WHTC University application subject guides

Mechanical Engineering

This guide has been written to help support you in your application to university. It contains the following information relevant to your subject to help you decide where to apply and put together the best application that you possibly can:

1. Links to the top courses for this subject in the UK (according to
2. Entrance requirements
3. Recommended A-levels
4. Admissions tests
5. Recommended reading
6. Interesting MOOCs
7. Useful additional resources
8. Related courses
9. Oxbridge example interview questions

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1. Course links

Below are links to the top courses for this subject in the UK (according to The Complete University Guide). Click on the links to find information about what the course is like, what you'll learn, and loads of information about things such as fees and accommodation. However, remember that there are loads of other great universities out there, so check out The Complete University Guide or just google studying your subject at university.

1. University of Cambridge
2. Imperial College London
3. University of Oxford
4. University of Bristol

5. University of Bath

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2. Entrance requirements

Here are the grades that the university suggests you need to get in to that course, and the likely offer that they will give you.

1. Camrbidge: A* A* A (Further Mathematics is strongly recommended)
2. Imperial: A* A* A (to include A* in Mathematics, A* in Physics, A in another two subjects)
3. Oxford: A* A* A (to include Mathematics and Physics. The A*s must be in Mathematics, Physics or Further Mathematics)
4. Bristol: A*AA including A*A (in any order) in Mathematics and any one of Physics, Chemistry, Further Mathematics or Computer Science
5. Bath: A* A A (n three A levels including Mathematics and Physics with A* in Mathematics or Physics (or Further Mathematics if applicable)

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3. Recommended A-levels

Different universities may differ as to what A-levels they ask you for. Some might list one subject as ‘essential’, while another might list the same subject as just ‘helpful’, so make sure to check out the course page (under Section 1 of this document, or on the university website) to be sure what your chosen university expects!

Maths: Almost all courses require you to have Maths. However, some universities offer an engineering degree with an integrated foundation year, designed for people who want to do engineering but don't have the correct qualifications.

Further Maths: For more mathematical courses (e.g. Cambridge), Further Maths is strongly recommended, although not absolutely essential.

Physics: Almost all courses require you to have Physics. However, some universities offer an engineering degree with an integrated foundation year, designed for people who want to do engineering but don't have the correct qualifications.

Engineering courses much prefer a maths and science mix, but will be interested if you have Maths, Physics and one essay-based subject such as History. Check the website of the course carefully before applying

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4. Admissions tests

What admissions tests are you typically required to sit in addition to submitting your application? This also differs from uni to uni, so if your chosen university isn't on this list, make sure you check out the course page so you know exactly what you need to apply.

1. Cambridge (2 hour written assessment)
2. Imperial (No test, short interview)
3. Oxford (2 hour written assessment)
4. Bristol (None)
5. Bath (None)

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5. Recommended reading

Reading some relevant books or articles is a really great way to demonstrate your passion for your chosen subject in your personal statement, and show how you've gone beyond the curriculum. Plus, if you really want to spend three years or more studying this subject at university, it should be enjoyable! Try taking notes and jotting down your thoughts as you're reading so that you can share some of this in your personal statement

1. **Thing Explainer: Complicated Stuff in Simple Words** - a series of brilliantly simple diagrams ('blueprints' if you want to be complicated about it) that show how important things work: from the nuclear bomb to the biro.

2. **Invisible Women: Exposing Data Bias in a World Designed for Men** - Invisible Women reveals how in a world built for and by men we are systematically ignoring half of the population, often with disastrous consequences.

3. **The Gecko's Foot: How Scientists are Taking a Leaf from Nature's Book** - Bio-inspiration is a form of engineering but not in the conventional sense. Extending beyond our established and preconceived notions, scientists, architects and engineers are looking at imitating nature by manufacturing 'wet' materials such as spider silk or the surface of the gecko's foot.

4. **Cats' Paws and Catapults: Mechanical Worlds of Nature and People** - Nature and humans build their devices with the same earthly materials and use them in the same air and water, pulled by the same gravity. Why, then, do their designs diverge so sharply?

5. **Sustainable Energy - Without the Hot Air** - Addressing the sustainable energy crisis in an objective manner, this enlightening book analyzes the relevant numbers and organizes a plan for change on both a personal level and an international scale--for Europe, the United States, and the world.

6. Interesting MOOCs

Another great way of learning more about your chosen subject and demonstrating your interest is to take a MOOC, or Massive Open Online Course. These are free courses delivered by universities that you can take online. If the ones below don't take your fancy, try looking at Class Central - they have a huge list of different courses for every subject imaginable, and they're all free!

Classical Mechanics (MIT) The principles of mechanics successfully described many other phenomena encountered in the world. Conservation laws involving energy, momentum and angular momentum provided a second parallel approach to solving many of the same problems. In this course, we will investigate both approaches: Force and conservation laws.

Introduction to Engineering Mechanics (Georgia Institute of Technology) - This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses you have taken in basic math and physics. The course addresses the modelling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving.

Engineering the Future: Creating the Amazing (University of York) Learn more about the fascinating world of engineering and discover where an engineering degree could take you. Learn what key skills and knowledge you need to study engineering. Engineering has played an immeasurable role in the advancement of our society and planet. On this course, you will get an introduction to the study of engineering, and find out why, as an engineer, you have the potential to change the world.

The Art of Structural Engineering: Bridges With a focus on some significant bridges built since the industrial revolution, the course illustrates how engineering is a creative discipline and can become art. We also show the influence of the economic and social context in bridge design and the interplay between forces and form.

7. Useful additional resources

There are loads of other great things out there that you might want to look at to develop your interest and strengthen your application, from videos to podcasts, to websites. Here are a few suggestions:

Scientific magazines and publications

Nature – www.nature.com

Free to access articles

Nature is a British multidisciplinary scientific journal, first published on 4 November 1869. It is one of the most recognizable scientific journals in the world, and was ranked the world's most cited scientific journal by the Science Edition of the 2018 *Journal Citation Reports* and is ascribed an impact factor of 43.070, making it one of the world's top academic journals.

New Scientist – www.newscientist.com

Free to access articles

New Scientist, first published on 22 November 1956, is a weekly English-language magazine that covers all aspects of science and technology. Based in London, it publishes editions in the UK, the United States, and Australia. Since 1996 it has been available online.

Discover – www.discovermagazine.com

Free to access articles

Discover is an American general audience science magazine launched in October 1980 by Time Inc.

Science - https://www.sciencemag.org

Free to access scientific articles

Science, also widely referred to as Science Magazine, is the peer-reviewed academic journal of the American Association for the Advancement of Science and one of the world's top academic journals.

Scientific journals

Warwick Journal Club

https://warwick.ac.uk/fac/sci/physics/outreach/journalclub

'This is aimed at people aged 16-18 who are studying physics and want to learn more about research within physics. Every Monday, we'll look at a different scientific paper covering completely different aspects of physics to attempt to understand some of the ideas and thoughts at the forefront of scientific thinking.'

Reading a scientific paper is a skill and Warwick have put together an incredible programme to help you do it. Each week they send out a new paper along with a list of comprehension questions designed to guide you through to understanding the implications of a paper.

I could list half a dozen other journals easily but honestly just go here. It'll be a consistent, handpicked paper designed to develop you as a physicist, what more could you want?

Physics Talks and miscellaneous

Ted Talks –

https://www.ted.com/topics/physics

https://www.ted.com/topics/engineering

TED is a nonprofit devoted to spreading ideas, usually in the form of short, powerful talks (18 minutes or less). TED began in 1984 as a conference where Technology, Entertainment and Design converged, and today covers almost all topics — from science to business to global issues — in more than 100 languages.

xkcd what if

Earth's atmosphere is really thin compared to the radius of the Earth. How big a hole do I need to dig before people suffocate?

https://what-if.xkcd.com/

xkcd is a great science and maths based webcomic (https://xkcd.com/) which is wonderful in its own right. 'xkcd what if' takes some pretty out there hypothetical question and applies physics to them until an often absurd answer is reached. Always an interesting, funny read.

Physics Courses and Learning Resources

Edx –

https://www.edx.org/course/subject/physics

https://www.edx.org/course/subject/engineering

An incredible number of courses from Universities around the world in physics, engineering, and everything else. This is a great way of sampling lots of different courses and working out what course you might like to go onto study after sixth form.

Isaac Physics

https://isaacphysics.org/gcse

Isaac Physics is a website full of exam style questions with hints and short video lessons to help develop your learning. Use the quick quizzes to fire up your physics brains and then move onto 'Preparation for A-level' so that you can start Y12 confidently.

Khan Academy- Physics

https://www.khanacademy.org/science/physics

Khan Academy has an excellent course on physics which starts off with the basics and then gets into the more advanced concepts we study at A-level and beyond.

STEM Learning –

https://www.stem.org.uk/14-16-science-resource-packages

https://www.stem.org.uk/alevelscience

Is there a particular topic you want to practise more? This website contains a huge number of resources arranged by topic. Some are games, some are notes, some are lessons. Worth having a look.

Physics Lab online

http://dev.physicslab.org/asp/reviewsessions/ap1.asp

Another great collection of lessons, tutorials, and quizzes by topic. I'd suggest using Khan academy primarily and then coming here for some additional practise.

Podcasts

Engineering Podcasts – STEM Sessions

A list of engineering podcasts. Have a look through and see which one interests you the most

https://www.borntoengineer.com/engineering-podcasts-stem-sessions

BBC Science and Nature - https://www.bbc.co.uk/podcasts/category/scienceandnature

Free to listen audio podcast series

The British Broadcasting Corporation is a British public service broadcaster. It is the world's oldest national broadcaster, and the largest broadcaster in the world by number of employees.

University of Oxford –
https://podcasts.ox.ac.uk/keywords/physics

Free to watch video podcast series

The University of Oxford is a collegiate research university in Oxford, England. There is evidence of teaching as early as 1096, making it the oldest university in the English-speaking world and the world's second-oldest university in continuous operation

Streaming Services

BBC iPlayer - https://www.bbc.co.uk/iplayer

Login needed but creating an account is free

Chasing the Moon

A series on the incredible efforts to put a man on the moon

Horizon- 2020 Hubble

To celebrate the 30th anniversary of its launch, this film tells the remarkable story of how Hubble revealed the awe and wonder of our universe and how a team of daring astronauts risked their lives to keep it working

Netflix – www.netflix.com

Account and paid subscription needed

Tesla: Master of Lightning

Even though Tesla is often overlooked in documentaries, this one tells you about personal life and professional career of an electrical guru Nikola Tesla

Egypt: Engineering an Empire

It's not a secret that Egyptian engineers could build structures bigger than ever before even though they didn't have technologies available today.

The Mars Generation

The Mars Generation takes a candid look at the science and big-thinkers behind our desire to explore the red planet and then juxtaposes that with the young people working tirelessly to be the generation that actually gets to put their boot print on the planet

YouTube – www.youtube.com

No account or login needed, free to use

Physics online

https://www.youtube.com/physicsonline

A Youtube channel with short videos on most (if not all) topics from the AS and A2 specification. Get a head start with some of the concepts!

There is also a 'Pre A level Physics 2020' playlist which is currently being added to

Minute Physics

https://www.youtube.com/user/minutephysics

Many excellent concise videoes on interesting physics topics which go beyond the AS specification. This is a really great way of exploring the different aspects of physics and finding out what areas might really interest you.

Practical Engineering

https://www.youtube.com/user/gradyhillhouse

A youtube channel which focuses on civil engineering with some additional mechanical/aerospace engineering content too. Well produced videos which will make you look at the built up area around you a little differently.

Smarter Everyday

https://www.youtube.com/user/destinws2

Lots of fascinating videos about all sorts of things: science, animals, illnesses, medicine and engineering.

Veritasium

https://www.youtube.com/user/1veritasium/

One of the best physics/engineering channels on YouTube, featuring science stories, interviews with experts in their fields, demos and much more.

8. Related courses

At university, there are loads of different combinations of subjects that you can do. Maybe you might find one of these alternatives more interesting? A few ideas are listed below with a sample link, but in most cases there are lots of universities that offer these different combinations so make sure to have a good look around!

Aerospace Engineering

Aerospace engineering is largely the design, construction and maintenance of aircraft, spacecraft, missiles and weapons systems. Main focuses can include flight safety, fuel efficiency, operating costs and environmental impact. Students of aerospace engineering apply concepts which can encompass maths, science and technology to the creation of aircraft and accompanying equipment. Specialisms include aerodynamics, avionics, propulsion and systems integration.

Automotive Engineering

If you're interested in cars, trucks, buses, motorcycles and similar motor vehicles, studying Automotive Engineering might be the right choice for you. Automotive engineers are concerned with the design and development of automobiles and their subsystems. With sophisticated, cutting-edge technology you will get to make products that are thrilling and bring more freedom in mobility to people. This subject is very hot right now with new, more environmentally friendly engine and drive technologies as well as the rise of self-driving technology.

Bioengineering & Biotechnology

Many exciting developments are taking place at the intersection of Biology and Technology. A degree in Biotech or Bioengineering lays out a future-proof career path for you. Biotechnology experts come up with quicker and better solutions to vital problems in medical practice and bio-renewable energy to enhance the life and welfare of humans. Studying Bioengineering or Biotechnology is the right choice for you if you are interested in medicine, biology, and how those disciplines relate to technology and engineering.

Chemical Engineering

Turning raw materials into valuable, useful products: That's what Chemical Engineering does at its core. Chemical Engineering is a multidisciplinary field in which you learn everything about complex industrial processes, from design to development to production. The job opportunities for Chemical Engineering graduates are extremely versatile: You can work in virtually any industry, e.g. in pharmaceuticals, food processing, pulp & paper, electronics, petrochemicals, biotechnology and many others.

Civil Engineering & Construction

Roads, railways, bridges, canals, dams, airports and more: Civil Engineering is a field that covers more or less everything that is built around us. Civil engineering and construction professionals work on major infrastructure projects that are usually large in scale. You should expect a Civil Engineering course to be heavy in Mathematics and Physics, too.

Environmental Engineering

Decades of pollution have left our environment in bad shape. Governments and businesses alike slowly realise that responsibility and sustainability are key imperatives for our future. That makes Environmental Engineering an exciting discipline with great career perspectives for years to come. As an Environmental Engineer, you will apply scientific and engineering principles to reduce industrial pollution and improve the environment for humans, animals and plants. Detrimental effects on the environment can be reduced and controlled by educating the public, promoting conservation of natural resources, defining and implementing regulations and by applying good, sustainable engineering practices.

Marine Engineering

If you have an interest in the research, development and construction of new marine craft and their components, a degree in marine engineering is an excellent option. Marine engineers are the people who design, build, test and repair boats, ships, yachts, underwater vessels, offshore craft, and drilling equipment, and they usually work hand in hand with naval architects.

9. Oxbridge example interview questions

As you will know, applicants to Oxford and Cambridge have to take an interview in order to get a place. It is normal to get open-ended questions, as well as being given charts or pieces of writing to analyse. Here is a sample of the kind of questions you might get asked. Remember, you're supposed to not know the answer! They often deliberately choose topics that they think no one will have studied in order to make the questions fair. What they're looking for is to see how you think under pressure, and how you can present your ideas and your logic.

Interviewer: Steve Collins, University College

Place a 30cm ruler on top of one finger from each hand so that you have one finger at each end of the ruler, and the ruler is resting on your fingertips. What happens when you bring your fingers together?

This would never be the opening question in an interview - we usually start with a first question that gives the candidate an opportunity to get comfortable by discussing something familiar. We then ask more technical questions based on material in the GCSE and A-level syllabi.

This question would come later in the interview, when we present candidates with an unfamiliar scenario and ask them to use what they know about familiar concepts (such as friction) to explain something.

Almost everyone in this example will expect the ruler to topple off the side where the finger is closest to the centre to the ruler because they expect this finger to reach the centre of the ruler first. They then complete the 'experiment' and find both fingers reach the centre of the ruler at the same time and the ruler remains balanced on two fingers. We like to see how candidates react to what is usually an unexpected result, and then encourage them to repeat the experiment slowly. This helps them observe that the ruler slides over each finger in turn, starting with the finger that is furthest from the centre. With prompting to consider moments and friction, the candidate will conclude that moments mean that there is a larger force on the finger that is closest to the centre of the ruler.

This means that there is more friction between the ruler and this finger and therefore the rule slides over the finger furthest from the centre first. This argument will apply until the fingers are the same distance from the centre. The candidate should then be able to explain why both fingers reach the centre of the rule at the same time as observed. In some cases, particularly if we have not done a quantitative question already, we might then proceed with a quantitative analysis of forces and moments. We might even discuss the fact that the coefficient of static friction is higher than the coefficient of dynamic friction and therefore the 'moving' finger gets closer to the centre than the static finger before the finger starts to move over the other finger.

Interviewer: Byron Byrne, Department of Engineering Science

How would you design a gravity dam for holding back water?

This is a great question because the candidate first has to determine the forces acting on the dam before considering the stability of the wall under the action of those forces. Candidates will probably recognise that the water could push the dam over. The candidate would then be expected to construct simple mathematical expressions that predict when this would occur. Some may also discuss failure by sliding, issues of structural design, the effects of water seeping under the dam, and so on. The candidate will not have covered all the material at school so guidance is provided to assess how quickly new ideas are absorbed. The question also probes the candidate's ability to apply physics and maths to new situations and can test interest in and enthusiasm for the engineered world.

Interviewer: Jeffrey Tseng, St Edmund Hall

A ball, initially at rest, is pushed upwards by a constant force for a certain amount of time. Sketch the velocity of the ball as a function of time, from start to when it hits the ground.

Physics interview questions often start with a question like this which looks as though it could have come from the Physics Admissions Test. In this example, I've asked the student to sketch a graph, and then I'd help him or her to get through the problem. Students do make mistakes, and that's fine as I don't expect them to know all the material, especially as the interview progresses. It's not assumed that a less-talented student will need more help on any given problem, and for this reason it can be difficult for students to judge how well they're doing during the interview.

If a student gets things correct straight away, I just move on, either to further aspects of the original question, or to others. For instance, the above line of questioning could easily result in a discussion of satellites, orbits, weightlessness, or dark matter. It is usually a guided discussion rather than a matter of getting answers right or wrong straight away. I want to see how students respond to guidance and how they correct themselves, hopefully less by guessing than by thinking through what they know and what I've told them. Or in other words, while I am looking for a correct answer in the end, I'm even more interested in rigorous thinking.