

## Formula Bharat 2023: MathWorks Modeling Award

<b>Event Name:</b>	Formula Bharat 2023: MathWorks Modeling Award
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### A. Award Overview

The MathWorks Modeling Award is structured to provide awards to the team that best applies The MathWorks tools in the Formula Bharat 2023. The award will be decided based on two stages and will be judged based on slides and formal presentation. Refer Section **B** for more details.

The 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> place teams will each receive **Cash Prizes** of **25000 INR**, **15000 INR** and **10000 INR**, respectively. These awards will be presented at the Formula Bharat 2023 award ceremony.

### B. Procedure

- Participation in this competition is free
- **Stage 1:**
  - The teams will need to submit their slides in pdf format to the organizers by **November 29, 2022, 11:30 p.m. IST**. Only one entry may be submitted by each team. The detail of submission is provided in Section **E**.
  - All entries will be judged by MathWorks engineers on a 100-point scale. The scoring criteria is provided in Section **C**.
  - Create original slides as per the format mentioned in Section **D**.
  - Up to **ten teams** will be selected to participate in Round 2 of the Competition.
  - The result for Stage 1 will be announced on **December 12, 2022**.
- **Stage 2:** The teams that qualify the **Stage 1** will be invited for a formal presentation and they will need to present their work to the MathWorks judges. The dates and the WebEx link for the presentation will be sent to the qualified teams by **4<sup>th</sup> week of December 2022**.
- The 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> winners will be announced at the Formula Bharat 2023 award ceremony.
- **Judges' decisions are final.**

### C. Content

Points (**100 available**) will be awarded based on the submitted slides and scripts/models (optional) based on the following criteria:

1. (**10 pts**) How the team has applied the core concepts of Model-Based Design with The MathWorks' tools to help achieve the overall competition objectives?
  - a. Summarize the application of The MathWorks' tools to the competition objectives.
  - b. Define and describe how The MathWorks' tools fit into the overall development process followed:
    - i. Requirements
    - ii. Design using modeling and simulation

- iii. Testing
  - iv. Verification and Validation
2. Relating overall competition objectives, how has the team applied The MathWorks' tools to the task of:
- a. **(20 pts) Plant Modeling**
    - i. How were the plant models developed using MATLAB and Simulink?
    - ii. How were the plant models validated and what level of correlation to real world results was obtained?
    - iii. Are the models architected in a way that provides for ease of use, understanding, extensibility and fast execution?  
Example: Vehicle model, or any component of the vehicle such as powertrain, vehicle dynamics, brakes, cooling system, battery model, suspension system, etc.
  - b. **(15 pts) Control Design and Tuning**
    - i. How were the control models developed using MATLAB and Simulink?
    - ii. How were the control models validated and what level of correlation to real world results was obtained?
    - iii. Are the models architected in a way that provides for ease of use, understanding, extensibility, and fast execution?  
Example: Lateral/longitudinal vehicle control, battery management system (BMS), control of any vehicle component such as brakes, motors, etc.
  - c. **(10 pts) Optimization**
    - i. How were the optimization techniques developed and applied using MATLAB and Simulink?
    - ii. How were the optimization models validated and what level of correlation to real world results was obtained?
    - iii. Are the models architected in a way that provides for ease of use, understanding, extensibility, and fast execution?  
Example: Optimization of suspension system, transmission system, etc.
  - d. **(15 pts) Lap Time Simulation**
    - i. How was the lap time simulation model developed using MATLAB and Simulink?
    - ii. What level of vehicle model was considered to perform the lap time simulation?
    - iii. How were the results validated and what level of correlation to real world results was obtained?
    - iv. Are the models architected in a way that provides for ease of use, understanding, extensibility, and fast execution?
  - e. **(10 pts) Data Analysis**
    - i. How was MATLAB and Simulink used to acquire, analyze, and visualize data?  
Example: Tire analysis, cooling system, etc.
  - f. **(10 pts) Embedded Systems**
    - i. How was MATLAB and Simulink used in designing the algorithm which was deployed on embedded system?
    - ii. How was the simulation model integrated with the actual vehicle?
    - iii. Was the auto-code generation capability in MATLAB and Simulink used on the embedded hardware?
3. **(5 pts)** Overall quality of the slides.
4. **(5 pts)** Plan for next year/ Lessons learnt– what would you do different next time and what is missing from the tools that would have helped you?

#### D. Slides Format

You need to prepare a set of slides using the format provided below briefly describing the content as mentioned in Section C. The number of slides is not limited.

- Slide 1
  - Institute name
  - Team name
  - Car number
- Slide 2
  - Briefly describe how you have applied the core concepts of Model-Based Design with The MathWorks' tools.
  - Refer to points 1 (a) and 1(b) of Section C for more details on the content
- Slide 3
  - Plant Modeling
  - Refer to point 2(a) of Section C for more details on the content
- Slide 4
  - Control Design and Tuning
  - Refer to point 2(b) of Section C for more details on the content
- Slide 5
  - Optimization
  - Refer to point 2(c) of Section C for more details on the content
- Slide 6
  - Lap time simulation
  - Refer to point 2(d) of Section C for more details on the content
- Slide 5
  - Data Analysis
  - Refer to point 2(e) of Section C for more details on the content
- Slide 7
  - Embedded Systems
  - Refer to point 2(f) of Section C for more details on the content
- Slide 8
  - Lesson learned
  - Refer to point 4 of Section C for more details on the content

#### E. Submission

- A specific upload portal for the MathWorks Award will be located on [www.formulabharat.com/deadlines](http://www.formulabharat.com/deadlines). Within the Deadlines table, head over to the row with item "MathWorks Modelling Award 2023". The portal link will be located along the same row.

(Please do not use the generic Upload Portal that your team uses for all its FB2023 document submissions).

- Please name your file in the following manner: *Car#\_TeamName\_MathWorks\_2023\_V#*. For example: *E01\_TeamKratosRacingElectric\_MathWorks\_2023\_V1*

- To avoid download errors, please submit the file as a '.pdf'.

- The deadline for submission is **November29, 2022, 11:30 p.m. IST.**

## F. Reference Materials

### Recommended Tutorials:

- [MATLAB Onramp](#)
- [Simulink Onramp](#)
- [Stateflow Onramp](#)
- [Physical Modeling Tutorial](#)
- [MATLAB and Simulink Racing Lounge – Improving Your Racecar Development](#)
- [‘How To’ – Videos using MATLAB and Simulink](#)

### Published Videos/Blogs by Teams:

- [Virtual suspension design processes with McGill Formula Electric](#)
- [Magic Formula Tire Modeling in Formula Student](#)
- [Lap Time Simulation; Essential Part of Concept Development](#)
- [How to Win at Formula SAE using Simulink](#)
- [How to Win at Formula Bharat using MATLAB and Simulink](#)