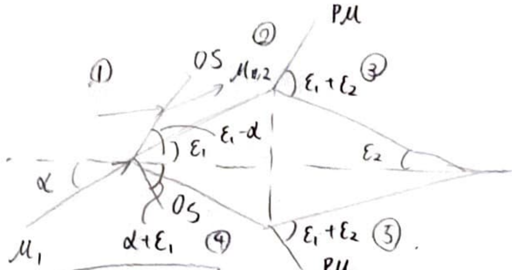


$\boxed{\alpha < \varepsilon_1}$

M_1, $\theta = \varepsilon_1 - \alpha \longrightarrow$ β-θ-M chart → betad function to get β.

$M_{n,1u} = M_1 \sin(\beta)$ $\quad M_{n,1L} = M_1 \sin(\beta)$

$[M_{n,2},\ \frac{P_2}{P_1}] = \text{flownormalshock}(\gamma,\ M_{n,1u})$

$[M_{n,4},\ \frac{P_4}{P_1}] =$ "

---

from PM table at $[M_2, M_4] = \frac{1}{\sin(\beta-\theta_1)} \begin{bmatrix} M_{n,2} \\ M_{n,4} \end{bmatrix}$ $\quad \theta_1 = \varepsilon_1 - \alpha$

$[\nu_{13},\ \nu_{15}] = \text{flowprandtlmeyer}(\gamma,\ [M_2, M_4])$

$[\nu_{23},\ \nu_{25}] = \theta_1 + [\nu_{13}, \nu_{15}] \longrightarrow [M_3,\ M_5] = \text{flowprandtlmeyer}(\gamma,\ [\nu_{23},\ \nu_{25}],\ \text{'mu'})$

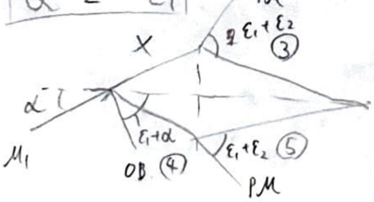
from isentropic table, goal : $\frac{P_3}{P_1}$, $\frac{P_5}{P_1}$

$\frac{P_3}{P_1} = \frac{P_3}{P_{03}} \cdot \underbrace{\frac{P_{03}}{P_{02}}}_{=1} \cdot \frac{P_{02}}{P_2} \cdot \frac{P_2}{P_1}$ $\qquad \left[\frac{P_{02}}{P_2},\ \frac{P_{03}}{P_3},\ \frac{P_{04}}{P_4},\ \frac{P_{05}}{P_5}\right] = \text{flwisentropic}(\gamma,\ [M_2, M_3, M_4, M_5])$

$\frac{P_5}{P_1} = \frac{P_5}{P_{05}} \cdot \underbrace{\frac{P_{05}}{P_{04}}}_{=1} \cdot \frac{P_{04}}{P_4} \cdot \frac{P_4}{P_1}$

$C_N = \frac{1}{\gamma M_1^2}\left[\frac{P_4}{P_1} - \frac{P_2}{P_1} + \frac{P_5}{P_1} - \frac{P_3}{P_1}\right]$ $\qquad C_A = \frac{1}{\gamma M_1^2}\left[\left(\frac{P_2}{P_1} + \frac{P_4}{P_1}\right)\tan(\varepsilon_1) + \left(\frac{P_3}{P_1} + \frac{P_5}{P_1}\right)\tan(\varepsilon_2)\right]$

$\boxed{\alpha = \varepsilon_1}$



M_1, $\theta = \alpha + \varepsilon_1 \rightarrow \beta - \theta - M$ $\quad [\beta] = \text{betad}(\quad)$.

$M_{n,1L} = M_1 \sin(\beta)$

$[M_{n,4},\ \frac{P_4}{P_1}] = \text{flownormalshock}(\gamma,\ M_{n,1L})$

---

from PM table at $[M_1, M_4] = [M_1,\ \frac{M_{n,4}}{\sin(\beta-\theta)}]$

$[\nu_{13},\ \nu_{15}] = \text{flowpm}(\gamma,\ [M_1, M_4])$

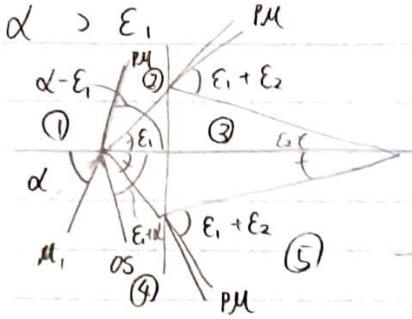
$[\nu_{23},\ \nu_{25}] = [\theta, \theta] + [\nu_{13},\ \nu_{15}] \longrightarrow [M_3,\ M_5] = \text{flowpm}(\gamma,\ [\nu_{23},\ \nu_{25}],\ \text{'mu'})$

from isentropic table, goal $\frac{P_3}{P_1}$, $\frac{P_5}{P_1}$

$\alpha > 0$ $\quad \frac{P_5}{P_1} = \frac{P_5}{P_{05}} \cdot \underbrace{\frac{P_{05}}{P_{04}}}_{=1} \cdot \frac{P_{04}}{P_4} \cdot \frac{P_4}{P_1}$, $\quad \frac{P_3}{P_1} = \frac{P_3}{P_{03}} \cdot \underbrace{\frac{P_{03}}{P_{01}}}_{=1} \cdot \frac{P_{01}}{P_1}$ $\qquad \left[\frac{P_{01}}{P_1},\ \frac{P_{03}}{P_3},\ \frac{P_{04}}{P_4},\ \frac{P_{05}}{P_5}\right] = \text{flwisentropic}(\gamma,\ [M_1, M_3, M_4, M_5])$

$\alpha <= 0$ $\quad \frac{P_5}{P_1} = \frac{P_5}{P_{05}} \cdot \frac{P_{05}}{P_{01}} \cdot \frac{P_{01}}{P_1}$ $\qquad \frac{P_3}{P_1} = \frac{P_3}{P_{03}} \cdot \frac{P_{03}}{P_{02}} \cdot \frac{P_{02}}{P_2} \cdot \frac{P_2}{P_1}$ $= 1$

$\alpha > \varepsilon_1$



$M_1 \,,\ \theta = \varepsilon_1 + \alpha \rightarrow [\beta] = \text{betad}(\,)$

$M_{n,1L} = M_1 \sin(\beta)$

$[M_{n,4},\ \frac{P_4}{P_1}] = \text{flowns}(\gamma,\ M_{n,1L})$

$M_4 = M_{n,4} / \sin(\beta - \theta)$

PM Exp. ① - ②.

$\nu_{11} = \text{flowpm}(\gamma,\ M_1)$

$\nu_{12} = \theta_{2} + \nu_{11} \rightarrow M_2 = \text{flowpm}(\gamma,\ \nu_{12},\ \text{'mu'})$

now I got M_2, & M_4., get M_3 & M_5 to find necessary preassure ratios

from PM table at $[M_2, M_4]$

$[\nu_{13},\ \nu_{15}] = \text{flowpm}(\gamma,\ [M_2, M_4])$

$[\nu_{23},\ \nu_{25}] = \theta + [\nu_{13},\ \nu_{15}]$

$\downarrow$

$[M_3,\ M_5] = \text{flowpm}(\gamma,\ [\nu_{23},\ \nu_{25}],\ \text{'mu'})$

$$\left[\frac{P_{01}}{P_1},\ \frac{P_{02}}{P_2},\ \frac{P_{03}}{P_3},\ \frac{P_{04}}{P_4},\ \frac{P_{05}}{P_5}\right] = \text{flowisentropic}\left(\gamma,\ [M_1, M_2, M_3, M_4, M_5]\right)$$

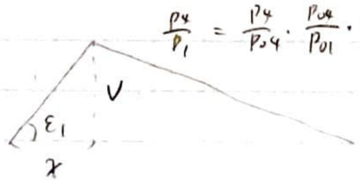
when $\alpha > 0$

$$\frac{P_2}{P_1} = \frac{P_2}{P_{02}} \cdot \underbrace{\frac{P_{02}}{P_{01}}}_{=1} \cdot \frac{P_{01}}{P_1} \qquad \frac{P_3}{P_1} = \frac{P_3}{P_{03}} \cdot \underbrace{\frac{P_{03}}{P_{02}}}_{=1} \cdot \underbrace{\frac{P_{02}}{P_{01}}}_{=1} \cdot \frac{P_{01}}{P_1}$$

$\frac{P_4}{P_1}$ from NS relations $\qquad \frac{P_5}{P_1} = \frac{P_5}{P_{05}} \cdot \frac{P_{05}}{P_{04}} \cdot \frac{P_{04}}{P_4} \cdot \frac{P_4}{P_1}$

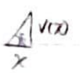
when $\alpha < 0$ $\quad \frac{P_2}{P_1}$ from NS relations $\qquad \frac{P_3}{P_1} = \frac{P_3}{P_{03}} \cdot \frac{P_{03}}{P_{02}} \cdot \frac{P_{02}}{P_2} \cdot \frac{P_2}{P_1}$

$\frac{P_4}{P_1} = \frac{P_4}{P_{04}} \cdot \frac{P_{04}}{P_{01}} \cdot \frac{P_{01}}{P_1} \qquad \frac{P_5}{P_1} = \frac{P_5}{P_{05}} \cdot \frac{P_{05}}{P_{01}} \cdot \frac{P_{01}}{P_1}$



$y_1 = \frac{V}{C_1} x$

$= \frac{\tan(\varepsilon_1) \cancel{\tan(\varepsilon_2)}}{\tan(\varepsilon_2)} x$



$\tan(x) = \frac{V(x)}{x}$

$V(x) =$

$$v(x) = \begin{cases} \tan(\varepsilon_1) x & 0 \le x < C_1 \\ V - \tan(\varepsilon_2)(x - C_1) & C_1 \le x \le C \end{cases}$$

$$\frac{dv(x)}{dx} = \begin{cases} \tan(\varepsilon_1) \\ -\tan(\varepsilon_2) \end{cases}$$

$\bar{g}_u^2 = \frac{1}{C}\left[\int_0^{C_1} \tan(\varepsilon_1)^2 dx + \int_{C_1}^{C} \tan(\varepsilon_2) \right.$

$\frac{1}{C}\left[\tan(\varepsilon_1)^2 x \Big|_0^{C_1} + \tan(\varepsilon_2) x \Big|_{C_1}^{C}\right]$

$\frac{C_1}{C} \tan^2(\varepsilon_1) + \tan(\varepsilon_2) - \frac{C_1}{C} \tan$