of important key topics from undergrad plus the introduction of advanced topics at the graduate level¿. The topics include Laplace Transformation; Vibration and Time Response; Linear Graph Representation of Mechanical Systems; Matrix Algebra; State Space Representation; Transfer Functions and System Response; Controllability, Observability, Stability and Pole Placement.
Offering Faculty: Fac of Engineering Appl Sci

MECH 861 Principles Of Metal Forming Units: 3.00
This course examines experimental, analytical and numerical methods employed for evaluating and predicting forming limits in a variety of industrial metal forming operations. The concept of a forming limit diagram (FLD) is introduced and related to classical theories for plastic instability and failure. Constitutive equations of elastic-plastic flow are derived using a continuum mechanics approach, with additional discussion regarding issues of plastic anisotropy, damage accumulation, localization and material length scales. Three term-hours. K. Pilkey.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 863 Materials Selection in Design Units: 3.00
This course presents the concept of materials selection as an integral part of the mechanical engineering design process. Materials selection addresses a number of issues: the choice of material; the method of part manufacture; potential modes/mechanisms of failure; as well as the tailoring of material microstructure to obtain optimal properties and in-service performance. Background topics will include mechanical engineering design, solid mechanics, engineering component design, and materials science and engineering. Material selection methodologies will range from conventional, holistic approaches to the deterministic method of Ashby. Course content will be reinforced through case studies that consider a variety of material classes.
Offering Faculty: School of Graduate Studies

MECH 864 Engineering Analysis Units: 3.00
Methods for formulating mathematical models for engineering problems; examples drawn from dynamics, elasticity, fluid mechanics, heat transfer, and electro-mechanics; lumped-parameter and continuum models; variational techniques; boundary conditions and their effects on the character of the model; techniques for obtaining approximate solutions; methods for casting models into forms appropriate for solution on digital computers. Three term-hours, lectures. R.J. Anderson.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 866 Advanced Phase Transformations Units: 3.00
This course focuses on the practical aspects and the relevant fundamentals of phase transformations in advanced manufacturing of metal alloys. The course offers a deep theoretical insight into solidification and solid-state diffusional transformations, along with an effective utilization of relevant analytical models to explore/explain the effect of material and processing variables on the evolution (i.e., types and kinetics) of phase transformations.
Offering Faculty: Fac of Engineering Appl Sci

MECH 868 Introduction to Computational Materials Science Units: 3.00
This course focuses in atom-scale modelling of materials using computational methods. Covered topics include electronic density functional theory, molecular dynamics, Metropolis Monte Carlo, and transition state theory. The course will cover fundamental theoretical aspects and hands-on application of the methods. It will include a short, open-ended, end-of-semester simulation project.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 878 Dislocation Theory Units: 3.00
This course attempts to cover the basic derivations from elasticity theory, the properties of dislocations in crystalline materials, and their role in inelastic material behaviour. This introduction should enable one to comprehend, examine, and criticize current literature on the mechanical behaviour of materials. Topics include: a brief introduction to applied elasticity theory; elastic stress fields of dislocations and their interactions with external ones; the role of a particular crystal structure on the properties and motion of dislocations. The use of dislocation mechanics in the theories of creep, fracture, and yield points will be discussed along with other topics as time permits. Three term-hours. B. J. Diak.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 883 Nuclear Materials Units: 3.00
A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures and stresses to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation that affect their performance, and often this dictates a requirement for a unique property that is not relevant in conventional applications. The effects of the radiation may be direct or indirect. This course considers materials typically used in nuclear environments, the unique conditions to which they are subjected, the basic physical phenomena that affect their performance and the resulting design criteria for reactor components made from these materials. This course is offered in conjunction with MECH-483*, but has additional assignments and reading. Three term-hours, lectures. R. Holt.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 884 Topics In Materials Engr. Units: 3.00
A timely topic of interest to materials engineers will be presented. The topics will vary from year to year. Three term-hours, lectures. A.K. Pilkey, Visiting Lecturers
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 891 Design Of Biomechanical Device Units: 3.00
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 892 Industry-Linked Project (Part 1) Units: 3.00
Students work on individual one-term research or development projects. Each project is defined by the academic project supervisor. The project is linked to a supporting company partner. Course evaluation is based on a final written report (typically 30-40 pages) and an end of term seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Exclusions: MECH-898 - Project, CMAS-898 ¿ Project
Requirements: Anti Requisits for MECH 892
Offering Faculty: Fac of Engineering Appl Sci

MECH 893 Industry-Linked Project (Part 2) Units: 3.00
Students work on individual one-term research or development projects that are the natural progression of projects started in MECH-892*. The project is linked to a supporting company partner. Course evaluation is based on a final written report (typically 50-60 pages) and an end of term seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Exclusions: MECH-898 - Project, CMAS-898 ¿ Project. Prerequisites: MECH 892 ¿ Industry-Linked Project (Part 1)
Requirements: Anti Requisite for MECH 893
Offering Faculty: Fac of Engineering Appl Sci

MECH 894 Intership Units: 3.00
Students work on a one-term (typically summer) internship at a sponsoring company site. The internship involves the student continuing with the same project work started in MECH-892 and continued throughout MECH-893*. The work will typically be conducted exclusively at the supporting partner company site. Course evaluation is based on a final written report (typically 40-50 pages) and an end of term project seminar presentation. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. Prerequisites: MECH-893* ¿ Industry-Linked Project (Part 2)
Requirements: Prerequisite for MECH 894
Offering Faculty: Fac of Engineering Appl Sci

MECH 895 Industrial Internship for M.Eng. Units: 3.00
The industrial internship involves spending 4 months in a paid industrial internship position in industry, or government. Successful completion of the course requires submission of a report on the industrial project to be submitted on the last day of the internship. Each project must be approved by the academic supervisor. Career Services manages the non-academic aspects of the course. This course is open only to Materials and Mechanical Engineering (MME) M.Eng. students. Permission of MME M.Eng. Coordinator is required for registration. This course is graded on a Pass/Fail basis. Exclusions: MECH-892,* MECH-893*, MECH-894*
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 896 Professional Development for MEng Students Units: 3.00
This course is designed to develop professional skills that expand on a student's existing technical and non- technical skills, as relevant to a future career in engineering. The topics covered will encompass aspects of project management; leadership and crisis management; written and oral communication; engineering integrity and ethics; and social responsibility. A key feature of the course will be the use of a simulation game in project management for both instruction and assessment. This course is open only to MEng students. PREREQUISITE: Permission of the instructor.
Offering Faculty: Fac of Engineering Appl Sci

MECH 897 Graduate Seminar Units: 3.00
Each research full-time graduate student is required to regularly attend the graduate seminar program and to give at least one seminar during their program at Queen's. M.Sc./M.Sc.(Eng.) students are required to take MECH-897 and Ph.D. students are required to take MECH-997. The content of the seminar is to be developed in cooperation with the student's supervisor. The seminar will be evaluated by assigned faculty and a pass/referred decision will be recorded. The student must obtain a pass grade to clear this course requirement. The evaluation process for the seminar is defined in the departmental procedures. This course carries no course credit but is a degree requirement in the Department of Mechanical and Materials Engineering.
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci

MECH 898 Master's Project (Non-Res.) Units: 3.00
weight= 0.50.
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

MECH 899 Master' Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci

MECH 924 Finite Element Analysis Units: 3.00
This course presents the formulation and use of finite element models for the analysis of a broad range of non-linear solid materials (plastics, metals, elastomers) subject to large deformations. Basic concepts from continuum mechanics (suffix notation, large strain theory, constitutive relations) are covered in order to provide a basis for the formulation of these models and for the interpretation of results. Testing procedures for the determination of non-linear material properties, required for model input, are also covered. Example analyses are conducted with commercial non-linear finite element code. Three term-hours; lectures. I. Y. Kim.
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 932 Adv Top. In Convect Heat Trans Units: 3.00
This course is, basically, a continuation of MECH-931* but may be taken by any student who has had adequate preparation. Among the main topics considered are: Analysis of laminar and turbulent free convective flows; local similarity methods in heat transfer; heat transfer with film condensation; prediction of turbulent Prandtl numbers; mixed (or combined) convection; combined heat and mass transfer; heat transfer in compressible flows. Three term hours, lectures. P.H. Oosthuizen
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 934 Comp. Fluid Dyns. II Units: 3.00
The objective of this course is to teach students to understand the potential and limitations of Computational Fluid Dynamics (CFD), develop advanced solution methods for fluid-dynamics problems, and run commercial software in a critical manner. The course begins by presenting various forms of numerical approximations of the governing equations. An in-depth analysis of iterative methods to solve linear systems will follow. Numerical methods for the solution of the Navier-Stokes equations will be presented, with emphasis on numerical stability and on conservation properties. Three term-hours lectures.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 935 Turbulence Simulations Units: 3.00
The objective of this course is to analyze numerical techniques for the simulation of turbulent flows. Emphasis will be placed on the understanding of the role of modeling and numerical errors, and on the development of "best practices" to validate and establish confidence in the numerical results. The course begins with a review of the governing equations for turbulent flows, of the role of turbulent eddies, and of the statistical quantities used to characterize turbulent flows. The important features of numerical methods will then be examined.An extensive review of the potential, requirements, achievements and limitations of direct simulation, large-eddy simulation and solution of the Reynolds-Averaged Navier-Stokes equations will form the core of the course. Time permitting, additional topics such as Lagrangian particle tracking, or applications to compressible flows will be covered. U. Piomelli.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 936 Radiative Heat Transfer Units: 3.00
This course covers the following topics related to heat transfer by thermal radiation: fundamentals of thermal radiation, blackbody thermal radiation, radiative properties of real materials, surface to surface exchange of diffuse radiation, numerical solution of diffuse radiation problems, non-diffuse and specular radiation from surfaces, spectral radiation, radiation with conduction and convection, radiation in absorbing, emitting and scattering media, gas volume radiation, surface-volume radiation, selected applications. Three term hours, lectures. A.M. Birk.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 940 Selected Topics in Thermal-Fluids Engineering Units: 3.00
This course is limited to those PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics can be selected from the general areas of heat transfer, fluid mechanics and thermodynamics. The course will include lectures, open discussion and directed study. The course content for a student or group must specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-942*, MECH-943*, MECH-944*
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 941 Turbulent Flow- Theory Units: 3.00
Introduction; Reynolds averaging; turbulent transport equations; turbulence modelling; statistics and dynamics of turbulence; turbulent diffusion; structure of turbulent flows; numerical and experimental methods. Three term-hours; lectures. A. Pollard.
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 942 Selected Topics in Dynamics, Manufacturing and Design Units: 3.00
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of dynamics, manufacturing and design. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-943*, MECH-944*
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 943 Selected Topics in Biomechanical Engineering Units: 3.00
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of biomechanical engineering. The course will include lectures, open discussions and directed study. The course content for a student or group must specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-942*, MECH-944*
Offering Term: W
Offering Faculty: Fac of Engineering Appl Sci

MECH 944 Selected Topics in Materials Engineering Units: 3.00
This course is limited to PhD students who already have a good background in the fundamental and advanced topics related to their research and are interested in other areas not offered in existing graduate courses. Topics will be selected from the general areas of materials engineering. The course will include lectures, open discussions and directed study. The course content for a student or group will be specified in writing at the beginning of the course and cannot be the same as their thesis research topic. The course mark will be based on reports and/or presentations and/or exams. Instructors: Various faculty members from within the Department of Mechanical and Materials Engineering. EXCLUSIONS: MECH-940*, MECH-942*, MECH-943*
Offering Faculty: Fac of Engineering Appl Sci

MECH 956 Nonlinear Control Systems Units: 6.00
Offering Term: F
Offering Faculty: Fac of Engineering Appl Sci

MECH 997 Graduate Seminar Units: 0.00
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci

MECH 999 Ph.D. Thesis Research Units: 6.00
Offering Term: FWS
Offering Faculty: Fac of Engineering Appl Sci