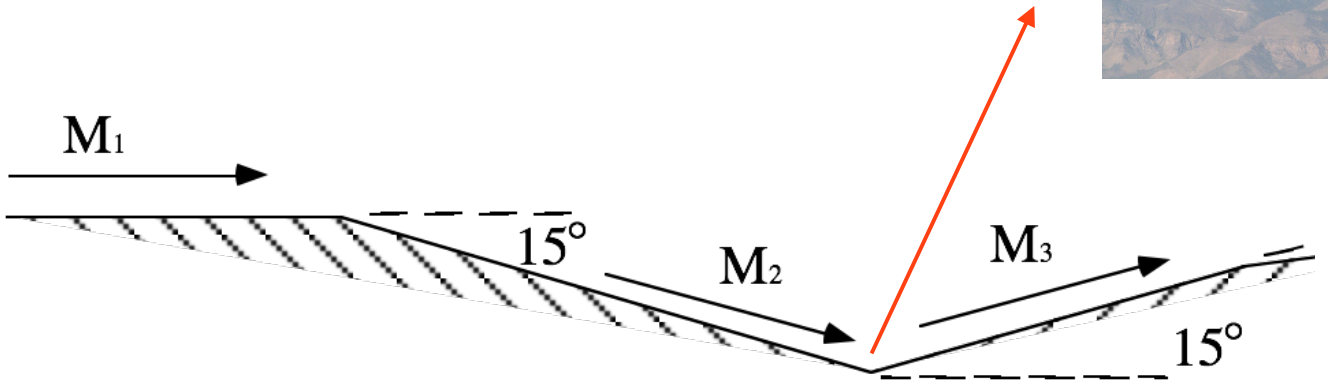
Section 6: Home Work #7

***Assigned Wednesday** November 3, Due Friday November 12*

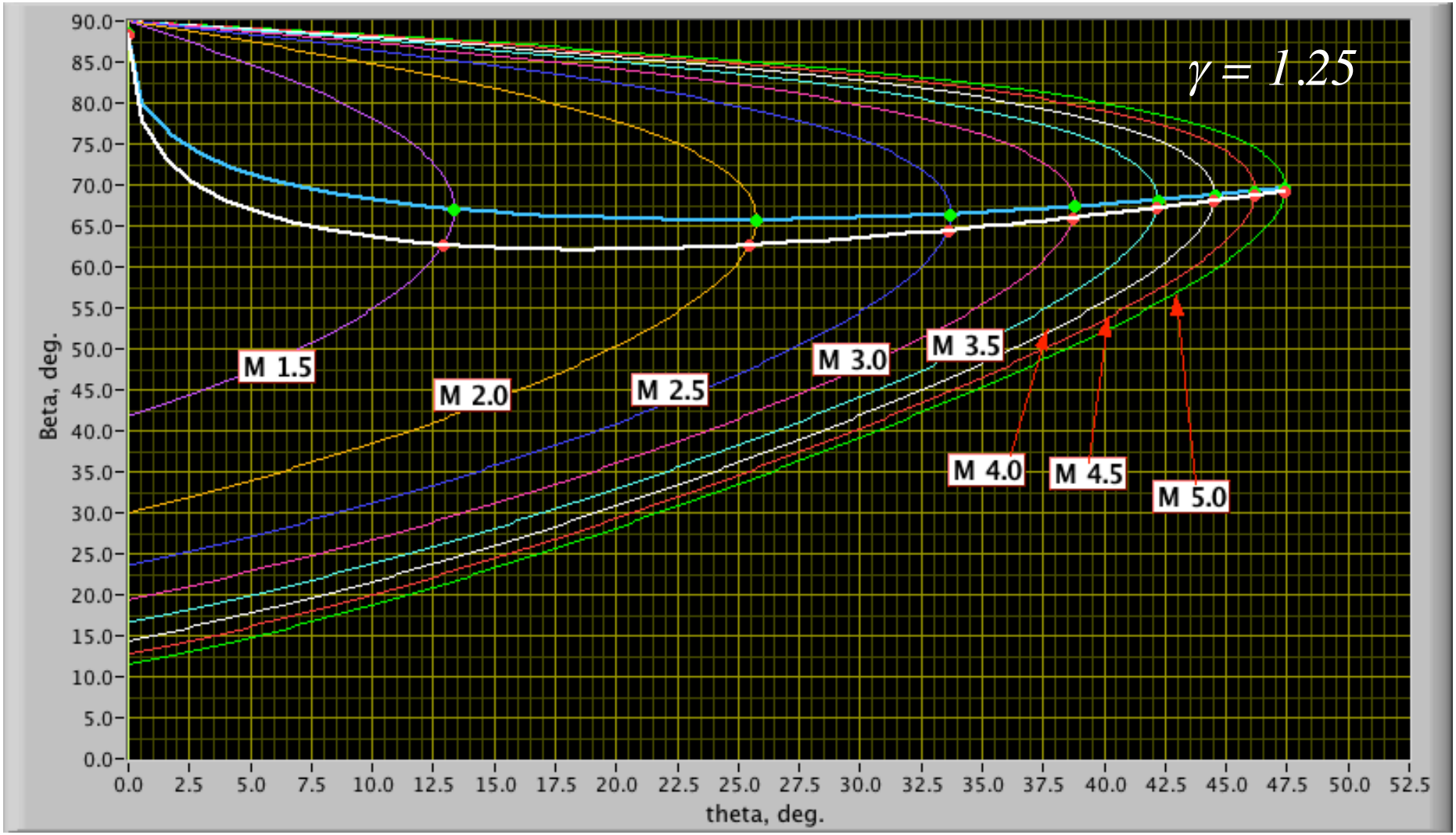
- $M_1=4$, $p_1=0.01$ atm, $T_1=217°K$, $\gamma=1.25$, $\theta_1=15°$, $\theta_2=15°$

- Compute conditions after each corner

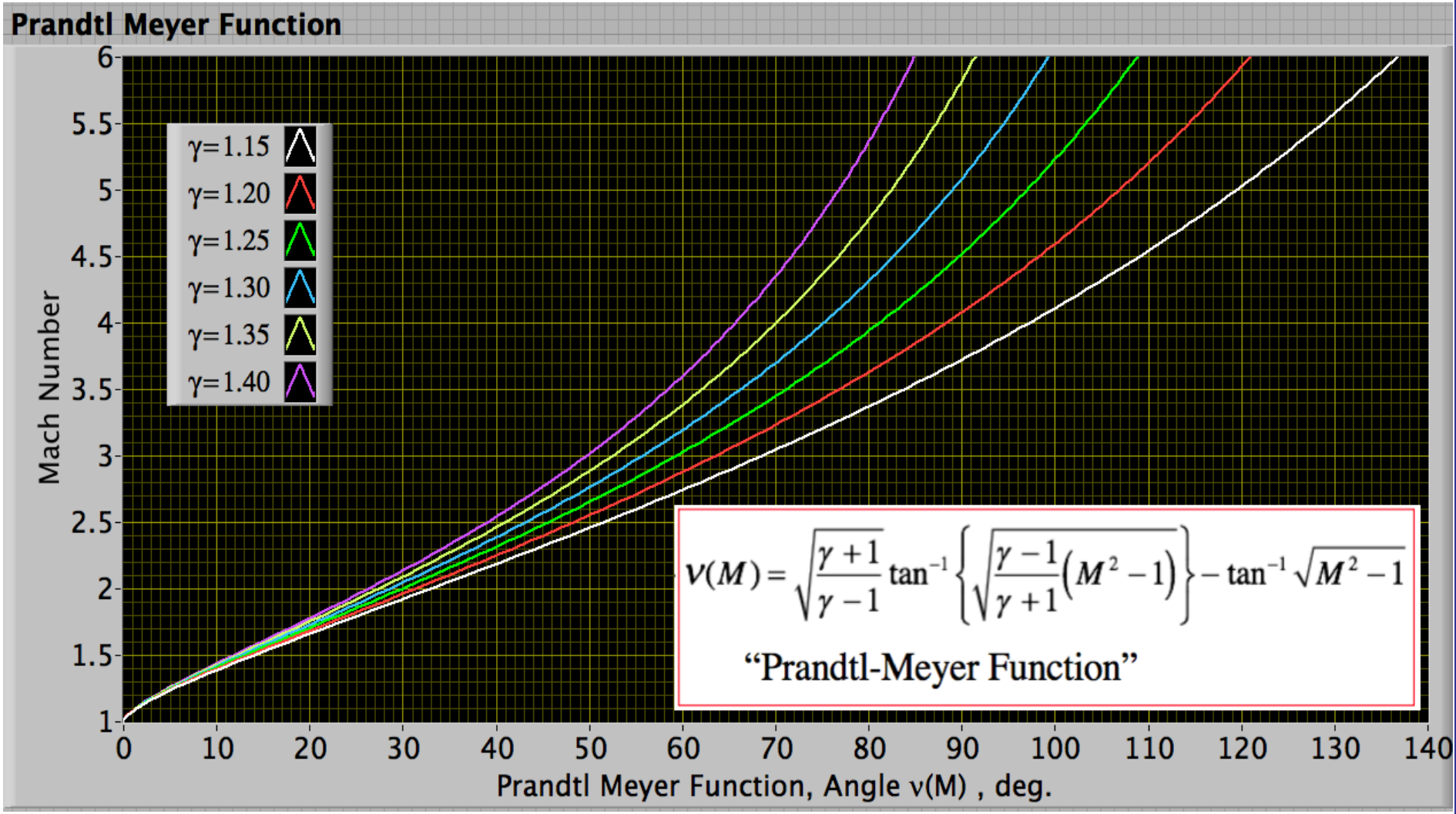
  - Entry and exit Mach wave angles or shock angles
  - Mach number
  - static & total pressure
  - temperature



Section 6: Home Work #7 (*continued*)

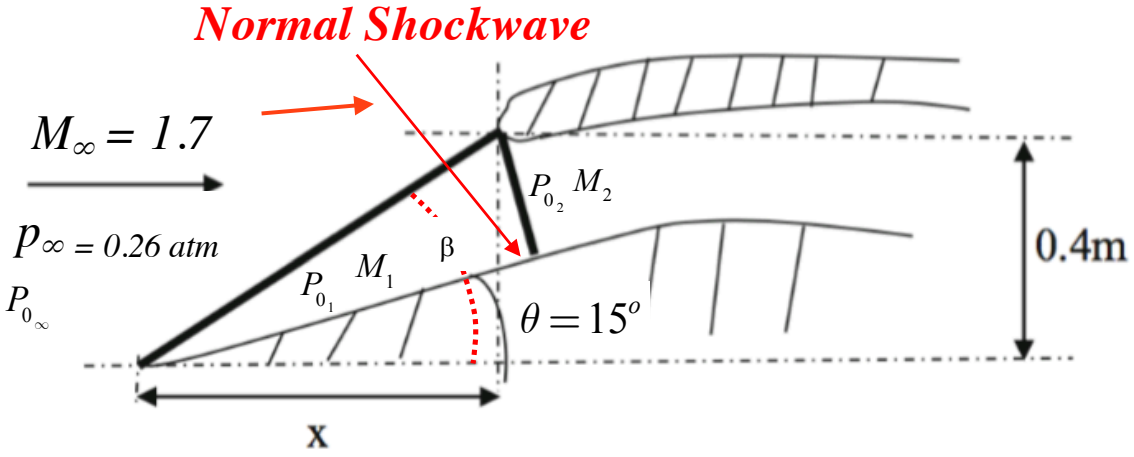


Section 6: Home Work #7 (*continued*)



Section 6: Home Work #7 Part2

A ramjet operates at an altitude of 10,000 m ($T_a = 223\ K$, $p_\infty = 0.26\ atm$, $\gamma = 1.4$) at a Mach number of 1.7. The external diffusion is based on an oblique shock and on a normal shock, as described in the shown figure.



$$\beta \rightarrow f(M_\infty, \theta)$$

$$Hint \rightarrow \left\{\frac{P_{0_1}}{P_{0_\infty}}, M_1\right\} \rightarrow f(M_\infty, \beta)$$

$$\frac{P_{0_2}}{P_{0_1}} \rightarrow f(M_1)$$

$$\frac{P_{0_2}}{P_{0_\infty}} = \frac{P_{0_2}}{P_{0_1}} \times \frac{P_{0_1}}{P_{0_\infty}}$$

...Plot $\frac{P_{0_2}}{P_{0_\infty}}$ vs θ

Calculate

- Stagnation pressure recovery, $\frac{P_{0_2}}{P_{0_\infty}}$?
- At what Mach number does the oblique shock become detached?
- What is the distance x, from the cone tip to the outer inlet lip, for the condition described in the figure? $\{M_\infty = 1.7, \theta = 15^o\}$
- What is the best turning angle θ in terms of highest pressure ratio, $\frac{P_{0_2}}{P_{0_\infty}}$?

this VI solves the the weak and strong shock wave angle given mach number and wedge angle

Input data

Theta 20.00000

gamma 1.40

Mach Nu mber 1.8400490210

Lamdba 1.52227

Chi -1.00000

Detached Shock Wave

Strong Shock Solution 2

Beta (strong shock), deg. 64.892

M1n (strong shock), deg. 1.66619

M1t (strong shock), deg. 0.7808

M2n (strong shock), deg. 0.6495

Weak Shock Solution

Beta (weak shock), deg. 64.892

M1n (weak shock), deg. 1.66619

M1t (weak shock), deg. 0.7808

M2n (weak shock), deg. 0.6495

Output Data

Rho2/Rho1 2.142062

P2/P1 3.072205

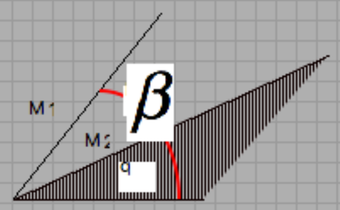
T2/T1 1.434227

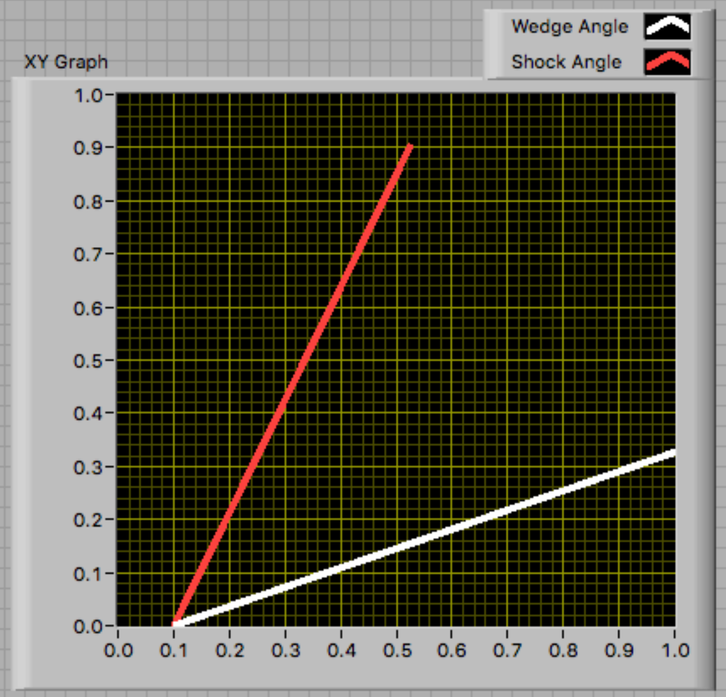
P02/P01 0.869535

M2 0.649505

P02/P1 4.079183

M2 (weak shock), deg. 2 0.920270





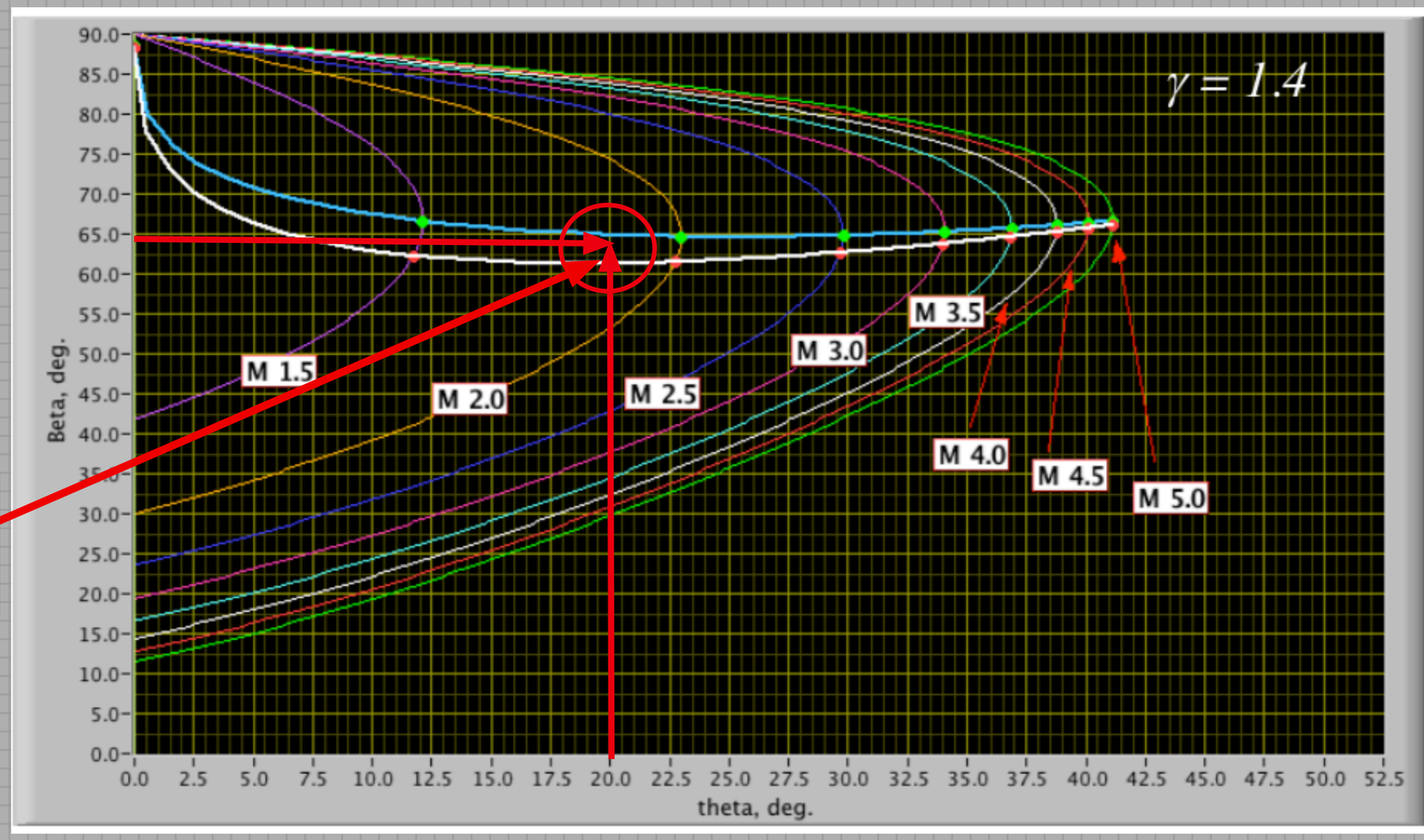
HINT: AT DETACHMENT MACH NUMBER -->

$$\beta_{weak} = \beta_{strong}$$

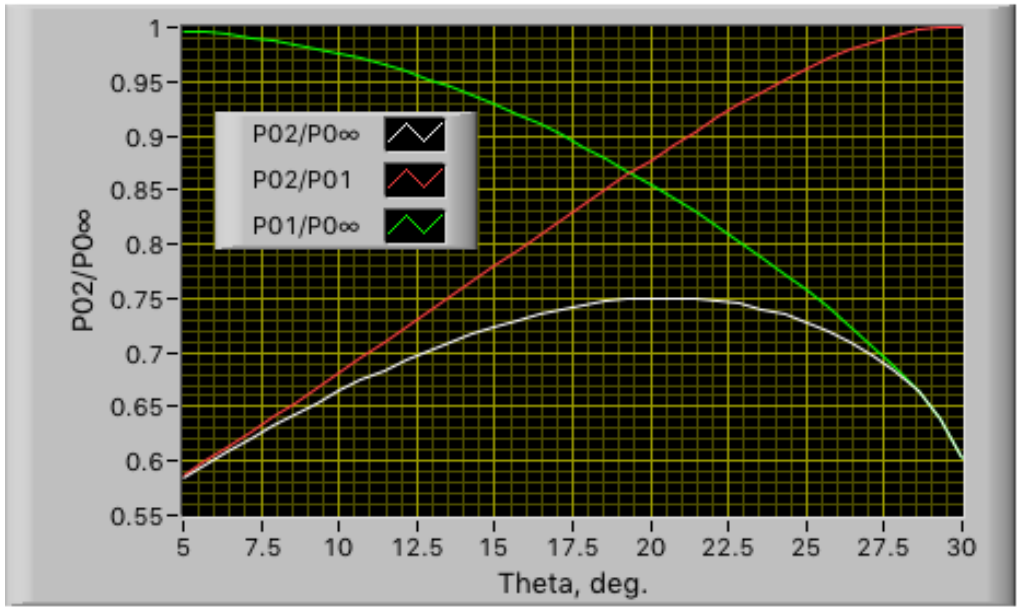
$$M_{2_{n_{weak}}} = M_{2_{n_{weak}}}$$

20 deg. Wedge Angle Example

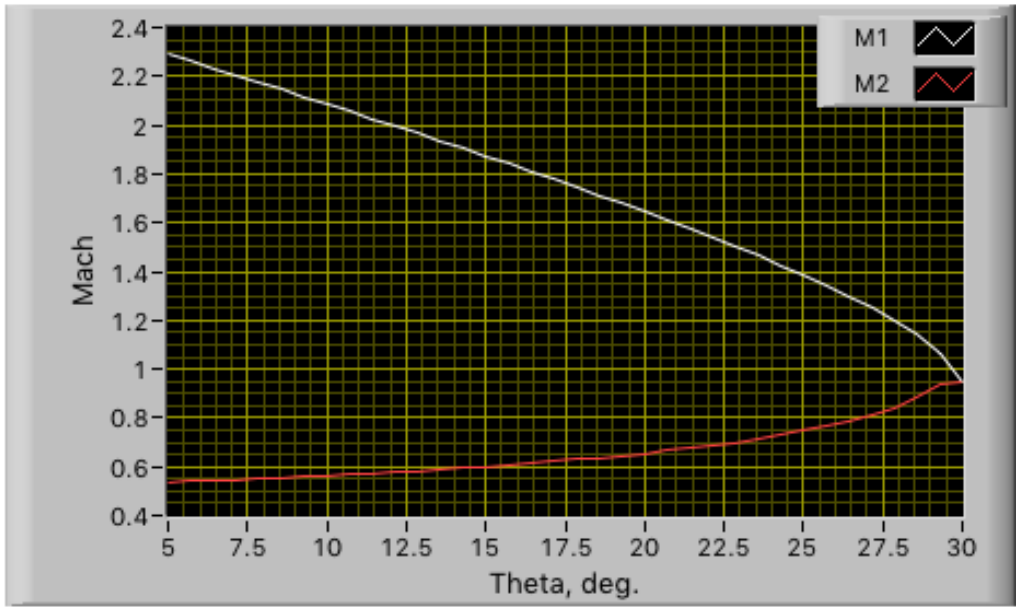
$$M_{\infty} = 1.84$$



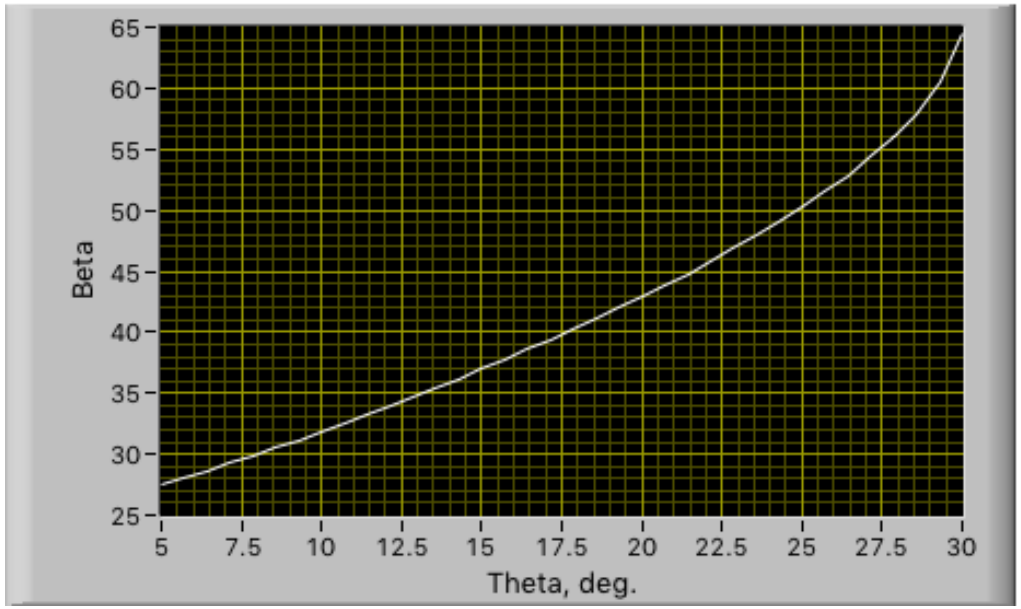
Stagnation Pressure Ratio



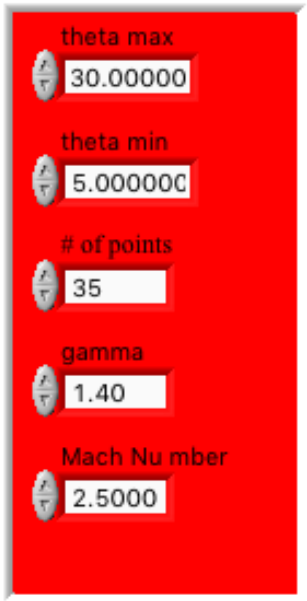
Mach Number



Obliaque Shock Angle



Input data



EXAMPLE OPTIMIZATION

Section 6: Home Work #7 *(Part 2 continued)*