EGR3024 Individual Project Options

This document is designed to introduce you to the catalogue of projects and supervisors on offer this for academic year 2023-24. Please read carefully the themes presented below. I suggest you select your top 5 choices after I have met with you in week 2. There is nothing to be gained by submitting your choices early. Allocations will not be made until the deadline passes.

When choosing, consider the type of project (as described below). Single projects will likely be more competitive than theme or linked projects, therefore it is advisable to choose a variety of types of project in your top 5 selection.

Some projects will be identified as linked or theme-based projects. These projects may see more than one student working on a particular area of interest however, each student will have their own dissertation work defined within the theme. In all projects students will be expected to produce the same 4 assessment elements individually and will be marked in this same manner.

The definitions of these types of projects are given below:

Linked Projects – a collection of connected individual projects requiring collaboration between students, each student must have their own distinct objectives and deliverables.

Theme-based Projects – a collection of individual projects addressing the same theme but NOT requiring collaboration between students. The theme you select will then be developed in the manner outlined in the accompanying project handbook.

Additionally, it is possible for a student to define an individual project by approaching a relevant member of staff. However this is identified in the listing below as an option and is subject to the same allocation as other projects – there is no guarantee the student can be allocated this option necessarily.

We endeavour to allocate students one of these 5 choices for their theme however, in some instances this may not be possible due to limited availability/high demand. In such circumstances where none of the preferences selected are available the module leader will organise a meeting with students to discuss options.

ID	Brief project Title	Supervisor	Project Type	Maximum number of students	Project Synopsis	Necessary Pre-requisite Knowledge or Optional Module choice	This project would suit a student with a special interest in...
1	Data analysis for surface measurement	Samuel Liu	Theme-based Projects	4	Data analysis for surface measurement In this project, students will develop data analysis techniques to process topography data from a surface. These techniques include (but not limited to) filtering, fitting, interpolation and registration, as well as calculating the surface texture parameters. Each student should focus on one of the data processing techniques, developing a software program (e.g. Matlab, Python) to process the surface data in point cloud format.	Matlab or Python	Programming, surface measurement, data processing
2	Novel insulation materials	Nikola Chalashkanov	Theme-based Projects	3	The projects's aim is to investigate novel composite materials including nanocomposites for various electrical insulation applications. The projects could be either experimental or more theoretical (modelling).	Matlab and Excel are beneficial. Lab experience is advantage.	HV transmission lines, material science, numerical modelling
3	Engineering Education	Alexander Borman	Theme-based Projects	4	Communicating technical concepts to people clearly and effectively is a key requirement in many professions. Education across all ages has seen many changes in recent years. Design and optimisation of an aspect of these communication pathways is the core focus of this project theme.	None	Communication, teaching.

4	Design and fabrication of a smoke visualisation equipment for wind tunnel laboratory experiments	Aliyu Aliyu	Linked Projects	2	Wind tunnels are highly important in testing scale models in engineering such as vehicles, wind turbine blades and aerofoils. They are also instrumental for validating CFD simulations. Apart from measuring forces on objects, the ability to visualise airflow over artefacts in a wind tunnel extremely valuable in understanding the fundamental principles of both fluid dynamics and aerodynamics. This project aims to design and build a smoke visualisation system to be installed in the laboratory TecQuipment AF-100 subsonic wind tunnel. Key requirements for the system included use of a non-hazardous smoke material suitable for a wind tunnel in a university setting and the ability to produce a uniform row of smoke lines sufficiently long to maintain their integrity throughout the test section. It is expected one student will tackle the design and fabrication of a rake to achieve this, while a second student will install this in the wind tunnel coupling it with a smoke generator (e.g. one of these which the student will specify and order). The second part of the project involves performing visualisation tests of the airflow over several solid objects by both students, including a cylinder and various aerofoil wings available in the Thermofluids Laboratory using a high-speed camera. These tests aim to demonstrate by way of the smoke streamlines the interaction of the airflow with the individual test objects. Ultimately, it is expected that a successfully demonstrated system would support aerodynamic research and teaching including for use with particle image velocimetry.	Thermofluids, CFD, Design Challenge	Mechanical design, 3D printing, Hands-on and workshop activity, Aerodynamics, Fluid mechanics
5	Biodegradable Electrical and Electronic Systems	Chris Bingham	Theme-based Projects	2	The project entails the production and testing of biodegradable electronic components that can make up passive (resistors, capacitors, inductors) and active electronic circuits. The project is largely experimental and will take place in the laboratories. Initially, Aquadag is considered for the production of passive components, although ultimately the possibility of 3D printing biodegradable circuits will be investigated.	Basic knowledge of electronic components	Electronic engineering and circuit design, and a passion for experimental work
6	Use of cellular automata for modelling engineering problems	Chris Bingham	Theme-based Projects	2	Cellular Automata uses an image of pixels (typically black and white) whose state (black or white) can change in response to changes of its neighbouring pixels. By using simple relationships it can be shown that dynamic modelling of 2D (in this case) characteristics eg. heat transfer or fluid dynamics, can be simulated graphically based on simple underlying rules about a pixels state and those of its neighbours. In this instance, the project will be required to use Matlab to set up an image grid and then apply rules to generate simulated dynamics of i) heat transfer, and ii) an explosive mass around a barrier.	Good experience of programming and Matlab	Image processing or modelling of fluid dynamics in alternative ways to FE or CFD
7	A high-quality low voltage three-phase sinusoidal test signal	Chris Phillipson	Single Project – for an individual student.	1	In order to calibrate a three-phase symmetrical component NPS detector, a high-quality three-phase test signal is required. The student will identify, justify, design, build and test a single-phase oscillator circuit connected to a three-phase converter.	Confidence in electronic simulation, prototyping and three-phase	Electrical and electronic engineering
8	The detection of unbalanced three-phase currents	Chris Phillipson	Single Project – for an individual student.	1	The presence of unbalanced three-phase currents in motor supply cables can indicate a motor fault or an unbalanced load. Being able to detect this can mean motor damage can be avoided. Unbalanced currents can be detected by special circuits looking for negative-phase-sequence currents.	Confidence with three-phase circuits.	Electrical power systems.
9	Domestic fridge temperature variation and compressor activity	Chris Phillipson	Single Project – for an individual student.	1	In this project you will investigate how much variation in temperature is there in a domestic fridge as the compressor cycles. What is the temperature gradient top-to-bottom and could the compressor be switched off more to save energy? Could an Arduino be used to monitor and log this data?	Confidence with microcontroller programming and interfacing.	Arduinos or other microcontrollers...

10	Detecting unbalanced mechanical loads on the shaft of a three-phase motor	Chris Phillipson	Single Project – for an individual student.	1	An eccentric mass on a motor shaft can create unbalance in the currents drawn which should be detectable. Measuring the unbalance in terms of the spectral composition of the current could be a way to see this. Motor current spectral analysis (MCSA) is an industrial application of this looking for motor faults.	Rotating machines and signal analysis	Electrical motors
11	Energy harvesting in a residential building	Nikola Chalashkanov	Single Project – for an individual student.	1	The project aims are to establish new ways of energy generation in a residential building to support the Net Zero objectives of the UK government.	ELE2004	Electrical machines, turbines, energy generation
12	Novel electrical insulation materials	Nikola Chalashkanov	Theme-based Projects	3	The projects aim to investigate various properties of novel insulation materials through experimental work and/or modelling.	EGR1004 Materials and Methods of Manufacture	Material science and electrical engineering
13	Energy Harvesting from Machine Tool vibrations for wireless IIoT	Faiz Iqbal	Single Project – for an individual student.	1	As the world moves towards smarter machines and digital capability increases in industrial machine tools, the existing machine tools which have many years of life still left will require a data face lift i.e., installation of sensors to retrofit the machine tool with latest advancement of industry 4.0 era. Installing new sensors mean having to deal with more wires for their power and data gathering which is a hindrance for the normal machine operator. This project will aim to utilize the vibrations from the machine tool during operation and store this vibration energy to power the sensors on board and avoid extra cables on the machine tool making less to no hindrance for the operators.	Sensors, IoT, Milling machine, piezoelectric sensors: These are pre-requisites, although thorough knowledge of these is not an absolute must but possessing it will greatly help pace-up the project.	Sensors and IoT
14	Automated low-cost testing of cable harness used in automobiles	Faiz Iqbal	Linked Projects	2	A cable harness is an assembly of wires used in automobiles for the various electrical functionalities of a vehicle. The cable harness is manufactured separately and tested before it can be used in a vehicle. As the technical world advances the need for automated testing becomes imminent. Existing solutions are either insufficient or very costly. This project will aim to develop a low-cost automated cable harness testing system in two parts. One student will work on hardware aspect and the other will develop a software-based dashboard for the user interface of the operator.	Software programming C or C# or Python or similar. Sensors, Arduino type controllers.	Industrial Automation, Mechatronics, User interface development (dashboards)
15	Surface finishing of Nylon-6 parts	Faiz Iqbal	Single Project – for an individual student.	1	Surface finishing is an essential part of any product's final manufacturing cycle. Final finish on the product surface determines its aesthetic appeals and functional value. Nylon-6 is a material used for various applications one of which is making seals for aircraft wings. These seals require high surface finish to perform tasks they are meant for. This project will conduct research into surface finishing of Nylon-6 parts to a high level of finishing to maintain functional capability of the Nylon-6 parts.	Surface Metrology, study of surface roughness parameters and surface characterization techniques.	Core mechanical engineering aspects of metrology, materials testing, measurement, characterization.

16	Applications of Electrospun Nanofibers	Saravana Jaganathan	Theme-based Projects	3	Electrospinning is a versatile technique with diverse applications in engineering domains, including filtering, water-oil separation, tissue scaffolds, and drug delivery systems. This method involves creating fibres through an electric field applied to polymer solutions, resulting in unique structural properties and mechanical strength. In these theme-based projects, students will delve into the engineering applications of electrospinning. For instance, electrospun membranes excel in filtering by efficiently removing contaminants. Water-oil separation benefits from the interplay of hydrophobic-hydrophilic polymer interactions. Tissue engineering utilizes electrospinning to create biomimetic scaffolds, while drug delivery systems ensure controlled therapeutic release. SK Jaganathan and his team offer 2-3 BEng projects. Each project focuses on a specific application, progressing through design, fabrication, and testing stages, all centred around the electrospinning technique. This approach provides hands-on experience in a multidisciplinary engineering context. These projects present a unique opportunity to learn and employ advanced characterization equipment, applying it to real-world engineering applications.	Materials science and engineering	Mechanical/ Materials/Chemical/Biomedical
17	Digital Twin capabilities for industrial automation systems (NOTE: This projetc is to be allotted to Mr Aagnesh Rajan student ID: 26106489)	Faiz Iqbal	Single Project – for an individual student.	1	This project intends to develop a comprehensive digital twin framework to build digital capabilities in industrial automation systems. This involves real-time synchronization of data between the physical system and its digital counterpart, ensuring accurate representation and enabling remote monitoring and control by implementing sensor-based data acquisition techniques. Develop analytical tools to interpret data, providing insights into system behaviour, efficiency, and potential areas for improvement and put the analytics forward on an enhanced user interface enabling an intuitive and immersive experience for operators and learners. This includes interactive visualization of processes, real-time data displays, and user-friendly controls. The project will utilize the digital twin to simulate and test different automation scenarios, allowing for rapid experimentation without affecting the physical setup. This includes optimizing control algorithms, assessing system performance under various conditions, and predicting potential failures. As an aspect of future scope the project will also intend to explore the integration of machine learning algorithms within the digital twin to enable predictive maintenance, anomaly detection, and adaptive control strategies, thereby enhancing the overall efficiency and reliability of the automation system.	NOTE: This project is intended for student Mr Aagnesh Rajan (student ID: 26106489). He has the required pre-requisite for the project as this project is phase-II of a summer project.	N/A
18	3D printed electrodes for hydrogen production via water electrolysis	Aliyu Aliyu	Single Project – for an individual student.	1	Electrode material, geometry and surface morphology are some of the key factors that need to be optimised if our goals of producing cost competitive green hydrogen are to be realised towards the energy transition of the coming decades. In this project, novel electrodes will be designed, fabricated, and tested. Fabrication will be done using 3D printing technology and 4 different conductive filaments (infused with iron, copper, and graphite of various concentrations) will be investigated and benchmarked against conventional platinum electrodes. Each electrode's surface finish will be characterised in the metrology lab to produce high-resolution images of its surface topology/roughness. Measurements you will carry out will include the resistivity of printed electrodes, cyclic voltametry in an electolysis setup and measure evolved hydrogen for each electrode. You will work with a PhD student working on this topic and will liaise with another student working on sensors for measuring hydrogen.	CAD, some knowledge and interest in additive manufacturing	Renewable energy, clean fuels, 3D printing, experimenting and laboratory work
19	Simulation of an indirectly cooled X-ray optic utilising an interference fit	Jonathan David Griffiths	Single Project – for an individual student.	1	In this project, you will use ANSYS to create a thermal-structural simulation of an indirectly cooled X-ray optic utilising an interference fit.	EGR3006 - Finite Element Analysis	Modelling and simulation, optics

20	Simulation of an indirectly base-cooled X-ray optic	Jonathan David Griffiths	Single Project – for an individual student.	1	In this project, you will use ANSYS to create a thermal-structural simulation of a base-cooled X-ray optic.	EGR3006 - Finite Element Analysis	Modelling and simulation, optics
21	Finite Element Analysis of a Novel Layer Jamming Gripper for Indirectly Cryogenically Cooled X-Ray Optics	Jonathan David Griffiths	Single Project – for an individual student.	1	In this project, you will use ANSYS to create a thermal structural model of an indirectly cooled X-ray optics, utilising a 'gripper' which takes inspiration from robotic soft grippers.	EGR3006 - Finite Element Analysis	Modelling and simulation, optics
22	Pumping requirements for hydrogen transportation in pipelines for net-zero - CFD study	Aliyu Aliyu	Single Project – for an individual student.	1	Hydrogen has been identified as a key fuel for the energy transition towards net-zero in the next 3-5 decades. Its efficient transportation from production (either by electrolysis or chemical processes) to usage is crucial to its economics. Retrofitting of current oil and gas pipelines is an attractive cost-effective option for transporting hydrogen from source to sink. However, the characteristics of hydrogen transport in pipelines (such as pressure drop behaviour), either in gaseous form at different pressures or in liquid form at elevated pressures, is not fully known. This project aims to carry out computational fluid dynamics simulations of compressed hydrogen transport in a 5 to 10 m pipeline under a wide range of conditions to establish the pressure losses for each case. This will be used to generate a loss coefficient map for use by engineers on the field and for the effective retrofit (or design) of such pipelines to safely transport hydrogen to usage points.	CFD, Matlab for postprocessing data.	Thermofluids
23	Improving gas turbine efficiency, performance, and emissions	Seong-Ho Jin	Theme-based Projects	2	This research proposal aims to improve the efficiency, performance, and emissions of gas turbines through alternative layouts of their components, such as the compressor, combustor, and turbine. The goal is to improve their efficiency, power output, and environmental impact. The research will use modelling method, including a literature review, data collection, and simulation techniques to identify promising layouts and optimize the design of the gas turbine components. The expected outcomes are the identification of the most efficient and environmentally friendly layouts, the development of validated computational models, and the optimization of the design and configuration of gas turbine components. This research can have a significant impact on a range of industries that use gas turbines for power generation.	Strong background in Applied Thermodynamics and Heat Transfer	
24	Investigation of zero-carbon alternative fuels combustion in internal combustion engines	Seong-Ho Jin	Theme-based Projects	2	Alternative fuels for internal combustion engines include a wide range of liquid and gaseous chemicals for both spark-ignition (SI) and compression-ignition (CI) applications. Alternative fuels can be used in place of a conventional fuels such as gasoline or diesel. The most common alternative fuels for SI engines are ethanol in blends with gasoline as well as compressed natural gas (CNG) , liquefied natural gas (LNG), liquefied petroleum gas (LPG), hydrogen gas (H2), and ammonia gas (NH3). Biodiesel, synthetic diesel, green diesel, and DME are the most common alternative fuels for CI engines. The specific aim of this project is to investigate and simulate zero-carbon alternative fuels combustion in internal combustion engines using commercial modelling software.	Strong background in Applied Thermodynamics and Heat Transfer	
25	Investigation of characteristics of premixed and non-premixed hydrogen (H2) combustion	Seong-Ho Jin	Theme-based Projects	2	Hydrogen is one of energy sources in achieving zero carbon emissions. However, there are operational challenges such as higher flame velocity, flashback, higher flame temperature, higher nitric oxide emission etc. A hydrogen gas turbine is a gas turbine operated using hydrogen instead of CNG/LNG, which is the conventional fuel. It is an environment-friendly power generation technology that reduces greenhouse gas emissions by mixing carbon-free hydrogen fuel with existing fuel. It is possible to build a low-carbon, large-scale power plant while utilizing a large-capacity hydrogen infrastructure in the future. The specific aim of this project is to experimentally investigate characteristics of premixed and non-premixed hydrogen	Strong background in Applied Thermodynamics and Heat Transfer	

					combustion in lab-scale burners (Bunsen and swirl burners) for application to aviation and industrial gas turbines.		
26	Towards efficient digital information display	Jarek Grebenik	Single Project – for an individual student.	1	Development of an energy efficient digital information display - for example, an e-ink display driven by Arduino or Raspberry-Pi.	None	Electronics
27	Modelling the Energy and Infrastructure Requirements for the Electricfication of Personal Transport in the UK 23-24	Nick Tucker	Single Project – for an individual student.	1	At the moment, the UK relies heavily on personal transport powered by fossil fuels. If the nation is to achieve net-zero carbon emissions, this must change. The aim of this project is to examine the current use of personal transport in the UK both in terms of what personal transport is used for, and what are the energy requirements to achieve this. Then to look at alternative net-zero friendly methods of personal transport, and to quantify the changes in energy supply (quantity of energy and the infrastructure needed to deliver it) that will be needed. In other words, what changes to the supply of energy and the delivery of energy to end-users will be required? The work should also consider other methods of personal mobility, and if the current model of mobility can be modified to reduce requirements.	None	transport issues
28	Development of a demonstration LED array	Jarek Grebenik	Single Project – for an individual student.	1	Red light therapy devices are designed to provide the user with exposure to specific wavelengths. This project is to work towards designing a competing device aiming to maximise the user benefits with minimal energy use. A demonstration device is expected to be built by the student.	Electronics / electrical background	Electronics
29	Design and manufacture of a swirler combustor for hydrogen/ammonia engine	Jun Peng	Linked Projects	3	This project is aiming to design and develop a swirler combustor system supported by a turbocharger for carbon-free fuel combustion which can provide expected combustion and power performances for mobility applications. The specific objectives are a). to design and develop a swirler combustor integrated with a turbocharger system for carbon-free fuel combustion; b). to utilise CFD simulations to analyse and optimize the combustion performance, including ignition and flame propagation, combustion stability, combustion efficiency, and pollutant formation. c). to manufacture required components, integrate sub-systems and prototype the combustor system; d). to carry out initial testing of the system operation and optimisation.	One for CAD, one for CFD and one for focusing on manufacture, integration and testing.	Combustion system, green fuels
30	Developing a battery generator including its remote monitoring system	Jun Peng	Linked Projects	2	As the prototype of a battery generator has been also ready, this project will finalise its system integration, monitoring system, safety and health requirements.	Electrical system, control and monitoring system	Battery energy storage
31	Exploring design requirements for an Unmanned Aircraft System based an Electric Propulsion	Ibrahim Albayati	Single Project – for an individual student.	1	For high altitude long endurance (HALE) unmanned aircraft system (UAS) where electrical propulsion system operates as a prime source of power. The design of the power-plant system and UAS frame structure may vary according to the type of the mission, in terms of cruising altitude, required flying hours, and the size and weight of the payload. Therefore, the designer must consider all these parameters during the design stage of the entire UAS. In this project, the structure of the UAS will be designed in terms of weight, dimension, endurance, and payload.	The student needs to have good modelling skills and initial understanding of aircraft aerodynamics, also good knowledge in	Mechanical or Electrical Engineering Background

						using (Matlab-Simulink).	
32	Investigating Performance of PEM Fuel Cell for High Altitude UAS Operation	Ibrahim Albayati	Single Project – for an individual student.	1	PEM fuel cells suffer from limited power density and slow dynamic response when a sudden change in power demand is presented, which limits their performance particularly for high altitude long endurance (HALE) UAS applications. For high altitude long endurance, where a fuel cell operates as the prime source of power, the operation and performance of a PEM fuel cell at different altitudes is vitally important. At a high altitude of 11 km, atmospheric temperature and pressure are approximately -56 °C and 0.227 bar, and unexpected variations in the load demand put severe stresses on the operation and performance of PEM fuel cells, these are severe conditions for a fuel cell to operate.	The student needs to have good modelling skills, and very good understanding of dynamics of heat and energy transfer, also good knowledge in using (Matlab-Simulink).	Mechanical Engineering Background
33	Energy storage systems for balancing power generation and consumption in grid	Yaxing Ren	Single Project – for an individual student.	1	As renewable energy generation is associated with weather changes, its instability poses a challenge to grid stability. Energy storage can balance the power generation and consumption of the grid. This project will model how energy storage responds to grid frequency, balances the supply and demand of the grid, and guides energy storage companies on how to derive revenue from it.	Has background in electronics and electrical engineering; Has knowledge of coding such as Matlab/Python	Power system and energy storage
34	Optimised trajectory planning algorithm for robotic manipulator	Yaxing Ren	Single Project – for an individual student.	1	In robotic arm motion control, optimal trajectory planning not only saves movement time, but also reduces collisions and extends the service life of the manipulator. This project aims at designing an optimised trajectory planning algorithm for robotic manipulator in simulation. Firstly, a model of robotic arm needs to be built in Simulink, and then plan the trajectory of the robotic arm based on this model, and finally optimise the motion path so as to reduce the motion time and collision risk.	Has competence with Matlab/Simulink; Has knowledge of control theory	Robotics and control algorithm
35	Modelling and control of brushless DC motor	Yaxing Ren	Single Project – for an individual student.	1	Brushless DC motors eliminate commutators and brushes compared to conventional DC motors, which reduces losses and allows higher speeds to be achieved. However, it requires an electronic converter based on solid-state switches to complete the commutation. The aim of this project is to model the brushed and brushless DC motors and to design controllers for them. It also compares and analyses the performance of brushed and brushless motors at low and high speeds.	Has background in electronics and electrical engineering; Has knowledge of Matlab/Simulink	Mechatronics and motor drive
36	Modelling the effect of running personal and commercial transport on biodiesel in the UK	Nick Tucker	Single Project – for an individual student.	1	The aim of this project is to assess the potential effects and feasibility of implementing biodiesel as an interim form of energy during the transition from transport powered by fossil fuels to electricity of sustainable origin, specifically within the United Kingdom. Some of the research questions are as follows. How much diesel fuel is currently used in the UK? What is the hectarage of farmland required to produce enough biodiesel to fuel UK personal and commercial transport using the process of transesterification to turn oil seed crops into biodiesel. What are the most suitable crops for biodiesel production? Ultimately, how practical is the proposition of replacement of fossil diesel with a crop origin equivalent?	None	Transport and sustainability

37	Modelling the effects of the addition of bioethanol to petrol for UK personal transport	Nick Tucker	Single Project – for an individual student.	1	The research project aims to investigate the potential benefits and challenges associated with using ethanol-petrol blends as a fuel alternative in the context of UK personal transport. The project will investigate how sustainable is the practice of adding bioethanol to petrol practices and the impact on the environment and engine performance. What is the limiting amount of bioethanol that can be added to petrol before engine modifications are required? What are the likely sources of bioethanol in the quantities required? Does the addition of bioethanol reduce the amount of fossil carbon released into the atmosphere	None	Sustainability and transport
38	Mapping results from 3D photogrammetry to thermal model via image recognition	Sepehr Maleki	Single Project – for an individual student.	1	Thermal indicating paint is used during turbine engine test to measure the operating metal temperatures of high temperature components. A temperature dependent colour map is produced on the component surface and is then scanned using 3D photogrammetry. The aim of this project would be to develop algorithms for automatic assignment of temperature isolines, and subsequent export in the form of x,y,z,temperature point clouds which could then be imported into CFD software and mapped onto thermal models for validation.	CFD	Deep Learning
39	Quantifying the Environmental Emissions of Electrical and Internal Combustion Engine Vehicles	Nick Tucker	Single Project – for an individual student.	1	Electric vehicles (EVs) are often assumed to be zero-emission vehicles. Whilst EVs do not have an exhaust pipe, they are not zero-emission vehicles. This project will investigate and compares the operating emissions of EVs with the emissions from internal combustion engine (ICE) vehicles. The main emission types are carbon dioxide emissions, tyre particulate emissions, brake particulate emissions, and waste heat. The absence of an exhaust pipe does not mean that EVs do not produce any carbon dioxide to operate. Their exhaust pipes are in the form of wherever the electricity comes from, and the national grid produces carbon dioxide. Whilst operating electric cars does indeed produce carbon dioxide, they still produce fewer carbon dioxide emissions than the equivalent ICE vehicle. EVs tend to be heavier than the equivalent ICE vehicle. This inevitably puts more stress on the tyres. This results in EVs producing more tyre particulate emissions than the equivalent ICE vehicle	None	Sustainability and transport
40	Predictions of 2D airfoil flows using Machine Learning	Sepehr Maleki	Single Project – for an individual student.	1	This project is aimed at predicting flow field in two-dimensional airfoil domain using machine learning models trained utilising datasets available in open literature or by creating them using CFD models. Compare different approaches from open literature. It is envisaged that CNN or GNN or similar might be appropriate.	CFD	Machine Learning, Deep Learning
41	Control and stability of road vehicles	Timothy Gordon	Theme-based Projects	4	The common theme for these projects is the control and stability of road vehicles. We are all familiar with the process of controlling a road vehicle, such as steering a car or heavy truck, or using the pedals for braking, acceleration. Electronic support is less obvious, though many people know about Electronic Stability Control (ESC) which can help prevent loss of stability, especially on slippery roads. The precise definition of the project will depend on the individual student's interests, but the recommendation is to focus on either automated driving (as in self-driving cars) or on support for a human driver (as in ESC). The simulation package CarMaker will be available, and during the project students will have a chance to become proficient at using this software. The following are examples of specific project aims, though students are encouraged to make other choices: designing and implementing an antilock braking system (in CarMaker); developing a controller to prevent an SUV from rolling over; controlling a high performance self-driving racing car; designing a controller that can self-drive on roundabouts (this is a challenge for the current generation of self-driving cars).	Students should have a strong (potential) interest in road vehicles and good familiarity with Matlab and (ideally) Simulink. Projects can be approached without an in-depth knowledge of control theory, though an interest in dynamics and control will also be expected.	Cars! Also electronic control, dynamics, control, stability.

42	Using AI to differentiate between partial discharges from void and electrical trees	Sepehr Maleki	Single Project – for an individual student.	1	Partial discharges (PDs), voids, and electrical trees are all dielectric defects that can occur in insulation materials. PDs are localized electrical breakdowns that occur within the insulation material. Voids are air pockets or other discontinuities in the insulation material. Electrical trees are branching conductive paths that form in the insulation material. It is important to be able to differentiate PDs from voids and electrical trees because they have different causes and consequences. PDs are caused by high electric fields, while voids and electrical trees are caused by moisture, contamination, or mechanical damage. PDs can lead to the breakdown of the insulation material, while voids and electrical trees can lead to the growth of larger conductive paths that can eventually cause a short circuit.	Partial discharges, machine learning, AI	
43	Collision free smart car using 3D printed components and Arduino	Edmond Nurellari	Single Project – for an individual student.	1	As the smart vehicles hit the road in large numbers, the Connected Intelligent Cars will become increasingly important in transportation and logistics in the next coming years. The Internet of Things (or of Everything) will make the Smart Cars & Vehicles even more connected. The aim of this project is to design and implement a Collison Free Smart Car. A set of robot car chassis will be equipped with relevant automotive sensors (ultrasonic, smoke, IR, temperature, and etc.) and a microcontroller (Arduino) in order to implement and configure such an Advanced System. The implemented system will focus on safety and driver assistance, therefore fault diagnosis and fault tolerance control will be considered.	Students will make use of the knowledge learned in CAD design, control systems and electronics and develop their practical skills to design a robot car chassis. ü The size of the robot car chassis and other hardware to be used will be part of the initial design process. ü The first part of the project will aim to use a microcontroller (Arduino) with set of servo motors and other 3D printed components to make a collision free working prototype. ü The final part of the project will deal with equipping the robot car chassis with other on-board relevant sensors to make it smart and implement and configure the System as a whole.	By undertaken this project, students will use their theoretical background and appropriate technical approaches in implementing an advanced smart car system. They will further develop their design skills and build a functional prototype. ü The initial design phase will require some research on prototyping and choosing the optimum configuration that fulfil the project specifications. For instance, what will be the size of chassis? How is it going to be powered? Which servo motor is best fitted for this application? ü The final design phase will require research on low-power electronic components to be considered for such a system. What is the optimum number of sensors required for the system to be robust? What type of sensors to consider and how to decide on the best mounting location on the chassis?

44	Design of Internet of Things (IoT) system for real world sensing applications	Edmond Nurellari	Theme-based Projects	3	Students should be very comfortable designing IoT systems using Arduino, Raspberry Pi or any other Arm board. Some of the projects will require knowledge of PCB design as well. Students should be very comfortable in soldering and using breadboard, oscilloscopes and other hardware needed for system design. It is expected that students will produce a working prototype that is able to sense data and communicate it to a web server. It is also expected that students will be able to use the collected data to perform data analytics and produce meaningful results	Hardware Design using Arduino, Raspberry Pi or any Arm processor based board. Good knowledge of libraries and C-programming needed to write programs that run on these boards. Students who are not comfortable in programming should not attempt this project. Familiarity with Matlab is necessary. Knowledge of image processing is desired but not required.	Digital Design/ Internet of Things / Embedded Systems. This project may also suits students with special interest in biomedical/electronic engineering and medical image processing
45	Soft Robotics - Multimodal Flexible Strain Sensors for Perceptive Soft Robots2	Behnaz Sohani	Linked Projects	4	Soft robotics is a rapidly growing research field that has revolutionised the way we perceive robots and has the potential of enabling exciting new applications that are rather challenging for conventional robots. Common rigid sensors used in robotics are often difficult to interface with a soft robot made from flexible materials that deform to generate motion. Hence, researchers have been investigating new concepts for flexible and stretchable sensors that can be seamlessly integrated with a soft robot, in order to provide vital sensory feedback for closed-loop control. Flexible sensors are also desired for wearable and medical devices since they can safely and gently interface with human skin. This project will focus on designing and prototyping a flexible strain sensor with multi-modal feedback capability to enhance the functionality of soft actuators. The aim is to demonstrate how the change in resistance due to different physical stimuli such as stretch, bend, pressure, and temperature can be decoupled through the sensor's design and postprocessing of the generated sensory feedback. The project will build on previous work on developing flexible strain sensors that were 3D printed directly from flexible and conductive materials, yet other fabrication methods from the literature can be considered, such as knitted conductive fabrics. A key element in this project will be the design of the sensor's interface and acquisition circuit in order to amplify, filter, and stabilise the sensory feedback. Basic machine learning techniques, such as Regression Analysis or Artificial Neural Networks (ANN), will be investigated at the end for processing and decoupling the acquired sensory feedback.	Essential skills that will be required for this project: • CAD (Inventor, Solid Edge or similar). • Design of experiments and practical testing. • Basic programming (Matlab or Arduino IDE).	Soft Robotics, Sensors, technical/scientific methods for data gathering, technical/scientific approaches for analysis, design of parts/components.

46	Pore Scale Computational and Experimental Direct Air Capture Engineering	Behnaz Sohani	Single Project – for an individual student.	1	Direct air capture (DAC) of carbon dioxide (CO2) and moisture for potable water has been identified as a prospective pathway to mitigate the effect of global warming by limiting average global temperature rise to 1.5 ºC above pre-industrial levels, as well as providing potable water to more than 1.1 billion humans without clean drinking water. Due to the low concentrations of CO2 (400 ppm) and water vapour (3 litres per million litres of air), massive air throughputs must be processed to capture enough moisture and CO2. For the latter, while night-time relative humidity can reach up to 40%, the lower atmospheric temperature (approx. 20oC) prevents the use of refrigeration for direct air-water harvesting. This project aims to use pore-scale CFD modelling to propose and develop DAC processes that will be material agnostic. The idea is to be able to establish a rigorous and optimised model that can accurately predict output from a DAC process irrespective of the material in use. Furthermore, the modelling of the flow process and techno-economic analysis will be combined to evaluate and optimise the pressure drop across different innovative bed designs and their impact on the overall cost/performance of the DAC process.	Fluid mechanical, computational fluid dynamics (CFD), Ansys, Matlab (Desired)	Mechatronics
47	Experimental Testing and Data-Driven Modelling of Soft Cylindrical Actuators	Behnaz Sohani	Linked Projects	5	Soft robotics is a rapidly growing research field that has revolutionised the way we perceive robots and has the potential of enabling exciting applications that are currently rather challenging for conventional robots. Soft pneumatic actuators are widely adopted in various soft robotic applications due to their unique passive adaptation, gentle interactions with the environment, and inexpensive fabrication. However, a key challenge with soft actuators in general is how to derive accurate models that accounts for their complex non-linear deformation behaviour? This project will investigate a data-driven approach in modelling soft pneumatic actuators following the cylindrical morphology, which are commonly used to create continuum robotic arms, locomoting snake robots, and soft endoscopes for surgical applications. The design and fabrication of the cylindrical actuator will follow previous work from the literature. Hence, the project will focus on systematic experimental testing of soft cylindrical actuator samples, in order to generate a rich dataset for subsequent data-driven modelling. This will require setting up a test rig with a pneumatic control board to test the actuator at varying input conditions, in addition to tracking the resulting actuator's 3D pose. The generated dataset will faciliatate initial investigations into data-driven modelling of the actuator whether online following a system identification approach, or offline using machine learning methods such as regression.	Essential skills that will be required for this project: • CAD (Inventor, Solid Edge or similar). • Design of experiments and practical testing. • Basic programming (Matlab or Arduino IDE). Desired skills that can be learned during the project: • Pneumatic circuits. • Matlab System Identification toolbox or Regression Learner app. • Basic image processing (Matlab or Python).	Mechatronics
48	Optimising Soft Fin Ray Robotic Fingers via Finite Element Analysis	Behnaz Sohani	Linked Projects	3	With the emergence of the soft robotics field, a range of soft grippers concepts have been proposed based on unique actuation technologies such as; fluidic elastomer actuators, granular jamming, Gecko adhesion, Electroadhesion, and others. One interesting example is the adaptive robotic fingers based on the Fin Ray® effect, which was originally inspired from fish fins. Soft fingers based on the Fin Ray structure exhibit remarkable adaptation to objects during grasping, while exerting minimal forces when handling delicate targets such as crops or food products. However, a common limitation with soft grippers in general is the difficult trade-off between their desired passive adaptation to delicate targets, and their limited force generation when higher payloads are required. The aim of this project is to study how the unique layer jamming behaviour occurring between the flexible ribs of the Soft Fin Ray fingers can be utilised to realise the trade-off between shape adaptation and force generation. The project will extend previous work conducted at the University of Lincoln, by further optimising the Fin Ray structure using ANSYS with the objective of enhancing force generation as well as shape adaptation of soft	• Finite element analysis (ANSYS) • CAD (Inventor, Solid Edge or similar). • Data acquisition and processing (Matlab). • Experimental analysis. Desired skills that can be learned during the project: • 3D printing (FDM). • Matlab hardware integration (Arduino and NI).	Mechatronics

					fingers based on this design. Different hyperelastic material models will be evaluated, in order to identify the best performing model for the material used in fabricating the Soft Fin Ray fingers. The optimised designs resulting from the Finite Element Analysis (FEA) will be 3D printed and tested, in order to validate the results experimentally and evaluate the improvement in grasping performance compared to previous work.		
49	Mechanical analysis of biological cells in end-stage diabetic nephropathy	Eleftherios Siamantouras	Theme-based Projects	4	Diabetic nephropathy is a serious complication of diabetes resulting in end-stage kidney failure, a life-threatening condition that requires dialysis or kidney transplant. Progression of the disease is associated with complex defects at the molecular and cellular level of the kidney's nephron. This project focuses on the investigation of mechanical alterations of single cells at the proximal tubule of the nephron. Nanoscale mechanical recordings of healthy and unhealthy cells contain valuable information about basic functional elements of the cell, such as the cytoskeleton. However, due to the intricate nature of the cell at the molecular level, mechanical data are often complex, requiring fine processing and sound statistical analysis. The aim of this project is to quantify mechanical properties of biological cells in healthy and diseased states by developing processing methods to analyse and compare force-displacement recordings. The experimental data are available in a raw form and tasks include processing of raw data, numerical analysis, development of data sets and statistical comparison of two or more variables. The results of the statistical analysis will be associated with the underlying molecular changes of the cellular cytoskeleton and diagnostic information at the cellular level.	The project would be most appropriate to a Biomedical Engineering student with competences in statistical packages (such as SPSS), contact mechanics (mathematics and numerical modelling using Matlab or dedicated industrial software). Some knowledge of cell biology would be beneficial. Other disciplines may include mechanical engineering students who are competent in FEA and are willing to apply their skills in a biomedical theme.	Mechanical properties of soft biological materials, Mechanical biology, Cell Biology
50	Three-dimensional printing of energetic materials	Nick Tucker	Single Project – for an individual student.	1	Additive manufacturing technology or three-dimensional (3D) printing has been applied in many fields of manufacturing. The combination of 3D printing and conventional energetic material fields can create sufficient space for preparing and moulding of energetic materials. Although recent advances in this field are encouraging, with the printing technologies offering many merits over the traditional fabrication technologies, application principles and material considerations need to be surveyed and evaluated. This project is to review the current state of the art and draw conclusions about the practicality of using additive manufacturing to make propellants explosives and pyrotechnics.	None	energetic materials

51	Energetic nanomaterials	Nick Tucker	Single Project – for an individual student.	1	The field of energetic materials has had considerable activity in recent years in nanoenergetics. A large part of this interest has lied in the reactivity of particulate metals, and, of features in bulk materials with nanometer length scales. The interest in nanosized metals for energetic materials began in the mid-1990s with the development of nanoaluminum particles in Russia and at the Los Alamos National Laboratory. This project is to review the current state of the art and draw conclusions about the practicality of using nano scale materials to make propellants explosives and pyrotechnics.	None	propellants explosives and pyrotechnics
52	Developing sustainable alternative for metallurgical coal	Amir Badee	Theme-based projects	4	The steel sector is a core pillar of the modern economy, but over the last decade it has been facing increased environmental and climate pressure to lower its carbon footprint while remaining economically competitive. Decarbonising this sector is challenging but key for achieving climate goals since the sector is currently responsible for about 8% of global final energy demand and 7% of energy sector CO2 emissions1. Biochar as by-product of feedstock pyrolysis has potential to provide a replacement for injection coal in the blast furnace iron making process. Agriculture biomass feedstock from sustainable re-wetted low peatland is a biochar source with net CO_2 emission reduction potential nearly an order of magnitude greater than the benefit from coal replacement. The huge additional benefit is due to the change of land use, where studies have shown up to 25t CO_2e per hectare year reduction in peat degradation carbon release2. In pyrolysis the feedstock goes through a thermo-chemical decomposition at high temperature up to 900°C in absence of oxygen. This process generates energy/heat alongside other by-products such as syngas, bio-oil and biochar. The feedstock has significant potential, but optimisation of pyrolysis is required to maximise its CO_2 mitigation benefits. This proposal aims to develop a sustainable alternative for metallurgical coal via assessing the impact of pyrolysis conditions.	Willing to be involved in experimental material characterisation	Experimental lab work
53	Electroceuticals	Anirban Dutta	Theme-based Projects	4	Students can expect to be working in electroencephalography (EEG) and electromyography (EMG) and near-infrared spectroscopy-based (NIRS) portable multimodal imaging to understand skeletal, muscle and brain physiology during non-invasive electrical stimulation. Discussion with supervisor will develop project focus.		Biomedical engineering
54	Industrial engineering	Ron Bickerton	Theme-based projects	4	Students can expect to be working with an industrially-related mechanical engineering project. This will be defined by the supervisor in conversation with the student.		Mechanical engineering

55	Student-defined projects	Academic member of staff	Single Projects – for individual students	1	Students may approach members of staff with expertise in particular areas, as prospective supervisors, to develop a bespoke project**. They must develop a strong case, which will depend on several factors including feasibility, resources and the supervisor's approval, by the end of week 1 for their project to be accepted as an option.**