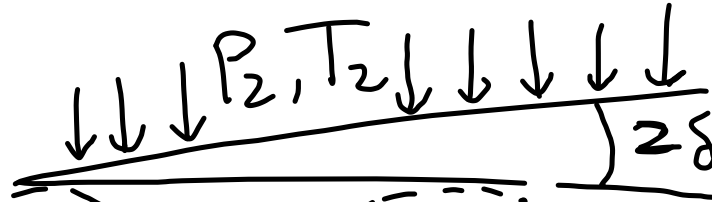


Lecture 18 : (cont'd)

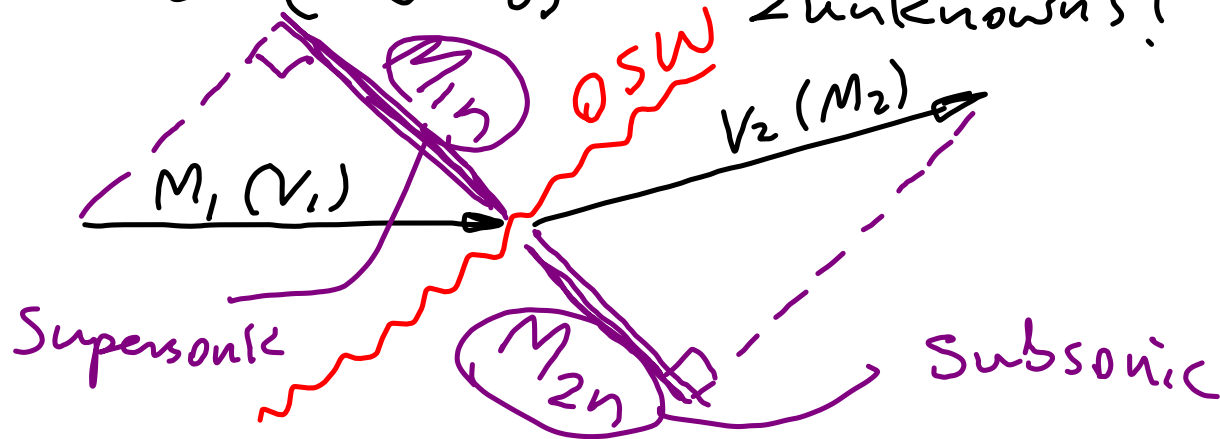


$$M_2 = \frac{V_2}{a_2} = \frac{V_{2n}}{\sin(\theta - \delta) a_{2n}} = \frac{M_{2n}}{\sin(\theta - \delta)}$$

$$M_2 = \frac{0.793}{\sin(40 - \delta)}$$

1 eq. &

2 unknowns!



$$T_{02} = T_{01} \quad (\text{adiabatic shock})$$

$$M_1 = 2, \quad \frac{T_1}{T_{01}} = 0.5556$$

$$T_{01} = 473.6 \text{ K}$$

After the OSW (2):

$$T_2/T_{02} = \frac{311}{473.6} = 0.6566$$

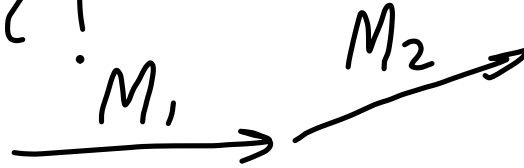
[Isentropic Table [App B]]

App B $\Rightarrow$

$$M_2 = 1.617$$

Supersonic

Note that: M_1 & M_2 are both
Supersonic!



But: $\begin{cases} M_{1n} \text{ MUST BE SUP.} \\ M_{2n} \sim \sim \text{SUBSONIC!} \end{cases}$

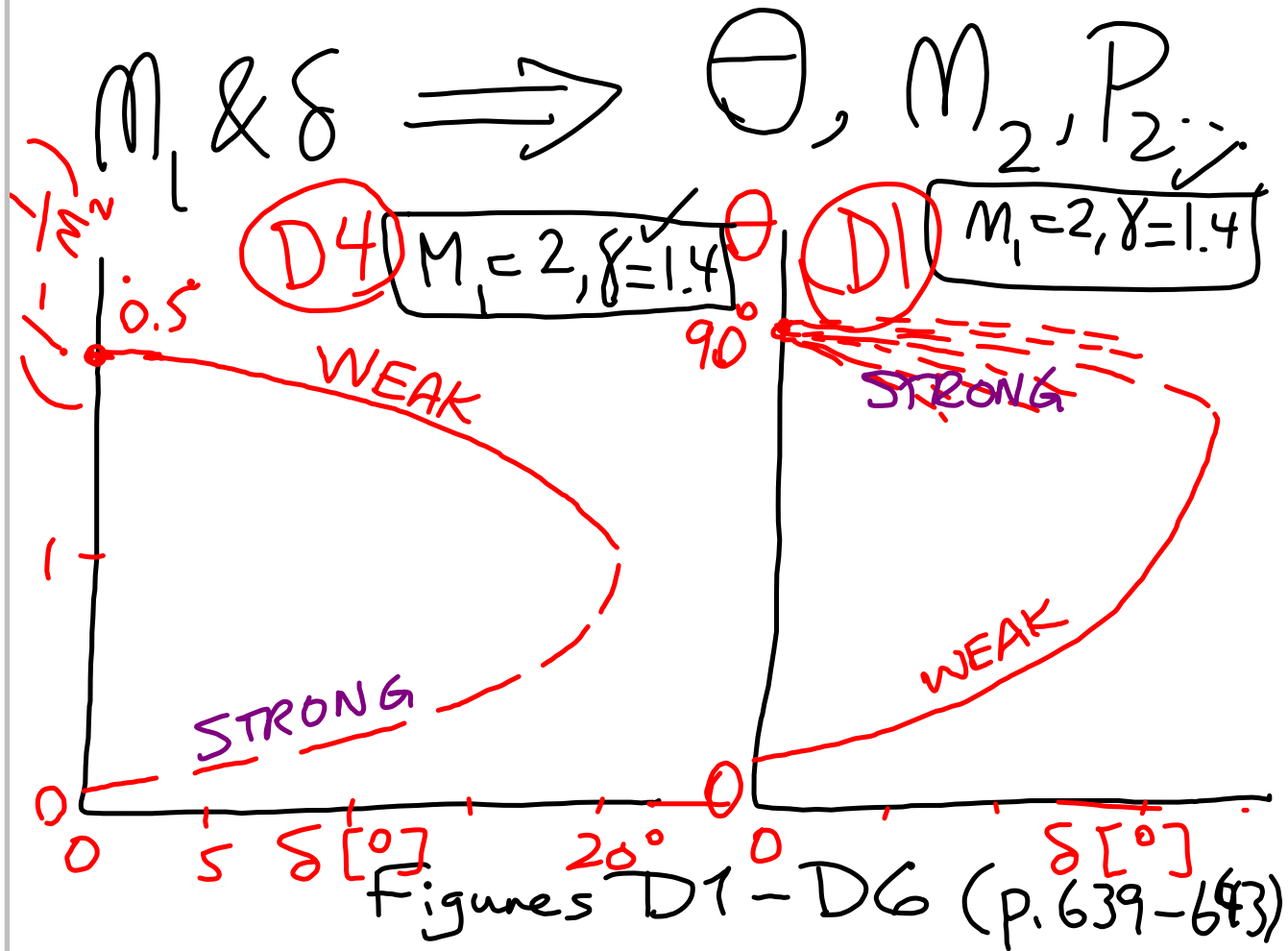
$$\text{Solve for } \delta: \sin(40 - \delta) = \frac{M_{2n}}{M_2}$$

$$40 - \delta = \sin^{-1} \frac{0.793}{1.617}$$

$$\boxed{\delta = 10.63^\circ}$$

Usually, angle θ is the unknown,

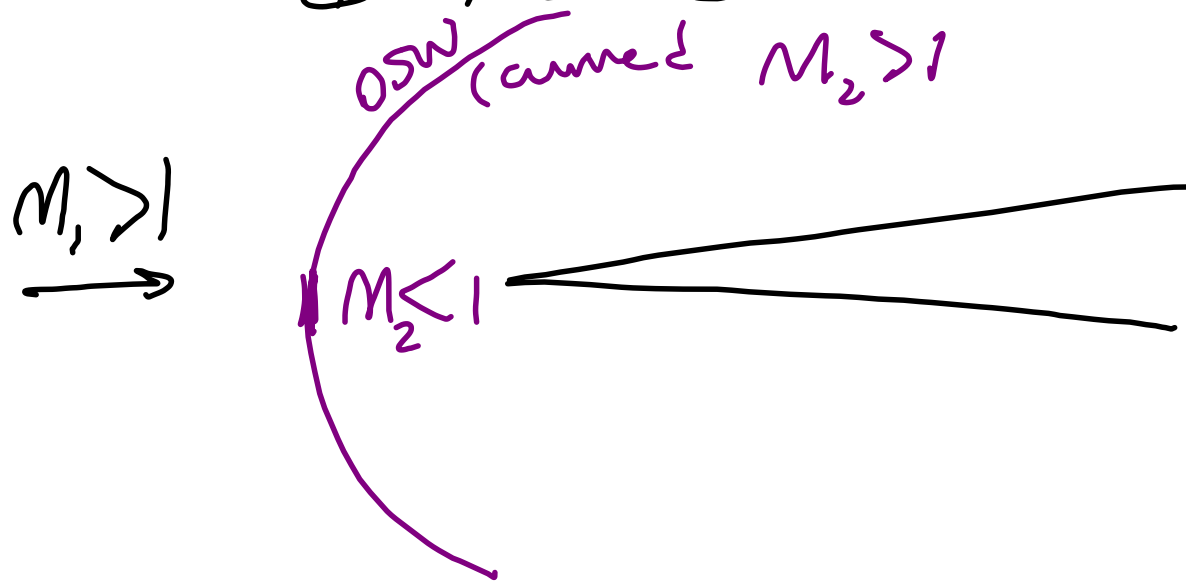
but M_1 & δ are both
known quantities:



For a given M_1 & δ combination:

A. No solution from Figures D1-D6 (eg. $M_1 = 2$, $\delta = 32^\circ$)

- $\Rightarrow$ - NO attached OSW
- Detached OSW



B. 2 Solutions

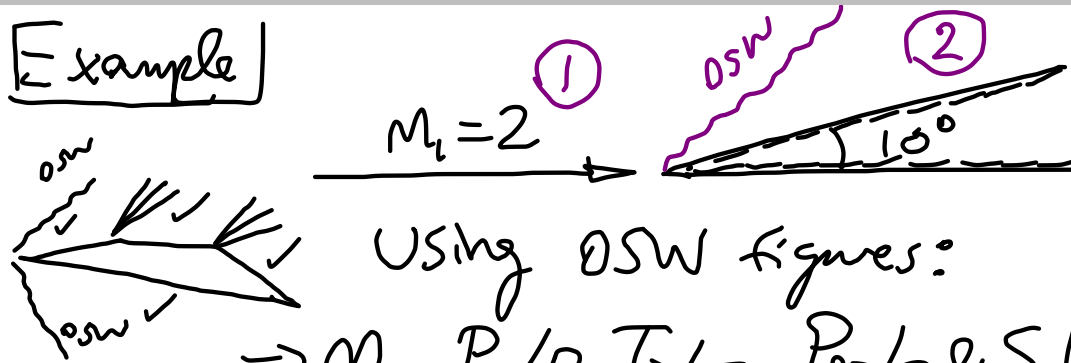
B.1. Weak Solutions (—)

$n_2 > 1$ or slightly less than 1
(small θ)

B.2. Strong Solution (---)
(θ is close to 90°)

NSW represent the limiting case
of a strong OSW when $\xi = 0^\circ$.

Example



Using OSW figures:

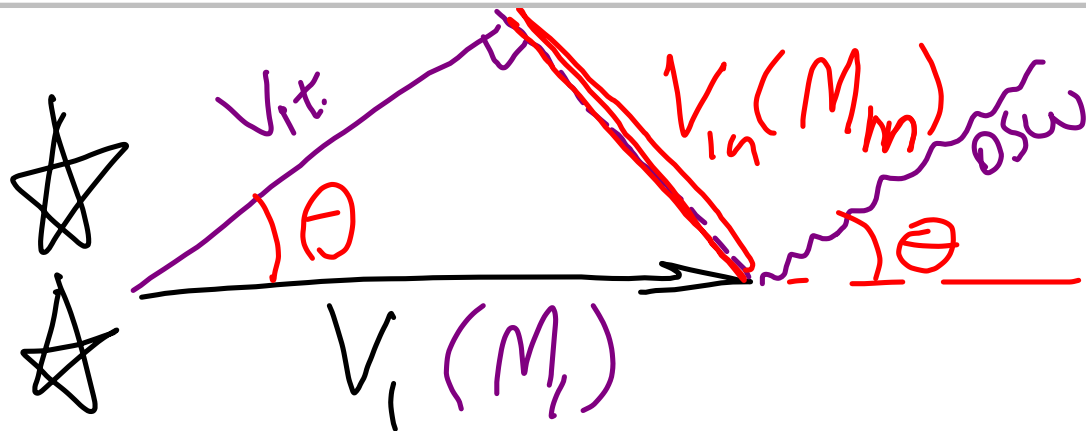
$$\Rightarrow M_2, P_2/P_1, T_2/T_1, P_{02}/P_{01} \& S!$$

$$\Rightarrow M_1 = 2, \delta = 10^\circ \text{ (Utilize weak solution)}$$

$$\Rightarrow \ominus = 39.3^\circ \text{ [Fig. D.1]}$$

$M_2 = 1.64$ [Fig. D.4]

$\Rightarrow M_{in}$ is the key quantity that allows you to use the NSW Tables of App. C.



$$\Rightarrow M_{1n} = M_1 \sin \theta$$

$$= 2 \cdot (\sin 39.3^\circ) = \underline{\underline{1.27}}$$

App. C $\Rightarrow M_{2n} = 0.8016$
MUST BE SUBSONIC

check this

$$M_{2n} = M_2 \sin(\theta - \delta)$$

$\Rightarrow$ App. C with $M_{in} = 1.27$

$$\frac{P_2}{P_1} = 1.715$$

$$\frac{T_2}{T_1} = 1.17$$

$$\frac{P_{02}}{P_{01}} = 0.984 \Rightarrow P_2, T_2, P_{02}$$

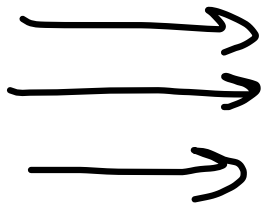
Drag & Lift

Biomimetics

SUBSONIC



MECH 7110



Transformation

Bio-inspired
Eng. Systems

