FORMULA STUDENT ALPE ADRIA 2023 REGISTRATION QUIZ

INSTRUCTIONS: *Read the questions carefully. You have* ***until 12:30 CET (28th of January) - approximate 90 minutes*** *- to complete the quiz and upload all extra files you made during the quiz onto google forms.*

Please be aware that all the quizzes which arrive after 12:30 ***will not be accepted!***

You can submit the quiz only one time.

*All final answers in numbers have to be written in the following format: XX**,**XX... (**comma**, not point between the decimals). The number of the decimals you're rounding to is written in each question.*

Write the answers without the units. We will only give points for the right answer in the right unit.

All complaints and/or questions will be resolved after the quiz.

Question 1

(5 points)

Your team put a 1-axis accelerometer in the middle of a rear wing, which is supported on each side, and did a test drive. The output of the sensor is a series of measurements in mV saved as ACC_data.txt. What is the first resonance frequency of the wing as measured by the sensor? The sampling rate was 2 kHz. The sensor is calibrated at 20,23 mV/g. Round the answer to the nearest 5 Hz. (e.g.5, 10, 15, 20…)

Link to the file ACC_data.txt: https://drive.google.com/file/d/1x95jACbs-iF0ax-aVgxw-QWq83yxO0ub/view?usp=share_link

Question 2

(5 points)

Make a technical drawing of a steel shaft of your design. The shaft must feature at least one parallel key slot, a gear, and secure placement for two bearings. The shaft must have at least 3 different diameters along its length.

The drawing must be drawn by hand. It must feature a cross-section view and show examples of surface roughness markings, dimensional tolerances, hole/shaft tolerances, and geometrical tolerances. Use ISO 7200 title block or equivalent.

The drawing must be scanned (can be done with a phone), titled Drawing_UniversityName.pdf (max 10 MB). Ensure that the quality of the scan is sufficient. The drawing will be judged by accuracy and aesthetics.

Question 3

(3 points)

You are the last car to start in the Endurance event. So far, the overall fastest time on the time board is 1300 seconds. While watching the event you also saw another team finish endurance in respectable time. You know that team has an Energy Storage that holds only 4,2 kWh.

From simulations, you know your power consumption depends on the average speed in one lap. The faster the lap, the more energy it consumes.

EN= P*v^4

Where:
EN is the energy consumed for the whole of Endurance
v is the average speed in km/h
P= 0,0005 [Wh^5/km^4]

Your Energy Storage holds 6 kWh of energy, and your driver is capable of driving it as fast as possible. BUT! You want to get as many overall points as possible. That means you want to maximize the sum of Endurance event AND Efficiency event points!

What lap times shall the drivers drive to maximize the points total for both events? The Endurance lap is 1 km long and there are 22 laps in total. Write the answer in seconds with 2 decimal points.

There is no regeneration of energy. No cones are hit.

$$ENDURANCE\_SCORE = 300\left(\frac{\frac{T_{max}}{T_{team}} - 1}{0.333}\right)$$

T_{team} is the team's corrected elapsed time.
T_{max} is 1.333 times of the corrected elapsed time of the fastest vehicle.

Teams whose uncorrected elapsed endurance time exceeds 1.333 times of the uncorrected elapsed time of the fastest vehicle receive zero points for efficiency.

If a team finishes the endurance event, efficiency points based on the following formula are given:

$$EFFICIENCY\_SCORE = 100\left(\frac{\frac{0.1}{E_{team}} - 1}{\frac{0.1}{E_{max}} - 1}\right)$$

E_{team} is the team's efficiency factor.
E_{max} is the highest efficiency factor of all teams who are able to score points in efficiency.

The efficiency factor is calculated based on the following formula:

$$EFFICIENCY\_FACTOR = \frac{T_{min} \cdot EN_{min}^2}{T_{team} \cdot EN_{team}^2}$$

T_{team} is the team's uncorrected elapsed driving time.
T_{min} is the fastest uncorrected elapsed driving time of all teams who are able to score points in efficiency.
EN_{team} is the team's corrected used energy.
EN_{min} is the lowest corrected used energy of all teams who are able to score points in efficiency.

Question 4

(5 points)

Your team has a potential new sponsor in mind. He has offered to invite you to a meeting if you send him a summary/handout (A4) of a management presentation within 24 hours which your contact person at the company can send to the management. Like all sponsors in Formula Student, this company is not a charity but is after good engineers and managers. Convince the company that your team deserves to get big money (or maybe other support) from them. Upload this document as a Handout_UniversityName.pdf file (10 MB max file size).

Details:

The same handout will be used at your on-site meeting.

The fictitious company has extensive expertise in the automotive field, especially regarding all powertrain components and electrification.

The fictitious company is willing to enter into a longer-term partnership if topics can be found that are profitable for both sides.

Question 5

(5 points)

Dimension a bolt-like part named “DESIGN PART” (required dimensions are D1, D2 and L) which is a part of the assembly provided in drawing “tolerance_stackup_analysis_drawing.pdf”.

Requirements for the part are:

- must protrude a minimum of 7 mm from an assembly
- must have minimum clearance possible to the holes through which it passes (it must not be interference fit)
- contact area of the head to surface D needs to be minimum of 130 mm2
- all of the requirements above need to be satisfied in worst case scenario of 1D tolerance stackup for each axis

NOTE: for dimensioning use worst-case scenario criteria of 1D tolerance stackup analysis. Do a 1D tolerance stackup analysis for each axis separately and then consider the worst case of those for each dimension.

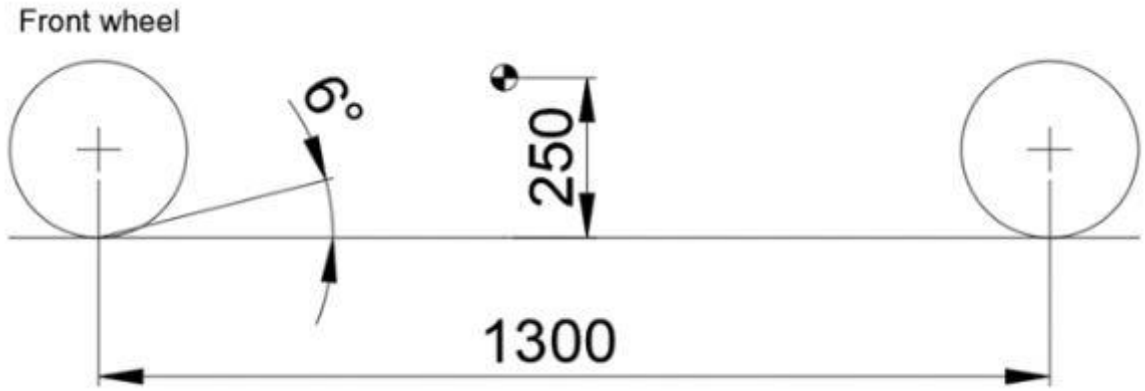
Round all dimensions to 3 decimal points (e.g.,0,123). Write the dimensions and separate them by a semicolon (X,XXX; Y,YYY; Z,ZZZ).

Link to tolerance_stackup_analysis_drawing.pdf:
https://drive.google.com/file/d/1pXgmBcbjjajGARKtOW8jq2YtPJPowPC8/view?usp=share_link

Question 6

(3 points)

The following side sketch represents the side of a car equipped with outboard brakes that provides 65 % of braking on front brakes. In the side view, the swing arm is inclined for 6°. Calculate the anti-dive percentage (round up to the first decimal place).



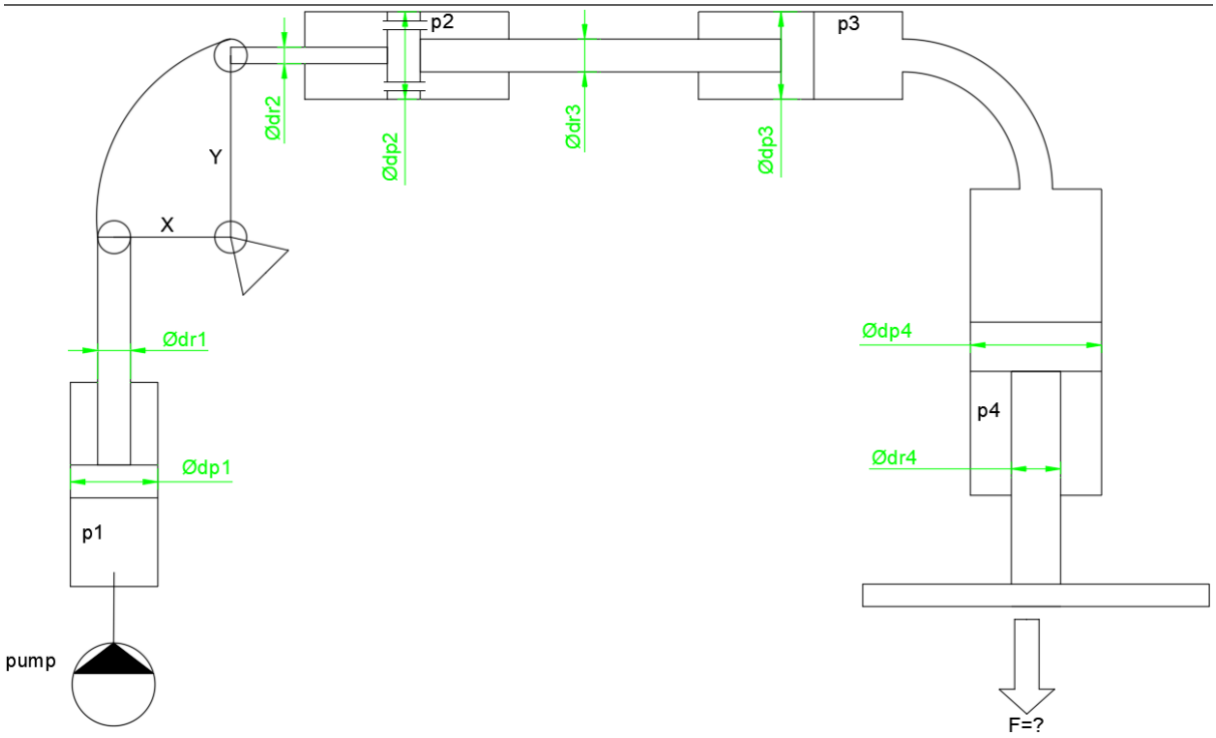
Question 7

(3 points)

Calculate the force (F) from the picture if the pump gives a pressure of 5 MPa. Round it to the second decimal:

- dp1 = dp2 = dp3 = 30 mm
- dr1 = dr3 = 15 mm
- Y = 1,6 X
- dr2 = 10 mm
- dp4 = 50 mm
- dr4 = 20 mm
- p4 = 3,5 MPa

Write the number in N.



Question 8
(3 points)

Suppose a current F1 with a power of 800 CV and a Coefficient of Resistance Aerodynamic SCx (multiplied by its frontal section) of 1,3 and a mechanical efficiency of 0,95. In an overtaking maneuver, it opens its DRS, which provides the top speed gain of 22 km/h. What is your new SCx? (Assume a Standard Atmosphere with ρ = 1,225 kg/m^3)

a) Remains Invariable
b) 1,365
c) 1,065
d) None of the above

Question 9
(3 points)

Based on question 8, what is the new Aerodynamic Balance of a car, after opening the DRS, if the initial balance was 46% (front) and if we assume that the car always acts in the linear segment of its polar SCz/SCx, whose slope has a value of 4,5.

SCzF constant : assumption (no FRH - Front Ride Height variation)

a) Remains Invariable
b) 42%
c) 56%
d) 60%

Question 10
(3 points)

Calculate the load in high-speed corners at 200 km/h of a car having a SCz of 3 at Mexico (air density 0,945 kg/m3). What is the loss compared to the sea level?

a) 5%
b) 14%
c) 23%
d) 32%

Question 11
(1 point)

You want to calculate the laminate of your front bulkhead when designing your monocoque. What is the minimum shear strength required?

Re= 235 MPa; Rm= 350 MPa; τ= 280

Write the answer in N. Round to the nearest whole number.

Question 12
(1 point)

An F1 car and a bus have nearly the same track (assume it's the same). At the same longitudinal acceleration, which one will have more longitudinal load transfer?

a) F1 car since it has lower CoG
b) It depends on the wheelbase
c) It depends on the wheelbase and CoG position

Question 13
(1 point)

A Formula Student car weighs 120 kg, has a wheelbase of 1475 mm, uses 10” tires with magnesium wheels, the front track is 1200 mm, the rear track is 850 mm, and it has a Honda CBR 650r engine. What is true?

a) everything is according to the rules
b) engine displacement is too big
c) bigger track should be at least 75% of the wheelbase
d) wheelbase and tracks are not according to the rulebook
e) weight is under the lower limit

Question 14
(1 point)

By the Formula 1 2022 Rulebook, if the race from Novi Marof Karting to Spar Novi Marof (there and back would be one lap, round to one decimal place) would be a Grand Prix, how many laps would the race have to be (consider minimum race length)?

Karting track Novi Marof: Karting staza Novi Marof - Google Maps

Spar Novi Marof: SPAR Novi Marof - Google Maps