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</thead>
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<tr>
<td>CE4257</td>
<td>Linear Finite Element Analysis</td>
<td>This module equips students with the fundamentals of finite element principles to enable them to understand the behaviour of various finite elements and to be able to select appropriate elements to solve physical and engineering problems with emphasis on structural and geotechnical engineering applications. It covers weak formulation, element shape function, isoparametric concepts, 1-D, 2-D, 3-D and axisymmetric elements, field problems, modelling and practical considerations, and special topics. The module is targeted at undergraduate and graduate students involved in research or application of the finite element method in civil engineering problems.</td>
<td>1. Weak formulation &amp; variational principle 2. Finite element concepts and modeling 3. 1-D, 2-D, 3-D and Axisymmetric elements 4. Isoparametric formulation &amp; numerical integration 5. Field problems 6. Special topics: Examples: Dynamic problems, Interface elements; infinite elements; mixed formulation; mesh refinement techniques.</td>
<td>40%</td>
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| CE5509      | Advanced Structural Steel Design | The primary objective of this module is to equip civil engineering students with sufficient design knowledge and skills on steel-concrete composite structures both for their further education and for their future engineering career. This module provides students with fundamental approaches in designing structural steel-concrete components and buildings. Students will acquire fundamental knowledge and skills to perform structural design for composite beams, slabs, columns, joints, multi-storey buildings. This enables the students to conceive a safe and economical structural system. The module is targeted at MSC civil engineering students and those with a keen interest on structural design. | 1. Part One – Structural Steel Design using Design tools  
- Local Buckling and Section Classification  
- Restrained Beams  
- Unrestrained Beams and Lateral Torsional Buckling  
- Buckling and Struts  
- Members Subject to Axial force and Moments  
2. Part Two –  
- Design of Multi-storey Steel Frames and Stability Issues  
  # Design of modular steel buildings  
3. Part three – Design of Steel-Concrete Composite Structures  
- Introduction to Composite Construction  
- Composite beams  
  # Serviceability Deflection and vibration  
- Composite Slabs with Profiled Steel Sheeting  
- Shear connectors  
- Composite columns  
  # Use of high strength steel and high strength concrete  
- Composite Building Systems and frames | 40%                                                                                                                                       | 60% |
| CE5510      | Advanced Structural Concrete Design | The objective of this module is to further equip civil engineering students with advanced knowledge and skills in reinforced and prestressed concrete design. The students will learn refined design methods for ultimate and serviceability limit states, and apply them to structural design of flat slab systems, slender columns, concrete bridges, and concrete water tanks.  
  At the end of the course, the students should be able to  
1. understand the underlying principles and apply advanced theories and methods in structural concrete design;  
2. design special structural concrete systems such as transfer girders and other discontinuous members, slender columns, and flat and irregular slabs;  
3. understand the special requirements in the analysis and design of bridges and water-retaining structures. | 1. Review of design philosophy  
2. Design for action effects  
3. Serviceability  
4. Strut-and-tie method for design  
5. Collapse load methods for slab design  
6. Flat slab system  
7. Column design  
8. Concrete Bridges  
9. Water-retaining structures | 50%                                                                                                                                       | 50% |
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| CE5513      | Plastic Analysis of Structures           | This module provides students with basic knowledge on the theory of plasticity and their application for analysis and design of civil engineering structures. The topics covered include basic concepts of plasticity; the plastic hinge; tools used in plastic analysis and design; plastic design of beams, portal frames and multi-storey buildings, and computer methods for analysing large scale framework. Students are taught to deal with general inelastic problems of frames including computer applications and numerical formulation. The module of specialized context targets at undergraduate and graduate students in research or engineering practices relating to structural analysis and design. | 1. Basic Concepts of Plastic Design  
2. Theorems of Limit Analysis  
3. Plastic Collapse Loads  
4. Deformation of Elastic-Plastic Frames  
5. Strength of Tubular Connections  
6. Introduction to USFOS  
7. Elastic-Plastic Frame Analysis  
8. Pushover Analysis of Offshore Platform | 50%                                                                                                                                  | 50%                                                                 |
| CE5515      | Structural Health Monitoring             | Continuous and ad-hoc structural health monitoring to obtain information of the structural integrity and damage allows engineers to pre-empt structural failures by carrying out preventive maintenance and thus reducing service downtime and avoiding potential catastrophe due to undetected structural degradation.  
Digitalisation of civil structures with integrating sensor systems together with identification algorithms allows the performance and health of the structures to be monitored in real-time to ensure safe and efficient operation. This module provides an overview of the state-of-the-art technologies and approaches implemented in civil structures in the field as well as cutting-edge techniques still under research and development. | • Concepts in Structural Health Monitoring (SHM)  
Definitions, Levels and Expectations of a SHM system. Components of a SHM system and historical development  
• Sensor technologies for smart civil structures  
Key sensor technologies e.g. strain gauges, LVDTs, fiber optics sensors, piezoelectric sensors, wireless sensors, smart paint, acoustic sensing, vision-based sensors  
• Energy harvesting for smart civil structures  
Wind energy, vibration energy, solar energy, wave energy and limitations and potentials of each energy harvesting technologies  
• Methods and algorithms for structural identification  
Local and Global structural health monitoring, Vibration-based methods for global system identification and damage detection.  
• Self-repair technologies for smart civil structures  
Intrinsic and extrinsic self-healing approaches, bacteria- and chemical-based healing in concrete structures, vascular, distributed approaches applied to concrete structures.  
• Examples of application and research work | 100%                                                                                                                                  | -                                                                 |
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| CE5604      | Advanced Concrete Technology               | This module provides students with in-depth knowledge on the role of constituent materials of concrete such as cements, mineral admixtures, and chemical admixtures and their interactions that affect properties of fresh and hardened concrete. It also provides students with in-depth knowledge on concrete response to stresses, time-dependent deformations, and durability of concrete exposed to severe environments. The module discusses the basic considerations and design philosophy for performance-based design of concrete mixtures and production of concrete. It also discusses the progress in concrete technology and the latest development on high-strength, high-performance, lightweight, and self compacting concrete. Sustainable development in construction industry and use of recycled aggregates and other recycled materials will be discussed as well. The module is targeted at post-graduate and final year undergraduate students who will gain knowledge from the module to complement their skill in structural design and to prepare them for their career as professional engineers. | 1. Part 1 –  
   • Cement hydration  
   • Admixtures  
   • Fresh concrete  
   • Response of concrete to stresses  
   • Time-dependent deformations  
   • Durability of Concrete  
  2. Part 2 –  
   • Mass concrete and concreting in hot weather  
   • Performance-based design of concrete mixtures  
   • Progress in concrete technology | 30% | 70% |
| CE5610      | Assessment and Retrofit of Concrete Structures | In this current era of Aging Structures & Infrastructures, the primary objective of this module is to equip civil engineering students with sufficient knowledge and skills on the durability of concrete structures and the basic principles and concepts of repair and retrofitting. Concrete is the most widely used construction material in the whole world. Various factors affecting durability of concrete will be dealt with including non-destructive tests to assess durability. The module also emphasizes the technological and application aspects in the assessment and retrofit of concrete structures including causes of deterioration and various in-situ and non-destructive tests. The module is targeted at MSc civil engineering students and those with a keen interest in durability of concrete, assessment of concrete and retrofitting of concrete structures. It is useful in doing A&A (Addition & Alteration) Projects | 1. Introduction  
  2. Sources of distress  
  3. Cracking and fracture  
  4. Structural appraisal  
  5. Assessment of in-situ reinforced concrete  
  6. Repair materials  
  7. Methods for Stabilization and Strengthening  
  8. Assessment of repaired structures | 40% | 60% |
| CE5611      | Precast Concrete Technology                | The Primary Objective of this CE5611 Module is to equip civil engineering students with sufficient design knowledge and skills on precast structural concrete both for their further education and for their future engineering career. This module provides students with fundamental approaches in designing precast concrete components and structures. The students will acquire fundamental knowledge and approaches to section analysis and design, design of connections, floor diaphragm action, precast frame structures and precast components. The module is targeted at MSc civil engineering students and those with a keen interest on precast concrete technology. This module is highly relevant to the current civil engineering practice in Singapore as apartments constructed of precast concrete structural frames houses more than 85% of the Singapore’s population. With the high cost of labour and the push for sustainability by the Ministry of National Development precast concrete is currently the norm for most public construction in Singapore. | 1. Materials and production  
  2. Design Theories  
  3. Frames, components and connections  
  4. Precast frames analysis  
  5. Precast concrete floors  
  6. Precast concrete beams  
  7. Columns and shear walls  
  8. Horizontal floor diaphragms  
  9. Joints and connections  
  10. Beam and column connections  
  11. Structural integrity  
  12. Handling, transportation and erection | 40% | 60% |
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| CE6006      | Advanced Finite Element Method | This module extends further the fundamentals and applications of finite element method to solve complex engineering problems. Topics covered include weak formulation and finite element concepts, degenerated beam and plate elements, time-dependent finite element procedure, nonlinear finite element procedures and meshless finite element method. Student should be able to analyse advanced problems in structural and geotechnical disciplines using finite element methods. | 1. Weak formulation and finite element concepts  
2. Degenerated beam and plate elements  
3. Nonlinear finite element formulation  
4. Finite elements with size effect  
5. Mesh-free method  
6. Finite element project | 50% | 50% |
| CE6077A     | Numerical methods in Civil Engineering | This course introduces the basic principles to the numerical methods used for analysis of mechanics and environmental flow problems. Fundamental concepts in finite difference method, and the associated convergence and stability issues will be covered. The concepts of grids, issues with them and possible solution methods will be discussed. The module will enable the students to acquire the basic numerical analysis knowledge and computational skills through mini-projects and homework assignments. | Mathematical models in engineering mechanics  
Ordinary and partial differential equations; boundary and initial value problems.  
Finite difference method  
Explicit mesh; implicit mesh; consistency; stability; convergence.  
Grids and grid systems  
Types of grids and how they impact the solutions | 100% | - |
| CE6077B     | Numerical Methods for Environmental Flows (Note: recommended for coursework students) | This course builds on the fundamental concepts of numerical methods introduced in CE6077A and applies it to the transport processes of environmental systems such as the atmosphere, freshwater systems, estuaries, coastal seas and oceans. The focus will be on how numerical methods impact solutions due to the fundamental transport equations. The module will equip students to understand the importance of transport processes to environmental impacts, limitations of computer/mathematical models to solve the transport processes and how to obtain relevant solutions given the limitations of the models. | Introduction to environmental flows  
Budgets; Conservation Equations; Models  
Numerical methods and solutions for fluids  
Review and application of FD to fluids; Finite Volume and the differences to FD; Accuracy issues  
Transport Processes in Flows  
Diffusion; Dispersion; Advection. Practical issues. | 100% | - |
| CE6077C     | Numerical Methods and Applications to Civil Engineering Mechanics (Note: recommended for research students) | This course extends the fundamental concepts in CE6077A and combines it with complementary numerical methods, for solving problems in engineering mechanics, e.g. wave propagation in solids, stability and dynamics of structural/engineering systems. The focus will be to understand the limitations of different numerical schemes for the various problems in mechanics. The module will enable students to select the suitable numerical strategy, develop the relevant numerical framework and to implement them. | Solution of nonlinear equations  
Nonlinear ordinary/partial differential equations; Suitability of different iterative schemes.  
Eigen analysis  
Eigen solvers; Applications of eigen analyses in engineering mechanics  
Introduction of boundary element method  
Steady state diffusion problem | 100% | - |