## Module Description: CIV8235

### Module Title
Advanced Concrete Design

### Credits
15

### Co-Ordinator
Maurizio Guadagnini

### Semester
Spring

### Unit Description
This course aims to give graduates with a basic background in the design of reinforced concrete structures an understanding of selected advanced topics in the field, including the use of new concepts, construction techniques and materials. The course also provides a revision of some of the fundamental principles of reinforced concrete design. In particular, it deals with short and long-term deflections, creep, shrinkage, ductility, section analysis, prestressing, shear and cracking. The lectures are supplemented by practice questions, intensive feedback (tutorial) sessions and laboratory sessions. The module is assessed by a single 2.5 hour online open-book exam.

### Unit Aims
This course aims to give graduates with a basic background in the design of reinforced concrete structures an understanding of the advanced topics in the field, including the use of new concepts, construction techniques and materials. The course also provides a revision of some of the fundamental principles of reinforced concrete design. In particular, it deals with short and long-term deflections, creep, shrinkage, ductility, section analysis, prestressing, shear and cracking.

At the end of this course students will be expected to undertake structural design to the level required for the professional examinations by the Institution of Structural Engineers.

### Syllabus

**Introduction and Probabilistic Issues**

**Deflections**

Calculating deflections using second moment of area and curvatures

Short-term deflections - uncracked and cracked concrete

Determination of shrinkage and creep strains and curvatures

Calculating long-term deflections

**RC Ductility**

Steel properties

Multi-axial concrete properties

Section analysis
Parameters that affect ductility
Design considerations

**Prestressed concrete**

Materials and prestressing systems
Prestress losses
Fundamentals of flexural design

**Shear**

Shear resisting mechanisms
Shear design according to the codes
Special design considerations
Shear walls
Punching shear

**Cracking**

Micro and macro-cracking in concrete
Bond and tension stiffening
Crack mitigation and control
Design and detailing considerations in structural members

**Laboratory Demonstration**

Lab visits to witness experiments relating to the above topics.

**Practical Design Exercises**

Practical design exercises and practice questions.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Remarks</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Hours of the Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lectures</td>
<td>36</td>
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<td>---------</td>
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<tr>
<td>Tutorials</td>
<td>Practical Classes</td>
<td>24</td>
</tr>
<tr>
<td>Indepeant Study (including Prep for Assessment)</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Laboratory Sessions</td>
<td>Deepen knowledge from lectures and tutorials through case study</td>
<td>6</td>
</tr>
<tr>
<td>Seminars</td>
<td>Seminars</td>
<td>3</td>
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</tbody>
</table>

Total Hours 150

- Lectures will be used to present new material and develop knowledge and understanding on the various topics.
- Seminars will be used to introduce recent research developments in the field.
- A large range of practice questions covering all learning objectives will be available on Mole. Students will be expected to attempt these before coming to formal feedback (tutorial) sessions.
- Tutorial sessions will be used to consolidate concepts examined during the lectures, discuss design issues and solve practical problems. The feedback sessions will be organised in small groups and several tutors will be there giving feedback to students on their attempts.
- Laboratory sessions will be used to develop experience on experimental methods and further understanding of behaviour of concrete under load.

H&S / Risk Management

- Understanding design risks and philosophy of design towards risk.
- Designing simple engineering systems for safety.
- Understanding good Health and Safety practices in the laboratory.

Learning Outcomes

2. Analyse the flexural and shear capacity of existing RC elements
3. Analyse reinforced concrete sections with general material characteristics, including confined concrete
4. Calculate the ductility of a reinforced concrete section and understand the important parameters that influence ductility
5. Analyse and design pre/post-tensioned reinforced concrete elements
6. Design for shear and understand the mechanisms of shear resistance
7. Understand the sources of cracking in concrete as well as mitigation/prevention measures
8. Interpret experimental results to further the understanding of reinforced concrete

Assessment Methods

The learning objectives will be assessed by an open-book online exam. The online exam will assess knowledge through multiple choice questions which may include critical thinking. Design calculations will be assessed by questions broken down in parts, each part requiring a numerical answer. Comments on the answers are also allowed.
Assessment Philosophy

Students are assessed on the fundamental understanding of the basic principles, their application in design and design scenarios. The open-book online exam consists of questions designed to examine most of what has been learned.

A large range of practice questions (which cover all learning objectives) will be provided to help students learn and exercise. Whilst the exam is open-book, it is fast-paced and therefore students are expected to prepare spreadsheets of calculation scripts in preparation for the exam.

Students who get most of the calculations correct will pass the threshold. To excel, a student will have to use advanced techniques and be able to critically appraise the results and the methods adopted.

Module Assessment

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Learning Outcomes</th>
<th>Week</th>
<th>Day</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Written Exam Invigilated</td>
<td>(LO1, LO2, LO3, LO4, LO5, LO6, LO7, LO8)</td>
<td>Nothing</td>
<td>Exam Period</td>
<td>100</td>
</tr>
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</table>

Total Percentage 100%

Formative Assessment and Feedback

Feedback on the practice questions will be provided in small groups during feedback (tutorial) sessions. The objective is to give a chance to each student to check their answers and understanding with a tutor.

The practice questions increase progressively in difficulty, starting from easy revision-type questions to questions where the students have to demonstrate a thorough understanding of the fundamentals. The indicative level of difficulty is given for both the practice questions and the online exam.

Recommended Reading

Book 1 - Highly Recommended

A thorough list of highly recommended texts, books and guidelines is given on Mole.

Book 2 - Recommended

Title: Reinforced concrete structures

Author: R. Park (Robert)

Other Contributors: Thomas Paulay

Publisher: New York; London etc.: Wiley, 1975
Book 3 - Recommended

Title: Seismic design of reinforced concrete and masonry buildings

Author: T. Paulay (Thomas)

Other Contributors: M. J. N Priestley

Publisher: New York : Wiley, c1992


Format: xxiii,744p.

Subjects: Earthquake resistant design; Reinforced concrete construction; Buildings, reinforced concrete -- Earthquake effects; Structures Effects of Earthquakes


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