Formula SAE-A: Design Score Sheet

JUDGING GROUP	NUMBER OF JUDGES	CATEGORY	SCORE
A	2	**Concept, Integration & Management** Team management, knowledge transfer, design goals, Engineering decision making and vehicle level validation.	___ /20
	1	**Manufacturability & Serviceability** Ease of assembly, manufacturing techniques, adjustable suspension / brakes / powertrain and service access.	___ /10
B	2	**Powertrain** IC: Air / fuel delivery, power generation and final drive. EV: Energy storage, distribution and propulsion system(s).	___ /20
	2	**Electronics & Data Acquisition** Control systems, power management, power distribution, wire harness, data acquisition and data analysis.	___ /20
C	2-3	**Mechanical & Composite Structures** Primary structure, materials, load path analysis, stiffness, mechanical joints, composite construction and validation.	___ /20
	1	**Safety & Ergonomics** Restraints, Driver's cell integration, energy absorption, driving ergonomics, adjustability and ease of in/egress.	___ /10
D	2	**Suspension** Tyre choice, dynamic handling, kinematics, spring & damper tuning, system friction, brakes and development.	___ /20
	2	**Aerodynamics** Principles, contribution to dynamics / speed / efficiency, thermal control, integration and development technique.	___ /20
All	All	**Design Report** Technical content, clarity and quality of submissions.	__ /5
		Aesthetics High performance appearance and build quality.	__ /5
		RAW SCORE TOTAL:	**___ /150**
		PENALTIES:	- ____

Notes:

1. Team(s) with the highest raw score awarded maximum competition points, with all others scaled proportionally.
2. All penalties are applied after scaling.

Formula SAE-A: Design Scoring Process

Judges will score each of the following criteria:

CRITERIA	WEIGHTING	DESCRIPTION
Process	20%	Engineering project objective/constraint definition, planning and evaluation
Analysis	20%	Research, benchmarking, integration, modelling and iteration(s) of the product
Validation	20%	Execute, document and review testing to show the design operates as intended
Understanding	20%	Student(s) knowledge of the system being discussed meets industry standard
Resources	20%	Effective use of resources (financial, workshop, personnel, computation, etc.)

Scores are determined using the below Rubric:

RATING	% RANGE	DESCRIPTION			
Outstanding	90 - 100	The team has demonstrated a very high level of competence with respect to the criteria being judged.	There is clear evidence of considerable original and innovative work of high quality, including analysis or other evaluation. Substantial experimental and numerical analysis had been undertaken.	The implementation and experimentation phases of the work have been completed to a very high standard.	The presentation and reporting of the results was free of error and of a very high standard.
Very Good	80 - 89	The team has demonstrated a high level of competence with respect to the criteria being judged.	There is clear evidence of considerable original work of high quality, reasonable innovation, including analysis or other evaluation. Some experimental and/or numerical analysis had been undertaken.	The implementation and experimentation phases of the work have been completed to a high standard.	The presentation and reporting of the results was free of error and of a high standard, but some aspects could be improved.
Good	70 - 79	The team has demonstrated a more than adequate level of competence with respect to the criteria being judged.	There is evidence of the team's ability to synthesise and organise information in a useful and critical manner. However, the team's work requires further experimental and/or numerical analysis.	The implementation and experimentation phases of the work have been completed to a reasonable standard.	The presentation and reporting of the results was of a good standard, but required improvement in several key areas.
Adequate	60 - 69	The team has demonstrated a minimum level of competence with respect to the criteria being judged.	There is evidence of the team's ability to synthesise and organise information in a useful and critical manner. However, the team's work showed several shortcomings and required substantial additional research and/or analysis.		The presentation and reporting of the results met the minimum level of competence, but required substantial overall improvement.
Inadequate	50 - 59	The team's work is deficient in one or more of the criteria being judged, and shows substantial shortcomings in the results and/or analysis.			
Failed	0 - 49	The team's work is so deficient with respect to one or more of the criteria being judged that it cannot be considered to have met the expected level of knowledge and understanding of the Formula SAE criteria.			

Notes:

- To achieve a rating (Outstanding, Very Good, etc.), **all description criteria** must be satisfied, else the next lowest rating is to be given; e.g. drop to "Good" from "Very Good" if only achieving 3 out of 4 criteria.
- Judges can apply any percentage value within the range shown for the achieved rating, to grade performance and establish relative performance of individual teams.

Formula SAE-A: Design Category Descriptions

JUDGING GROUP	CATEGORY	SCORE
A	**Concept, Integration & Management** Team management, knowledge transfer, design goals, Engineering decision making and vehicle level validation. Team Management and Knowledge Transfer • Structured decision-making processes • Sound understanding of the vehicle level design trade-offs • A structured breakdown of design goals from full vehicle level cascading down to component level • Evidence of an appropriate design decisions being made for the resources available • Evidence of a structured vehicle testing program with defined goals and validated conclusions Innovativeness • Unique Systems / Components? • Innovative Material Use or Manufacturing Methods • Team Rationale of Potential Performance Contributors	/20
	Manufacturability & Serviceability Ease of assembly, manufacturing techniques, adjustable suspension / brakes / powertrain and service access. Manufacturability • Ease of Assembly • Reasonable, Efficient Manufacturing / Assembly Technique • Economic Prod. of 1000 Units? (drawings, photos of tools) Serviceability • Suspension Adjustments (easy, precise?), wheel alignment (ease of adjustment / method?) • Ease of Engine Service / Removal • Ease of Brake Bias Adjustment • Ease of Belt / Chain / Ratio Change	/10
B	**Powertrain** IC: Air / fuel delivery, power generation and final drive. EV: Energy storage, distribution and propulsion system(s). Fuel tank and fuelling system Radiators and coolant system • Cooling system; sizing, thermal calc, heat rejection characteristics Engine intake and exhaust systems • Induction / Restrictor / Inlet Manifold • Exhaust manifold / fundamental maths data, muffler selection criteria • Fuel injection / Engine Management / Turbocharging / Supercharging • Turbocharging / Supercharging - advantages? Engine, gearbox, and final drive system • Engine Lubrication • Internal modifications to engine / is it a stressed member? • Gear ratio / selection criteria / do they use all gears? • Selector mechanism; manual / auto / assisted. • Transmission type / any reduction in inertia • Final drive / Differential selection / modified elements or off shelf. • Differential / spool, drive shafts, and any joint in the driven shafts • Have they modified clutch, any integrated declutch system Test data / evidence • Engine dyno • Fuel economy • Math data	/20

B continued…	**Electronics & Data Acquisition** Control systems, power management, power distribution, wire harness, data acquisition and data analysis. <u>Modules / ECUs (including display, dataloggers, etc)</u> • ECU selection: design considerations / reasoning / student design or 'off the shelf' / communication system (diagnostics) / packaging / serviceability <u>Power Distribution / Management</u> • Power Distribution - relays / electronic management (FETs, diagnostics) / packaging / serviceability • Protection:- fusing (strategy, sizing, type) / reverse battery protection / over and under voltage considerations • Power Supply - battery (type, sizing, packaging considerations) / charging system (capability, load calculations, load management) <u>Wiring Design</u> • Connector and wiring selection / loom layout and mounting / appearance • Design considerations - shielding / twisted pair / segregating circuits / grounding <u>Documentation / Validation</u> • Schematics / architecture diagrams / validation plan and results <u>Data acquisition systems and data usage</u> • Data Acquisition : Parameters measured - reasoning / flexibility to change / sensors used / calibration / logging rates and / resolution • Data Analysis: Tools used for analysis / benefit of data analysis / how team uses the data to learn and improve / identify relationships between parameters	/20
C	**Mechanical & Composite Structures** Primary structure, materials, load path analysis, stiffness, mechanical joints, composite construction and validation. <u>Composites</u> • Safety Structure Deviations - Integration of composite components / panels / monocoque with metallic space frame / substructure / roll hoop etc. • Correct use of adhesives, reinforcements etc. • Understanding of Heat Deflection Temperatures (HDT) and material spec / targets, especially exposed surfaces <u>Composite Constructions</u> • Number of manufacturing steps, avoidance of secondary bonds, single step cure of entire structure. • Theoretical prediction and subsequent test of monolithic and sandwich structure performance, eg strength and stiffness. <u>Mechanical Design</u> • Explanation of Design Objectives • Load paths, Stress/Strain Concentrations • Component Sizing to Load • Attachments (double shear? freeplay? neat design) • Use of Analysis Tools (FEA, ADAMS, Algor, etc.) • Simplicity/Elegance/Integration • Bench /Lab Test Data • Mechanical Joints (appropriate joints/ retention / housing methods) • Steering System (suitable ratio, freeplay, efforts, uni-joint angles) <u>Chassis strength and stiffness</u> • Bending / Torsional Stiffness numbers (calc,meas.)	/20
	Safety & Ergonomics Restraints, Driver's cell integration, energy absorption, driving ergonomics, adjustability and ease of in/egress. <u>Ergonomics and safety:</u> • Cockpit Appearance • Driving Position / Cockpit Comfort / Seat Support • Control Function / Location / Ease of Use • Adjustability for Drivers Sizes (seat, controls, pedals etc) • Frontal / Side Impact Design (theoretical / measured.) • Restraint Systems (head, belts, anchor points.) • Ease of Ingress / Egress	/10

D	**Suspension** Tyre choice, dynamic handling, kinematics, spring & damper tuning, system friction, brakes and development. <u>Explanation of Design Objectives</u> <u>Tyres</u> • Tire / Wheel Size and Type Justification <u>Suspension / springs / dampers</u> • Susp. Kinematic Analysis (theoretical / measured) • Susp./ Strg. Friction Assessment • Damper Tuning Program (calcs, data) <u>Vehicle handling and dynamics</u> • Knowledge of C.G. location (calc., meas.) • Test & Development Program (plan, methods) <u>Brakes</u> • Brake Sizing / Bias Bar / Plumbing / Pedal Ratio	/20
	Aerodynamics Principles, contribution to dynamics / speed / efficiency, thermal control, integration and development technique. <u>Aerodynamics</u> • Can teams show a basic understanding of how aerodynamic principles contribute to their vehicles' performance (i.e. consideration of downforce, low drag and use of ground effect) to improve handling, Vmax, fuel economy. • Use of aero aids as a holistic or piece-meal approach i.e. Wings / panels designed independently to body / or well integrated into body design. • Does the team understand the benefits of holistic vs piece-meal design approaches. • Data / understanding of aero principles, enhancement of vehicle performance including methodology, CFD and / or testing, technique, accuracy, correlation, implementation and innovation to introduce an aero advantage.	/20
All	**Design Report** Technical content, clarity and quality of submissions. <u>Concise technical introduction of overall vehicle concept and Engineering accomplishments.</u>	/5
	Aesthetics High performance appearance and build quality. <u>Aesthetics</u> • Attractive? Paint / Finish Quality? High performance appearance? <u>Build Quality</u> • Fit, finish, detail attention, welds, machine work	/5