Module Title: 3A2 Structural Design

Code: CE3A2

Level: Junior Sophister

Credits: 5

Lecturer(s): Professor Brian Broderick (bbrodrcck@tcd.ie)
Professor Biswajit Basu (basub@tcd.ie)

Module Organisation
This Module runs for the 11 weeks during the first semester, with three lectures and a tutorial every week. In addition, students complete four laboratory experiments.

<table>
<thead>
<tr>
<th>Engineering Semester or Term</th>
<th>Start Week</th>
<th>Hours of Associated Practical Sessions</th>
<th>End Week</th>
<th>Lectures</th>
<th>Tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>8</td>
<td>11</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>11</td>
</tr>
</tbody>
</table>

Total Contact Hours: 52

Module Description
In this Module, students learn to design, dimension and detail elementary steel and reinforced concrete members: beams, columns/struts and ties. The Module consists of two equal parts – structural steelwork and reinforced concrete. The Module takes place in the first semester and consists of lectures, tutorials/design studies and laboratories.

Learning Outcomes
At the end of the Module students should be able to:
1. Describe the engineering properties of structural steel, reinforcing steel and concrete.
2. Distinguish between serviceability and ultimate limit states, and apply appropriate partial safety factors.
3. Discriminate between the different types of failure observed in reinforced concrete and structural steelwork, and identify when each of these is likely to occur.
5. Describe the types of failure displayed by bolted steel connections.
6. Calculate the ultimate resistances of steel and RC members from first principles and using design code methods.
7. Evaluate the shear and bearing resistances of a bolted connection.
8. Draw bending moment and shear force diagrams for statically determinate beams.
9. Design structural steel and RC members to possess required bending, shear, buckling and tensile resistances.
10. Choose suitable steel and RC beam and column section sizes for given situations.
11. Select suitable member sizes in a steel truss.
12. Develop bending-shear and bending-axial force interaction diagrams and expressions.
13. Observe the experimental response of steel and RC specimens under load, identify and describe the forms of failure displayed, calculate the resistances of the test specimens and compare with theoretical or design values, write a laboratory report.

Module Content
- **Introduction to Structural Design**: Serviceability and ultimate limit states, forms of failure, partial safety factors, characteristic and design values.
- **Material properties**: Uniaxial behaviour of structural steel, reinforcing steel and concrete; engineering properties, design values for steel and concrete grades.
- **Steel Tension members**: Examples of members under axial tension; effect of holes, effect of steel grade; design approach; worked example.
- **Compression members**: Pure axial compression; axial compression with bending; failure modes; cross-section analysis; member buckling resistance, slenderness, imperfections; buckling curves and design tables, bending moment-axial force interaction in RC members; design code provisions.
- **Steel members in bending**: Examples; comparison of truss and I-section behaviour; review of elastic theory, extension to plastic sections, shape factors; local buckling and section classification; elastic shear distribution, shear resistance, coincident high shear and bending moment; web buckling, web bearing
- **RC members in bending**: Properties of composite, uncracked and cracked sections, ultimate bending moment resistance of RC sections, singly- and doubly-reinforced sections; under- and over-reinforced beams; shear in RC sections.

Laboratory Experiments
Elastic-plastic steel beam, bolted connections, over- and under-reinforced concrete beams, deflection and strain response of RC beams.

Assessment
85% of the assessment is due to a two-hour formal, written, end-of-year examination. The remaining 15% is allocated for Modulework (lab experiments/reports and tutorials/design studies) divided equally between the steel and reinforced concrete parts of the Module.

Recommended Texts
- Reinforced and Prestressed Concrete Design, O’Brien and Dixon, *Longman*
- Reinforced and Prestressed Concrete, Kong and Evans, *Van Nostrand Reinhold*
Further Information
http://www.tcd.ie/Civil_engineering/Staff/BiswaB/Basu/3A2/