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BAJA SAEINDIA
2027

Under the Aegis of
SRI VISHNU EDUCATIONAL SOCIETY · NATRAX · Sairam · ACROPOLIS · CHITKARA UNIVERSITY · ARAI

HANDBOOK

PRELIMINARY ROUND

22nd November 2026

Autonomous
a-BAJA
Autonomous

BAJA SAEINDIA 2027

20 YEARS OF
BAJA SAEINDIA
mBAJA | eBAJA | hBAJA | aBAJA



BAJA SAEINDIA 2027 is set to captivate participants and spectators with its innovative blend of Physical and Virtual rounds. This highly anticipated edition encompasses three distinct Phases, with the initial first & second phases taking place in a virtual format, and the third phase culminating in an exciting physical event. The Preliminary Round of aBAJA SAEINDIA 2027, will be conducted on **22nd November 2026**.

Understanding the Preliminary Round:

- Similar to aBAJA SAEINDIA 2026, the Preliminary Round of aBAJA SAEINDIA 2027 will be a **non-elimination round**. The points scored in this round will be included in the team's overall score, along with the points earned in Phase-II and Phase-III events.
- The objectives of the Preliminary Round of the aBAJA SAEINDIA 2027 event are as follows:
    1. To acquaint the teams with the objectives of the aBAJA SAEINDIA 2027 event as described in the rulebook
    2. To develop a comprehensive understanding of the fundamental and advanced aspects of Autonomous Vehicle (AV) technology, including but not limited to ADAS features like Lane keep assist, Automated Emergency Braking; Vehicle modifications like Brake-By-Wire, Steer-By-Wire, Throttle-By-Wire, Feedback Systems; and Software Development like Image Processing, Computer Vision, RADAR Data processing, GNSS/INS system, In-vehicle communication, Lane detection, Traffic Object Detection, Traffic Object Classification, Traffic Object Tracking, Sensor Fusion, and Control system.

Events	Description	Points
Phase I: Preliminary Round	**Presentation Round**	**40**
	Online Quiz	**10**
Total Points		**50**

- Teams must prepare for the following sub-events:
    1. **Presentation Round:** A maximum of 40 minutes will be allotted per team to present their models, which includes,
        - Presentation by the team to showcase the Autonomous/ADAS design: 20 minutes
        - Questions put up by the panel to be answered by the team: 20 minutes
    2. **Quiz Round:** The Quiz will consist of questions from General Engineering / Automotive Engineering, Autonomous Vehicle Technology, and Rulebook.

    Note - Teams must strictly adhere to their respective timelines.

- The entire presentation round evaluation process will be conducted digitally on a Video Conferencing Portal. The Standard Operating Procedure (SOP) for the same will be released later.
- A maximum of **5 team members** per team, which must include either a Captain or Vice-Captain, will be allowed for the presentation. The presenter's details will be collected separately at a later time.

- One faculty member must be present as a silent observer, in addition to the team members, for the presentation round.
- Teams are required to submit the following files for the Preliminary Round:
    1. Presentation File
    2. An optional slide for Innovation (Only a single slide)

  Both these submissions must be made through the **BAJA SAEINDIA Website** submission portal in PDF format by **21st November, before 23:59 IST**.

  The file size must not exceed 5 MB for the Preliminary Round presentation pdf and 1 MB for the Innovation slide pdf.
  The Presentation shall be named as **TeamID_TeamName_Presentation_Phase1_2027.pdf**
  The Innovation slide shall be named as **TeamID_TeamName_Innovation_Proposal_2027.pdf**
- The Quiz and presentation will be conducted via an Online Platform. The Standard Operating Procedure (SOP) for the same will be released later

- **RETURNING TEAM**
  The teams/colleges/institutions, who participated in the Main Physical Event of aBAJA SAEINDIA 2026 2025, aBAJA SAEINDIA 2024, shall be called RETURNING TEAM. Participation in the 'Main Physical Event' means, the team should have built their BAJA vehicle, brought it to the main event, and have got their team registered at Sri Sairam Engineering Chennai, Global Automotive Research Centre (GARC) or ARAI, Kothrud for on-site stages of the competition in aBAJA SAEINDIA 2026, aBAJA SAEINDIA 2025 or aBAJA SAEINDIA 2024.
- **NEW TEAM**
  The teams/colleges/institutions, who could not participate in the Main Physical Event of aBAJA SAEINDIA 2024, aBAJA SAEINDIA 2025 and aBAJA SAEINDIA 2026 shall be called NEW TEAM. Teams switching from one category to another shall also be considered as NEW TEAM. Additionally, the teams not covered under the RETURNING TEAM criteria shall be considered as NEW TEAM.

Presentation Round Guidelines:

- Kindly go through the **Slide Sequence** below for detailed information on evaluation parameters/topics, respective slide sequences, and score weightage. The team's presentation should not exceed the maximum number of slides indicated.
- Slide Numbers. Must be mentioned as per the order defined in the Slide Sequence
- No slide transitions/animations are allowed.
- Teams must use Font Style 'Calibri' and Font Size' '14 or above'.

Slide Sequence:

Slide No.	Title	Points

1	**Team ID, College Name**	**Nil**	
2	**Lessons Learnt (Only for Returning Teams)**	**20**	
3	**Throttle By Wire**	**10**	
4	**Brake By Wire**	**10**	
5	**Steer By Wire**	**10**	
6	**Complete Software Architecture**	**10**	
7	**Autonomous Emergency Braking**	**10**	
8	**Lane Keep Assist**	**10**	
9	**Endurance**	**20**	
10 & 11	**Object Detection ,Classification & Tracking**	**10**	
12	**Failure Analysis and Mitigation**	**10**	
13 & 14	**Development Plan**	**10**	
15	**Team Composition**	**5**	
Max Slides = 15	**Overall Marks**	**115 (New Teams)**	**135 (Returning Teams)**

Note - The score obtained by the respective team will be scaled down to 40 points.

The following points have been sketched out to assist teams in their preparation for the Preliminary Round presentation. Teams are encouraged, but not limited to, include the following points under each title/slide:

Slide 1: Team ID and College Name:

- Team ID, Team name, College name
- Returning Team or New Team of aBAJA SAEINDIA 2027

Slide 2: Lesson Learnt (Only for Returning Teams):

- Achievements and issues faced in aBAJA SAEINDIA 2026
- Steps taken to overcome these issues in the current season.
- Justification for the change in the team's concept that is believed to mitigate the issues faced
- Cost and performance difference between the old and the new concept

Slide 3: Throttle By Wire

- Hardware architecture showcasing various electrical and electronic components, showing how each component communicates with one another and gets power supply
- Integration with the traction motor controller and the supervisory controller

- Interaction with the autonomous switch and longitudinal switch
- Functionality and performance metrics considered
- Feedback systems and Low-level control algorithms planned to be used
- Justification of the chosen communication frequency between various hardware components in the architecture
- Justification on why a particular hardware is chosen and the proposed cost of the entire system (excluding the Base vehicle components)

Slide 4: Brake By Wire

- Hardware architecture showcasing various E/E components, showing how each component communicates with one another and gets power supply
- Integration with the vehicle's manual brake and hydraulic system, and with the supervisory controller
- Interaction with the autonomous switch and longitudinal switch
- Functionality and performance metrics considered
- Feedback systems and Low-level control algorithms planned to be used
- Justification of the chosen communication frequency between various hardware components in the architecture
- Justification on why a particular hardware is chosen and the proposed cost of the entire system (excluding the Base vehicle components)

Slide 5: Steer By Wire

- Hardware architecture showcasing various E/E components, showing how each component communicates with one another and gets power supply
- Integration with the vehicle's manual steering system and with the supervisory controller
- Interaction with the autonomous switch and the lateral switch
- Functionality and performance metrics considered
- Feedback systems and Low-level control algorithms planned to be used
- Justification of the chosen communication frequency between various hardware components in the architecture
- Justification on why a particular hardware is chosen and the proposed cost of the entire system (excluding the Base vehicle components)

Slide 6: Complete Software Architecture

- Full Software Architecture block diagram showcasing the various software components (Supervisory controller, Go button, Sensor data processing, Perception, Sensor fusion, Localization, Planning, Controlling, etc.)

- Detail the interface between the individual software components/blocks within the architecture.

- Justification for the selected software stack (ROS, Python, MATLAB, etc.), and hardware compute platform to support real-time AI/ML model inference including advantages, possible failures, and challenges anticipated with its implementation.

- Communication mechanism between different software nodes/components (e.g., message passing, shared memory, etc.).

- Supervisory controller and feedback sensors planned to be used, justification of selection, and cost of hardware alongside integration of physical Go button connected to supervisory controller.

Slide 7: Autonomous Emergency Braking

- Event requirements and performance targets – decomposed from the dynamic event description in the rulebook
- Explanation of event-specific control and how selective software components of the proposed software architecture will achieve event-specific use cases
- Compute resource allocation prioritizing safety critical scenarios and network latency, data throughput constraints and bus message priorities, different dynamic test scenarios considered, KPI driven dynamic evaluation and justification on how the proposed software and hardware will work for all the different dynamic test scenarios considered
- Explanation of the calculation behind how the software decides when and how much brake to be applied

Slide 8: Lane Keep Assist

- Event requirements and performance targets – decomposed from the dynamic event description in the rulebook
- Explanation of event-specific control and how selective software components of the proposed software architecture will achieve event-specific use cases
- Compute resource allocation prioritizing safety critical scenarios and network latency, data throughput constraints and bus message priorities
- Different dynamic test scenarios considered, KPI driven dynamic evaluation and justification on how the proposed software and hardware will work for all the different dynamic test scenarios considered
- Explanation of the logic behind how the lane center deviation is calculated and in turn corrective steering commands are generated
- Maximum speed at which the proposed software is expected to meet the requirements

Slide 9: Endurance:

- Event requirements and performance targets – decomposed from the dynamic event description in the rulebook
- Explanation of event-specific control, handoff logic from lane tracking (stage 1) to GPS point-based navigation (stage 2) and how selective software components of the proposed software architecture will achieve event-specific use cases

- Compute resource allocation prioritizing safety critical scenarios and network latency, data throughput constraints and bus message priorities
- Different dynamic test scenarios considered, KPI driven dynamic evaluation and justification on how the proposed software and hardware will work for all the different dynamic test scenarios considered
- Explanation of logic/calculation behind how the vehicle adapts its speed and steering demand based on lane curvature, while maintaining vehicle stability.

Slide 10 & 11: Object Detection, Classification & Tracking:

- Event requirements to be met – decomposed from the event description in the rulebook
- Explanation of how selective software components of the proposed software architecture will achieve event-specific use cases
- Compute resource allocation and network latency, data throughput constraints and bus message priorities
- Logic behind how the detection, classification and tracking happens
- Process to be followed to retrain (if needed) models to specifically meet the event requirements
- Process to be followed to generate custom datasets (if needed)
- Various lighting and environmental conditions considered and justification on how the proposed hardware and software will meet the requirements in these conditions

Slide 12: Failure analysis and mitigation

- Process followed to identify the various failure modes and their effect on the vehicle control
- Process followed to work out the mitigation and reaction strategies for a failsafe behavior
- Any communication safety checks planned to be implemented
- Any fail-safe mechanisms when individual blocks fail within the software architecture
- Prevention of unintended steering, acceleration and deceleration
- Restricting vehicle speed to certain limits
- Bringing the vehicle to a standstill in case of any risk anticipated by the autonomous operator
- Failure data logging and debugging strategy
- Mitigation strategy for any failure in drive-by-wire components, including actuators, feedback sensors, microcontrollers, and other components.
- Mitigation strategies for failure in critical sensors, such as camera, RADAR, etc.

Slides 13 & 14: Development Plan:

- Complete project plan from vehicle modification, hardware integration, software development, to testing and validation on track
- Showcasing understanding of V-Cycle and how it is adapted for aBAJA use case
- Target milestones, aligning to the tentative timeline given for various event phases
- Standard template for V-cycle can be found here - https://bit.ly/ReferenceV-CycleTemplate. The templates provided are for reference purposes. Teams can modify it as necessary

- Model in loop, Software in Loop, Hardware in Loop, Driver in Loop and Physical vehicle testing strategies planned to be used in various stages of development

Slide 15: Team composition with work allocation and facilities:

- Team hierarchy (detailed structure with captain, vice-captain, safety drivers, other members, and Faculty Advisors)
- Team split up based on different engineering departments (Mechanical, CSE, IT, EEE, ECE, etc.), also mention at which stage of the project, which department would have a critical role (thus needing more members)
- Involvement of college facilities/mentors at various stages of the project, like software development, testing and validation plan for individual features
- Work allocation among team members considering the various activities involved in the overall development process

Quiz Round: (10 Marks)

- In addition to the presentation, a General Engineering / Autonomous Vehicle Systems basic knowledge & rulebook knowledge test will be conducted during the Preliminary Round of the BAJA SAEINDIA 2026 event for all the teams.
- The test will be conducted online. A maximum of 30 minutes will be allotted per team for the test.
- The test will contain 15 questions on General Engineering / Automotive Engineering with no negative marks for wrong answers.
- The test will contain 20 questions on Rulebook Understanding with 0.5 marks deducted for every wrong answer.
- Scores obtained by the respective team will be scaled down to 10 marks.

Sections	No. of Questions	Marks / Question	Negative marks / Wrong Attempt
Rulebook Understanding	**20**	**1**	**0.5**
General Engineering / Autonomous Vehicle Systems	**15**	**2**	**0**

Reference Training Videos

Sr.No.	Topic	Description	Video Link
A	**ADAS Autonomous Vehicle**		
1	Overview of ADAS and Autonomous Driving and SAE levels of AD.	History and background of ADAS, evolution of Automated Driving and their linkage	https://bit.ly/Overview_of_ADAS_Functionalities
2	SAE level for AD	Explanation of various SAE levels and expected autonomy	https://bit.ly/SAE_Levels_of_AD (From 00:00:00 - 00:15:34)
3	Overview of ADAS Functionalities	Overview of ADAS functionalities (EBA, ACC, LCF, etc.) and sensors involved in realizing those functions	https://bit.ly/ADAS_Function_Overview
B	**Sensing & Perception**		
1	Introduction to different sensing systems	Overview of different sensors and their use cases, concept of multiple sensor integration depending upon application needs	https://bit.ly/Intro_to_diff_sensing_systems (From 00:15:35 - 00:55:31)
2	RADAR	Basic concepts of Radar like FMCW, dopplers, azimuth estimations, range, radar cube, etc. Overview of long range and short-range radar, applications, pros and cons	https://bit.ly/Radar_sensor
3	Camera	Principles of Camera functioning, FOVs, types of cameras like mono, stereo, etc., applications, pros and cons	https://bit.ly/Camera_sensor
4	IMU & GPS	Concepts of IMU, various axis data sensed, working principle and basic concepts	https://bit.ly/IMU_and_GPS
5	Concepts of fusion - 2 parts	Understand the need of fusion, types of fusion methodologies, how fusion is done (e.g., low-level, high-level fusion, Kalman Filter variants, etc.)	https://bit.ly/Concepts_of_Fusion_Part_1 https://bit.ly/Concepts_of_Fusion_Part_2
6	Overview of AI/ML	Introduction to Machine Learning, various concepts like Neural Networks, application to ADAS.	https://bit.ly/Overview_of_AI_ML
C	**Vehicle Dynamics Control**		
1	VDC controls - 3 parts	Architecture, Kalman Filter Fundamentals	https://bit.ly/VDC_Part_1

			https://bit.ly/VDC_Part_2
			https://bit.ly/VDC_Part_3
2	ESP	ABS - Fundamentals TCS- Fundamentals YSC - Fundamentals - Over Steer, Under Steer, Yaw rate determination, Cornering Physics, characteristic speed, critical speed, side slip angle, estimation of curve radius, understeer gradient determination	https://bit.ly/Vehicle_Dynamics_Controller_ESP
D	**Communication Protocols**		
1	Communication Protocols	Overview of CAN, LIN, Flexray and basics of ethernet in Automotive	https://bit.ly/Communication_Protocols
E	**Scenario Creation**		
1	Introduction to scenario creation	Basics of understanding a critical driving scenario in real world conditions, parameters to be considered for scenario re-creation	https://bit.ly/Intro_to_Scenario_creation
2	Overview of regulations and consumer group protocols	Overview of NCAPs across the globe. Overview or other major regulations, e.g., UNE C152, etc.	https://bit.ly/Overview_of_regulations_and_consumer_group_protocols
3	Overview of parameters to be monitored for scenarios	Introduction to various performance parameters like TTCs, position accuracies, sensitivity checks and data analytics, False Positive, True Negatives, etc.	https://bit.ly/Overview_of_parameters_to_be_monitored_by_scenarios
4	Introduction to data acquisition	Introduction to various data recorders, tools and equipment's and analysis tools	https://bit.ly/Intro_to_Data_Acquisition
F	**Functional Safety**		
1	SAEINDIA – Webinar Series	Functional safety principles and practices along with verification and validation	http://bit.ly/Fuctional_Safety_Reference_videos

BAJA SAEINDIA Playlist Videos

Teams can refer to past training webinars conducted by BAJA SAEINDIA for technical guidance and preparation - aBAJA Playlist

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