

This report summarises the types of questions in the mock exams and past papers(not including mastery questions). Each number in the bracket indicates the number of marks this type of question appeared.

This summary is based on four mock exams and the test paper of May 2022.

Chapter	Questions	Total Marks
<b>Unconstrained Optimisation</b>	<ul style="list-style-type: none"> <li>- Finding Stationary Point and Classification: global/local, min/max/saddle, strict/non-strict (56) <ul style="list-style-type: none"> <li>- May involve unknown constants</li> </ul> </li> <li>- Judge Coerciveness of functions (10)</li> </ul>	66 <b>16.5%</b>
<b>Least Square</b>	None	0
<b>Gradient Descent(GD), SGD</b>	<ul style="list-style-type: none"> <li>- Write down explicit gradient descent iteration for a problem (6)</li> </ul>	6 <b>1.5%</b>
<b>Convex Sets and Functions</b>	<ul style="list-style-type: none"> <li>- Judge if a function is convex(45)</li> <li>- Prove propositions, logical deductions: like analysis question (30) <ul style="list-style-type: none"> <li>- e.g. prove that a convex and concave function must be affine</li> </ul> </li> </ul>	75 <b>18.75%</b>
<b>Convex Optimisation</b>	<ul style="list-style-type: none"> <li>- Judge if an optimisation problem is convex(10),</li> <li>- Stationarity Condition: proving stationarity of a problem is equivalent to some formulae (40),</li> <li>- solving optimisation problem directly(26)</li> <li>- proving equivalence of optimality, optimality solutions etc. (10) <ul style="list-style-type: none"> <li>- e.g. show problem A and problem B have the same set of optimal solutions</li> </ul> </li> <li>- Proving existence of solution, or uniqueness of solution (14)</li> </ul>	100 <b>25%</b>
<b>Optimality Conditions</b>	<ul style="list-style-type: none"> <li>- find KKT conditions of a problem: sufficiency, necessity(34)</li> <li>- find solution using KKT (53)</li> <li>- find KKT points (8)</li> </ul>	95 <b>23.75%</b>
<b>Duality</b>	<ul style="list-style-type: none"> <li>- Finding dual problem, finding equivalent constrained optimisation(45)</li> <li>- Find duality gap(5)</li> <li>- Explanations: comparing dual, primal problems; relation of solutions (4)</li> </ul>	54 <b>13.5%</b>
<b>Others</b>	<ul style="list-style-type: none"> <li>- calculate function value (4)</li> </ul>	4 <b>1%</b>

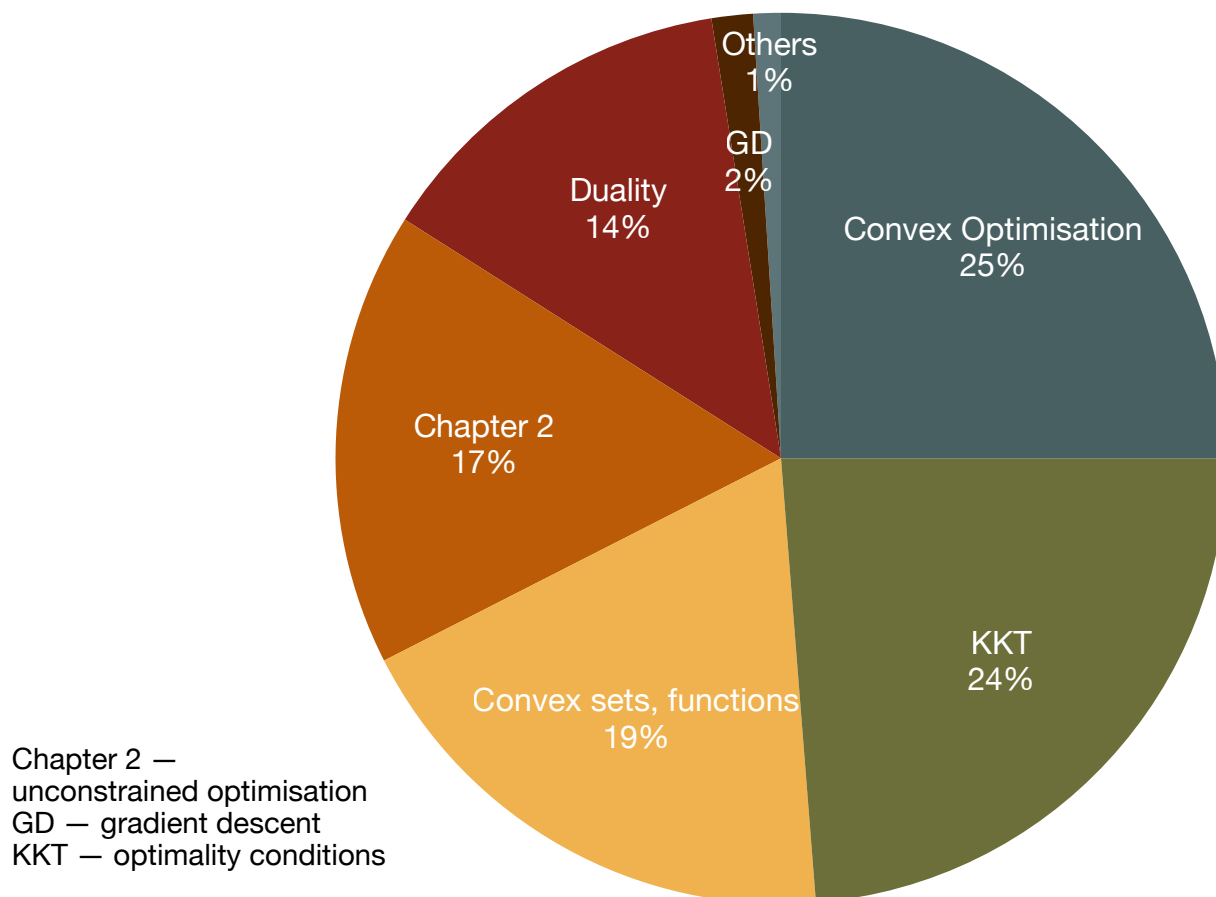
## Distribution of Marks by Question Type

Bookwork(writing down or using definitions from books):	150 (37.5%)
Calculation(mainly solving optimisation problems):	152 (38.0%)
Logical Deductions (questions that look like analysis):	94 (23.5%)
Explanation:	4 (1.0%)

## Top Questions

- Finding Stationary Point and Classification: global/local, min/max/saddle, strict/non-strict
- Find solution using KKT
- Finding dual problem, finding equivalent constrained optimisation
- Judge if a function is convex
- Stationarity Condition: proving stationarity of a problem is equivalent to some formulae
- find KKT conditions of a problem: sufficiency, necessity

## Distribution of Marks by Topic



## Potential Future Problems

QUESTIONS THAT HAVE NOT APPEARED IN MOCK, PAST EXAMS, BUT APPEARED IN PROBLEM SHEETS AND MAY APPEAR IN FUTURE EXAM

Chapter	Questions
<b>Unconstrained Optimisation</b>	<ul style="list-style-type: none"> <li>- Matrix Classifications: definiteness</li> <li>- Find/prove Equivalent formulations of optimality conditions (first and second order)</li> </ul>
<b>Gradient Descent(GD), SGD</b>	<ul style="list-style-type: none"> <li>- show that a function is in <math>C^{1,1}</math>, i.e. gradient is Lipschitz continuous <ul style="list-style-type: none"> <li>- may have to find Lipschitz constant</li> </ul> </li> <li>- Deduce formula for nth iteration value, and study convergence of GD</li> <li>- write explicit Gauss-Newton iteration</li> </ul>
<b>Convex Optimisation</b>	<ul style="list-style-type: none"> <li>- find orthogonal projection formulae</li> </ul>

## List of Algorithms:

Least Square: Data Fitting, Polynomial Fitting, Regularised Least Square, Denoising, Circle Fitting

Gradient Methods: Ordinary Gradient Descent, Scaled Gradient Method, Gauss-Newton Method, Damped G-N Method, Newton's Method, Damped Newton's Method, Kaczmarz Algorithm, Stochastic Gradient Descent.

Gradient Projection Method