MathWorks Math Modeling Challenge

A CONTEST FOR HIGH SCHOOL STUDENTS
M3Challenge.siam.org
m3challenge@siam.org

SCORING GUIDELINES

Teams should:

- Use mathematical models **either developed originally or discovered through research**.
- **Demonstrate a depth of understanding** of their solution.
- Provide **additional insight** if their solution is drawn from sources.

For each of questions 1 through 3, teams should ***create a mathematical model***, which means:

- Define all variables and parameters (with units).
- Justify assumptions.
- Describe the mathematical approach(es) used to develop the model and find a solution.
- Apply to or demonstrate for any situations presented.
- Discuss implications of the result(s).

Guidance on the parts of the problem is below; a solution paper template can be downloaded for more direction:

Solution Component	Considerations	Value
Executive Summary	• Overview of the problem (all three parts). • Brief description of the mathematical approaches that were used. • Provide and discuss a summary of the results (even if they are incorrect).	Up to 20%
Question 1	• An accessible entry point to a larger problem. • A warm-up—it is anticipated that most teams will develop a solution for this question.	Up to 20%
Question 2	• Investigation of essential issues underlying this real-world problem. • The main event—every team can have some success and many teams will cover it well.	Up to 25%
Question 3	• A challenging aspect; requires broader and/or deeper perspective. • The discriminator—many teams will do something, while only a few will have striking results.	Up to 15%
Discretionary points	• Team examined a wider set of circumstances. • Team used a creative problem solving perspective. • Team made connections between all three parts and the overall driving question. • Paper is exceptionally well written/organized. • Detailed sensitivity analysis is presented. • Model verification is performed. • Strengths and weaknesses are addressed. • Effective and well-motivated use of technical computing.	Up to 20%

More on reverse

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Other considerations

Basic Modeling and Writing Concerns:

- Check that the units are consistent.
- All figures and graphs should have a title, a label, a caption, and the axes should be labelled.
- All tables should have a title, a header, a label, and a caption.
- All variables and parameters should be clearly defined.
- Motivate and fully explain the use of any complicated mathematical expressions.
- When citing outside sources, clearly explain what statistics, models, equations, or insights you took from each source.

Clearly insincere or disrespectful submissions should receive a total score of 0 (zero) and do not receive certificates of participation.

Comments from judges for teams are encouraged and are emailed to teams. Judges may be brief and/or relay questions they had about a team's work.

The Technical Computing Award

If a team chooses to solve one or more parts of the Challenge using a programming platform (specifically something other than a spreadsheet), they may be eligible for the Technical Computing Award. Solutions must demonstrate outstanding use of computing which advances the model and/or reveals its implications.

Code must be formatted to make it easy for judges to understand what the program is doing and how the algorithm is executed[1]. This means:

- Code must include comments that describe how the code works.
- Variables should have meaningful names.
- Code should use consistent indentation to allow for easy readability.

Equally Important - teams must also discuss their program **in the paper**:

- Teams must justify the use of technical computing. That is, it must be clear why the team leveraged a computer program instead of just a calculator.
- Teams should include a brief summary of the purpose and key features of their code.
- If "built-in" functionality is used:
  - it should be clear that the team knows what the underlying function does and why it was chosen, and
  - the input parameters should be clearly provided and justified.
  - For example, the following would be considered a weak explanation.

    We fit an AR model in MATLAB to the time series and got the plot below.

    This could be improved as follows.

    Since the time series did not appear to follow a simple linear or logistic trend, we chose to fit it with an Autoregressive (AR) model. This model approximates a time series using the equation..... To fit the model to our time series, we used MATLAB's built-in "arima" function. This function can actually fit more general ARIMA models, so to fit an AR model, we set the input parameters D and q to 0. The other parameters p was chosen to equal 5 because....
- Teams must include an explanation or demonstration of how the code was tested for accuracy or correctness.

[1]See Appendix B of the handbook *Math Modeling: Computing & Communicating* for examples.