Computer Science @ Cambridge

www.cl.cam.ac.uk/admissions
What is Computer Science at University Level?
The department past and present
The aims of our course
The course ("Tripos") structure
The first year options
Employment prospects
The CS application process
Interviews and tests
Where to get more info
**What is CS?**

**Combines Elements of...**

<table>
<thead>
<tr>
<th>Natural Science</th>
<th>Maths</th>
<th>Natural Language</th>
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<tbody>
<tr>
<td>Engineering</td>
<td>Electronics</td>
<td>Philosophy</td>
</tr>
<tr>
<td>Technology</td>
<td>Psychology</td>
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</table>

**Teaches...**

<table>
<thead>
<tr>
<th>Critical thinking</th>
<th>Solution Evaluation</th>
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<tbody>
<tr>
<td>Rigorous problem analysis</td>
<td>Programming skills</td>
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<tr>
<td>Efficiency</td>
<td>Logic and proof</td>
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Why Study it Here?

All the usual Cambridge advantages apply: the College structure, the supervision system, the learning environment, the smart peers

But Computer Science here is particularly special: there is a rich history both in the technology *and* the teaching of the subject
80 Years Ago...

We started as a part of the Mathematics Department in 1937.
Back then we were the Mathematical Laboratory because the term “computer science” hadn't been invented.

The world's first usable computer (EDSAC) was built here.

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First Job Queue too..!
An (Abridged) Timeline

- We are founded (1937)
- Oxford Computing Lab (1957)
- School of Computing at Manchester (1964)
- EECS at MIT (1975)
Not forgetting...
Our Undergraduate Degree
(the “Computer Science Tripos”)
Our Aims

To give an understanding of fundamental **principles** that will outlast today's **technology**

To produce graduates who **create** the future not just cope with it
The Course

**Year 1**
- Fundamentals
- Programming
- Electronics
- Maths
- [+Option]

**Year 2**
- Theory
- Systems
- Hardware
- Programming
- Group Project

**Year 3**
- Free choice of advanced topics
- Personal project

**B.A.**

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# The Course

## Part IA
- Fundamentals
- Programming
- Electronics
- Maths
  [+Option]

## Part IB
- Theory
- Systems
- Hardware
- Programming
- Group Project

## Part II
- Free choice of advanced topics
- Personal project

## Part III
- Free choice of research topics
- Research project

## Year 1

**B.A.**

## Year 2

## Year 3

## Year 4
(Optional)

**M.Eng.**

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The Course

Year 1
Part IA
- Fundamentals
- Programming
- Electronics
- Maths
[+Option]

Year 2
Part IB
- Theory
- Systems
- Hardware
- Programming
- Group Project

Year 3
Part II
- Free choice of advanced topics
- Personal project

Year 4
(Optional)
Part III
- Free choice of research topics
- Research project

B.A.
M.Eng.

Needs a First
Our First Year Options

CST 75%

CST 1
CST 2
NST Maths
CST 3

CST 50% NST/PSY

CST 1
CST 2
NST Maths
NST Option

CST 50% Maths

CST 1
CST 2
MST 1
MST 2

There are always **four** exam papers to sit

You spend a quarter of your first year studying material for each paper
Our First Year Options

- CST 75%
  - CST 1
  - CST 2
  - CST 3
- CST 50% NST/PSY
  - CST 1
  - CST 2
  - NST
  - Maths
- CST 50% Maths
  - CST 1
  - CST 2
  - MST 1
  - MST 2

> Ran for first time in 2016-2017
> Three CS papers coupled to one maths
> The material covers graphics, databases and machine learning
> Intended for those with prior experience
Our First Year Options

- Lets you study two CS papers, one maths and a Natural Sciences subject of your choice
- Physics, Chemistry, Evolution & Behaviour, Geology, Physiology of Organisms

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Our First Year Options

> Lets you study two CS papers, one maths and a Natural Sciences subject of your choice

> Physics, Chemistry, Evolution & Behaviour, Geology, Physiology of Organisms

> You can switch into the NST subject in the second year without any penalty (nice option, rarely used)
Our First Year Options

- Lets you study two CS papers and two Maths papers from the Mathematical Sciences Tripos

- Good way to do more maths in IA if you are more theory-oriented. But it's not an easy option.

- You cannot switch to mathematics in the second year
Our First Year Options

- CST 75%
  - CST 1
  - CST 2
  - NST Maths
  - CST 3

- CST 50% NST/PSY
  - NST Maths
  - NST Option

- CST 50% Maths
  - CST 1
  - CST 2
  - MST 1
  - MST 2

> Lets you study two CS papers and two Maths papers from the Mathematical Sciences Tripos
> Good way to do more maths in IA if you are more theory-oriented.
> You cannot switch to mathematics in the second year.

Add STEP Maths Requirement
2016 (2017) Intake Choices

Total 100 CST Students (and 63 NSTs)
Implications for Future Years

CST exam papers

75%:
- Year 1
- Year 2
- Year 3

50%:
- Year 1
- Year 2
- Year 3
Implications for Future Years

CST exam papers

Year 1: 75%
Year 2: 50%
Year 3: Everyone is assessed on 11 exam papers across the three year B.A.

Plus two more papers: Maths, NST Maths, Psy Maths, Maths

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CS as an NST Option

You can select CST Paper 1 as an option within Natural Sciences

It is possible to catch up CS Paper 2 in your summer vacation and switch to Computer Science in your second year (and some do)
## Practical skills

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Weekly practicals to consolidate lecture material</th>
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</table>
| Year 2 | Weekly practicals to consolidate lecture material  
**Group Project** (team work) |
| Year 3 | **Personal project** |
| Year 4 | **Research project**  
Some modules associated with additional practicals |
Languages aren't important.

**Principles** are.

**As of today:**
Java, C/C++ for imperative programming
ML for functional programming
Prolog for logic programming
Verilog for hardware programming
Python for data science
You DON'T need programming experience

We teach from the ground up.

However, if you've never programmed before, how do you know you'll enjoy a degree that uses it?

A survey of our first years...

- No experience (39%)
- Not much experience (24%)
- Some experience (18%)
- Quite a lot of experience (14%)
- Programming expert (2%)
Employment Prospects
Cambridge graduates 'the most employable in the world'

The Global Employability University Ranking, published by the International New York Times, names Cambridge as the world's top institution for graduate employment.
The course gives vital skills for every sector. Good computer scientists go on to a multitude of careers: IT, business, politics, finance, science, engineering, education, arts.
Very sought-after graduates

Jobs galore!

Our annual recruitment fair attracts 50+ companies, each looking to recruit 3 or 4 graduates on average.

We only produce ~100 graduates in total!

Some of the Companies

Google, ARM, Amazon, Disney, Barclays, Cisco, BT, Mozilla, MathWorks, Citrix, Frontier, Red Gate, Morgan Stanley

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Applications Process
The Process

- **Apply via UCAS**: October
- **Supplementary Questionnaire**: November/December
- **Written Test (CSAT)**: Interview Day (Early December)
- **Two Technical Interviews**: Early January
- **Admissions Pool**
Admissions is Done by the Colleges

The University is a combination of:

**Colleges** – these admit and look after students both in terms of welfare and academics. They arrange the supervisions we are famous for.

**Departments** – these set syllabuses, provide lectures and handle exams. They also perform research (their 'day job').

**Administration** – there is a large number of admin-related entities: everything from finance to entrepreneurship to IT to dental services.
DoS – Director of Studies. At least one per subject per College. In charge of the academic progress of the students in their subject. Key for the admissions process.

Admissions Tutor – One per College. Makes the final decision on who gets in or pooled based on the recommendations of the DoSes.
Choosing a College for CS

Colleges are responsible for academic guidance, supervisions and pastoral care
They provide diverse communities where you build life-long friends and associations

**The best College for you is an individual choice**

Modern or classical buildings?
Centre or out of town?
Large or small CS cohort?
More formal or more relaxed feel?
How active is the DoS in teaching?
What do past and present students say?

etc...

*We can't tell you which College is right for you (sorry!). Visit them and talk to the Fellows, staff and students there.*
Every application is individual but usually all of these factors contribute to our decisions:

- Exam predictions and results
- Interviews
- Personal statement
- School references
- Special circumstances (if any)
- CSAT
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**Prerequisites**

**A*A*A at A-Level**

**A-Level Maths**

is absolutely essential

**Further Maths**

AS is essential (if your school offers it)
A2 is desirable
AEA/STEP is useful

Not doing Further? We recommend doing at least AS Further in your A2 year
Other A-Levels

Physical sciences

Very useful and desirable at admissions
Prerequisites for some first year options

Electronics

Relevant and useful

But not as desirable as maths and physical sciences so please don't drop these in favour of electronics

Other A-Levels

Computing/Computer Science

NOT a prerequisite

Good way to show interest in the subject and to “try before you buy”

However, the syllabuses overlap with our first year

We don’t recommend dropping maths (or even a physical science) in favour of Computing in the A2 year: often better to drop Computing in A2
Every application is individual but usually all of these factors contribute to our decisions:

- Exam predictions and results
- Interviews
- Personal statement
- School references
- Special circumstances (if any)
- CSAT
~25 minutes each

Questions related to CS but will not assume actual CS knowledge (unless we know you have it)

Questions start simple and ratchet up in difficulty. Our interest is in when you leave your comfort zone

Correct answers (and there may be multiple) aren't as important as you might think

We are assessing your logical thinking and problem solving abilities and your motivation to study CS
Every application is individual but usually all of these factors contribute to our decisions:

- Exam predictions and results
- Interviews
- Personal statement
- School references
- Special circumstances (if any)
- CSAT
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- Exam predictions and results
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- CSAT
It's there to help you!
Another opportunity to shine, besides the interview.
Another opportunity to shine, besides the interview.

Our interest: what you can do (not what you can’t). We want you to do well (it’s not there to catch you out).
Another opportunity to shine, besides the interview.

Our interest: what you can do (not what you can’t). We want you to do well (it’s not there to catch you out).

Your choice of questions! Like pure maths more than algorithmic problems? No problem. Show us what you enjoy!
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Your choice of questions! Like pure maths more than algorithmic problems? No problem. Show us what you enjoy!

No pass mark. We consider the positive aspects.
The CSAT

We have a CSAT stand upstairs in the Intel Lab today.
Ask us anything about the CSAT.

www.cl.cam.ac.uk/csat
Instructions:

- The test duration is 120 minutes. Section A has 8 questions. Section B has 12 questions which are more challenging and worth more marks.

- All questions attempted are marked. Your best 5 questions from each section are considered. Partial answers are taken into account. You can choose the questions to answer and their order.

- Write only on the work-booklet provided and clearly label the question you are solving at the top of each page. Answers without working may not gain full marks. You should show sufficient working to make your solutions clear to the Examiner, but these need not be extremely thorough.

- Calculators, phones, watches, smart-glasses or other electronic devices or paper are not permitted.

- All paper must be handed in. Do not write on the cover or question sheets.

- Do not discuss any test questions with others (e.g. candidates at the same or another College, the Internet, or elsewhere), especially before March. You would disadvantage yourself.

It is recommended that you:

- take 5 minutes first to read through all questions,
- start with Section A and spend no more than 30 minutes on it,
- aim for 5 questions in each section; if you finish early then attempt more from Section B.

Good luck!
Designed to aid preparation for the CSAT, with hints, related topics, worked solutions and more. Attempt first and reveal content gradually.

Practice Paper 1 Question 15

Does $30$ divide $n^5 - n$ for all positive integers $n$?

Related topics [+]
Warm-up Questions [+]

Hints
- Hint 1 [+]
- Hint 2 [+]
- Hint 3 [+]
- Hint 4 [+]

Solution [+]

If you have queries or suggestions about the content on this page or the CSAT Practice [+]) Platform then you can write to us at practice.plus@csat.io. Please do not write to this address regarding general admissions or course queries.
Practice Paper 1 Question 15

Does $30$ divide $n^5 - n$ for all positive integers $n$?

Related topics

- Factorization
- Mathematical Induction

Warm-up Questions

1. Factorise $n^3 - 2n^2 - 3$.
2. Is $n^2 + n$ always even when $n$ is an integer?
3. Does $6$ divide $100002$? Try to reason about the divisors of both numbers.

Hints

- Hint 1
  - How do you split $30$ into a product of prime factors?
- Hint 2
  - Can you factorise $n^6 - n$?
- Hint 3
  - You should obtain $n(n - 1)(n + 1)(n^2 + 1)$. What can you say about the product of $3$ consecutive numbers in terms of divisibility by $2$ and $3$?
- Hint 4
  - If you assume that $5$ divides $n^3 - n$, how can you prove that $5$ divides $(n + 1)^5 - (n + 1)$?

Solution

First notice that $30 = 2 \cdot 3 \cdot 5$. Since $2$, $3$ and $5$ are all coprime we will prove that each of them divides $n^5 - n$ and hence conclude that their product does too. We now factorise $n^5 - n$:

$$n^5 - n = n(n^4 - 1) = n(n^2 - 1)(n^2 + 1) = n(n - 1)(n + 1)(n^2 + 1)$$

The product $(n - 1)n(n + 1)$ is of $3$ consecutive numbers, hence necessarily both $2$ and $3$ must divide it. We must now prove divisibility by $5$. There are several approaches to do this, but here we shall use induction. It's easy to verify the base case for $n = 0$ or $n = 1$.

Then do the inductive step:

$$(n + 1)^5 - (n + 1) = n^5 + 5n^4 + 10n^3 + 10n^2 + 5n - n$$

$$= n^5 - n + 5(n^4 + 2n^3 + 2n^2 + n)$$

First part is divisible by $5$ owing to the induction hypothesis, while the rest is obviously a multiple of $5$. 
Q1. You have two numbers \((a,b)\). At each step you can either multiply just one number by 2, or add any number (negative included) to both. What is the minimum number of steps to get from \((a,b)\) to \((0,0)\)? Justify.
Q1. You have two numbers \((a,b)\). At each step you can either multiply just one number by 2, or add any number (negative included) to both. What is the minimum number of steps to get from \((a,b)\) to \((0,0)\)? Justify.

Q2. You start at some fixed point on a Cartesian grid. You can move up, down, left or right. You make 5 moves. In how many different locations can you end up? Can you generalize to \(n\) moves?
Q1. You have two numbers \((a,b)\). At each step you can either multiply just one number by 2, or add any number (negative included) to both. What is the minimum number of steps to get from \((a,b)\) to \((0,0)\)? Justify.

Q2. You start at some fixed point on a Cartesian grid. You can move up, down, left or right. You make 5 moves. In how many different locations can you end up?

The first 10 correct answers to either question presented at the CSAT stand win a limited edition CSAT 1337 t-shirt!
What Now?

**Upstairs** you will find:

- DoSes to answer those burning questions
- Past students to get the real story from
- The CSAT stand
- Overviews of the syllabus
- Examples of student projects
More info...

Department
Ask us upstairs today! Visit website or email at undergraduate.admissions@cl.cam.ac.uk

CSAT
Website (www.cl.cam.ac.uk/csat/)
Practice [+ Platform

University
Prospectus
Website (www.cam.ac.uk)

Colleges
Websites, DoSes, Admissions Tutors
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