MID-TERM EXAM BMEGEÁTNW19 Vehicle Aerodyn. (8th of Dec. 2021, WED 14:15, KM34, 90 min)

NAME:…… NEPTUN code:……..

PLEASE READ CAREFULLY THE QUESTIONS! TAKE CARE OF YOUR HANDWRITING! GIVE YOUR ANSWER IN A SHORT & CLEAR FORMAT! USE SKETCHES IF NEEDED!

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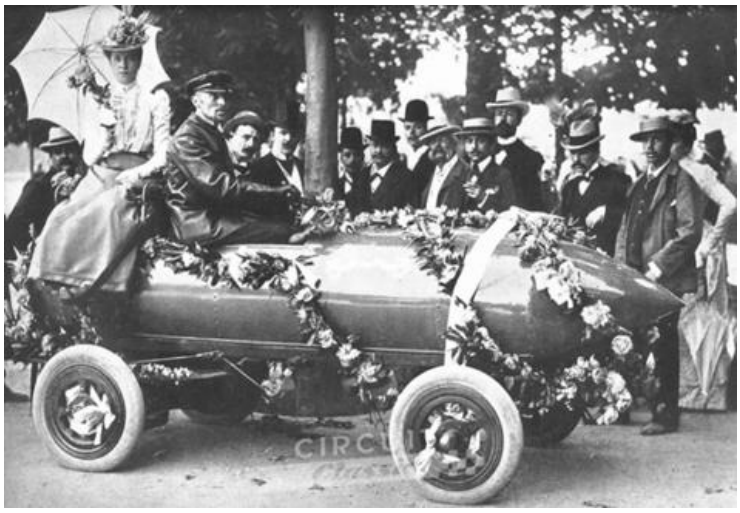
1)HISTORY (10p)

Fill in the table below with the <u>names</u> of the four main periods of history of aerodynamic developments and indicate the approximate <u>time intervals</u>, too!

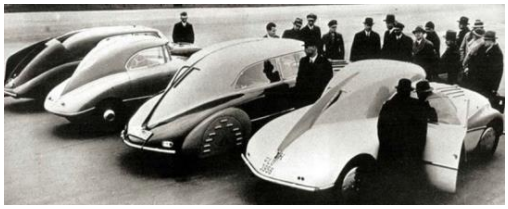
PERIODs	NAME of the PERIOD	time interval: ? from approx. year/decade ? to approx. year/decade
I.		
II.		
III.		
IV.		

The "La Jamais Contente" (="The Never Satisfied") was the first automobile to break the 100kmh (62 mph) record in 1899.
<u>Explain the disadvantages of the torpedo shape used for ground vehicles!</u>



2)HISTORY (10p)

Pál (Paul) Járay is the most famous aerodynamicists of the **II. period in the history of aerodynamic developments.**



<u>Explain his "combined form" concept idea!</u> (use sketch in your answer!)

List/sketch/denote famous vehicles designed based on his idea!

3)BASICS (10p)

The $\underline{F}_{ae}$ aerodynamic force acting on a vehicle is defined as being the sum of the $\underline{F_p}$ pressure-based force term and the $\underline{F_f'}$ viscous force term:

$$\underline{F_{ae}} = \underline{F_p} + \underline{F_f'}$$

Starting with the above equation, with short explanations on each main derivation steps, please show how the pressure coefficient and the wall (skin) friction coefficient and the reference parameters (velocity, ambient pressure and fluid density) are included in the formulation!

The final form of the equation must contain both the pressure coefficient and the skin friction coefficient.

Define the c_p pressure coefficient and the c_f' wall friction coefficient with their <u>formula</u> and indicate their range, magnitude, min/max. limits, if any!

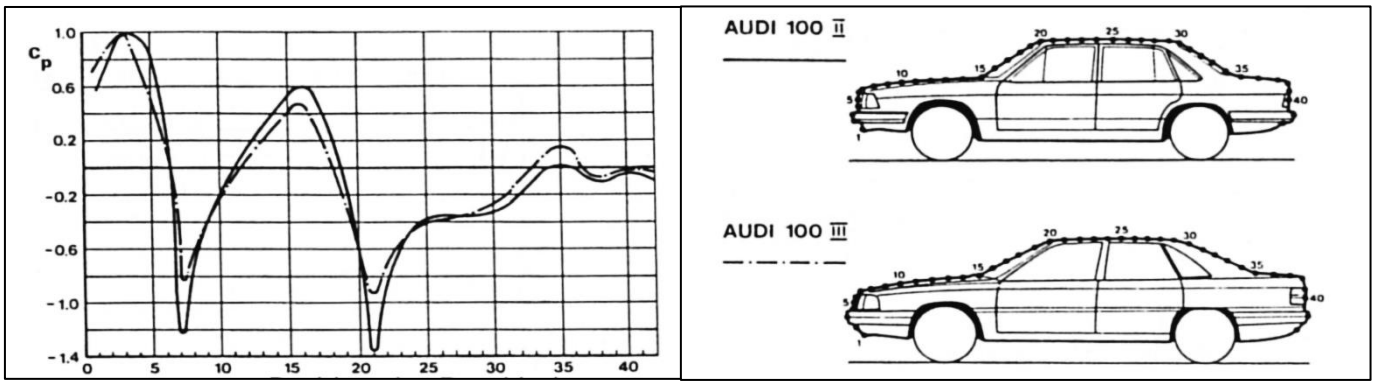
pressure coefficient $C_p =$	wall (skin) friction coefficient $C_f' =$
range, magnitude, min/max limit values:	range, magnitude, min/max limit values:

4)BASICS (10p)

The change of drag area ($c_D \cdot A_{proj}$) is the proper parameter to use if we need to analyse the aerodynamic redesign of a vehicle. Explain why is it better to use the drag area instead of the drag coefficient in vehicle aerodynamics!

5)PASSENGER CARS (10p)

The figures below show the position of the pressure taps and typical c_p distribution along the centre-line of upper body contour for the II. and III. steps in the development of AUDI-100. Give a short explanation in the table below of Δc_p and evaluate its influence on the drag! Use ↑ sign when drag increases, ↓ sign if drag decreases and "**0**" when drag remains the same.



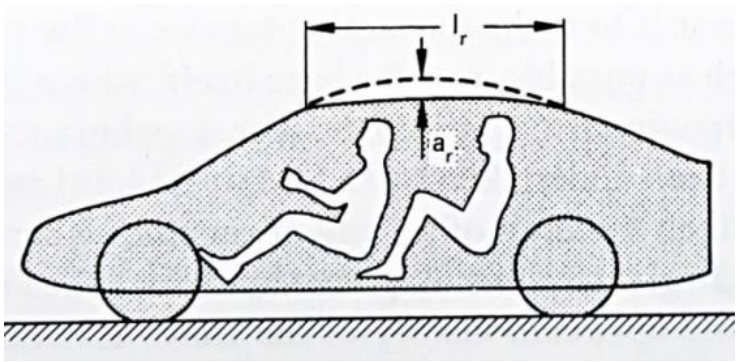
NR.	CHANGE in c_p	EXPLANATION of the change:	CHANGE in DRAG (↑ or **0** or ↓)
3.	Δc_p= 0		
5.	Δc_p= – 0,30		
7.	Δc_p= + 0,40		
16.	Δc_p= – 0,15		
21.	Δc_p= + 0,45		
35.	Δc_p= + 0,15		
40.	Δc_p= + 0,05		

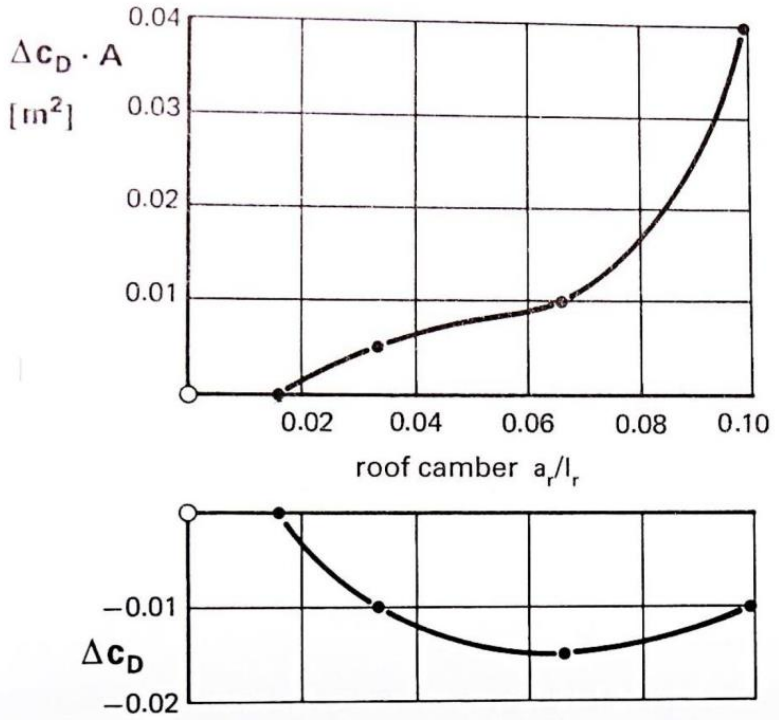
6)PASSENGER CARS (10p)

Boat-tailing / tail-elongation / truncated rear: Explain its mechanism with the help of a sketch. How does it effect on the drag / lift / side forces & moments? Why truncated rear are used on today cars?

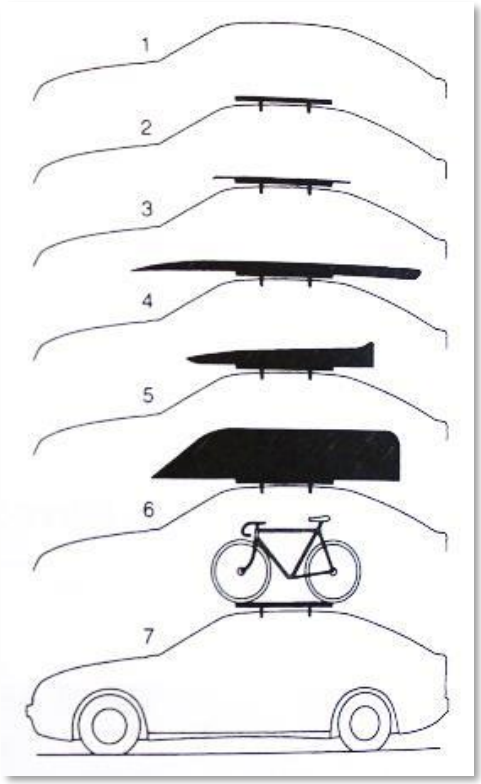
7)PASSENGER CARS (10p)

Evaluate the influences (advantages/disadvantages) of the roof cambering! (Think about both aerodynamic performance and passenger comfort.)





8)PASSENGER CARS (10p)



A passenger car's maximum velocity is $\mathbf{v_{max}=234km/h}$ in still ambient ($\mathbf{\rho_{air}=1,2kg/m^3}$). The vehicle's projected frontal area is $\mathbf{A_{proj,ref}=2,1m^2}$. The force coefficients are known: $\mathbf{c_D=0,34}$ and $\mathbf{c_L=0,14}$.

QUESTIONS:

A) Calculate the drag and lift forces! $\mathbf{F_D=?\ [N];\ F_L=?\ [N]}$

B) A boat (see in Fig. Nr.6.) is placed on the roof rack.

The projected reference area increases by $\mathbf{\Delta A_{proj,ref}=0,3m^2}$, and the drag coefficient increases by $\mathbf{\Delta c_D=0,21}$. and the lift coefficient increases by $\mathbf{\Delta c_L=0,07}$. We experience now that the maximum velocity of the vehicle is also changed.

Calculate the modified maximum velocity! $\mathbf{v_{max,mod}=?}$

C) Calculate the aerodynamic power loss for both cases (without and with boat)! $\mathbf{P_{ae}=?\ [W],\ P_{ae,mod}=?\ [W]}$

9)COMPETITION CARS (10p)

The diagram shows the lift coefficient vs skirt gap height for a race car. Explain the role of the side skirt in underbody flow! How does the skirt influence underbody flow?

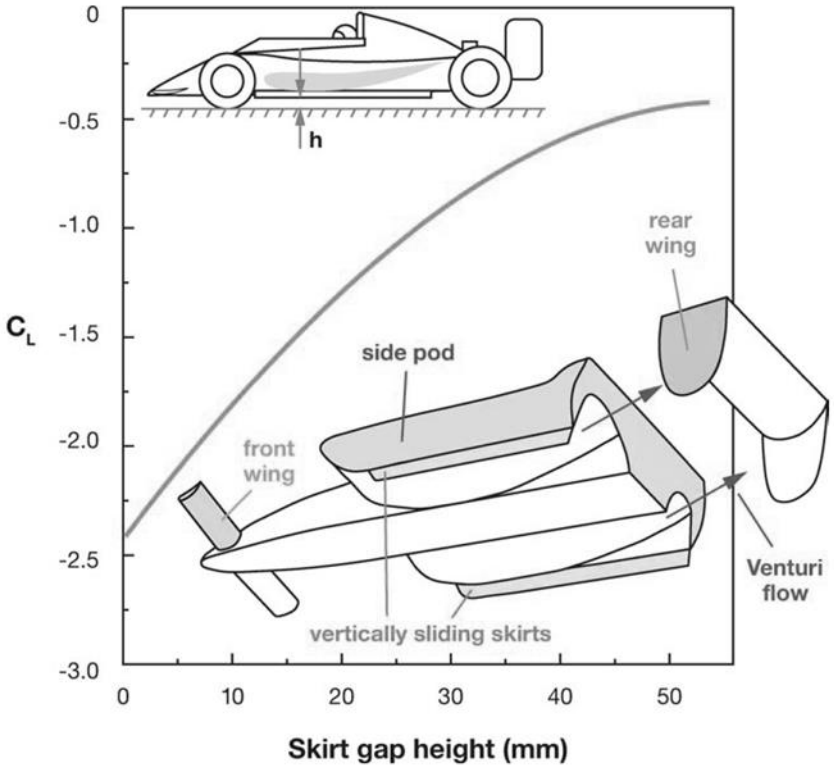
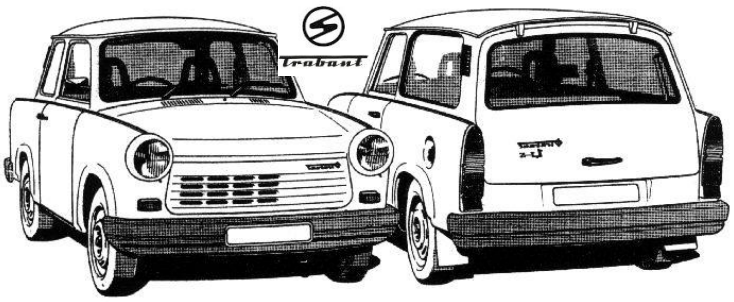


Figure 10

Effect of side skirt to ground gap clearance on vehicle's total downforce coefficient. (From Wright 1983.) (Note that the underbody diffuser is called "venturi" in this sketch.)

10) QUESTION (10p)



You are working as an "aerodynamics engineer" for a company that was contracted by the redesign of the "Trabant" (vehicle produced in the former East-Germany). Redesign of **notchback** and **square-back** body shape versions are planned. Keep in mind that *"Carmakers are scared of shocking the customer, and this means cars are going to remain pretty much the same."* Roberto Piatti, CEO of Italy's Torino Design

Explain with your own sketches in the figures below the main areas of the aerodynamic optimisation for this vehicle! What are the most important changes that would need to apply?