MATH0028 Combinatorial Optimisation

Year:	2024–2025
Code:	MATH0028
Level:	6
Normal student group(s):	UG Year 3 Mathematics degrees
Value:	15 credits (= 7.5 ECTS credits)
Term:	2
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	MATH0014
Lecturer:	Dr A Pokrovskiy

Course Description and Objectives

The course aims at an introduction to combinatorial algorithms and to the theory of efficiency of algorithms. One main topic is network flows and extremal problems on graphs, including minimum spanning trees, shortest paths, and maximum flows. Another main topic is the theory of combinatorial algorithms, including Turing machines and NP-completeness. Various examples will illustrate the difference between polynomial and exponential time algorithms.

Recommended Texts

(i) W. J. Cook, W. H. Cunningham, W. R. Pulleyblank, and A. Schrijver, *Combinatorial Optimization*, Wiley (1998).

(ii) J. Talbot and D. Welsh, *Complexity and Cryptography: An Introduction*, Cambridge (2006).

Detailed Syllabus

- Graph problems: shortest paths, spanning trees, matchings.
- Combinatorial algorithms: sorting, merging, binary trees.
- Network flows: maximum flows, integral flows, their applications, matchings in bipartite graphs.
- Algorithms and complexity: Turing machines; difference between polynomial and exponential time algorithms, NP-complete problems, satisfiability problem; Cook's theorem; polynomial equivalence.
- Various problems for instance: fast multiplication of integers and matrices, stable matchings, finding the size of maximal independent sets and cliques, primality testing.