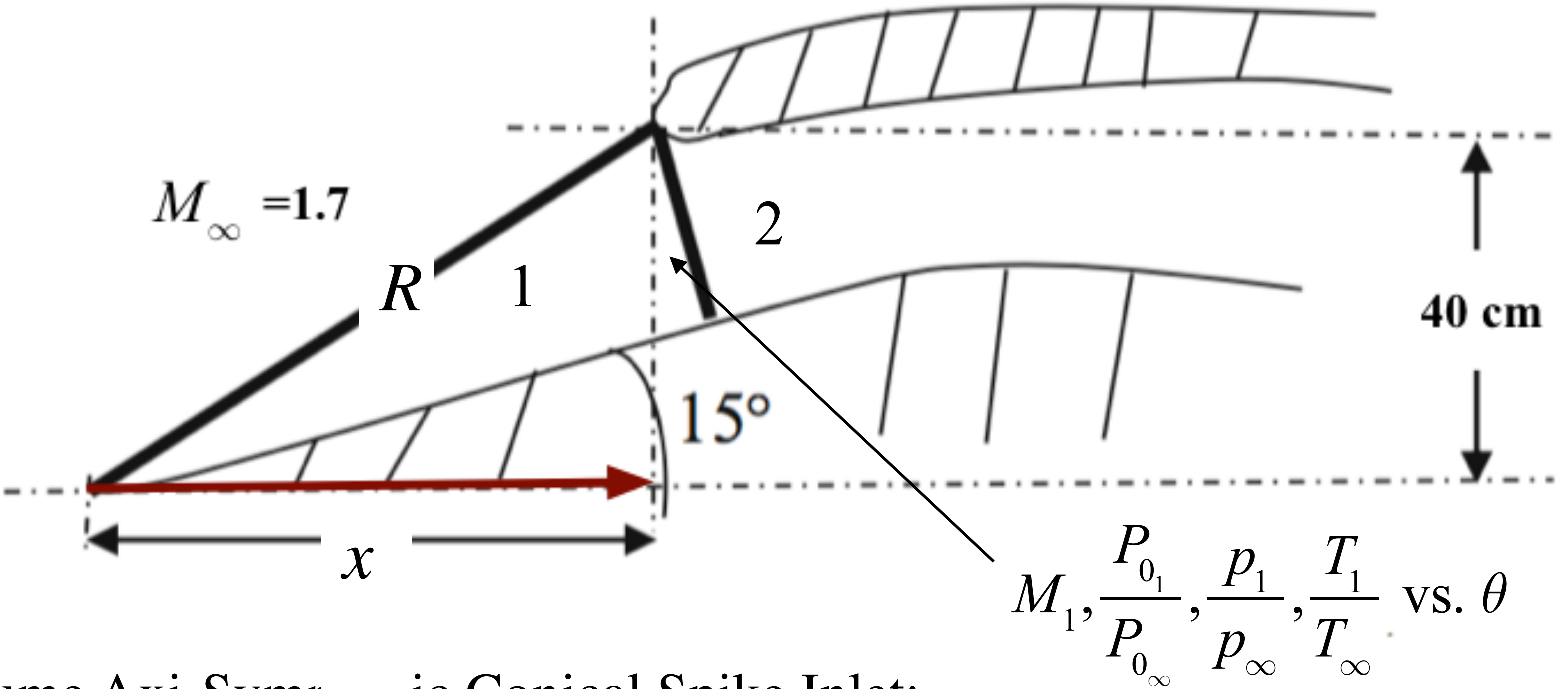
Homework 2.1 , Part 1

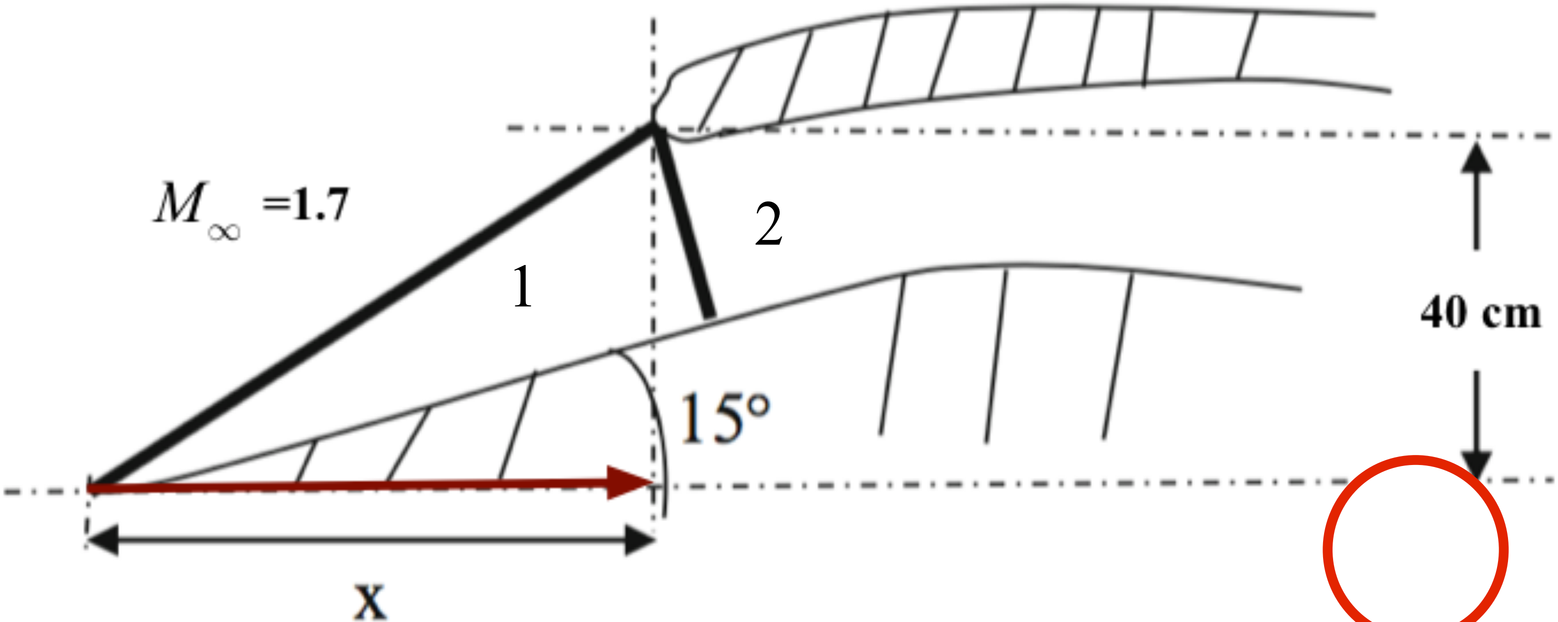


Assume Axi-Symmetric Conical Spike Inlet:
15° Spike Half Angle
40 cm Inlet Half Width

→ Calculate:

Shock Angle (β)
Radial (*R*), Longitudinal (*x*) Distance from Spike Tip to Cowl Inlet
Mach Number, Total, Pressure, Temperature Ratio Distribution vs. θ at Cowl Inlet (1)→(2)

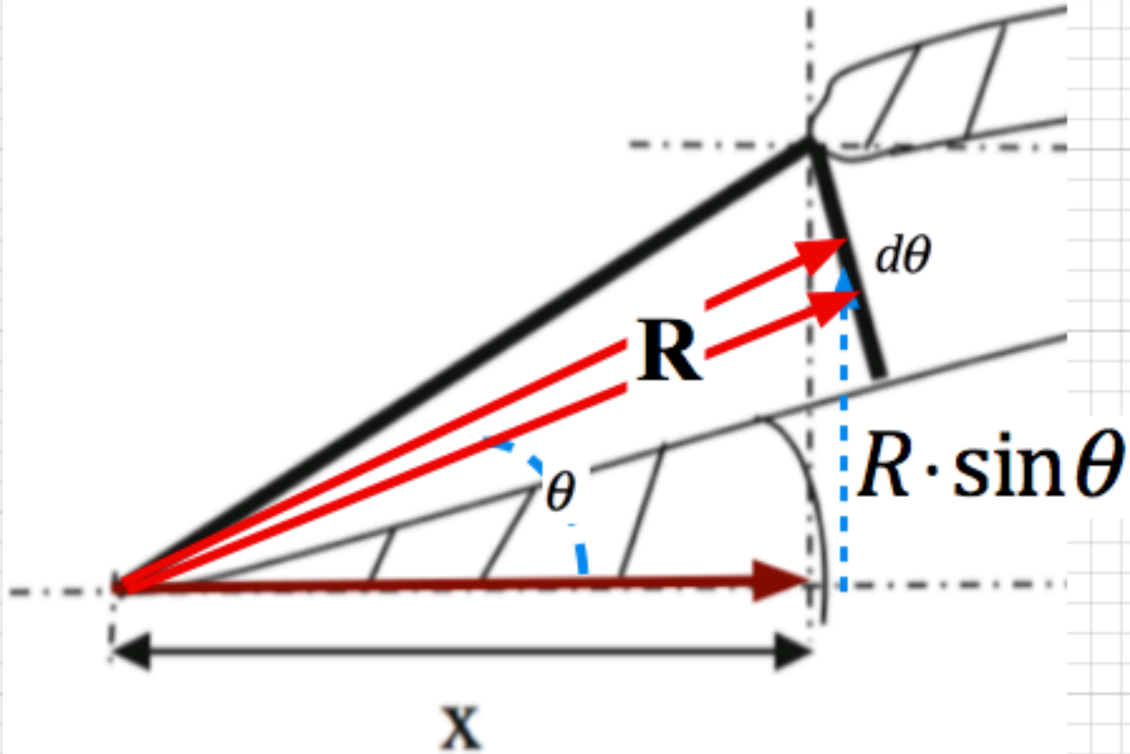
Homework 7.1. Part 2



- Calculate Area-Weighted Mean Mach Number, Pressure Ratio at Cowl Inlet (1) → (2)

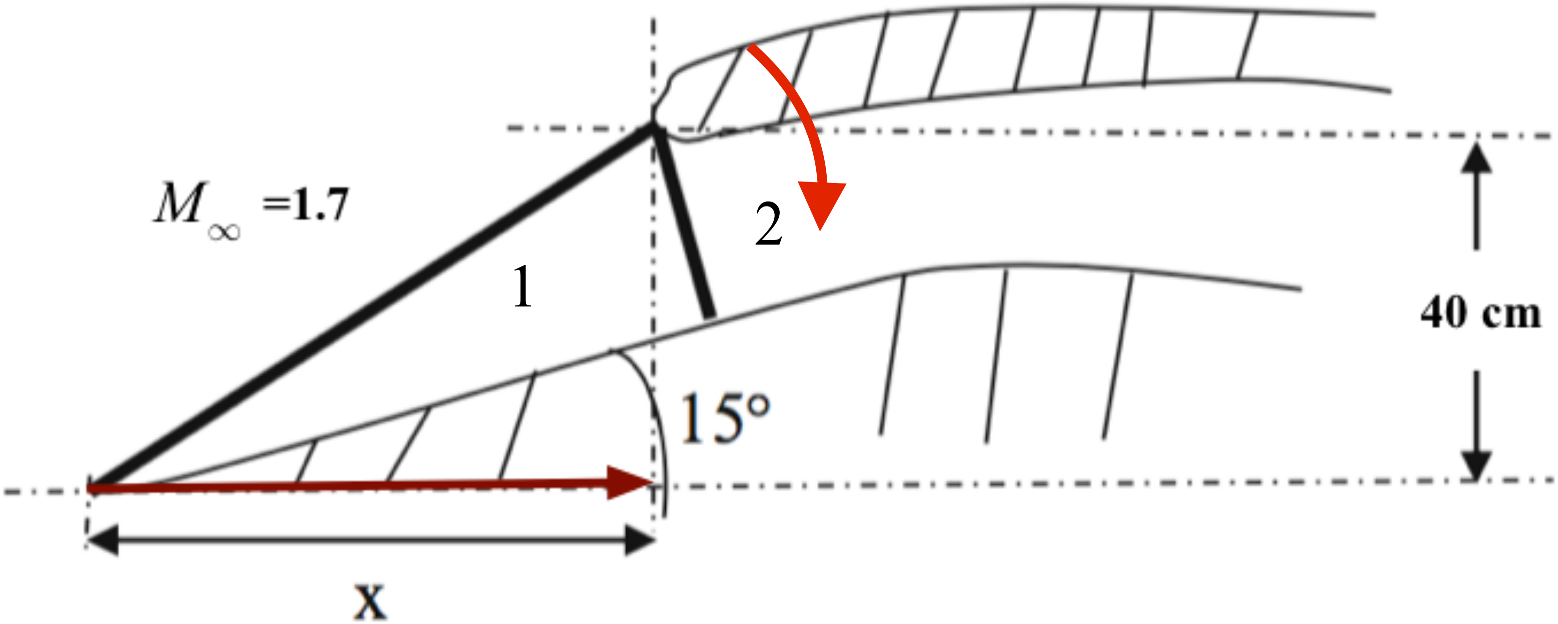
Example …

$$\bar{M} = \frac{2\pi \cdot \int_{\theta_{cone}}^{\beta} M_\theta R \cdot \sin\theta \cdot R \cdot d\theta}{2\pi \cdot \int_{\theta_{cone}}^{\beta} R \cdot \sin\theta \cdot R \cdot d\theta} = \frac{2\pi \cdot R^2 \int_{\theta_{cone}}^{\beta} M_\theta \sin\theta \, d\theta}{2\pi \cdot R^2 \left(\cos\theta_{cone} - \cos\beta\right)} = \frac{\int_{\theta_{cone}}^{\beta} M_\theta \sin\theta \, d\theta}{\left(\cos\theta_{cone} - \cos\beta\right)}$$



$$dA_\theta = \left(2\pi \cdot R \cdot \sin\theta\right) \cdot R \cdot d\theta$$

Homework 7.1. Part 3

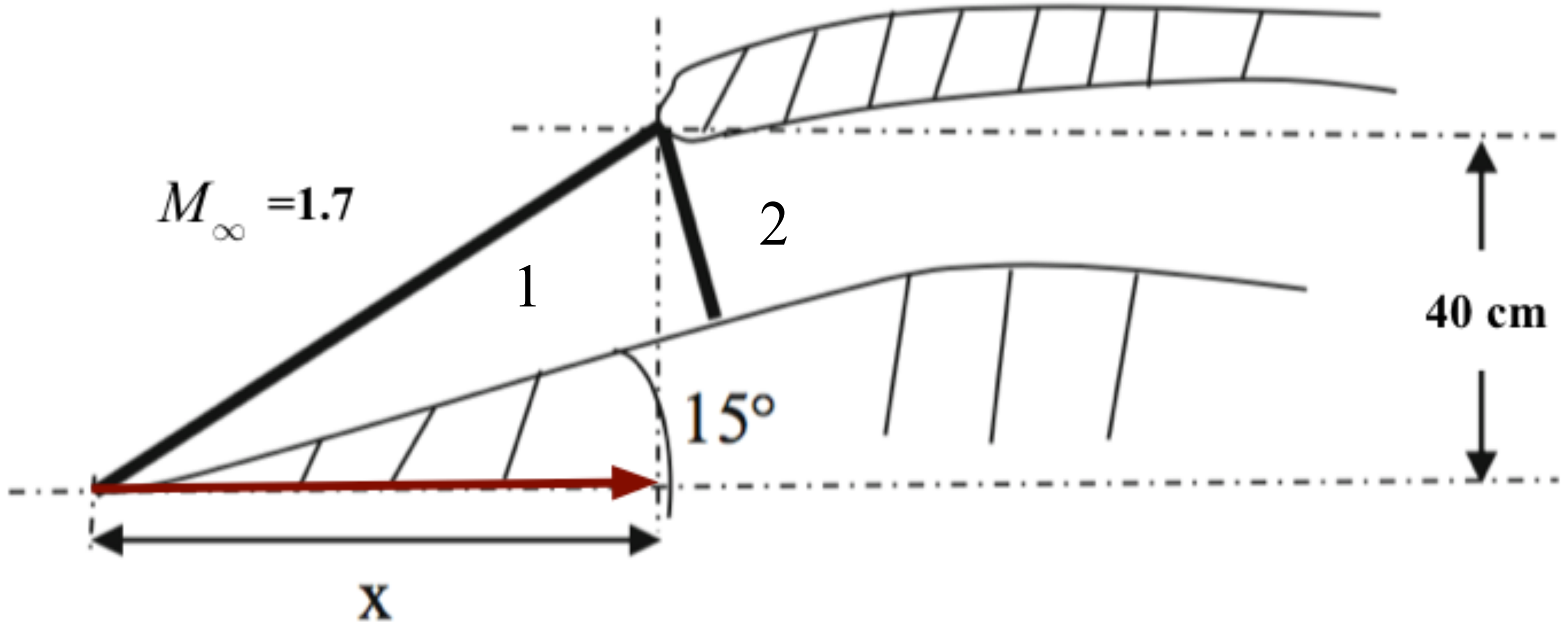


• Based on Mean Conditions at Cowl Inlet, Calculate 1-D Mach Number, Compression Ratio, Stagnation Pressure Behind Normal Shock (2), Relative to Freestream

• Compare to 2-D Inlet Solution from Problem 4.3

• What is the Optimal Cone Angle for Minimum Stagnation Pressure Loss

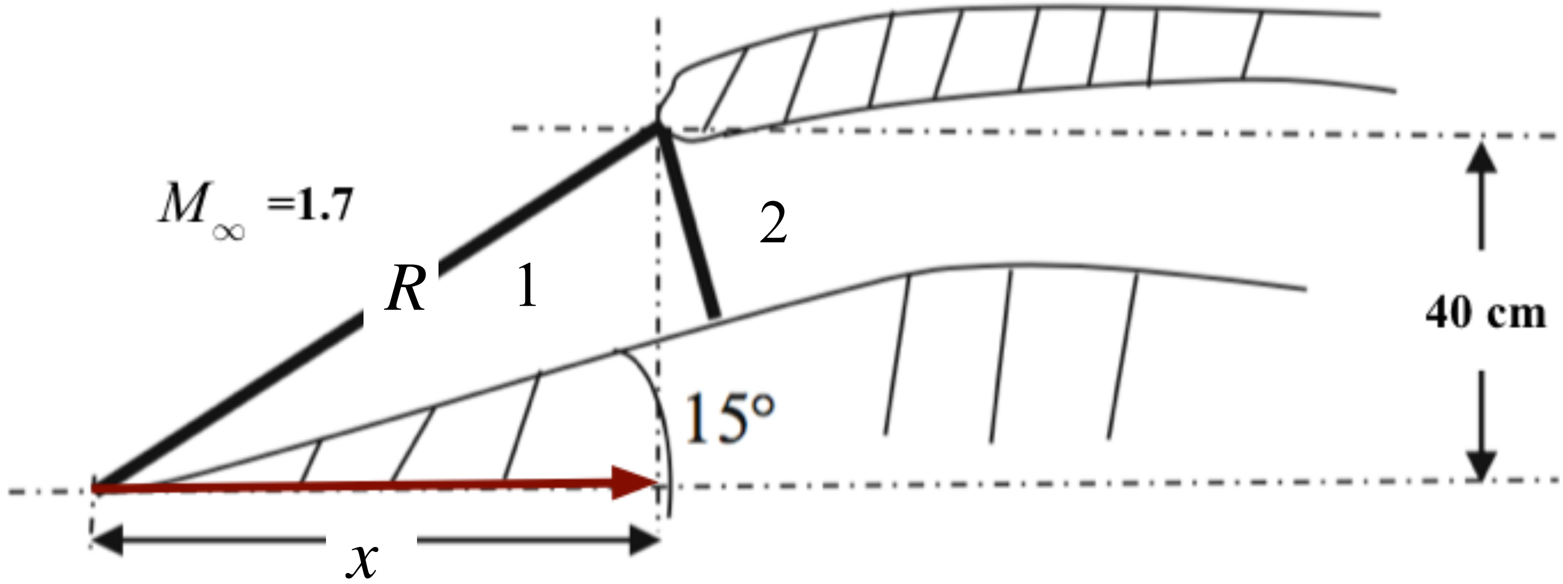
Homework 7.1. Part 4



- What is the Optimal Cone Angle for Minimum Stagnation Pressure Loss

- Compare Optimal to 2-D Inlet Solution from Problem 4.3

Homework 7.1, Part 1

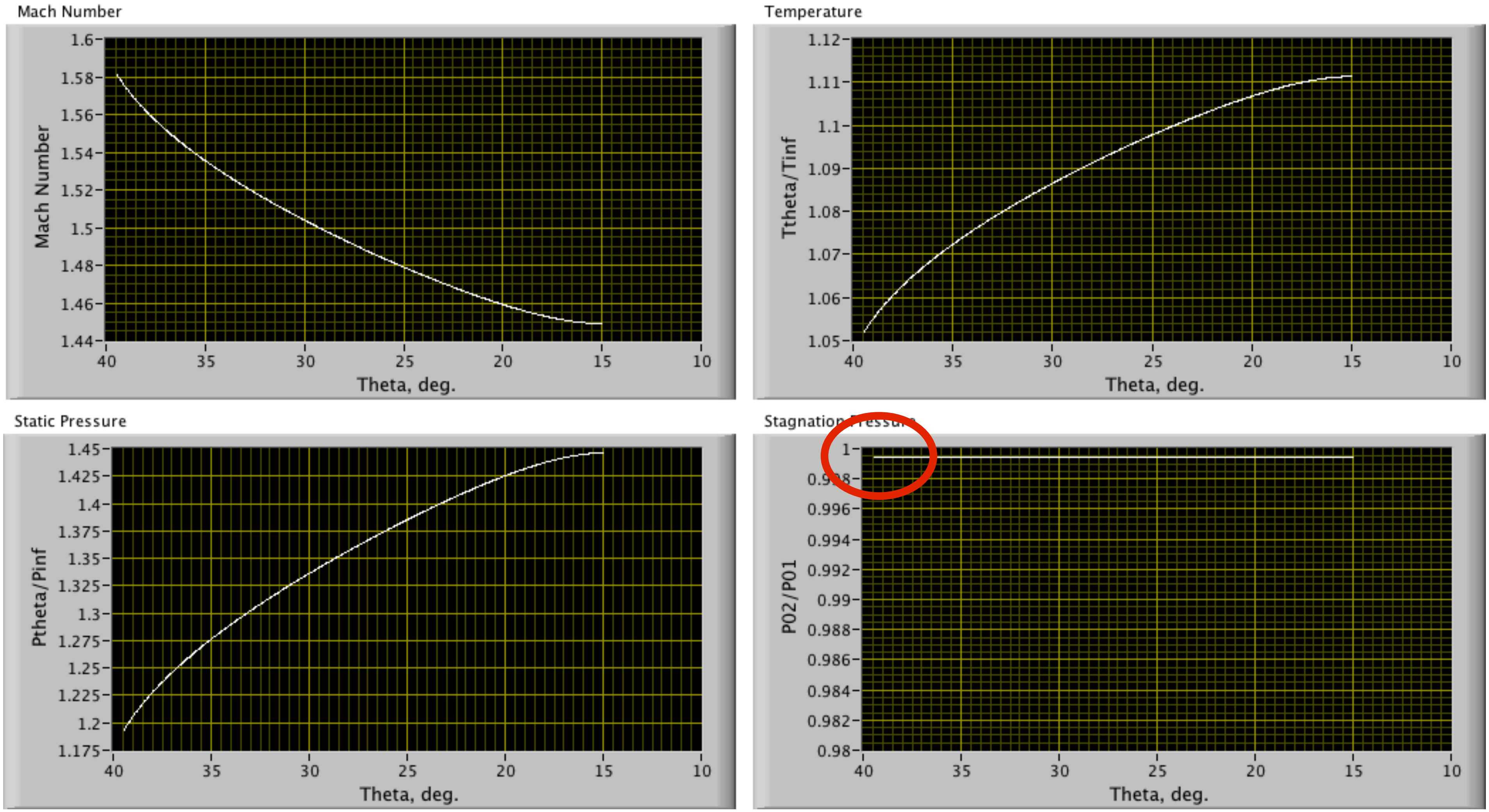


$$\beta = 39.43515^o$$

$$x = 40_{cm} \,/\, \tan\left(\frac{\pi}{180} 39.43515^o\right) = 48.6359_{cm}$$

$$R = \sqrt{x^2 + y^2} = (40^2 + 48.6359^2)^{0.5} = 62.9718 \text{ cm}$$

Homework 7.1, Part 1

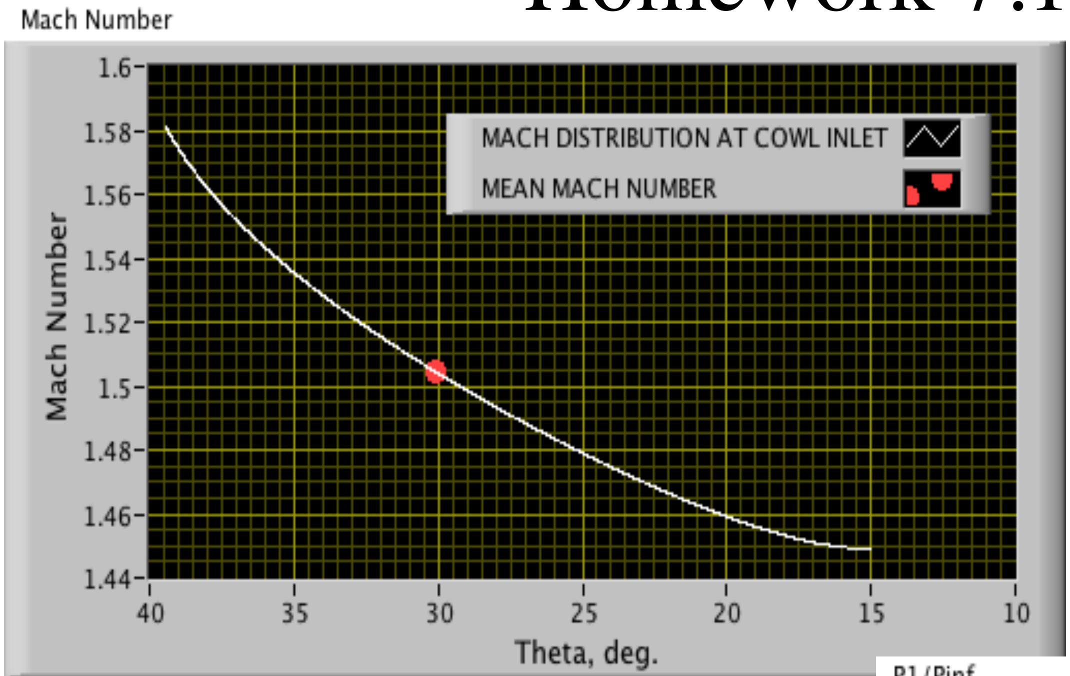


- Properties Behind Oblique Shock Wave and Cowl Inlet

Utah State University

Mechanical & Aerospace Engineering

Homework 7.1, Part 2



Mach Integral

Dtheta, deg.
0.007884

Scale factor
5.1649(

Avg Mach
1.50462

Avg Theta
30.1243

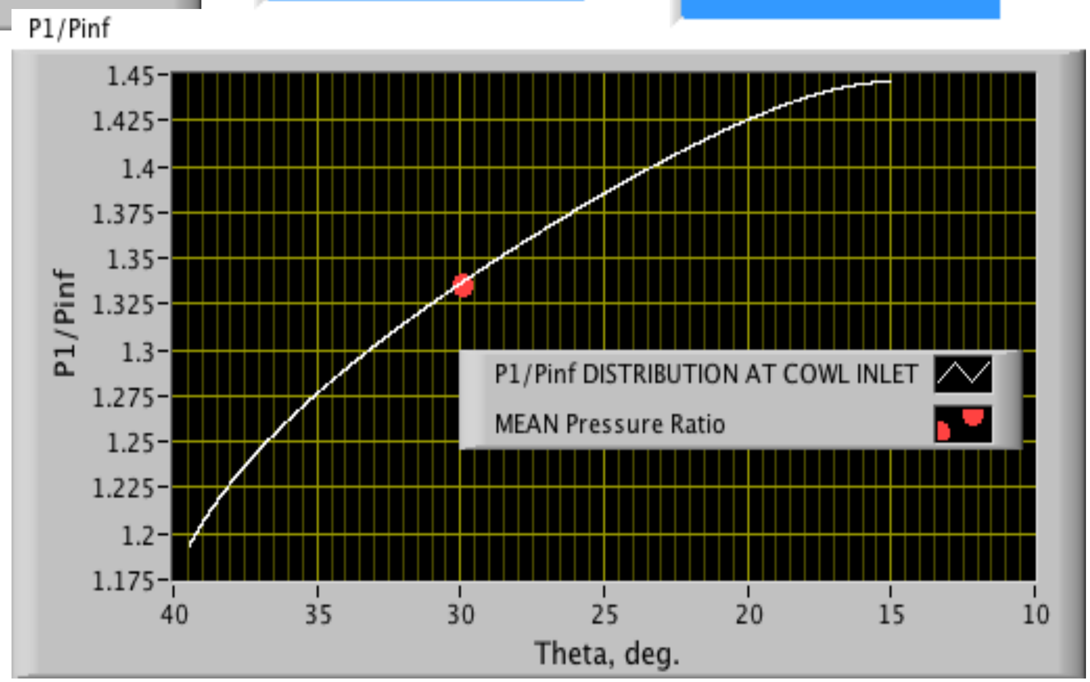
Pressure Integral

Dtheta, deg.
0.007884

Scale factor
5.1649(

Avg Pratio
1.33642

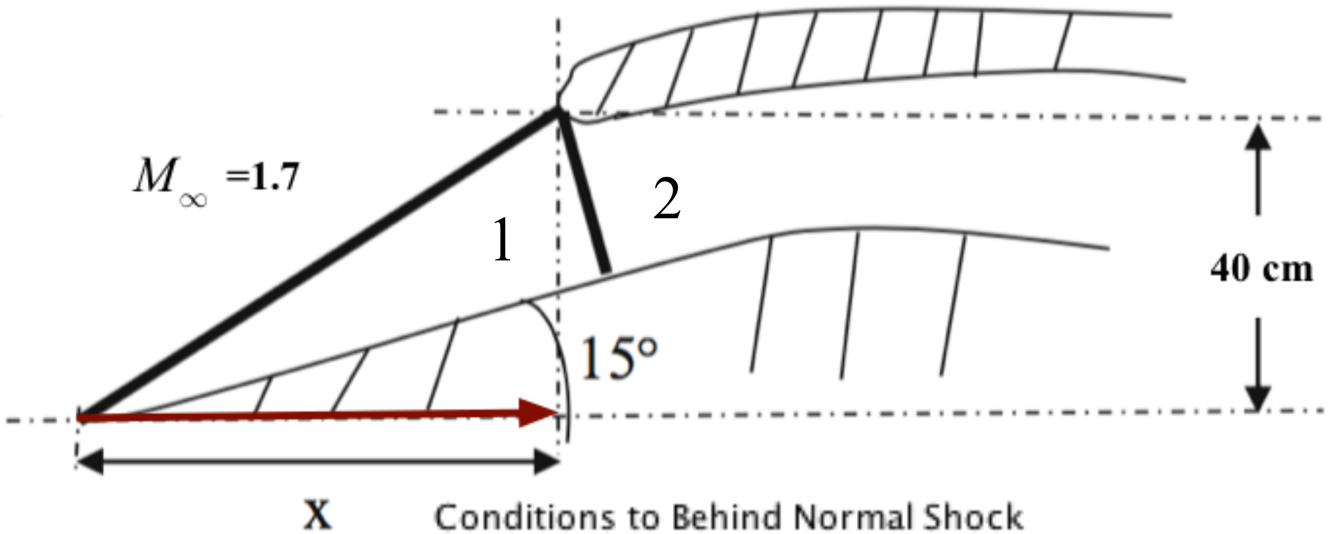
Avg Theta
29.9767



Homework 7.1, Part 3

Conditions Across Normal Shock

Rho2/Rho1	1.869980
P2/P1	2.474536
T2/T1	1.323295
P02/P01	0.928315
M2	0.699459
P02/P1	3.430775



Conditions to Behind Normal Shock Freestream

Rho2/Rho1	2.121801	P02/P1	16.924690
P2/P1	2.953975	**M1 Avg**	1.50462
T2/T1	1.392202	M2	0.699459
P02/P01	0.927789		

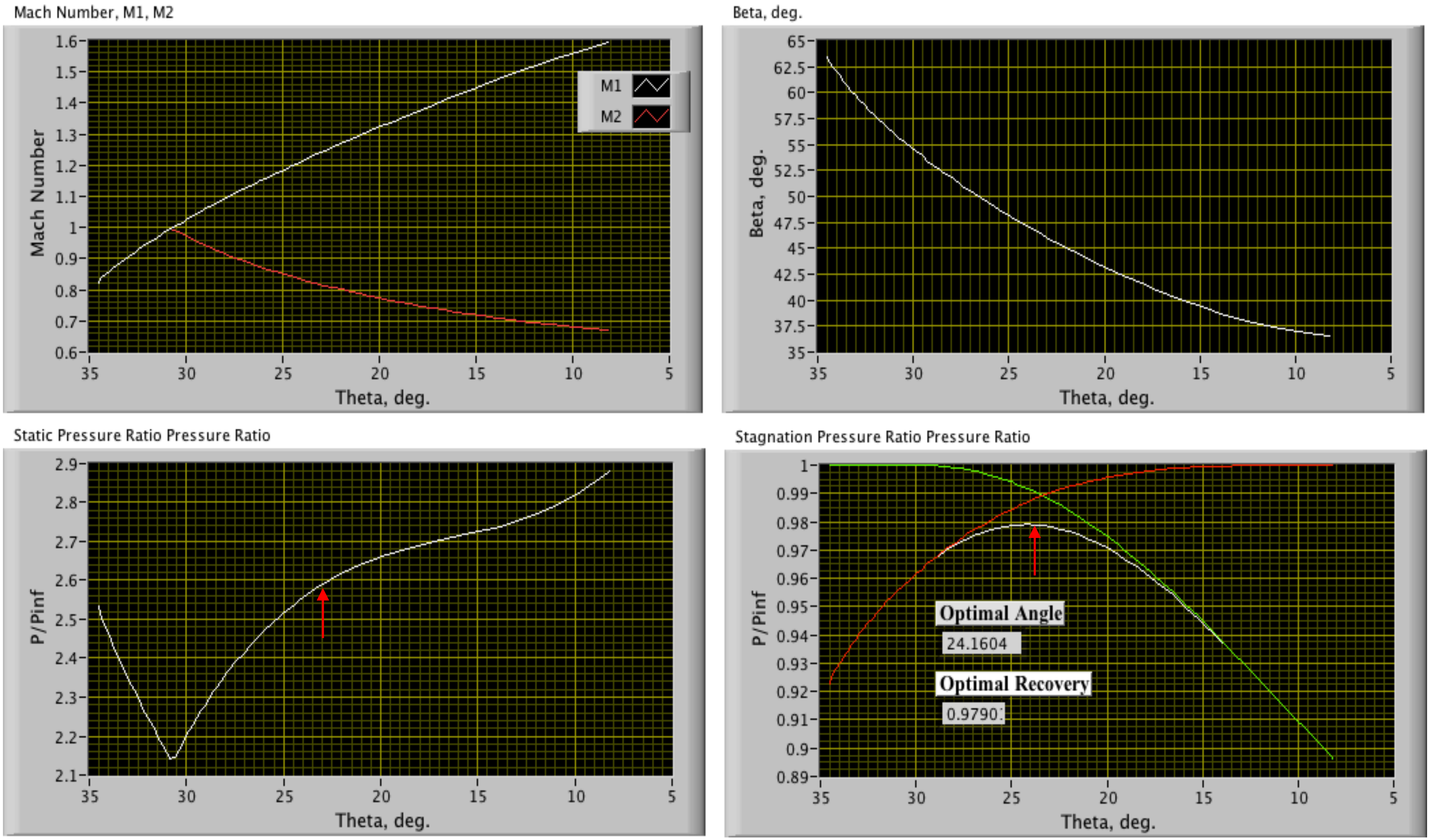
Homework 7.1, Part 3

Compare to 2-D inlet, with 15 Degree Ramp Angle

Inlet	b, deg	M 1	M 2	$\frac{p_1}{p_\infty}$	$\frac{p_2}{p_\infty}$	$\frac{P_{0_1}}{P_{0_\infty}}$	$\frac{P_{0_2}}{P_{0_\infty}}$
2-D	55.984	1.122	0.895	1.302	2.800	0.956	0.954
3-D	39.435	1.581 (*max*) 1.449 (*min*) 1.505 (*mean*)	0.674 ≤ 0.699 ≤ 0.720	1.194 (*max*) 1.446 (*min*) 1.336 (*mean*)	2.283 ≤ 2.954 < 3.282	0.999	0.902 ≤ 0.928 ≤ 0.945

- Slightly Higher Compression, Slightly Larger Stagnation Pressure Loss
- Significantly Higher Capture Area for given Max Lateral Dimension

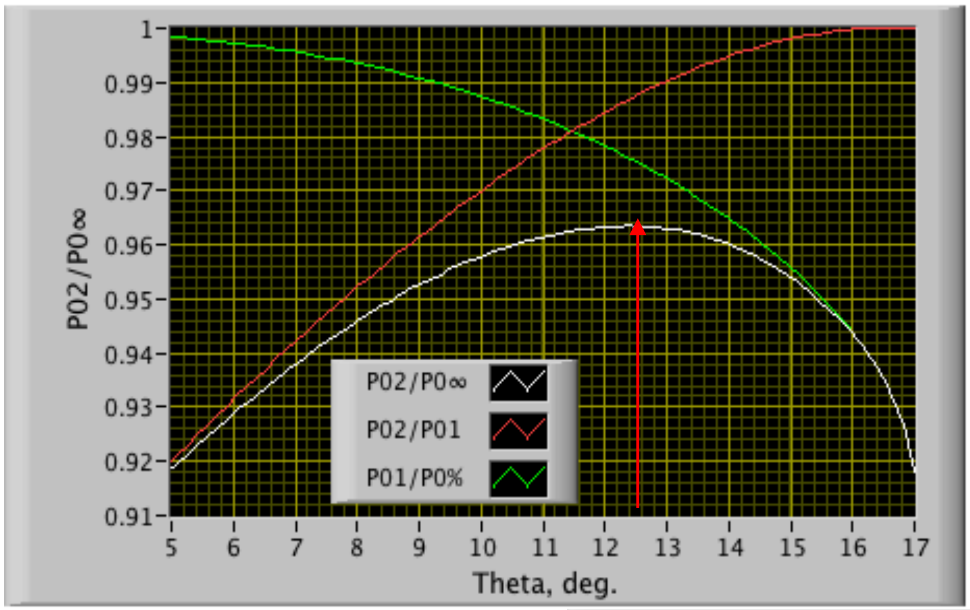
Homework 7.1, Part 4, Conical Inlet



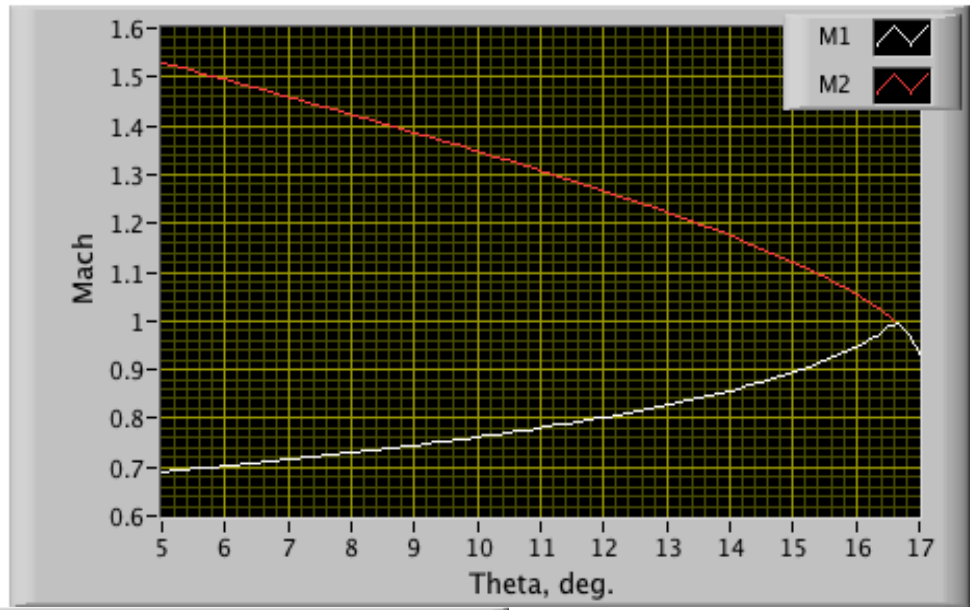
Homework 4.3, 2-D Inlet

- What is the best turning angle θ in terms of highest pressure ratio, $\frac{P_{02}}{P_{0a}}$?

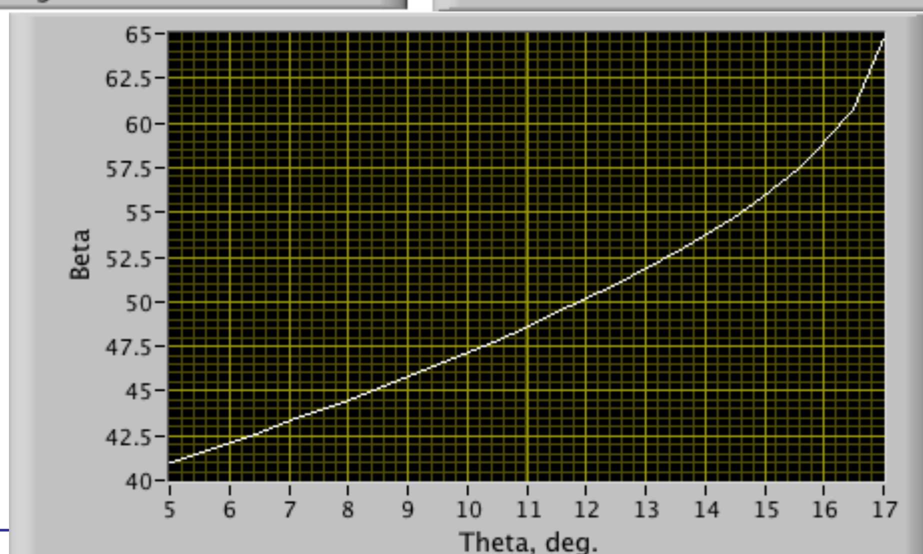
Stagnation Pressure Ratio

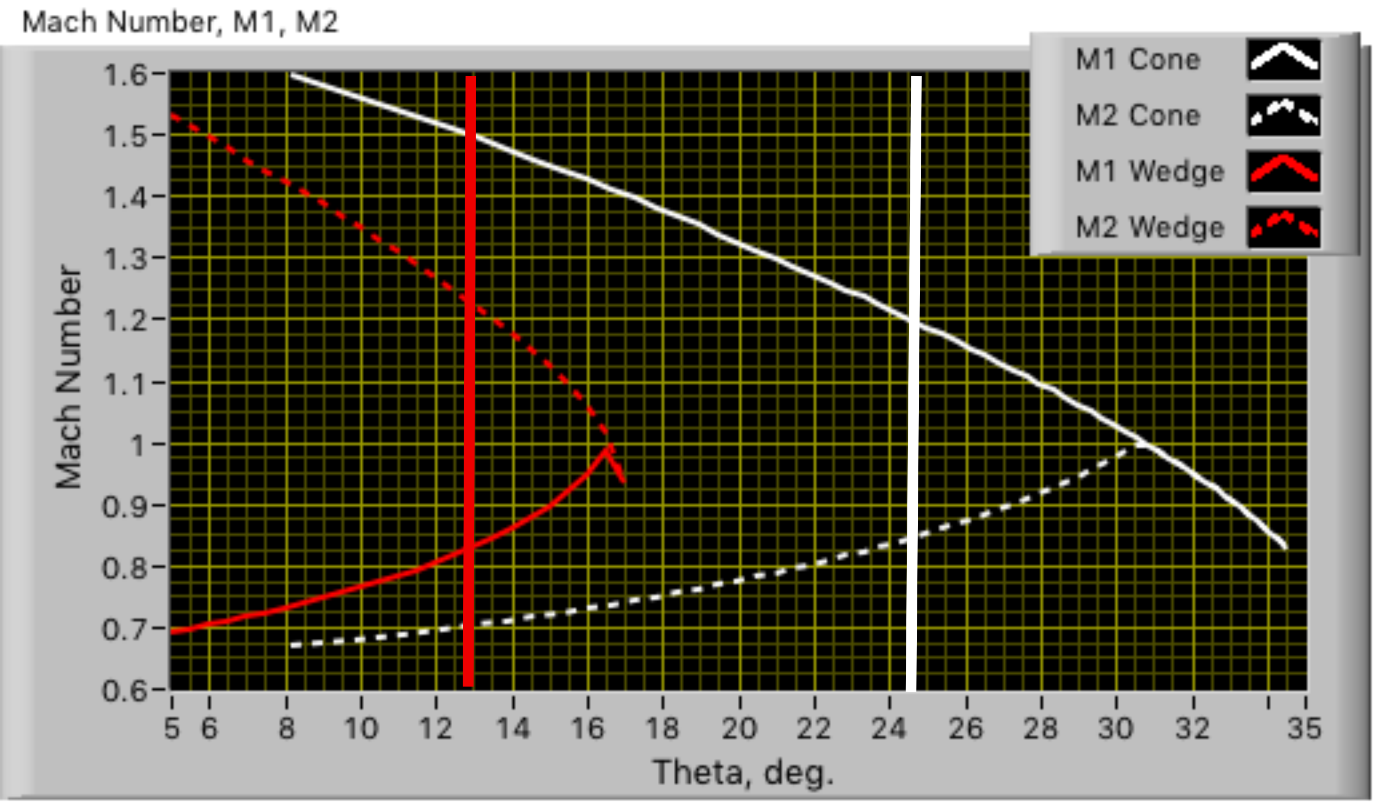


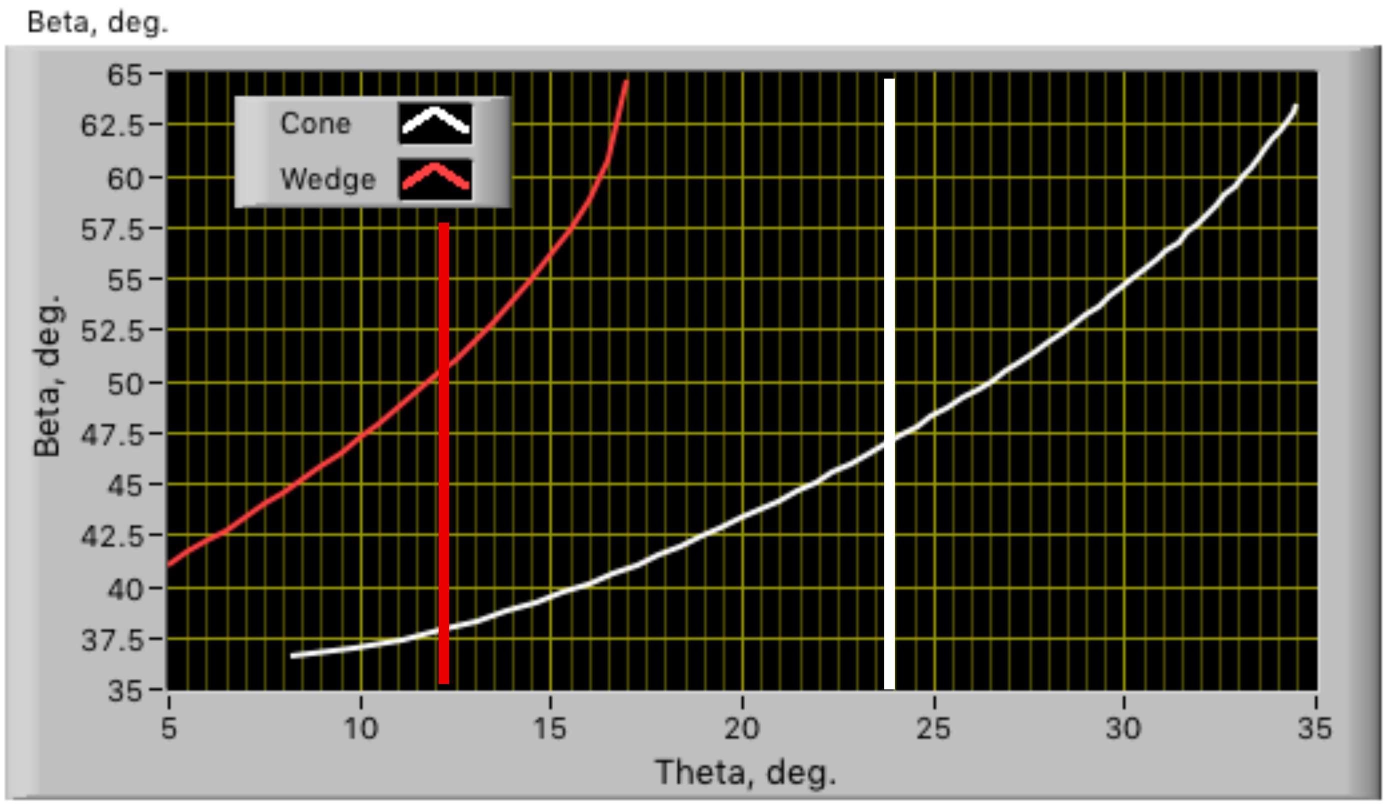
Mach Number



$$\theta_{OPT} \approx 12.4^{O}$$

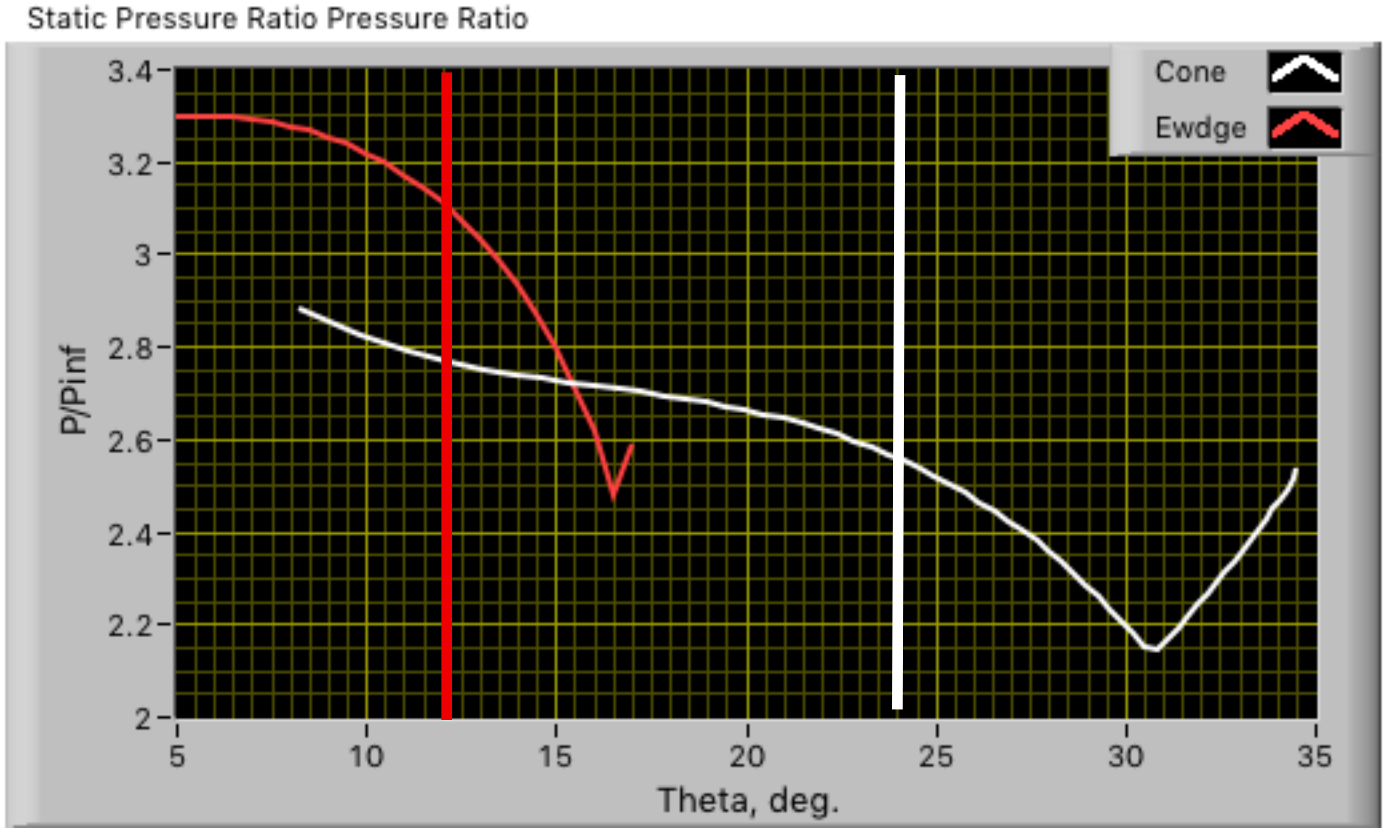


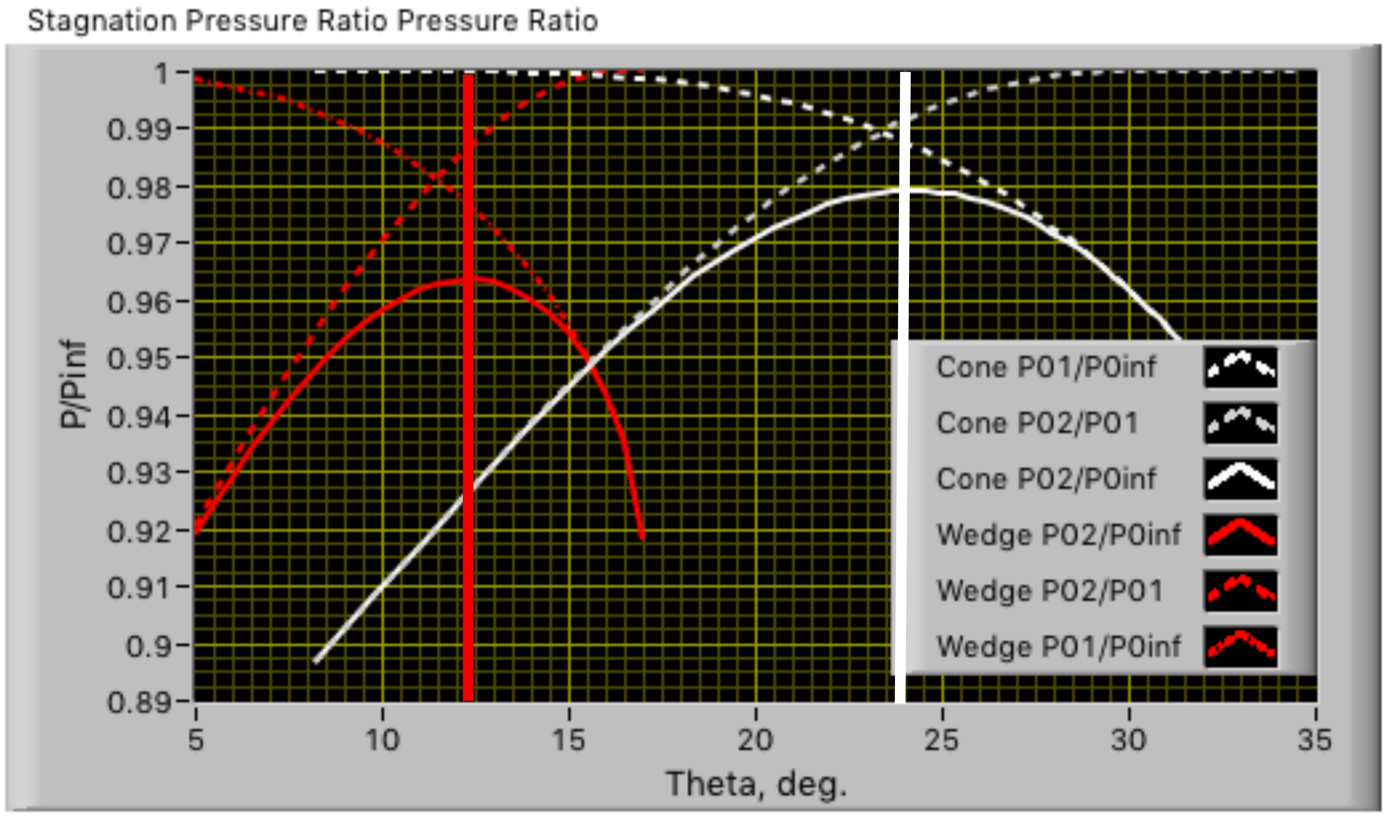




Cone Optimal Angle
24.1604

Cone Optimal P0 Recovery
0.9790





Wedge Optimal Angle
12.5

Wedge Optimal P0 Recovery
0.963466