ECOLE NATIONALE DE L'AVIATION CIVILE

HANDLING QUALITIES EXAMINATION

SIAE 2011

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Duration : 2H

Please provide also your **French first name** on the top of your copy.

You can answer to the questions **in French or in English**, as you prefer.

1°) a) What is called the dihedral effect?
b) What is the associated aerodynamic coefficient ?
c) What is its sign? Why?
d) How the design of an aircraft can modify this dihedral effect?
e) Do you know some effects on handling qualities linked to this coefficient?

2°) Same questions with directional stability

For next page exercice :

A twin engine airplane is defined by the following features :
- Reference area S=100 m^2
- Reference chord (or MAC) l=3 m
- Weight = 70 000 kg
We will use g = 9,8 m/s^2 ρ_0=1.225 kg/m^3

The following aerodynamic coefficients are given
***(Take care of units!)** :*

Cz_α*=0.1 deg^{-1} (gradient in incidence),* $Cz_\delta m=0$
Incidence for null lift α_0=-4°
Cm_α*=-1.5 rd^{-1},* $Cm_\delta m$*= -5 rd^{-1},* Cm_q*= -10 rd^{-1}*

$C_{y\beta}$ *= -1.4 rd^{-1}* $C_{y\delta n}$*=0*
$C_{l\beta}$ *= -5 rd^{-1}* $C_{l\delta l}$ *= -0.5 rd-1* $C_{l\delta n}$ *= 0* C_{lp} *= -5 rd^{-1}* C_{lr} *= 11 rd^{-1}*
$C_{n\beta}$ *= 1,1 rd^{-1}* $C_{n\delta l}$ *= 0* $C_{n\delta n}$ *= -1,5 rd^{-1}* C_{np} *= -2,5 rd^{-1}* C_{nr} *= -10 rd^{-1}*
Rudder stops : +/- 30°.

3°) Pull-up manoeuvre (*in French : "ressource")*

The aircraft performs a pull-up manoeuvre at 1.5 g at a constant speed equal to 150 m/s (with bank angle=0°)

a) What is the name of the equation used to compute the angle of attack during this pull-up manoeuvre?
b) Provide the expression of the increase of angle of attack during this manoeuvre
c) Compute it (numerical result)
d) Is the elevator deflected during this stabilised manoeuvre at constant load factor? Why?
e) What is the name of the equation used to compute the elevator deflection during this pull-up manoeuvre?
f) Provide the expression of this deflection
g) Compute it (numerical result in °)

4°) Stabilised turn

The same aircraft performs a stabilised and correct turn at 1.5g and 150 m/s *(constant bank angle, constant speed).*

a) Provide the expression of the increase of angle of attack during this manoeuvre.
b) Is the elevator more deflected than during the pull-up manoeuvre? Why?
c) What is the sideslip? Why?
d) What is the yaw rate? Compute it (numerical result)
e) Are the ailerons deflected during this stabilised turn at constant bank angle? Why?
f) What is the name of the equation used to compute the ailerons deflection?
g) Provide the expression of this ailerons deflection
h) Compute it (numerical result in °)
i) Is the rudder deflected during this stabilised turn? Why?
j) What is the name of the equation used to compute this rudder deflection?
k) Provide the expression of this deflection
l) Compute it (numerical result in °)