

Student proposed?	N	
ID: eg YAG-01	SP24-02	
SUPERVISOR:	Stephen Paine	
TITLE:	Plastic to Power - Microwave Energy for Plastic Decomposition	
DESCRIPTION:	<p>Plastic materials are used extensively throughout the world, with their ever-rising proliferation being particularly marked during the past half century. Currently the vast majority of the 4.9 billion tons of plastics ever produced accumulate into landfills or the natural environment. This number is estimated to increase to around 12 billion tons by 2050.</p> <p>Polyolefins such as polyethylene, polypropylene and polystyrene are currently produced, used and discarded at the highest rate of all plastics, thereby accounting for over half of all plastic waste. To overcome the problem of such large quantities of plastic waste, researchers have studied various ways to convert these waste polymers into value-added products such as hydrocarbon fuels, carbon nanotubes and so on.</p> <p>Researchers have demonstrated (https://doi.org/10.1038/s41929-020-00518-5) that it is possible to use microwaves and a catalyst to efficiently and cost effectively break down these plastics.</p> <p>In 2021, a prototype device was designed, built and tested at UCT with great success. The next step of the process is to improve upon the existing design. There are many ways that this can be accomplished, for example, the device can be made more electrically efficient, easier to feed and provide the end user with additional data such as temperature readings, power usage and variable power output.</p> <p>This is a project that has the potential to reduce plastic waste around the world on both a large and small scale.</p> <p>Note: this project focuses on the microwave aspect and NOT the chemical components of the system.</p>	
DELIVERABLES:	<p>Literature Review: A comprehensive literature review and background research on microwave cavities, waveguides, waveguide modes and their effects and limitations.</p> <p>System Design: Design and simulation of a system (using FEKO) that can produce the results shown in the paper (from a microwave point of view – excluding the chemical aspect.). The student will need to demonstrate that the design can deliver the correct waveguide modes required and compare the updated design to the one in the paper as well as the device that was built previously at UCT.</p> <p>Experimental Results: The device needs to be properly tested, characterised and upgrades need to be validated.</p> <p>Report: Comprehensive report detailing each step, along with suggestions for future work and improvements.</p>	

SKILLS/REQUIREMENTS:	Must have completed a course on EM or Microwave systems.
GA 1: Problem solving: <i>Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively</i>	<p>The student needs to demonstrate understanding of the problem at hand and develop a practical solution that can be manufactured.</p> <p>Microwave engineering is a complex and difficult field of engineering that requires creative solutions to the many difficult problems one encounters in designing a practical system.</p>
GA 4**: Investigations, experiments and analysis: <i>Demonstrate competence to design and conduct investigations and experiments.</i>	The student needs to design and simulate a device that can be used to generate the required microwave energy in a very specific waveguide mode. The student needs to design experiments to adequately determine the performance of the system and perform a quantitative analysis to verify that the design is working as expected
GA 5: Use of engineering tools: <i>Demonstrate competence to create, select and apply and recognise limitations of appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, to complex engineering problems</i>	<p>Part of this project requires the design, simulation and testing of a unique microwave device.</p> <p>To do this, specialised software is required in the form of FEKO. This is an advanced piece of engineering software used to model electromagnetic systems such as waveguides and antennas.</p>
EXTRA INFORMATION:	https://doi.org/10.1038/s41929-020-00518-5
BROAD Research Area:	Electromagnetic and Microwave Engineering
Project suitable for ME/ ECE/EE/ALL?	ECE / EE

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and have one or more of the characteristics:

- are ill-posed, under- or overspecified, or require identification and refinement;
- are high-level problems including component parts or sub-problems;
- are unfamiliar or involve infrequently encountered issues;

and their solutions have one or more of the characteristics:

- are not obvious, require originality or analysis based on fundamentals;
- are outside the scope of standards and codes;
- require information from variety of sources that is complex, abstract or incomplete;
- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

****NOTE: GA 4:** The balance of **investigation and experiment** should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline. An **investigation differs from a design** in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.

Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection	X	
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "Yes" to any of the above questions.

If the answer is "Yes" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		X

If the answer is "Yes" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animal-related information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		
Q10	If the answer to Q9 is "Yes", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "Yes" to **Q5**, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		