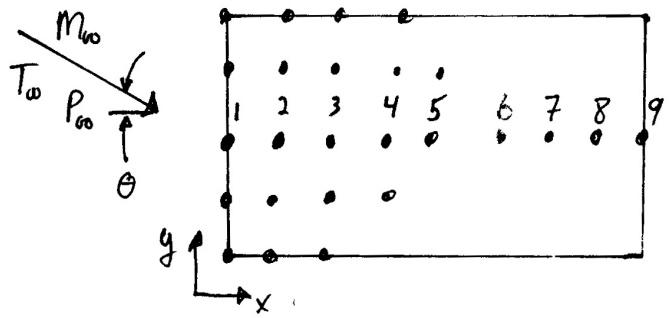
Computational Aerodynamics
Assignment 5 — Boundary Conditions

Question #1

Consider the following domain:



The freestream properties correspond to $M_\infty = 2$, $T_\infty = 300$ K, $P_\infty = 1$ atm, $\theta = 30^\circ$ and the properties on the nodes at the iteration n are as follows:

Node	P^n, atm	T^n, K	u^n, m/s	v^n, m/s
1	1.0	300	400	-400
2	1.1	310	300	-300
3	1.1	310	300	-300
4	1.2	320	200	-300
5	1.2	330	200	-200
6	1.3	340	100	-200
7	1.3	340	100	-100
8	1.4	350	100	-100
9	1.4	360	100	-100

Knowing that the node spacing is constant, do the following:

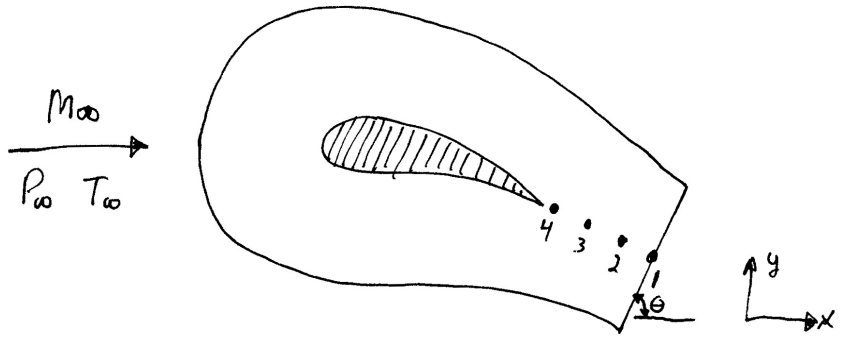
(a) Find the properties at iteration $n + 1$ at node 1 using a 2nd degree polynomial to extrapolate the properties.

(b) Find the properties at iteration $n + 1$ at node 9 using a 2nd degree polynomial to extrapolate the properties.

Outline clearly what kind of boundary condition (subsonic inflow/outflow, supersonic inflow/outflow) you are choosing and why.

Question #2

Consider the following domain:



The freestream properties correspond to $M_\infty = 0.7$, $T_\infty = 300$ K, $P_\infty = 1$ atm, $\theta = 70^\circ$ and the properties on the nodes at the iteration n are as follows:

Node	P^n, atm	T^n, K	u^n, m/s	v^n, m/s
1	1.0	300	100	-80
2	1.1	330	130	-100
3	1.1	350	150	-130
4	1.2	380	170	-160

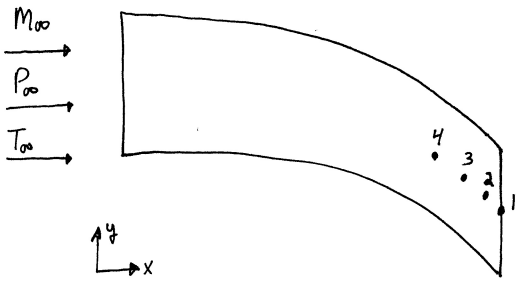
Knowing that the node spacing is constant, do the following:

(a) Find the properties at iteration $n + 1$ at node 1 using a 1st degree polynomial to extrapolate the properties.

Outline clearly what kind of boundary condition (subsonic inflow/outflow, supersonic inflow/outflow) you are choosing and why.

Question #3

Consider a computational domain as follows:



with the gas constant $R = 286$ J/kgK, the ratio of specific heats $\gamma = 1.4$, $P_\infty = 2$ atm, $T_\infty = 300$ K, and $M_\infty = 0.8$. Knowing the properties at nodes 1, 2, 3, and 4 at time level n:

Node	x, m	y, m	P^n, Pa	T^n, K	u^n, m/s	v^n, m/s
1	1.00	1.00	90000	310	400	30
2	0.99293	1.00707	90000	310	380	20
3	0.97879	1.02121	90000	350	350	10
4	0.96464	1.03535	90000	330	340	0

Do the following:

(a) Determine what kind of boundary condition node 1 is.

(b) Find the pressure and temperature at time level $n + 1$ at node 1 using a 2nd degree polynomial to extrapolate the properties from the inner nodes 2, 3 and 4.

Hint: the spacing between the nodes 4, 3, 2, and 1 can not be assumed constant.

Answers

1.

2. 1 atm, 310 K, 110 m/s, -70 m/s.

3. 267.5 K, 90 kPa.

Due on Thursday May 9th at 16:30. Do all questions.