EEE 471

FOURTH YEAR M.ENG.

GROUP PROJECT PORTFOLIO

2014-2015 SESSION

MEng 4th Year Project Description: Choice 1 of 12

Project title	**Wide band 3Φ power monitoring system for monitoring a 25 kW industrial microwave oven.**

Supervisors	James E Green, Betime Nuhiji & Tim Swait

Industry sponsor	AMRC with Boeing

Project description

The Advanced Manufacturing Research Centre (AMRC) with Boeing is an industrially funded research and development center located in Catcliffe, Rotherham. The AMRC is a part of the faculty of engineering at UoS, although it is not a 'traditional' academic department. Industrial partners include the likes of Boeing, Rolls Royce, Airbus, Spirit Aerosystems, as well as IBM. Consisting of six research groups within the AMRC, including the Composite Centre, Process Technology Group (machining), Integrated Manufacturing Group (robotics, automation and large-volume metrology), Design and Prototyping, Structural Testing and Medical AMRC, this project is in collaboration with the Composite Centre.

Microwave irradiation is a rapid way of heating materials for domestic, industrial and medical purposes. In composite (e.g. carbon fiber etc.) manufacturing, economic and environmental drivers have encouraged the aerospace industry to consider using microwave curing technology, as it potentially offers improved turnaround times and energy consumption compared to traditional techniques such as autoclaves.

The Advanced Manufacturing Research Centre (AMRC) with Boeing, have purchased new industrial microwave equipment from Vötsch, and established themselves as leaders in this field of rapid curing technology for composite materials.

To validate that the use of microwave curing can reduce the energy consumption when compared to autoclave curing, this project will investigate the development of an instrumentation system designed to monitor the power consumption of a microwave test bed. There is potential for this system to then be implemented into the industrial microwave, moving it closer to a production ready technology.

http://www.amrc.co.uk/research/composites/

Required skills

This project requires four driven students with good interpersonal skills. Together the team should be well on the way to becoming competent in all areas associated with electronic instrumentation design including: hardware design (design, layout and production of PCBs, mechanical layout), software (embedded systems and PC software) and robust, low noise, analogue electronics design. Some knowledge of EMC considerations and a little background in 3 phase systems would also be useful but these are not essential.

MEng 4th Year Project Description: Choice 2 of 12

Project title	**Electrically assisted buggy**

Supervisor 1	Antonio Griffo
Supervisor 2	Guang-Jin Li

Industry sponsor	

Project description

Electrically assisted buggy

Electrically assisted mobility is gaining increasing commercial interest. However, so far only one commercial product is available on the market for an electrically assisted buggy. The group will specify and design an optimised electrical drive to be used, possibly as a retrofit, in an electrically assisted buggy. The project will include design of the electric in-wheels brushless motors, selection of battery pack, design of the power electronics drive as well as analog/digital electronics and microcontroller programming for signal acquisition, speed/torque control, battery management, supervisory and safety control.

Required skills

Experimental practical skills
Hardware
Electromagnetics
Analogue electronics
Digital electronics
Programming

MEng 4th Year Project Description: Choice 3 of 12

Project title	**Freescale Cup : Autonomous model race car**

Supervisor 1	Dr Dan Gladwin
Supervisor 2	Dr David Stone

Industry sponsor	Freescale

Project description
The Freescale Cup is a global competition where student teams build, program, and race a model car around a track for speed. The fastest car to complete the track without derailing, wins. Information regarding last year's finalists can be viewed at: http://www.sheffield.ac.uk/eee/news/freescale_cup. The creation of this autonomous car requires • Circuit creation and mechanical build using Freescale parts • Embedded software programming to manage the car • Create motor control hardware and software to propel and steer their intelligent car • Interface to a camera to navigate the car through the race course by following the guide line • Practice track construction More than 100 university teams from across EMEA enter the Freescale Cup challenge. Each team receives the same standard model kit containing the chassis, a line scanning camera, servo, and a controller kit. The teams are then tasked with manoeuvring their battery-driven electric car autonomously through an obstacle course designed with road bumps, inclines, chicanes and crossings. There are set rules that you must adhere to when designing the car. If you undertake this project and the progress of the car is good then it is envisaged that you will travel to the EMEA race qualifications, usually held mid-March 2015 in Germany. If successful and your team reach the final then this will be towards the end of April 2015 at the Fraunhofer Institute for Integrated Circuits, Erlangen, Germany. Travel costs will be paid for. Note that you will have to submit an additional technical report 30 days before racing to the competition judges. Should there be more than one group from Sheffield EEE it may be necessary to hold a knock out event within the department with the winner going forward to the qualifying race in Germany. Further details see: https://community.freescale.com/groups/tfc-emea

Required skills
Analogue electronics, hardware design, embedded programming

MEng 4th Year Project Description: Choice 4 of 12

Project title	**Future Assisted Living**

Supervisor 1	D A Stone
Supervisor 2	J K Mitchell

Industry sponsor	N/A

Project description
With an ageing population more elderly and disabled people wish to lead independent lives in their own homes. This project will investigate how assisted living technologies (ALTs) will allow these people to live longer and richer lives at home. A key aim of the project will be the continuous monitoring of the activities of the individual (e.g. detecting movement to ensure they have not had a fall, or monitoring eating and sleeping patterns) and alerting the emergency / healthcare services where appropriate. For individuals with chronic medical conditions this technology could be extended to early home diagnosis and SMS-based systems to remind them to take medicines or linked to real-time drug administration. Another area of investigation will be the use of navigation systems on mobile devices allowing people with visual impairments to find their way around safely outside their home and in the local area to give them a greater sense of independence. A further area would be to consider automation of the domestic environment. This could range from the control of household systems and appliances (e.g. heating, lighting, curtains, TV etc.) from a mobile phone, motors and actuators to assist with personal mobility, to the use of robots to perform basic household tasks.

Required skills
Analogue / digital electronics, microcontrollers and communication systems, motor/actuator design, software, hardware.

MEng 4th Year Project Description: Choice 5 of 12

Project title	Next generation mobile communications

Supervisor 1	Lee Ford
Supervisor 2	Tim O'Farrell

Industry sponsor	Various

Project description
Anyone with a mobile phone knows the terms "3G" and "4G" as defining the evolution of mobile communications as we move towards faster and more reliable networks. What is less well known is what will 5G bring and how will we achieve this? This project will aim to build a prototype "5G" demonstrator and will address design options for network modulation, RF hardware and their combined integration. Although this project has a communications theme it will also require programming and electronic design skills. Specifically the project will investigate:- • Frequency selective surface design; • Antenna design; • Transmitter design; • Receiver design; • Manufacture and data transmission demonstration. A successful project will require close group interaction to ensure all team members understand how each element of the project is progressing and how they can have a positive impact on the project. The outputs from the project will be of significant interest to a new EPSRC project SERAN, (Seamless and Efficient Radio Access Networks). This is a £800k venture between the Universities of Sheffield, Edinburgh and Bristol and also includes industry partners NEC, Thales, Toshiba, Huawei and Vodaphone. Students will have the opportunity to engage and influence this wide range of project partners.

Required skills	
Maths/theory	Experimental
Hardware	Electromagnetics
Measurements	
Digital	
Programming	

MEng 4th Year Project Description: Choice 6 of 12

Project title	**Optical Antennas**

Supervisor 1	J Rigelsford
Supervisor 2	J Green

Industry sponsor	

Project description
This project continues ongoing research into optically fed antennas for wireless communications systems. Enhancing the concept of Green Radio and Fibre to Air, it addresses questions such as “How can we reduce the energy consumption of mobile phone base stations?”, “How can we enhance wireless capacity of existing systems?” In current cellular mobile communication systems, coaxial cable is used to transport the modulated RF signals between the base transceiver station (BTS) and the antennas located at the mast head. Furthermore, coaxial cables or microstrip feeds are used within multi-element antennas to facilitate beamforming and beam-steering. Whereas low transmission loss microstrip feeds can occasionally be utilised within the antenna to provide amplitude and phase distributions between the elements, they usually have limited operation bandwidth and for obvious practical and logistical reasons cannot be used between the antenna and BTS. Furthermore, as energy prices and environmental awareness increases, there is a distinct commercial requirement to reduce the power consumption of the BTS by improving its efficiency.

Required skills
• Optical circuit design (laser and detector) • Optical phase shifter design • Antenna design

MEng 4th Year Project Description: Choice 7 of 12

Project title	**Ultra Electronics PMES PT – Segway® style personal transport system**

Supervisor 1	Marin Foster
Supervisor 2	Andrew Race

Industry sponsor	**Ultra Electronics**

Project description
In this exciting and diverse sponsored project your group will design, construct and test a full-scale two-wheeled, self-balancing, battery powered personal transport system. Your vehicle should be capable of transporting a single person safely over a reasonable distance. This is a multidisciplinary project and students will be exposed to all manner of technologies including electric motor and drive systems, embedded controllers, rapid prototyping technologies to program embedded controllers directly from Simulink simulation models and hardware-in-the-loop (HIL) testing. Students will be expected to take a full systems engineering approach from mathematic modelling of the balancing stability control system to the full implementation of the electrical, electronic and mechanical systems and testing. This project is sponsored by Ultra Electronics, PMES an internationally successful defence, security, transport and energy company. PMES provides innovative, high-technology power conversion and control solutions, signature management systems and high integrity sensors for a variety of defence and industrial applications. http://www.ultra-pmes.com/

Required skills
Maths
Experimental
Hardware
Measurements
Analogue
Digital
Programming

MEng 4th Year Project Description: Choice 8 of 12

Project title	**Photo-Acoustic Gas Sensor System For Environmental Monitoring**

Supervisor 1	Richard Hogg
Supervisor 2	Chee-Hing Tan

Industry sponsor	N/A

Project description
A new type of gas sensor has recently been invented [1] which relies on the photo-acoustic effect, discovered by Bell over 130 years ago [2]. This project aims to commission and develop a similar sensor system. The group will determine a suitable target species to detect, source suitable light sources, develop drive electronics, design the photonic and acoustic system, deliver a signal measurement and analysis system, and demonstrate the measurement sensitivity of their system. References [1] Lassen et al. OPTICS EXPRESS **22(10)**, 11660, (2014) [2] A.G.Bell, Philos. Mag. **11**, 510, (1881).

Required skills
Experimental Skills
Hardware
Measurements
Software applications
Analogue Electronics
Programming

MEng 4th Year Project Description: Choice 9 of 12

Project title	**Physical Layer Security**

Supervisor 1	J Rigelsford
Supervisor 2	L Ford

Industry sponsor	

Project description
This project continues ongoing research into physical layer security for communications systems. Conventional cryptographic techniques are applied to the data. Physical Layer Security applies new cryptographic techniques to the underlying modulation scheme. It address questions such as “How robust are existing techniques?”, “Can we detect when a physical layer security system is being implemented?”

Required skills
• Literature review • Analysis of existing system (strengths and weaknesses) • Design of a physical layer cryptographic system • Threat and resilience analysis

MEng 4th Year Project Description: Choice 10 of 12

Project title	**Autonomous Electric Quadcopter**

Supervisor 1	J. K. Mitchell
Supervisor 2	M. Odavic

Industry sponsor	N/A

Project description
Remote sensing of hazardous environments is being increasingly undertaken by the use of remote control vehicles. The purpose of this project is to design and construct a miniature electric quadcopter which will fly automatically between locations based on GPS coordinates transmitted from a base station to the aircraft. The quadcopter should be capable of automatic take-off, travelling to a new location determined by GPS coordinates and performing a controlled landing or hovering at a specified point. The system will be able to receive text messages to inform it of the next destination, and have a remote camera onboard for surveillance work. The aim of the project is to have a working system by the end, having considered the communication system, the motor control and design, drive design and navigation systems.

Required skills
Analogue electronics / power electronics. Motor design and control. Mechanical engineering. An interest in electric vehicles. Hardware. Software.

MEng 4th Year Project Description: Choice 11 of 12

Project title	**Smart Low-energy House**

Supervisor 1	D A Stone
Supervisor 2	J K Mitchell

Industry sponsor	

Project description
The spiralling cost of domestic energy prices and the desire to 'go green' require much higher levels of control and efficiency for household systems and domestic appliances. This project will undertake a full audit of the energy consumption and power usage of a typical house and display real-time information via an App on a smart phone. It will investigate the possibility for local microgeneration using a wind turbine and roof-mounted solar panel array and use will be made of maximum power point tracking methods for harvesting maximum energy from these systems. Consideration will also be given to localised energy storage, such as batteries, and will involve the design and realisation of a power electronic converter to interface between the local generation systems (wind turbine, solar panels etc.), energy storage buffer and the mains electricity input to the house. One of the most important aims is not only to reduce the overall energy consumption of the house, but also to avoid periods of high power usage. Hence, the project will also consider load scheduling of appliances using an intelligent control system to minimise power fluctuations throughout the day and the development of low power appliances.

Required skills
Analogue electronics / power electronics, machine design, digital electronics and microcontrollers, system modelling, Matlab/Simulink.

MEng 4th Year Project Description: Choice 12 of 12

Project title	**Battery Energy Storage with an Inverter that Mimics Synchronous Generators**

Supervisor 1	M P Foster
Supervisor 2	J K Mitchell

Industry sponsor	N/A

Project description
Renewable generation is a growing component of electricity grids around the world however most renewable energy sources are location-dependent and experience a degree of non-controllable variability and partial unpredictability. One solution to this drawback is to adopt distributed energy storage systems. Energy storage systems could enhance the reliability of power systems and the security of supply and increase the level of the penetration of renewable energy sources. Grid-connected storage systems can be installed at different voltage levels, depending on the location and the application scenario. The charging/discharging process of energy storage systems Introduces' different dynamics into the grid, which may lead to heavy burden to the grid and threaten the system stability. How to integrate energy storage systems into the grid so that they can behave similarly as conventional power plants is very important. The main objective of this project is to develop a grid-connected energy storage system with an inverter that can mimic the functions of synchronous generators. It should be able to autonomously deliver the right amount of real power and reactive power according to the grid frequency and voltage or to regulate the frequency and voltage via changing the real power and reactive power delivered. At the same time, the harmonic components of the generated voltage should be maintained low. Moreover, such inverters should also achieve seamless transition between grid-connected mode and stand-alone mode to facilitate the applications in renewable energy and micro-grids.

Required skills
Excellent team working skills, analogue electronics, power electronics, systems control, simulation and modelling