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# PrimeTimes

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## Inside this issue:



## Messages from the Committee

Dear MathSoc,

Congratulations on completing all your coursework for these last two terms and pushing through all those exams!

It's been a good couple of terms, with various MathSoc events along the way. We had the Winter Wonderland event, Paintballing, Picnic in the park, and a few more, including (not hosted via MathSoc) Tony's Magic night!

Volunteering in MathSoc is a great asset to have on your CV. A new committee has already been elected but there are still opportunities to volunteer and get involved. If this sounds interesting and you want to find out more, just get in touch with the MathSoc committee—we are also happy to help and we'll be excited to hear from you!

If you are interested in volunteering but worried you may not have the time, then being a part of MathSoc might be just the ticket. It does not require you to spend a huge amount of time (after all, we all have degrees to obtain!), but will help you gain valued skills for your CV and future job applications.

If you can, get some work in over the summer! Extra experience is really helpful and highly valued by employers!!

Here is to all of your exams and your coursework results! Good Luck everyone and have an amazing break over the summer!

*Storm Viviers (Second year student, PrimeTimes Editor)*

This has been another successful year for MathSoc, with a record number of members and several events taking place. We hope to plan many more for the following year.

We have now elected our committee for next year, and so we are looking forward to seeing what the new committee have in mind and their plans to make us even more successful. The first years have some excellent ideas and have been encouraged to suggest them so that we can see what we can do! MathSoc remains free to join for any student, and I hope it will stay that way.

Next year I will be taking more of a back seat and Ana Paula and Tim will take over the running of the society. So this is a perfect opportunity to thank everyone who has contributed to MathSoc over the last few years, the society has grown massively and that is thanks to the efforts of the student community. All committee members past and present deserve commendation, and I am sure this will continue in the future!

*Steve Lakin (Senior Lecturer)*

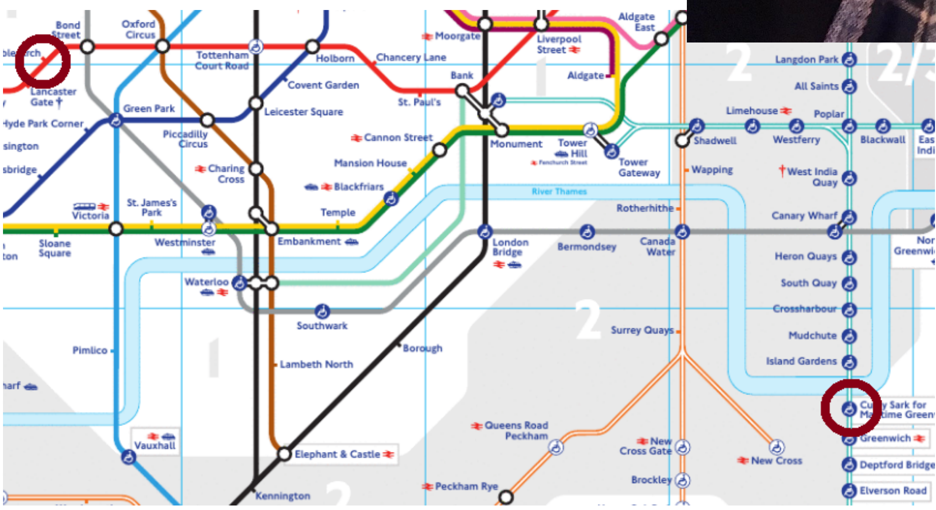
# Christmas Outing

## Winter Wonderland outing

Last December, MathSoc executives planned the trip to Winter Wonderland within 10 working days and it turned out to be a successful event with us all left wanting more. Even with the short notice, MathSoc members still came out on that cold Thursday night of **-5°C!** The aim of our trip was to socialise and relax after we had all successfully completed Term 1.

There was so much to do at Winter Wonderland and we participated in a series of activities, such as going on the rides, playing games, visiting "Santa Land", and the Christmas markets. A lot of food and drink was also available, and was thoroughly enjoyed!

We converged at John Smith's bookshop on campus and started our train journey from Cutty Sark DLR Station. Much to our satisfaction, we were able to apply what we learnt in our lectures to find the quickest route on public transport to Winter Wonderland! The shortest path problem (in time) can be formulated as a network flow with diagraph $G=(V,A)$, where $V$ is the set of vertices and $A$ is the set of arcs, arc times $t_{ij}$ and variables $x_{ij}$ (equal to 1 if the arc $(i,j)$ is in the path and 0 otherwise).




The linear programming formulation is:

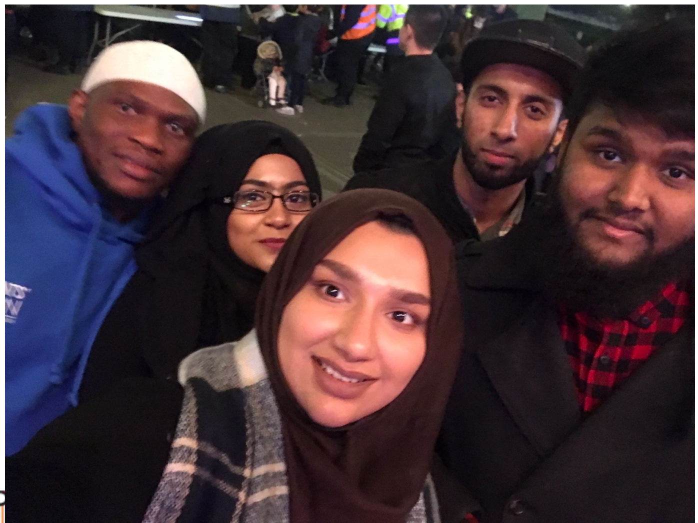
$$\min \sum_{(i,j)} t_{ij} x_{ij}$$

$$s.t.$$

$$\sum_{(i,j)} x_{ji} - \sum_{(i,j)} x_{ij} = \begin{cases} -1, & i = g \\ 0, & i \neq g, w \\ 1, & i = w \end{cases}$$

$$x_{ij} \geq 0$$

where $g$ is the starting node (Greenwich campus) and $w$ is the final destination (Winter Wonderland). From our calculations, our estimated journey time was 35 minutes, passing through 17 stations over 2 lines for the fastest possible route which equaled the most direct route. We got to Winter Wonderland at Hyde Park around 19:00 and we all left in our friend groups after spending a considerable amount of time there and having had a great time.



It was a really good outing and we did thoroughly enjoy ourselves, and would like to do something like this again next year.

*Peper Shoyemi*

# Paintballing!

After months of planning, re-scheduling, and stressful days, the paintball event finally took place on the 26th January 2017.
The group was divided into two teams: girls vs boys. We left the centre full of dirt and bruises (except Rawa, of course!), but it was great fun and worth the pain. Some bruises looked much more painful than others, like Billy's incident with an unexploded paintball which left a mark looking like the number six!

You never imagine that you'd be ambushed by your own team members, but this is exactly what happened to the boys. In the first round of the "Tower Defence" game, the boys had to defend our posts from the enemy (the girls) to prevent them from taking it. The strategy was going well until two of the boys decided to ambush the rest of the team for fun, giving the girls an easy victory. When it was the girls turn to defend the tower, they worked much more effectively, trapping all of the enemies for the duration of the game – **this was an excellent demonstration of team work**. The boys won the "Capture the Flag" game, although the girls did question the legitimacy of their "dropping guns and running" strategy! We also played another scenario where we had to secure the landing site of a helicopter before the enemy.

*"A once in a lifetime experience"*

Despite the cold weather and wounds, it was (un)safe to say that we all had a blast that we will never forget. A once in a lifetime experience.

*By: Zakia Faruke, Billy Burroughs, Rawa Shwan, Nayeem Chowdhury, Hafija Khatun, Momtaz Ullah, Fatima Khanom.*

# Fermat's Last Theorem

Proving Fermat's Last Theorem was one of the most difficult problems in the history of mathematics. Fermat proposed that there are no three positive integers, *x, y, z,* that satisfy the equation $x^n + y^n = z^n$ when *n* is any integer greater than two. Although the problem seems quite trivial at first sight, it boggled numerous mathematicians for four long centuries.

One day while reading through a chapter of Diophantus' *Arithmetica* (which concerned Pythagoras's theorem), Fermat was astonished by the fact that there exists infinitely many Pythagorean triples (three positive integers, *a*, *b* and *c* that satisfy $a^2 + b^2 = c^2$ ) . So he started playing with similar equations and looked for interesting properties. He replaced the exponent 2 in Pythagoras's famous equation with 3 and tried to find triples. He changed the power to 4 and attempted to find at least one integer triple but he faced nothing but utter failure.

Fermat thought he could prove that there exist no integer solutions to the equation which is now named after him and, in the margin of his *Arithmetica,* he scribed a note: "I have a truly marvellous demonstration of this proposition which this margin is too narrow to contain". Soon after this claim, Fermat died (1665) . His work was not published until 20 years after his death when his son found the copy of *Arithmetica* used by the mathematician.

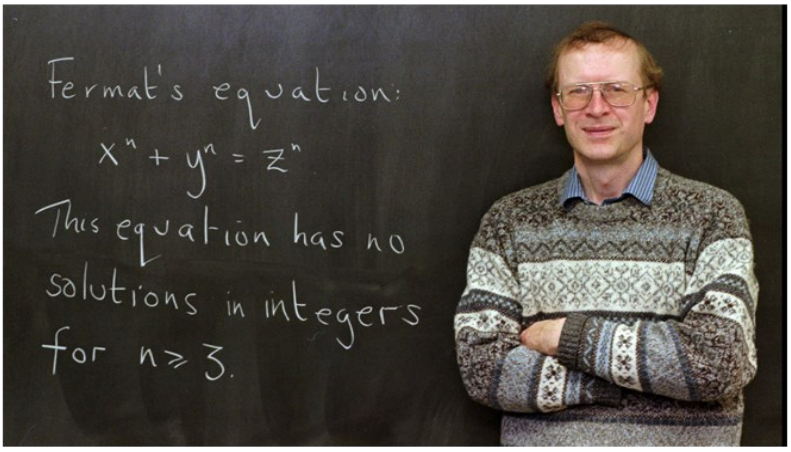
The news of Fermat's conjecture spread quickly and its proof was of much intrigue to mathematicians. A proof by infinite descent was written by Fermat for the special case when $n = 4$, but other and more general cases where never found. Mathematicians embarked on the challenge of proving Fermat's conjecture but this seemingly trivial problem remained elusive.

Despite the failure of many great mathematicians to find a complete proof, their attempts did not go in vein. Leonard Euler proved the particular case when $n = 3$ and many mathematicians then focused on proving the theorem for the case when *n* is a prime number. Still, for about 200 years, only cases for when *n* is *3*, *5* and *7* were proved. No more great progress was made until the mathematician Sophie Germaine (see next page) used an elegant argument to prove Fermat's Last Theorem for *n* equal to $(2p + 1)$ where *p* is a prime number. This was a big breakthrough that years later inspired many mathematicians who, with the aid of computers, showed that Fermat's conjecture held for millions of other prime numbers. However, a general proof was not discovered until 1994 by Professor Andrew Wiles. This proof was based on Elliptic equations and modular form, two completely different area of mathematics. These two are linked by the Taniyama-Shimura conjecture, which states that every elliptic equation has got a modular form.

Wiles, who was born in Cambridge in 1953, became obsessed with Fermat's Last Theorem at the age of ten. He dedicated most of his life trying to find a proof and even worked in isolation over six years. In his attempts Wiles faced many dead ends and failures. In 1993 he presented a full proof for the theorem but it turned out to contain a critical error. On 24th October 1994, Wiles submitted his manuscript which contained the full, correct, proof of Fermat's Last Theorem. Wiles received great honour and awards, including the Abel Prize and the Copley Medal.

It took over 3 centuries for Fermat's Last Theorem to be proved. Many mathematicians tried and failed, but it was the fruits of their attempts that inspired and assisted future generations of mathematicians. Our subject is surely much the richer because of Fermat's Last Theorem.

*Shahzeb Raja Noureen*




Sir Andrew John Wiles. AP Photo/Charles Rex Arbogast

# Biography: Marie-Sophie Germain

In an era of turmoil and chauvinism, a baby girl was born in France who would grow up to become one of the greatest mathematicians of the $18^{th}$ century. Marie-Sophie Germain, daughter of a wealthy French merchant, opened her eyes on the $1^{st}$ April 1776.

When Sophie was 13 years old, the Bastille fell and she was forced to stay indoors due to the troubles of the French Revolution. Sophie never went to school and taught herself from books in her father's library. She fell in love with mathematics when she stumbled upon a book by Jean-Etienne Montucla, called *History of Mathematics*. In this book the chapter that really caught her attention was the account on Archimedes, especially the moments before his death. Sophie was captivated by this story and taught herself calculus and the basics of number theory. She studied really hard day and night.

In this era, ladies of Germain's background were not actively encouraged to study mathematics and Sophie's parents tried to stop her learning the subject. They confiscated her clothes and removed sources of light and heat from her surroundings. But Sophie was not to be stopped. Her determination to learn mathematics was so profound that she kept a secret cache of candles that she used to light her room enough to be able to read and write. In the end her parents surrendered to her determination for mathematics and gave her their blessing to study.

Throughout her life Sophie faced difficulties from society. She had to use a false identity to be able to study at *Ecole Polythecnic.* Here she met Joseph-Louis Lagrange**,** one of the leading mathematicians of the day, who became her friend and mentor. Having a mentor encouraged her to explore mathematics at a deeper level. The area that particularly interested Sophie was number theory and she soon came across Fermat's Last Theorem. She worked on this theorem for several years before she made a famous breakthrough. She didn't want to publish her result at first, perhaps because she worried if it was correct, but she decided to have another number theorist check it. Sophie contacted Carl Frederich Gauss, one of the most influential mathematicians of all time. She wrote to him with respect and admiration and asked him to read through her work. Gauss was surprised by her sublime intellect and he appreciated it. Sophie used an elegant argument to prove Fermat's Last Theorem for a myriad of numbers of a special form. In contrast to earlier mathematicians who focused on one particular case, she focused on a set of prime numbers $p$ such that $(2p + 1)$ is also a prime number, for example, $p=5$ gives the prime $11$.

In addition to being a mathematician, Sophie was also an ingenious physicist. Her greatest work *'Memoir on the vibrations of elastic plates'* laid the foundation for the theory of elasticity. For this and her contributions towards Fermat's Last heorem she received a medal from the *Institut de France* and an honorary degree from Gottingen University on Carl Frederich Gauss's request. But, before Sophie could witness that day by herself, she died of breast cancer on 27th June 1831.

*Shahzeb Raja Noureen*

References:

Simon Singh (1997), *Fermat's Last Theorem,* London: Fourth Estate Ltd.
Jean-Etienne Montucla (1758), *History of Mathematics,* Paris: Henri Agasse.

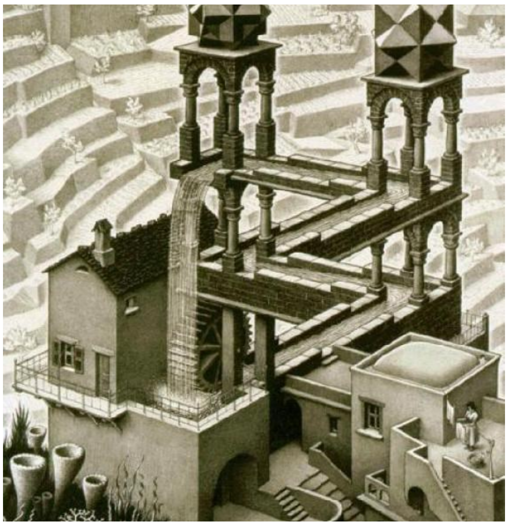
# Extended Degree Presentations

I was fortunate enough to attend the presentations of our Extended Degree students about mathematical aspects in the art of M. C. Escher (1898 – 1972). His work was often featured illusions and geometry, presenting such things as impossible cubes and impossible stairs which make sense in two dimensions but are actually impossible in real-life three-dimensions. One of his most famous works is a seemingly impossible water flow which appears to flow upwards, but in the drawing, actually goes back to the start. Escher, although an artist, often collaborated with some of the worlds most respected mathematicians, including Donald Coxeter and Roger Penrose.

The presentations were extremely insightful. I particularly enjoyed the tessellations that the students had created themselves. There is a huge amount of mathematics behind Escher's art that was clearly explained. I can honestly say I gained a lot of knowledge from seeing these presentations.

The promise that our students showed and their excellent research gives us great confidence in the future for maintaining our high standards of mathematics – it was a thoroughly enjoyable session!

*Steve Lakin (Senior Lecturer)*



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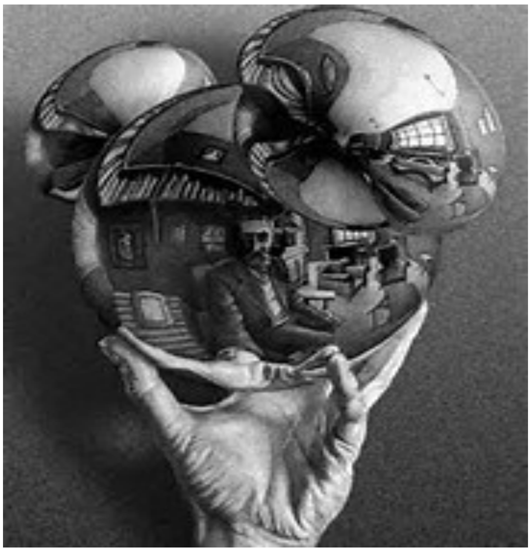

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