UNIVERSITY OF CAPE TOWN
Department of Electrical Engineering
EEE4022F/S - Final Year Project
Graduate Attribute Tracking Form

Student name:	Zuhayr Halday	DP Awarded? [Y/N]	**Y**
Student no:	HLDZUH001	Supervisor name:	Prof Simon Winberg
Date:	25/09/25	Date:	26/09/25
Student signature:		Supervisor signature:	

Instructions:

Students must explain in this document what they **have already done** and what they **plan to do** to satisfy each Graduate Attribute. Descriptions of each GA is provided at the end of the document. Supervisors respond to the student's plans and current progress, providing additional comments or advice as they see fit. Once the student's progress is deemed sufficient (a few weeks before submission at the due date for this form), supervisors indicate that DP can be awarded.

VERY IMPORTANT: Receiving DP for the course does NOT imply that all GA's have been met in the course. Assessment of GA's only happen in the final marking of the project report.

GA 1: Problem Solving

Student Response:
I framed the project as complex problem which can be solved by designing a compact, low-power cosmic-ray (muon) detector that converts tiny SiPM currents into robust, measurable signals. I identified requirements and specifications from first principles (energy deposition, scintillation yield, SiPM PDE, ADC constraints) and used them to set design targets for a signal shaping feedback network, peak detection headroom, and sampling. To ground decisions, I completed a literature review spanning primary/secondary astroparticle showers, ionisation in matter, expected muon flux vs. geography/overburden, and scintillator/SiPM device physics, then translated those findings into simulation parameters and test plans. I analysed trade-offs between multiple different solutions and proposed a sustainable, affordable, and buildable solution using accessible materials and 3D-printed light-tight enclosures. I will validate conclusions with bench data (oscilloscope captures) iterating until the analytical, simulated, and measured behaviours agree. This approach demonstrates identification, formulation, literature-based analysis, and substantiated conclusions using maths, natural science and electronics engineering science.

Supervisor Response:
The student has provided good explanations of problem-solving tasks for this project, shows good understanding of what to do. The student is following an effective approach to refine the design and produce a functional prototype with which to do experiments. The student shows good understanding of the design process, and shows much competence in creative problem solving and design.

GA 4: Investigations, Experiments, and Data Analysis

Student Response:
I planned a practical research-methods workflow that starts with modelling and ends with validated measurements. I built MATLAB models to estimate photo-electron charge/current per muon event and LTspice models for a transimpedance amplifier and precision peak detector (including double-exponential SiPM pulses), then designed experiments to test these predictions. When all my components have arrived, I plan to hand-solder the PCB, 3D-print a light-tight housing, and use the oscilloscope plus Arduino logging via USB to acquire datasets across operating points and environments. Data analysis using a Python program will include filtering, curve-fits to decay constants, and correlation with environmental variables (pressure/weather) to derive valid conclusions from measured data. This integrates contemporary literature, experimental design, data interpretation, and synthesis into specifications and performance metrics appropriate to the goals of my project.

Supervisor Response:
The student has used a well-considered and explained approach in this project, and has given detailed explanation of the actions and tools involved. Effective planning for the project has been done, including deciding ways to do the design and experiments to obtaining data for further analysis.

GA 5: Use of Engineering Tools

Student Response:
I selected and combined modern tools with a clear understanding of their limits. KiCAD and LTspice were used for prediction/modelling of circuitry and analog front-ends, and MATLAB for translating physics into expected SiPM charge and pulse shapes. I used AutoCAD/3D-printing tools to design a light-tight enclosure, the Arduino IDE/C++ for peak capture/USB logging, and Python for data reduction and visualisation. I recognised limitations such as op-amp output headroom and idealised device models in simulation, and the Nano ADC's sampling/impedance constraints, and I mitigated them in the design. Tool choices were justified by task effectiveness (prediction, modelling, measurement, data analysis), and each step produced artefacts (schematics, netlists, scripts, plots) that inform the next. Manual tools such as a UV light will be used to test the response and efficiency of the scintillator when struck with a known source of radiation. I also plan to use oscilloscope readings, function generators, and other electronic bench tools to iteratively test and improve my circuit design and performance when reading real-world cosmic radiation data.

Supervisor Response:
The student has decided effective development approaches and an appropriate choice of tools, and has tested and configured these to established an effective development environment to proceed with the system development and testing. The student recapped and relevant knowledge and use of tools to complete the needed development and testing for this project.

GA 6: Professional and Technical Communication

Student Response:
I documented the project in a structured, professional style and communicated effectively with varied audiences, while continuously updating my supervisor on my project progress during scheduled meetings. This included progressively drafting a formal report with IEEE referencing, clear figures/tables, and appendices aimed at engineering peers and assessors, and involved preparing a short presentation to my supervisor and peers to professionally communicate my project progress and design justifications. I produced block and circuit diagrams, and waveform annotations to convey design intent and simulated performance. Externally, I wrote professional and courteous emails to academic staff (Masters students, Doctors, and lecturers) to secure scintillator access and advice through UCT's Physics Department. I will present interim testing results and final findings clearly, ensuring that methods, evidence, and limitations are traceable and suitable for an academic/professional context at exit level.

Supervisor Response:
The student has good oral and written technical communications skills. He has been making a decent amount of progress, has explained this clearly and coherently and shows good capability in the writing of the report. Accordingly, I find the student shows a good understanding of what is expected, and a suitably level of academic and technical writing. Accordingly, and the student's progress is at a good stage at this point, and the student is expected to complete and submit on time.

GA 8: Individual Working

Student Response:
As an individual, I engaged effectively across disciplines (Radiation Physics and Electrical Engineering) to progress the project. I scoped tasks (literature, simulation, procurement, build, test, software), set milestones, and executed them, seeking targeted input only when necessary (e.g., scintillator sourcing and safety practices). I adhered to professional responsibilities (lab safety, ESD care, ethical use of borrowed equipment) and coordinated with Physics Department staff to integrate scintillator constraints into the design. This shows independent execution, appropriate collaboration across disciplines when needed, and awareness of professional norms and responsibilities. I plan to continue working individually on this project until completion, gathering as much first-hand knowledge as I can through my own research.

Supervisor Response:
The student has done mainly focused individual work in this project, and has demonstrated much competence in independent work and decision making that this sort of complex design and testing tasks of this project involves.

GA 9: Independent Learning Ability

Student Response:
I demonstrated independent learning by moving from very limited prior knowledge of radiation physics to producing a theoretically functional detector design. Through research and literature review, I taught myself the necessary physics of cosmic radiation and scintillation, the materials science of plastic scintillators (including feasibility of DIY fabrication), and the practicalities of SiPM biasing and low-noise analog design - then applied that knowledge in simulations and test planning. I iterated based on results and feedback, adjusting thresholds, component values, and code to meet constraints. I plan to complete the building stage, collect long-run datasets, and correlate muon counts with environmental/geo data in Python to extract meaning and reflect critically on the performance and limitations of my project. Throughout, I've operated with initiative in an ill-defined problem space, sought advice appropriately, and captured lessons learned for future work on the project.

Supervisor Response:
The student has demonstrated good individual working ability, and has taken responsibility for learning what is needed and to use the theory and tools to develop and test the required system.

GA 1: Problem Solving

Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development.

- A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline, much of which is at the forefront of the discipline.

GA 4: Investigations, Experiments and Data Analysis

Demonstrate competence to conduct investigations of complex engineering problems using research methods, including research-based knowledge, design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

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.

Note: 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 artefact could be produced.

GA 5: Use of engineering tools

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.

- Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- Knowledge of engineering practice (technology) in the practice areas in the engineering discipline

A range of techniques, resources and modern engineering and IT tools appropriate to the disciplinary designation of the programme.

GA 6: Professional and Technical Communication

Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large, taking into account cultural, language, and learning differences.

This course evaluates the long report component of this outcome at exit level. Material to be communicated is in an academic or simulated professional context. Audiences range from engineering peers, management and lay persons, using appropriate academic or professional discourse. Written reports (10 000 to 15 000 words plus tables, diagrams and appendices) should cover material at exit-level. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject-specific methods.

GA 8: Individual, Team and Multidisciplinary Working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments. This course evaluates the **individual** working component of this learning outcome at exit level.

Knowledge of professional ethics, responsibilities and norms of engineering practice.

GA 9: Independent Learning Ability

Demonstrate competence to engage in independent learning through well-developed learning skills.

Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

Operate independently in complex, ill-defined contexts requiring personal responsibility and initiative, accurately self-evaluate and take responsibility for learning requirements; be aware of social and ethical implications of applying knowledge in particular contexts.

- Openness to constructive feedback, awareness of own limitations, ability to cope with the discomfort of uncertainty and having access to a range of approaches, reflective self-evaluation, curiosity and proactive engagement, resilience, confidence to ask for help and draw from a broad range of stakeholders.
- Reflection of self-learning to begin to recognise if what has been covered meets the needs of the activity or task.