I have divided the course material into three levels below. You will pass (fail) the exam if you can solve all (none) of the problems from Level 1. There will be 6 questions on the exam, of which about 4 will belong to Level 1, and about one each from each of levels 2 and 3. Note that, by contrast, the nomework exercises have been divided much more evenly between all three levels, with perhaps even a surplus of Level 2 and 3 exercises.

Finally note that, of the 6 questions, 2 will come from Del 1 (Kombinatorik), 2 from Del 2 (Aritmetik), 1 from Del 3 (Grafteori) and 1 will be a 'Wild Card', i.e.: it can come from anywhere.

Level 1

Everything which involved carrying out some *algorithmic procedure*.

DEL 1 :

Solving linear recurrence relations

$$au_{n+2} + bu_{n+1} + cu_n = f(n),$$
$$u_0 = \alpha, \qquad u_1 = \beta.$$

DEL 2 :

(i) Euclid's algorithm to compute $\mathrm{SGD}(a, b)$.
(ii) Euclid's algorithm to solve linear Diophantine equations

$$ax + by = c.$$

(iii) Euclid's algorithm to compute $a^{-1} \pmod{n}$ when $\mathrm{SGD}(a, n) = 1$.
(iv) Computing $a^b \pmod{n}$ quickly when a and b are large. The square-and-multiply method always works, but can be slow. If b is much bigger than n and $\mathrm{SGD}(a, n) = 1$, then we can use Fermat's/Euler's theorem.
(v) The Chinese Remainder Theorem to solve a system of linear congruences.
(vi) Solving quadratic congruences in $\mathbf{Z}_p$, where p is a prime.

Del 3 :

(i) Checking whether a graph has an Euler cycle or path and finding one using DFS when it has.
(ii) FInding a Hamilton path or cycle in a graph - there is no good algorithm here, you just have to experiment.
(iii) Greedy algorithm for graph coloring ; computing $\chi(G)$.
(iv) Finding a minimal spanning tree in a weighted graph.
(v) Finding a shortest path between two points in a (directed) graph - Dijkstra's algorithm..
(vi) Ford-Fulkerson algorithm for finding a maximal flow in a network.

Level 2

Some kind of *formula* is available, but it's not perhaps immediately obvious how to use it.

Del 1 :

(i) Use of the multiplication principle and applications of it (permutations, combinations, binomial theorem, unordered selection with repitition) for counting.
(ii) Inclusion-Exclusion principle.

Del 2 : Nothing really.

Del 3 :

(i) Using Euler's formula for plane graphs.

Level 3

Solving the problem requires a bit more *creativity*, or a deeper *understanding* of the theory.

Del 1 :

(i) Proving a combinatorial identity (usually involving binomial coefficients).
(ii) Finding or verifying (with proof) a recurrence relation.
(iii) Catalan numbers, Stirling numbers, partitions.

Del 2 :

Everything not included under Level 1. Similar stuff to that which appears on the homework exercises 2.6, 2.7, 2.8, 2.9, 2.10. In particular, clever use of the Fundamental Theorem of Arithmetic.

Del 3 : To be updated.