Variable-Geometry Throat Example: Design an isotropic CD inlet, with a variable geometry throat for design mach number $M_d = 3.3$

1. inlet design contraction ratio $\frac{A_1}{A_{th}}$
2. percent opening of throat to start the inlet
3. throat mach number after starting shock is swallowed

A:

1. First get $\frac{A}{A^*}$ for $M - 3.3$.

```
[M,Tr,Pr,¬,Ar] = flowisentropic(1.4,3.3,'mach'); -> 5.6286
```

$$\frac{A_1}{A_{th}} = 5.629 \qquad \text{From normal shock function}$$

```
[M0,T,P,rho,M1,P0,P1] = flownormalshock(1.4,3.3) -> M_1=0.4596
```

With the new mach number we go back to the instrompic fuction to find the $\frac{A}{A_{th}}$

```
[M,Tr,Pr,¬,Ar] = flowisentropic(1.4,0.4596,'mach'); -> Ar=1.4256
```

$$\boxed{\frac{A_1}{A_{th}`} = 1.4256} \qquad \text{We can do this because } A_{th} \text{ is chocked so it corresponds to } A^*$$

2. $$\frac{A_{th}` - A_{th}}{A_{th}} \times 100 = \frac{\frac{A_{th}`}{A_1} - \frac{A_{th}}{A_1}}{\frac{A_{th}}{A_1}} \times 100 = \frac{\frac{1}{1.425}` - \frac{1}{5.629}}{\frac{1}{5.629}} \times 100 \rightarrow \boxed{\frac{\Delta A_{th}}{A_{th}} = 295\%}$$

3. $$\frac{A_{th}`}{A^*} = \frac{A_{th}`}{A_1} / \frac{A^*}{A_1} = \frac{1}{1.425} / \frac{1}{5.629} = 3.95$$

```
[M,Tr,Pr,¬,Ar] = flowisentropic(1.4,3.95,'sup')-> M=2.927
```

$$\boxed{M_{th}` = 2.927}$$

Example of K-D Inlet: Design a self starting CD inlet for $M_D = 2.65$. Calculate...

1. inlet contraction ratio $\frac{A_1}{A_{th}}$
2. maximum total pressure recovery (at best back-pressure)

A:

1. From the normal shock relations at $M_D = 2.65$

```
[M0,T,P,rho,M1,P0,P1] = flownormalshock(1.4,2.65) -> M1=0.4996
```

From isotropic relations at $M_1 = 0.4996$

```
1      [M,Tr,Pr,¬,Ar] = flowisentropic(1.4,0.4996,'mach')-> Ar=1.3406
```

$\boxed{\frac{A_1}{A^*} = 1.3406}$

2. Next need to find throat Mach number after thr shock sweeps through. Using instropic relations at $M = 2.65$

```
1      [M,Tr,Pr,¬,Ar] = flowisentropic(1.4,2.65,'mach') -. Ar=3.0359
```

$\frac{A_{th}}{A^*} = \frac{A_1}{A^*} / \frac{A_1}{A^th} = 3.0359/1.3406 = 2.2646$ using the isentropic table where M¿1.

```
1      [M,Tr,Pr,¬,Ar] = flowisentropic(1.4,2.2646,'sup') -> M=2.3353
```

the best back pressure places the shcok at the throat

```
1      [M0,T,P,rho,M1,P0,P1] = flownormalshock(1.4,2.3353)-> P0=0.5678
```

$\boxed{\text{Best Back Pressure} = 0.5678}$