MID-TERM EXAM BMEGEÁTMW19 Aerodynamics and its application for vehicles 16th Nov. 2016.

NAME:..... NEPTUN code:.....

PLEASE READ CAREFULLY THE QUESTIONS!

TAKE CARE OF YOUR HANDWRITING!

GIVE YOUR ANSWER IN A SHORT & CLEAR FORMAT!

TRY TO POINT TO THE MAIN ESSENTIALS ONLY!

USE SKETCHES IF NEEDED!

THERE IS ENOUGH FREE SPACE LEFT for your short answers,

therefore -if possible- DO NOT USE THE REAR SIDE OF THE SHEETS!

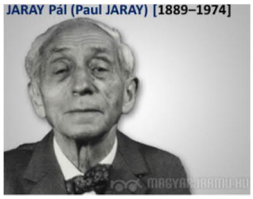
QUESTION TOPIC	max. achievable	achieved score
HISTORY		
1.	10	
BASICs		
2.	10	
3.	10	
4.	10	
PASSENGER CARS		
5.	10	
6.	10	
7.	10	
8.	10	
COMPETITION CARS		
9.	10	
10.	10	
ADDITIONAL question		
+	10	
RESULT	$\Sigma 100$ =max.50% of the term-end mark	Σ..... =.....%

1)HISTORY

List the four main periods of history of developments in vehicle aerodynamics!

PERIODs	NAME	approx. interval: from year(decade) to year (decade)
I.		
II.		
III.		
IV.		

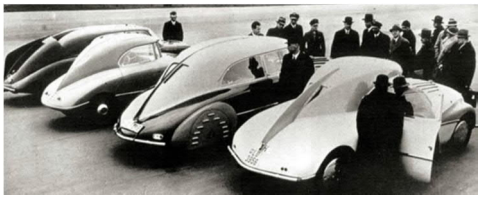
Describe the main characteristics of the I.st period only: sketch example vehicles, list names of the most famous vehicles!



Pál (Paul) Járay is the most famous aerodynamicists of the II. period.

Explain his idea!

List vehicles that are designed based on his idea!



2)BASICS

Derive the equation for the F aerodynamic force acting on a vehicle in case of viscous fluid flow! Explain shortly the main steps of derivation!

Starting point of the derivation is, that the origin of the aerodynamic force is the pressure distribution on the vehicle's surface ($\underline{F_p}$ pressure based force term) and the wall friction ($\underline{F_f'}$ friction force term):

$\underline{F}$ =

The derivation ends up with the expression below:

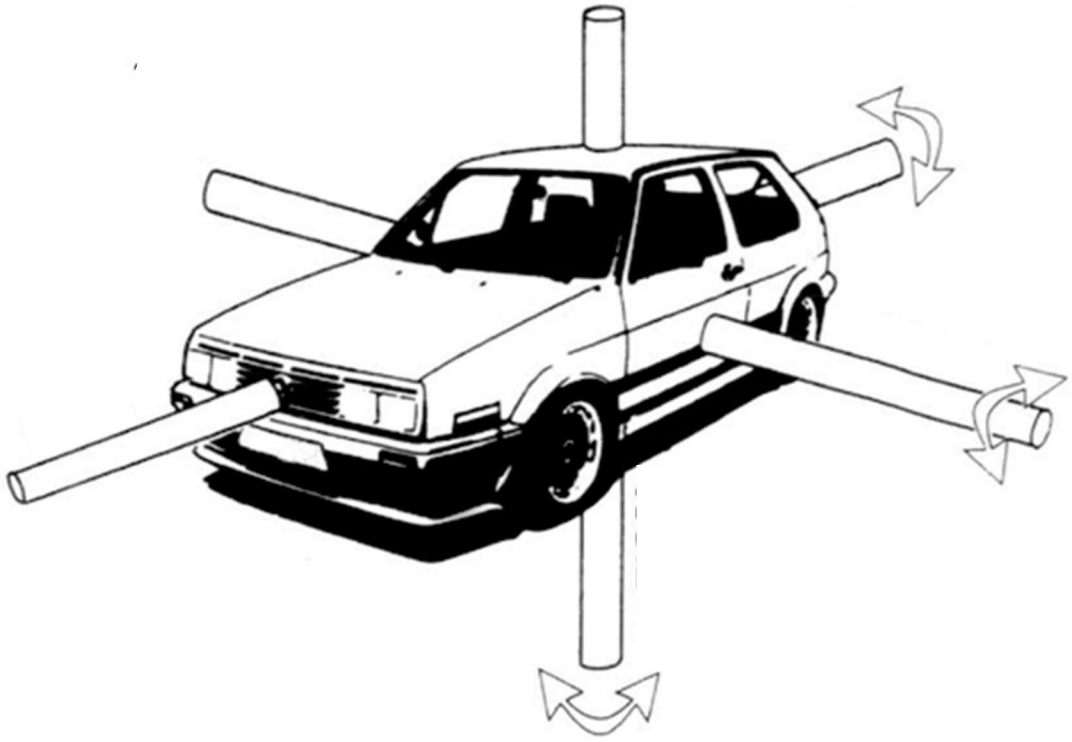
$$\underline{F} = \frac{\rho}{2} v_\infty^2 \cdot \left[- \int_A \frac{p - p_\infty}{\frac{\rho}{2} v_\infty^2} d\underline{A} + \int_A \frac{\tau_0}{\frac{\rho}{2} v_\infty^2} \underline{e} dA \right]$$

Define the c_p pressure coefficient and the c_f' wall friction coefficient with their formula!
Explain their role in vehicle aerodynamics based their magnitude!

pressure coefficient	wall friction coefficient
c_p=	c_f'=

3)BASICS

Define the coordinate system: denote the axes (x;y;z) in the figure below!
Define in the figure the various forces and moments !



Define in the table below the drag and lift coefficients with their formula! Define in figure the A_{ref} projected frontal area, and the v_∞ relative flow velocity vector, too!

drag coefficient	lift coefficient
$c_D =$	$c_L =$

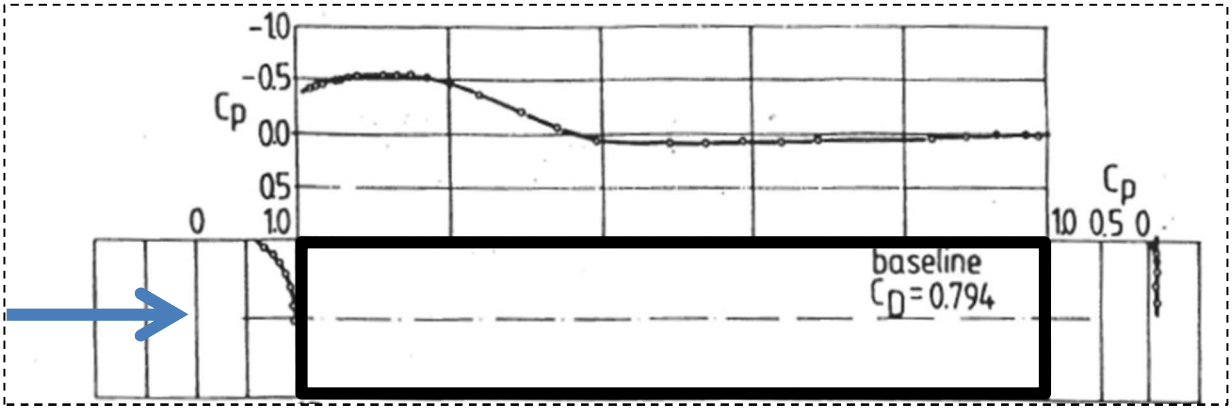
4)BASICS

What are main the consequences on drag and lift of rounding-up of front edges together with the ground proximity in case of a prismatic bluff body?

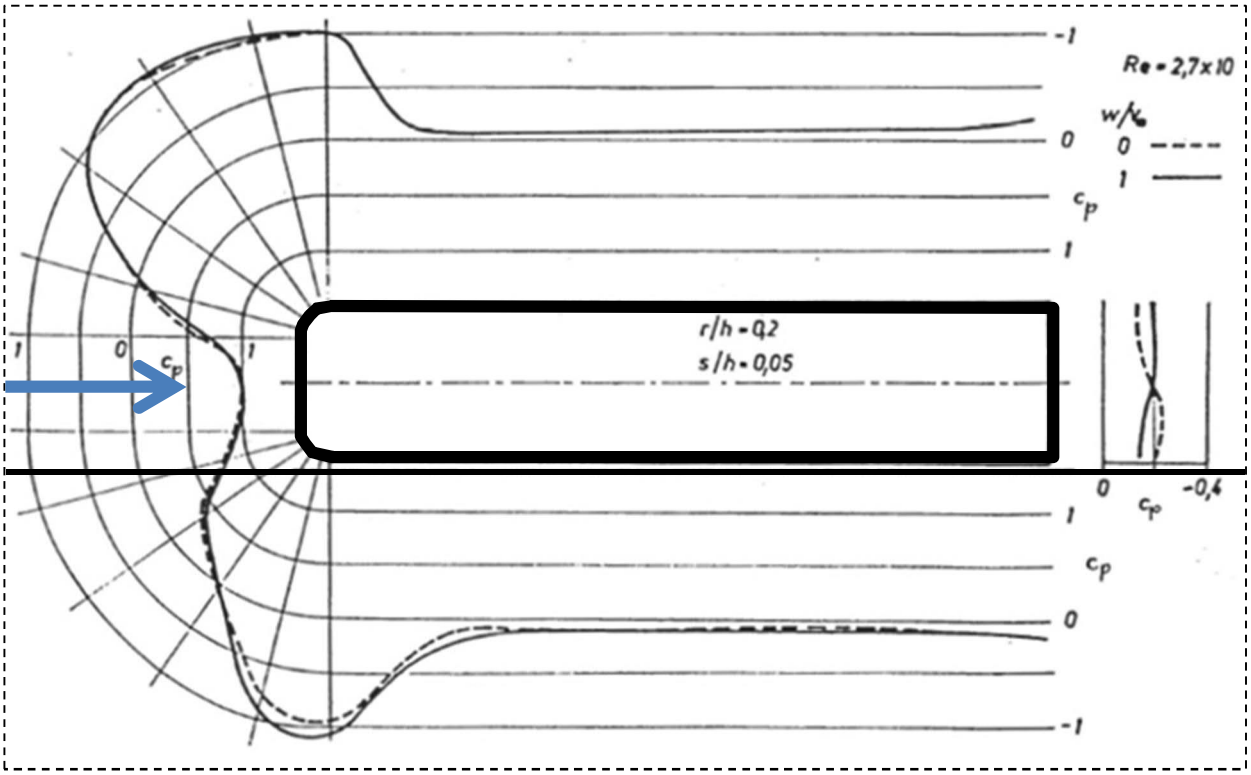
ON DRAG:

ON LIFT:

SHARP EDGES, NO GROUND

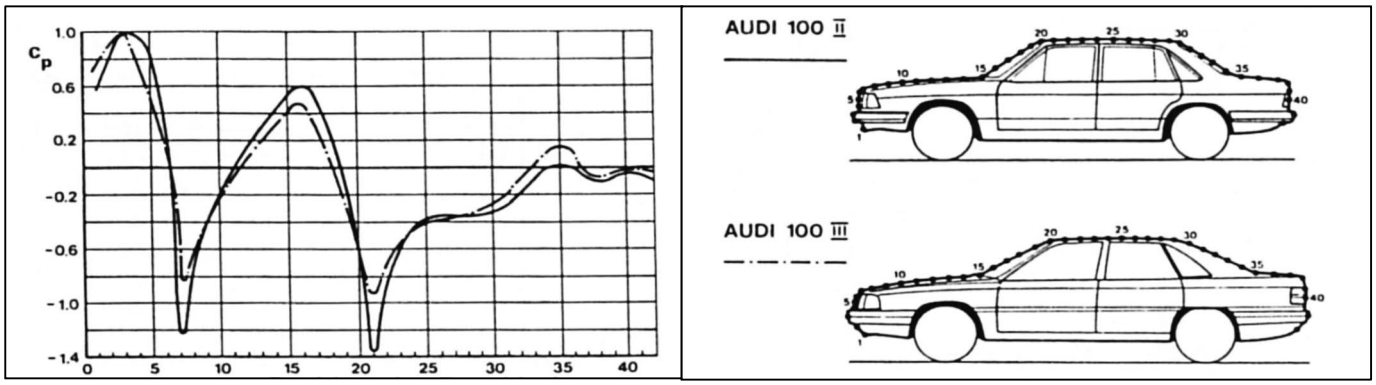


WITH ROUNDING-UP of the front EDGES, WITH GROUND PROXIMITY



5)PASSENGER CARS

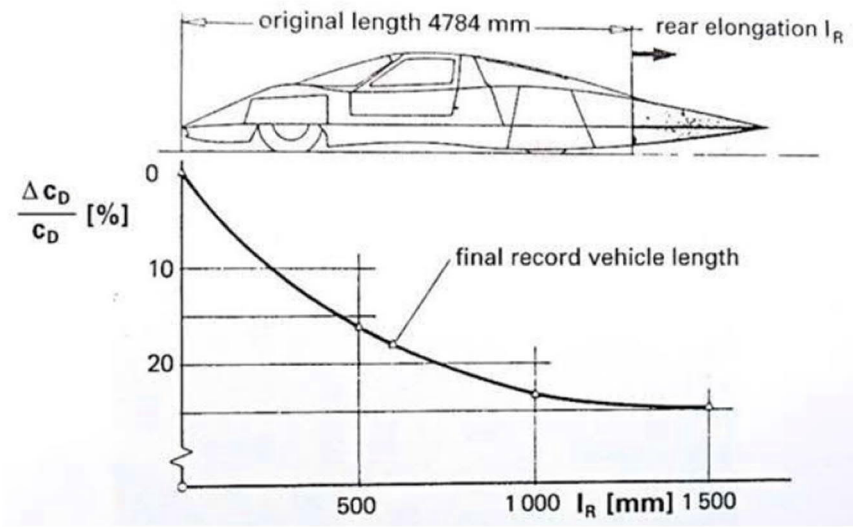
The figures below show the position of the pressure taps and typical c_p distribution along the mid-center-line of upper body contour for the II.nd (continuous line) and the III.rd (dash-dot line) development steps of AUDI-100 type car. Give a short explanation in the table below of Δc_p and evaluate its influence on drag drawing arrows (↑? or ↓?) in the last column!



NR.	CHANGE of the pressure coeff. $\Delta c_p = c_{p,III} - c_{p,II}$	EXPLANATION of the change:	CHANGE in DRAG (increase ↑ ? or decrease ↓ ?)
1.	$\Delta c_p = + 0{,}10$		
3.	$\Delta c_p = 0.00$		
5.	$\Delta c_p = - 0{,}30$		
7.	$\Delta c_p = + 0{,}40$		
16.	$\Delta c_p = - 0{,}15$		
21.	$\Delta c_p = + 0{,}45$		
35.	$\Delta c_p = + 0{,}15$		
40.	$\Delta c_p = + 0{,}05$		

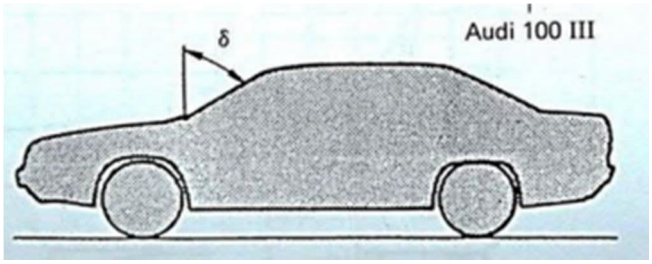
6)PASSENGER CARS

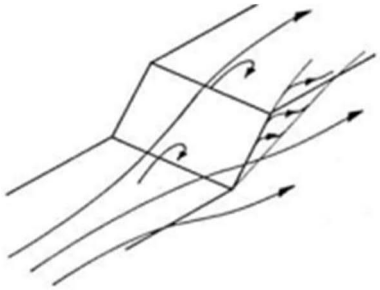
Boat-tailing / tail-elongation / truncated tail: Explain its mechanism with the help of a sketch of drawing streamlines or separation bubble. How does it effect on the drag, lift and side forces & moments? Why truncated tails are used in today cars?

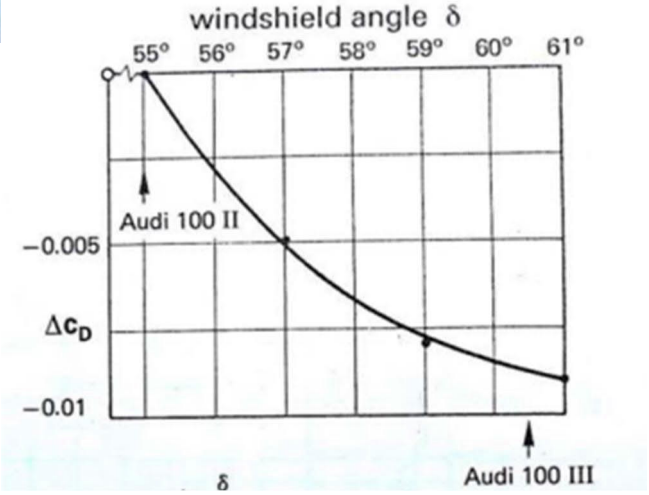


7)PASSENGER CARS

Evaluate the influence (advantages / disadvantages) of the windshield angle on drag and lift!







8)PASSENGER CARS

List at least 3 aerodynamic elements that is visible on your choosen VEHICLE CARD!

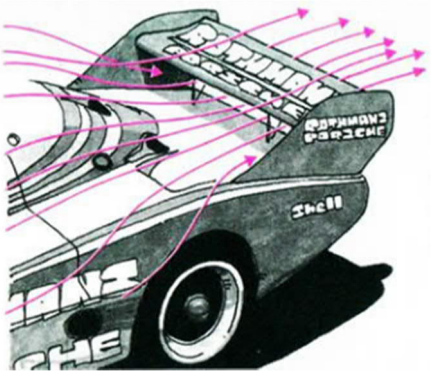
VEHICLE NAME / TYPE /card Nr:
at least 3 aerodynamic elements
1.
2.
3.
(4.)
(5.)

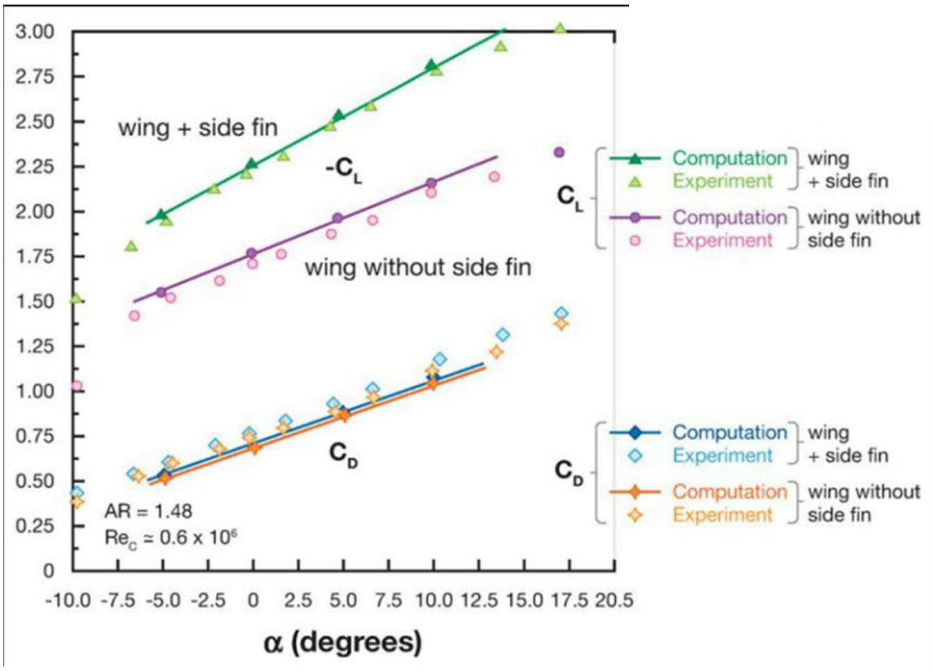
Choose one of the elements listed above, and analyse its influence on the drag and on the lift coefficient of this vehicle! use arrows (↑? or ↓?)

influence on drag	influence on lift

9)COMPETITION CARS

With the help of a sketch show the working mechanism of the rear wing placed on a race car. How do they effect on the rear downforce of the race cars? What is the role of the wing's end-plate (side fin)?





10)COMPETITION CARS

Explain the role of the proper design of the underbody channel flow of a competition car! (Keep in mind: moving ground effect, front wing, front nose, Venturi channel flow, rear diffuser, side skirt etc.)

+) ADDITIONAL QUESTION for +10points

Explain the role in reducing of drag force and lift force of the so-called active aerodynamic elements on the most recent passenger cars and sports cars!