

# South African Mathematical Modeling Contest

## SAMMC

### Contest Outline 2022

**Outline:** SAMMC (“Sam-see”) is an annual contest in mathematical modeling. It aims to provide South African undergraduate students in science and engineering disciplines exposure to applied mathematics problems more relevant to real-world applications than they might otherwise encounter in the classroom. It is a chance to challenge your brain and develop problem-solving skills, gain experience in working in a team, and possibly win some prizes!

The format of the contest is based loosely on the international COMAP MCM competition, held every January/February: <http://www.comap.com/undergraduate/contests>. A secondary aim of SAMMC is to provide SA students with experience in solving MCM-type problems and help select teams for the international competition.

For SAMMC, contestants enter as a team of up to 4 and will choose from one of 3 available problems, spanning different areas of applied mathematics. Typically there is one ‘continuous’ problem, one ‘discrete’ problem, and one ‘data-driven’ problem (some examples can be found on the next page).

At 9AM on the first day of the competition the 3 available problems will be made available to teams via email. Contestants will then have 4 days to work on the problem and by 3PM on the final day they must submit a 1-page summary sheet outlining their chosen problem and results, plus a 10-15 page report describing their work in more detail. By 5PM on the final day, the team should also submit a short video (5 minutes max) describing their chosen problem and proposed solution.

It is important to note that partial solutions are acceptable and there is no passing or failing cut-off score. (Numerical scores will not be assigned.) The contest judges are primarily interested in the team’s approach, ideas, methodology, and enjoyment of the contest. Prizes are on offer to the top teams.

More specific rules and details of the contest are available here: <http://appliedmaths.sun.ac.za/SAMMC/>

Those interested in entering the competition should pre-register (with no obligation at this stage) at the website: <http://appliedmaths.sun.ac.za/SAMMC/>.

For more information contact the organisers at [sammc@sun.ac.za](mailto:sammc@sun.ac.za).

## **Past problems:**

### **Shooting Hoops**

When a basketball player is fouled in the act of shooting a basket they are awarded a "free throw" from approximately 2 metres from the hoop. Different players have different strategies for free throws. Some use a high loopy shot whereas others prefer a flat shallow shot.

By constructing a suitable model of the flight of the ball given some initial uncertainty around the initial angle and velocity of the player's shot, determine the optimal angle for a successful free throw.

As part of your report you should include a half page non-technical summary addressed to a fictional NBA player and his/her coach explaining your findings.

### **STOP, wait, ..., GO!**

A busy two-way highway is reduced to a single lane via STOP-GO boards for a distance of  $L$  kilometres. Determine an optimal strategy (for example, in terms of the waiting time  $T$ , the number of queuing cars  $Q$ , or some combination of both) for when to change the direction of traffic in order to minimise delays.

As part of your final report you should include:

- a one-page summary for the provincial Minister of Transport and Public Works
- a roadside billboard explaining your strategy to waiting motorists

Possible extensions:

- consider the case of a sequence of STOP-GOs
- consider the case of a three-way STOP-GO (e.g., where there is a T-junction within the closed section.)

### **Home field advantage**

In many sports the idea of "home field advantage" describes the potential benefit a home team gets over the away team. The advantages may be physical (for example, differing climates or weather conditions, different pitch sizes, or fatigue from travel) or psychological (typically due to increased support from fans). There has been much debate recently over the effect of home field advantage in Super Rugby (particularly with the introduction of teams from Argentina and Japan). The CEO of Super Rugby has hired you to quantify the effect this has on the competition, and possibly suggest some remedies (such as introducing a bonus point for an away win or draw).

As part of your final report you should include:

- a one-page lay summary to the CEO of Super Rugby explaining your findings.

### **Zip it!**

In a bid to counter dropping tourism following recent droughts, the city of Cape Town is considering the installation an aerial zip line from the top of Table Mountain to either the top of the nearby Lion's Head or Signal Hill, or a maybe even a "splash down" landing in to the water off of Camps Bay beach. You have been contracted develop a suitable mathematical model of the proposed zip line(s), to assess the feasibility of the project, and give recommendations on its design. (An engineer has been contracted to consider most of the construction details.)

As part of your final report you should include:

- a one-page summary for the Mayor of Cape Town
- a short advertisement for a local paper