CE 304   SYSTEMS ENGINEERING
Co-ordinator: Dr C.J. Onof (Room 410), c.onof@imperial.ac.uk **Status:** Core Module

Lecturer:	Dr C.J. Onof (CJO) (Room 410)
Tutors:	Dr C.J. Onof, Dr D. Lloyd Smith (DLS) (Room 426)
Structure:	13 lectures and 12 tutorials
Links:	CE102, CE201

Aims

To introduce the students to the systems approach in solving Civil and Environmental problems, with a particular emphasis on the one hand upon the breadth of this approach, by looking at design, operational and project management issues, and on the other hand upon the mathematical tools available.

SYLLABUS

1 Lecture   The systems approach in Civil Engineering. An overview of the relevant techniques in operational research and systems.

6 Lectures   Linear programming Problem.formulation. Geometricsolution in two dimensions. The simplex method. Generation of basic feasible solutions. The two-phase simplex method. Multiple optima, unbounded problems, degeneracy. Sensitivity analysis, shadow prices and duality. Application to design and management problems in water resources, structures, transport. Use of "Solver".

3 Lectures   Network algorithms Hamiltonian and Eulerian problems. Shortest path algorithm. A brief examination of the link with Critical path analysis. Application to project management and transport.

3 Lectures   Non-linear programming Differences between linear and non-linear problems. Search methods. Lagrange multipliers. Application to design and water resources.

Coursework and submission dates

Assessment will include coursework involving the use of the software **Solver (Excel)**. This coursework will focus upon a sensitivity analysis for a linear optimisation representation of a production problem. (Deadline – Friday 18th December -*Week 11*).

Assessment

A 3-hour written examination in common with CE305 : *Rubric* – Answer 2 out of 3 questions.

Recommended textbooks:

The following do not cover the full syllabus, but provide useful, supporting reference material.

WAGNER, H.M., Principles of Operations Research, with Applications to Managerial Decisions, 2nd ed., *Prentice-Hall, 1975.*
SMITH, A.A., HINTON, E. and LEWIS, R.W., Civil Engineering Systems: Analysis and Design, *Wiley, 1983.*
OSSENBRUGGEN, P.J., Systems Analysis for Civil Engineers, *Wiley, 1984.*

Learning Outcomes
- First, there should be an appreciation of how problems in many areas within (and outside) civil engineering, while they may appear superficially quite different, may share a common mathematical structure.
- Second, given any decision-making problem it should be possible to identify the decision variables, the constraints, and the criteria for choosing between alternative courses of action.
- And third, the elementary principles underpinning the numerical solution of a broad class of linear (and in part nonlinear) optimisation problems should be appreciated.