Section A: Overview of the Research Project

1. *Title of the research project*
   Development of a low cost analog receiver chain for MFAA demonstrators

2. *Broad area of research (Engineering or Science):* Engineering

3. *Academic level of research project (Masters or Doctoral):* Masters

4. *Abstract of research project*
   The Mid-Frequency Aperture Array system is envisaged to form part of SKA-phase 2. It will operate around the 500-1500 MHz frequency band, and the final version will be fully-digital in all channels. During development, several demonstrator antennas need to be prototyped and tested. This project will design an analog receiver chain for such demonstrator antennas. It must be able to mix a chunk of bandwidth to baseband, from anywhere in the operating band of the system. Furthermore, large numbers of these receivers must be connected coherently and in a small form factor. The final system must be packaged and mass-producible.

5. *Primary supervisor's details:*
   a. *Full name of primary supervisor:* Dirk Izak Leon de Villiers

   b. *Primary supervisor's email address (please note that if this project is approved, this email address will be made available to students to contact the primary supervisor)*
   ddv@sun.ac.za

   c. *University where primary supervisor is employed:* Stellenbosch University

Section B: Details of Research Project

1. *Scientific/Engineering merit: describe the objectives of the research project, placing them in the context of the current key questions and understanding of the field.*
   Several groups around the world are working on antenna concepts for the MFAA. One of the main difficulties in developing array systems is in the integration of coherent receivers to all the channels. SDR's are widely available and cheap, but most of these do not provide access to input mixers or raw output data. As such, there is still a requirement for a stand-alone receiver chain that can be easily integrated into any demonstrator antenna system. Such a receiver can be made with custom ports to fit the specific form factor of the antenna, or just have simple SMA or smaller connectors. In most cases it is not required to process the full bandwidth at once when testing prototypes, but it is certainly required to have access to the full frequency band. As such, a traditional heterodyne receiver will still do the job, while providing the student developing the system with very valuable radio engineering experience which can be used outside radio astronomy as well.

2. *Feasibility: outline the methods that will be used to achieve the objectives. Provide details on the availability of required data / access to required equipment / availability of research facilities and other resources required. Include any relevant expected intermediate milestones and associated timeframes towards attaining the overall objectives of the project.*
   A standard systems engineering approach will be used to develop the system in this project. Specifications are easy to set for the system. The student will select and design different subsystems and components, have them made, test them, and integrate them. All the measurement and simulation equipment is available in house.
   The timeline will probably be broken into four terms. The first term will be used for course work, the second for design and prototyping, the third for testing and integration, and the fourth for thesis write up. This system will probably the first iteration in a range of similar designs – later ones being more sophisticated than earlier ones.

3. *Link the proposed project to one or more of the SARAO research priority areas for 2021 (refer to Section 5 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).*
   (1) Antenna, receiver, (analogue and digital) signal processing, data analysis and data recording systems associated radio telescope and geodesy instruments supported and hosted by SARAO.

   This project is most suited to a student with an undergraduate background in RF engineering, and who is very practically minded and likes building and testing real-world systems.