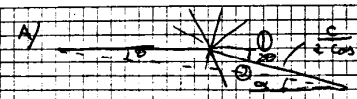
UNIVERSIDAD CARLOS III DE MADRID
Escuela Politécnica Superior

ASIGNATURA _____ FECHA _____
NOMBRE DEL ALUMNO _____
CURSO ____ GRUPO ____ TITULACIÓN _____

A/



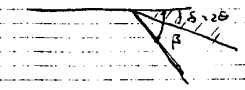
$M_\infty = 3$ Región ① Expansión $\theta = 20°$

$\nu(M_\infty) = 49.76 \Rightarrow \nu(M_1) = \nu(M_\infty) + 10 = 69.76$

$M_1 = 4.33$

$\frac{P_1}{P_\infty} = \left(\frac{1+\frac{\gamma-1}{2}M_\infty^2}{1+\frac{\gamma-1}{2}M_1^2}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{2.8}{4.75}\right)^{3.5} = \boxed{0.157 = \frac{P_1}{P_\infty}}$

Región ② ONDA CHOQUE $\delta = 20°$ $M_\infty = 3$
$\beta = 37.5°$



$M_{1n} = M_1 \operatorname{sen}\beta = 1.826$

$\frac{P_2}{P_\infty} = \frac{2\gamma M_{1n}^2 + 1 - \gamma}{\gamma+1} = \boxed{3.724 = \frac{P_2}{P_1}}$

$C_L = \frac{P_\infty}{\frac{1}{2}\rho_\infty V_\infty^2}\left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right) = \frac{2}{\gamma M_\infty^2}\left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right)\frac{c\cos 2\theta}{c/2\cos\theta}$

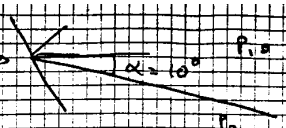
$C_L = \frac{1}{\gamma M_\infty^2}\left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right)\frac{\cos 2\theta}{\cos\theta} = \boxed{0.27 = C_L}$

$C_D = C_L \tan 2\theta = \boxed{0.098 = C_D}$

$L = \frac{1}{2}\rho_\infty V_\infty^2 \, c \, 0.27 = \boxed{\frac{\gamma}{2} P_\infty M_\infty^2 \, c \, 0.27}$

$D = \frac{1}{2}\rho_\infty V_\infty^2 \, c \, 0.098 = \boxed{\frac{\gamma}{2} P_\infty M_\infty^2 \, c \, 0.098}$

c/



Región Superior ① Expansión $\theta = 10°$ $M_\infty = 3$

$\nu(M_\infty) = 49.76 \Rightarrow \nu(M_1) = 59.76$

$M_1 = 3.57$

$\frac{P_1}{P_\infty} = \left(\frac{1+\frac{\gamma-1}{2}M_\infty^2}{1+\frac{\gamma-1}{2}M_1^2}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{2.4}{8.55}\right)^{3.5} = \boxed{0.4357 = \frac{P_1}{P_\infty}}$

Región ② ONDA CHOQUE $\delta = 10$ $M_\infty = 3$
$\beta = 27.6$
$M_{1n} = M_\infty \operatorname{Sen}\beta = 1.385$

$\frac{P_2}{P_\infty} = \frac{2\gamma M_{1n}^2 + 1 - \gamma}{\gamma+1} = \boxed{2.072 = \frac{P_2}{P_\infty}}$

$L = \left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right) c\cos\theta \frac{P_\infty}{\frac{1}{2}\rho_\infty}\frac{\frac{1}{2}\rho_\infty}{V_\infty^2} V_\infty^2$

$= \left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right) c\cos\theta \, \frac{1}{2}\rho_\infty V_\infty^2 \frac{a_\infty^2}{\frac{1}{2}\gamma V_\infty^2} = \frac{1}{2}\rho_\infty V_\infty^2 \left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right)\frac{c\cos\theta}{\frac{1}{2}\gamma M_\infty^2}$

$L_\alpha = \frac{1}{2}\rho_\infty V_\infty^2 \, c \, 0.255$

$D_\alpha = \frac{1}{2}\rho_\infty V_\infty^2 \, c \, 0.0451$

$L_\alpha = \left(\frac{P_2}{P_\infty} - \frac{P_1}{P_\infty}\right) P_\infty \, c\cos\theta = \boxed{1.6114 \, P_\infty c = L_\alpha}$

$D_\alpha = 0.284 \, P_\infty c$

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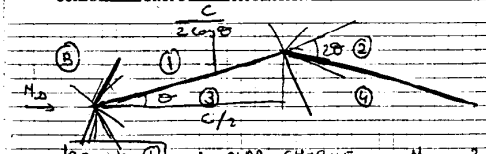

Región ① : ONDA CHOQUE $M_\infty = 3$ $\delta = 10$
$\beta = 27.5$ $M_{1n} = 1.385$

$\frac{P_1}{P_\infty} = 2.072$ $M_{1n} = \left(\frac{2+(\gamma-1)M_{1n}^2}{2\gamma M_{1n}^2 + 1 - \gamma}\right)^{1/2} = 0.746$

$\alpha = \beta - \delta = 17.5$ $M_1 = M_{1n} / \operatorname{sen}\alpha = \boxed{2.48 = M_1}$

Región ② EXPANSIÓN $M_1 = 2.48$ $\theta = 20°$

$\nu(M_1) = 38.5 \Rightarrow \nu(M_2) = 58.5 \Rightarrow M_2 = 3.5$

$\frac{P_2}{P_1} = \left(\frac{1+\frac{\gamma-1}{2}M_1^2}{1+\frac{\gamma-1}{2}M_2^2}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{2.23}{3.45}\right)^{3.5} = 0.217$

$\frac{P_2}{P_\infty} = \frac{P_2}{P_1}\frac{P_1}{P_\infty} = \boxed{0.45 = \frac{P_2}{P_\infty}}$

Región 3 EXPANSIÓN $M_\infty = 3$ $\theta = 10$
$\nu(M_\infty) = 49.76$ $\nu(M_3) = 59.76 \Rightarrow M_3 = 3.57$

$\boxed{\frac{P_3}{P_\infty} = 0.4357}$

Región 4 ONDA CHOQUE ~~$\delta = 20$~~ $\delta = 20$
$M_3 = 3.57$
$\Rightarrow \beta \simeq 34°$ $M_{3n} = M_3 \operatorname{Sen}\beta = 1.996$

$\frac{P_4}{P_3} = \frac{2\gamma M_{3n}^2 + 1 - \gamma}{\gamma+1} = 4.48$

$\frac{P_4}{P_\infty} = \frac{P_4}{P_3}\frac{P_3}{P_\infty} = \boxed{1.958 = \frac{P_4}{P_\infty}}$

$L_\theta = \left(\frac{P_3 - P_1 + P_4 - P_2}{P_\infty}\right) P_\infty \frac{c}{2} = \boxed{0.0666 \, P_\infty c = L_\theta}$

$D_\theta = \left(\frac{P_1 - P_3 + P_4 - P_2}{P_\infty}\right) P_\infty c \frac{\tan\theta}{2} = \boxed{0.27676 \, P_\infty c = D_\theta}$

$L_\alpha = 1.6114 \, P_\infty c$

$D_\alpha = 0.284 \, P_\infty c$

$L_\alpha + L_\theta = 1.54475 \, P_\infty c$; $D_\alpha + D_\theta = 0.56076 \, P_\infty c$

$L_A = \left(\frac{P_{2A} - P_{1A}}{P_\infty}\right) P_\infty \frac{c}{2}\frac{\cos(\alpha+\theta)}{\cos\theta} = \boxed{1.70 \, P_\infty c = L_A}$

$D_A = \left(\frac{P_{2A} - P_{1A}}{P_\infty}\right) P_\infty \frac{c}{2}\frac{\operatorname{sen}(\alpha+\theta)}{\cos\theta} = \boxed{0.62 \, P_\infty c = D_A}$

$\frac{L_A - (L_\theta + L_\alpha)}{L_A} = 9.13\%$

$\frac{D_A - (D_\theta + D_\alpha)}{D_A} = 9.55\%$