CE 411 SYSTEMS ANALYSIS

Co-ordinator: Dr C.J. Onof (Room 410), c.onof@imperil.ac.uk

Status: Environmental Elective

Lecturer: Dr C.J. Onof (CJO)

Structure: 38 lectures and 16 tutorials

Links: CE304 Systems Enginering

Aims

To introduce the students to some more advanced topics in the systems approach to Engineering and Management problems so as to provide them with the requisite tools for the mathematical representation of decision-making problems, in particular emphasising the roles of uncertainty and risk.

SYLLABUS

A: Broadly Deterministic Systems

1. Dynamic programming
   Application to:
   - Minimal path problem.
   - Allocation of resources.
   - Production scheduling.
   - Replacement policy.
   - Resolution of linear or non-linear problems.

2. Probabilistic dynamic programming
   Application to the representation of uncertainty in production scheduling.

3. Game theory
   Zero-sum games. Saddle points. Minimax strategy. Mixed strategies. The problem of non zero-sum games. Application to the management of competitive situations.

B: Stochastic Systems

1. Reminder of elements of the theories of *probability* and *statistics*.
   - Random variables, distributions, functions of random variables.
   - Standard distributions, central limit theorem, parameter estimation.
   - Application to uncertainty evaluation in production.
2. Decision theory
   - Minimax criterium. Maximum likelihood and Bayes criterion.
   - The use of extra information. Application to exploitation of resources under uncertainty (water, minerals).

3. Markov chains
   - Probability transition matrix. Steady-state.
   - Application to project management.

4. Queuing theory
   Single and multiple server queues.
   Application to transport.

Coursework and submission dates
Assignment 1 (Week 11): Applications of Dynamic programming to a multivariate machinery replacement and a production problem
Assignment 2 (Week 24): Application of Markov Chain theory to production management and reduction of uncertainty in data logger information transmission

Assessment
A 3-hour written examination at the end of session for which you receive 60% of the overall module mark. Two formal pieces of coursework, each receiving 20% of the overall mark.

Recommended Textbooks
HILLIER, F.S. and LIEBERMAN, G.J., Operations Research, 2nd Edition, *Holden-Day, 1974.*

Learning Outcomes
- formulate an engineering decision problem in terms of a mathematical programme;
- use appropriate tools to solve it, in particular when it is a dynamic problem;
- assess the different types of uncertainty involved in the decisional problem;
- incorporate these uncertainties into a probabilitistic decision-making framework