THEORY AND FLUENT DATA

Volumetric flow rate	Q_V	8.33E-07	m^3/s
Width	W	0.04	m
Length	L	0.1	m
Gap	2H	0.0016	m
Aspect ratio	2H/W	0.04	1/AR=20
Area of cross section	A	0.000064	m^2
Flow velocity	U	0.013015625	m/s
Hydraulic diameter	DH	0.003076923	m
Temperature	T	288	K
Kinematic viscosity	ν	1.00E-06	m2/s
Density	ρ	998	kg/m3
Specific heat	Cp	4,187	J/kg-K
Thermal conductivity	K	0.598	W/m-k
Reynolds number	Re	40.04807692	
Prandtl number	Pr	8.00	
Expected flow development length	x	0.012322485	m
Expected thermal development length	xt	0.02	m
Inlet temperature	T_in	288	K
Bulk temperature at exit	T_out	310	K
Q to be supplied for getting above temperature	Q	76.61	W
Surface area (each side)	As	0.004	m2
Heat flux on each surface for above Q	q	9576.25	W/m^2
Nu_analytical	Nu	8.325	
h_analytical	h	1617.96375	W/m^2-K
Temperature difference	dT	5.918704915	K
Estimated maximum wall temperature	T_wall_max	315.9187049	K
		42.76870492	C
Total heat transfer rate	inlet	-441.4024963	W
	outlet	58.35807800	W
	wall	383.04998	W

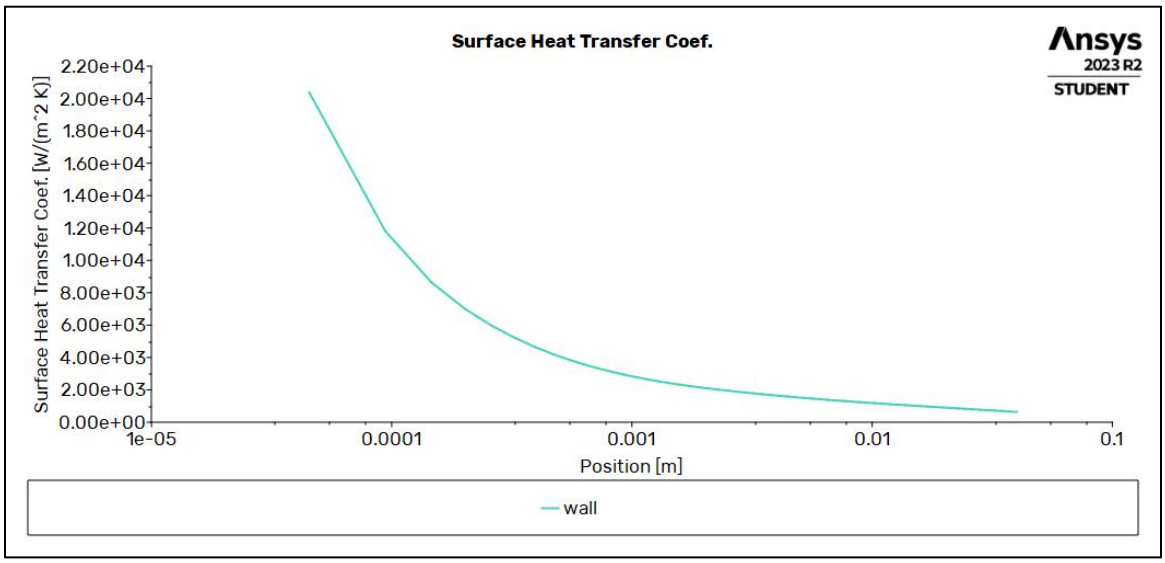
FLUENT			
Pressure drop	dP	2.575993	Pa
T_wall_max	T_wall_max	303	K
Wall shear	τ	0.05112791	Pa
Friction coefficient	Cf	0.604821805	
Pumping power	Q_p	2.1458E-06	W
flow development length	x	0.0128	m
Nusselt No	Nu	8.42	

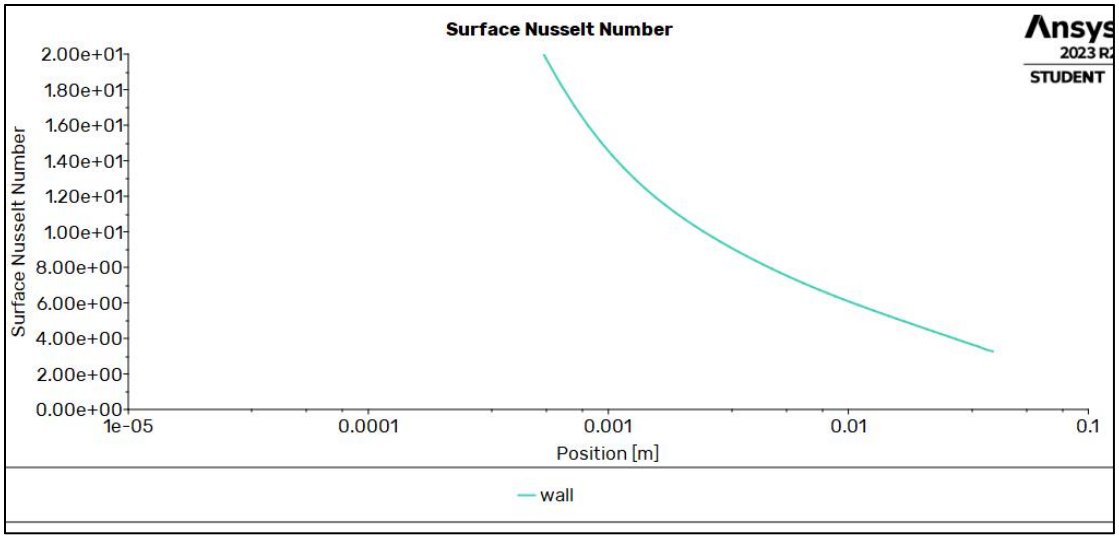
THEORY			
Wall shear for fully developed flow	τ	0.050659416	Pa
Friction coefficient	Cf	0.599279712	
Pressure drop for the length L	dP	1.646431008	Pa
Pumping power	Q_p	1.37148E-06	W

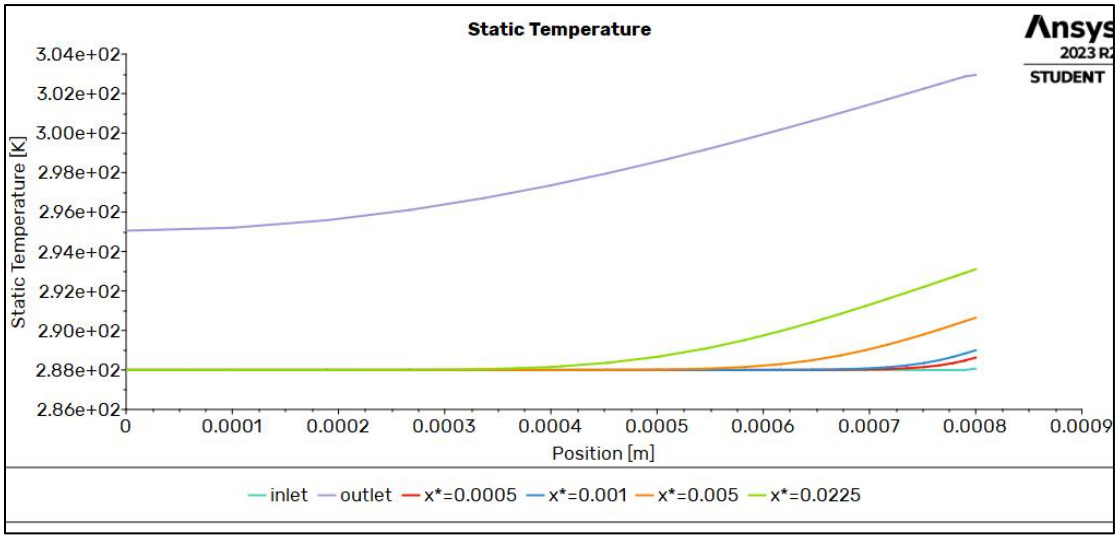
ERROR ESTIMATION			
Friction coefficient		0.9247923	%
Pumpimg power		56.45921316	%
Flow development length		3.87515006	%

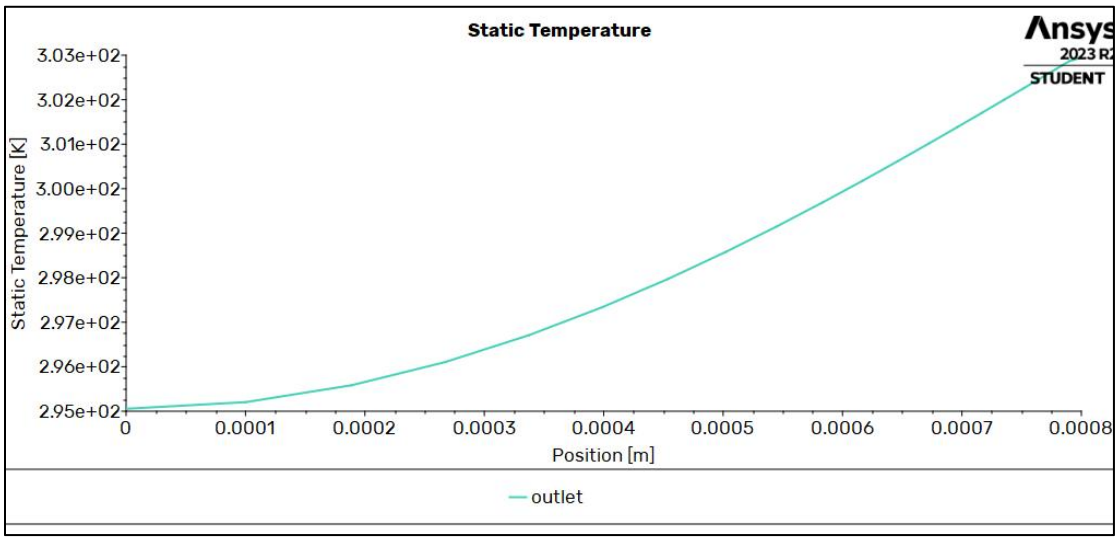
FLUENT PLOT RESULTS

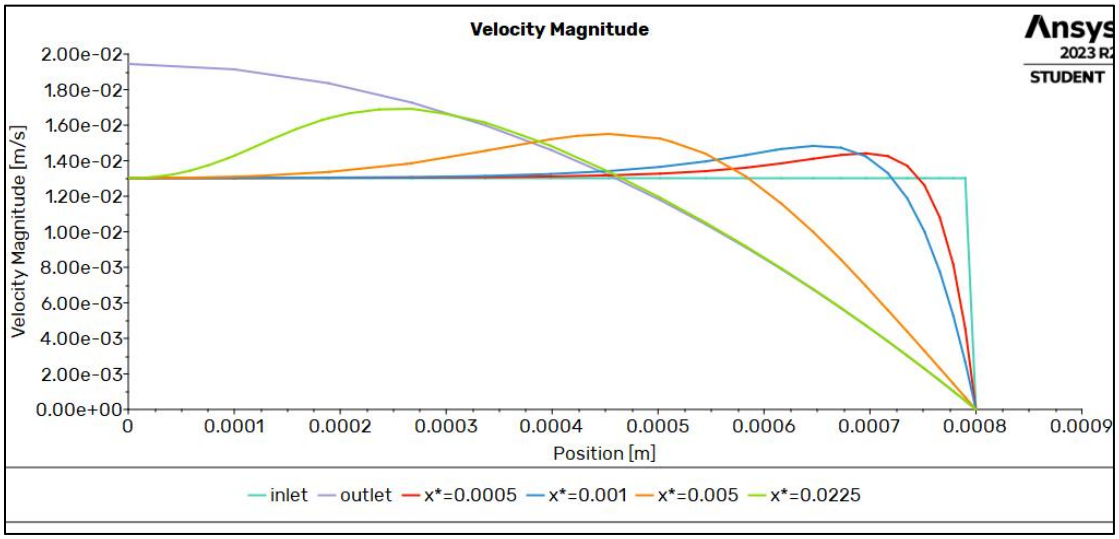
Sample plotting coordinates	x2	6.16124E-05	m
	x2	0.000123225	m
	x2	0.000616124	m
	x2	0.002772559	m
	y2	0.0008	m

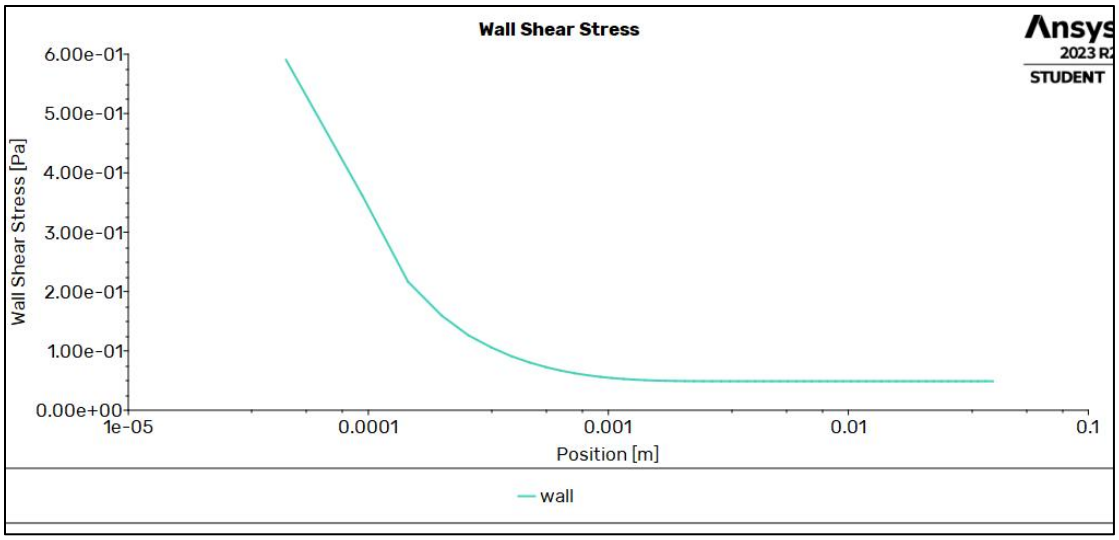



Surface Nusselt Number
Ansys
2023 R2
STUDENT
Surface Nusselt Number
2.00e+01
1.80e+01
1.60e+01
1.40e+01
1.20e+01
1.00e+01
8.00e+00
6.00e+00
4.00e+00
2.00e+00
0.00e+00
1e-05
0.0001
0.001
0.01
0.1
Position [m]
wall


Static Temperature
Ansys
2023 R2
STUDENT
Static Temperature [K]
3.04e+02
3.02e+02
3.00e+02
2.98e+02
2.96e+02
2.94e+02
2.92e+02
2.90e+02
2.88e+02
2.86e+02
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
Position [m]
inlet
outlet
x*=0.0005
x*=0.001
x*=0.005
x*=0.0225

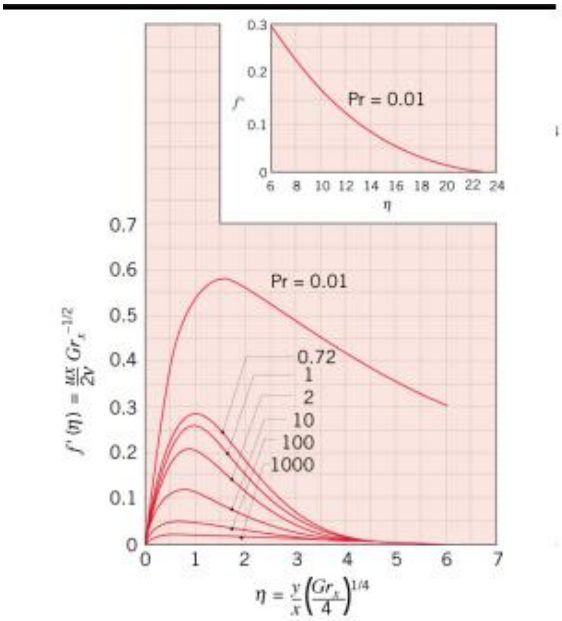

Static Temperature
Ansys
2023 R2
STUDENT
Static Temperature [K]
3.03e+02
3.02e+02
3.01e+02
3.00e+02
2.99e+02
2.98e+02
2.97e+02
2.96e+02
2.95e+02
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
Position [m]
outlet


Velocity Magnitude
Ansys
2023 R2
STUDENT
Velocity Magnitude [m/s]
2.00e-02
1.80e-02
1.60e-02
1.40e-02
1.20e-02
1.00e-02
8.00e-03
6.00e-03
4.00e-03
2.00e-03
0.00e+00
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
Position [m]
inlet
outlet
x*=0.0005
x*=0.001
x*=0.005
x*=0.0225

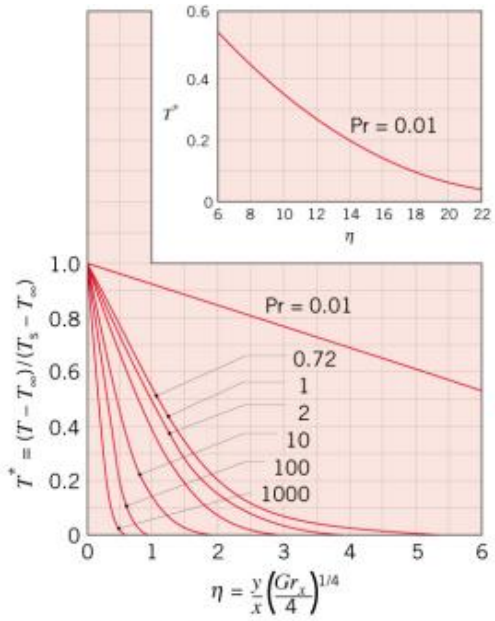

Wall Shear Stress
Ansys
2023 R2
STUDENT
Wall Shear Stress [Pa]
6.00e-01
5.00e-01
4.00e-01
3.00e-01
2.00e-01
1.00e-01
0.00e+00
1e-05
0.0001
0.001
0.01
0.1
Position [m]
wall

				NATURAL CONVECTION					
				length(L)	10	mm			
				Tw	78	deg C			
				Tambient	25	deg C			
				T_mean	51.5	deg C			
			Properties of air at T_mean						
				Nu					
				Pr	0.7228				
				nu	0.00001798	m^2/s			
				beta	0.00308166	K^-1			
	(g*beta*(Tw-Tamb)*L^3)/nu^2			Gr	4956.22257				
	Gr*Pr			Ra	3582.357673				
			As Ra <(10^9) ,Convection is laminar						
			Calculate BL thickness at TE ,by considering eta=6 from fig						
				at eta	6				
eta=(y/x)*((Gr/4)^0.25))			Thermal BL thickness		0.010112966	m			
					10.11296602	mm			
			From Fig the max.Velocity is at eta=1						
				eta	1				
				f(eta)	0.28				
				T*	0.5				
	T*=(T-Tamb)/(Tw-Tamb)			T_max vel	324.5	K		**From CFD**	
				y_max vel	1.68	mm		1mm	
	f(eta)=(ux/2*nu)*(Gr^-0.5)			max_vel	0.071	m/s		0.11m/s	
		FROM CFD	**From emperical**						
	h (W/m^2-K)	12.11744	13.01						
	q (W/m^2)	642.2243	689.49						
	Q (W)	1.503677	1.614						

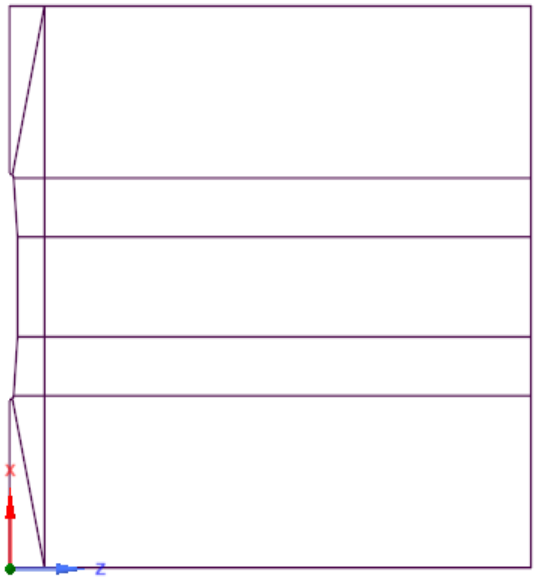
	% ERROR
y_max vel	40.5
max_vel	-54.9
h (surface heat transfer coefficient)	6
Q(heat rate)	7



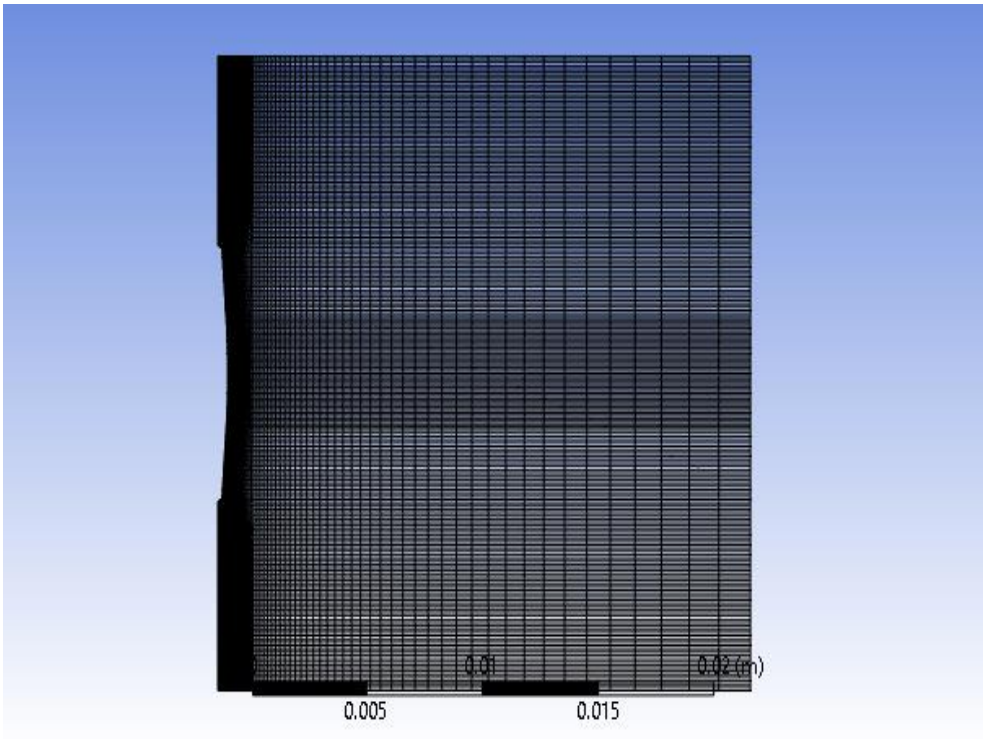
dimensionless *x*-component velocity

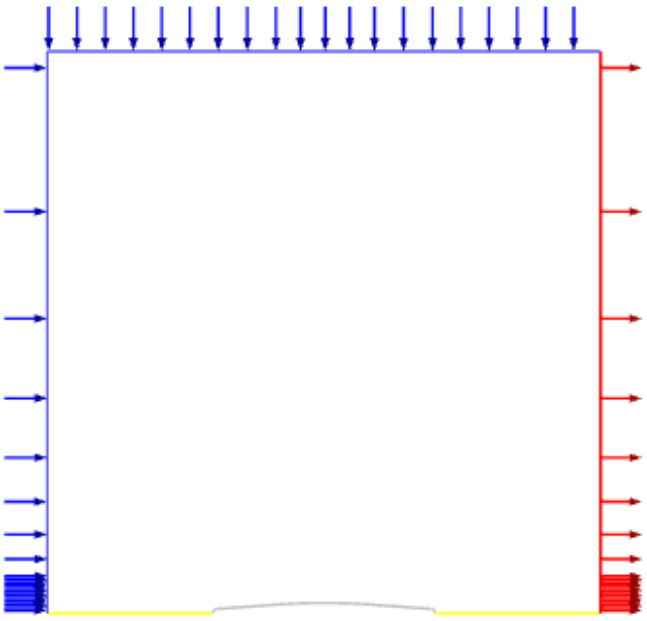


dimensionless temperature

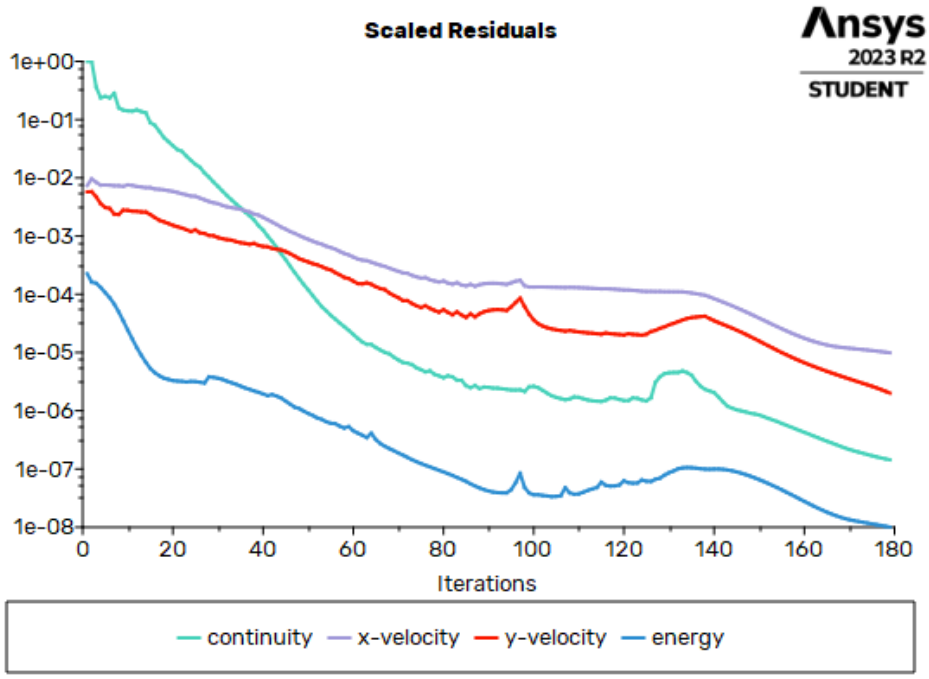


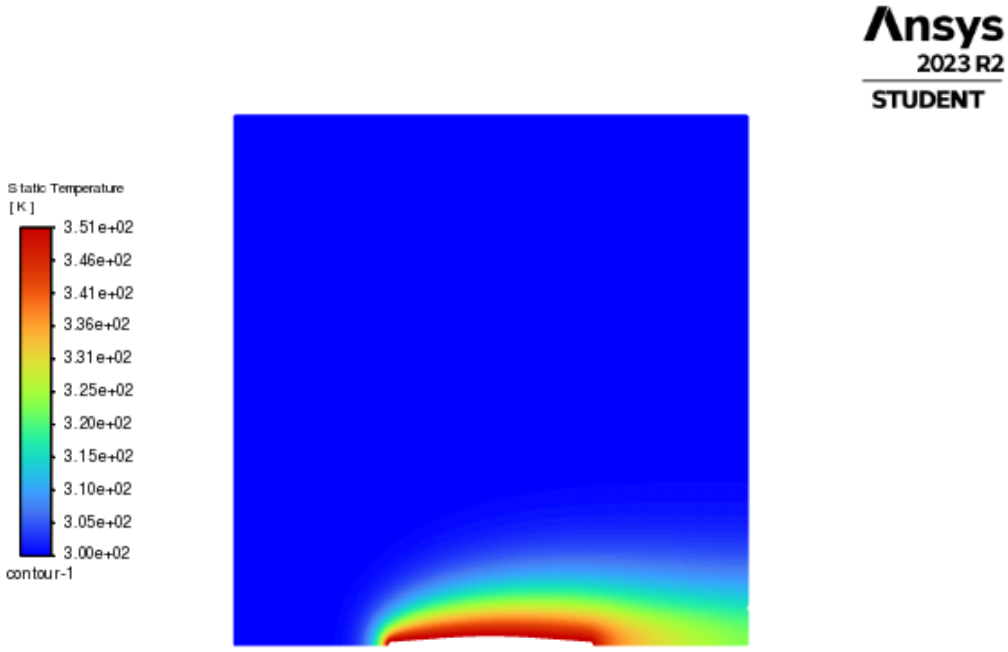
Geometric Model of the fin



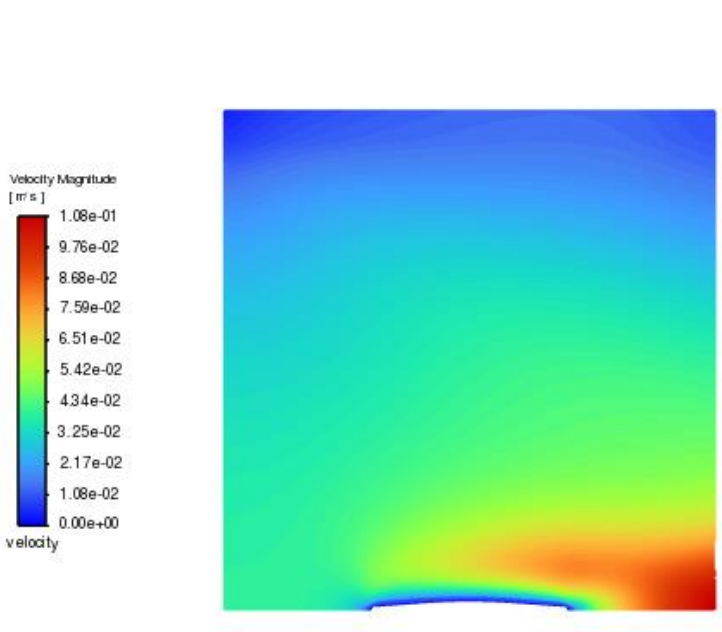


Solvent Domain

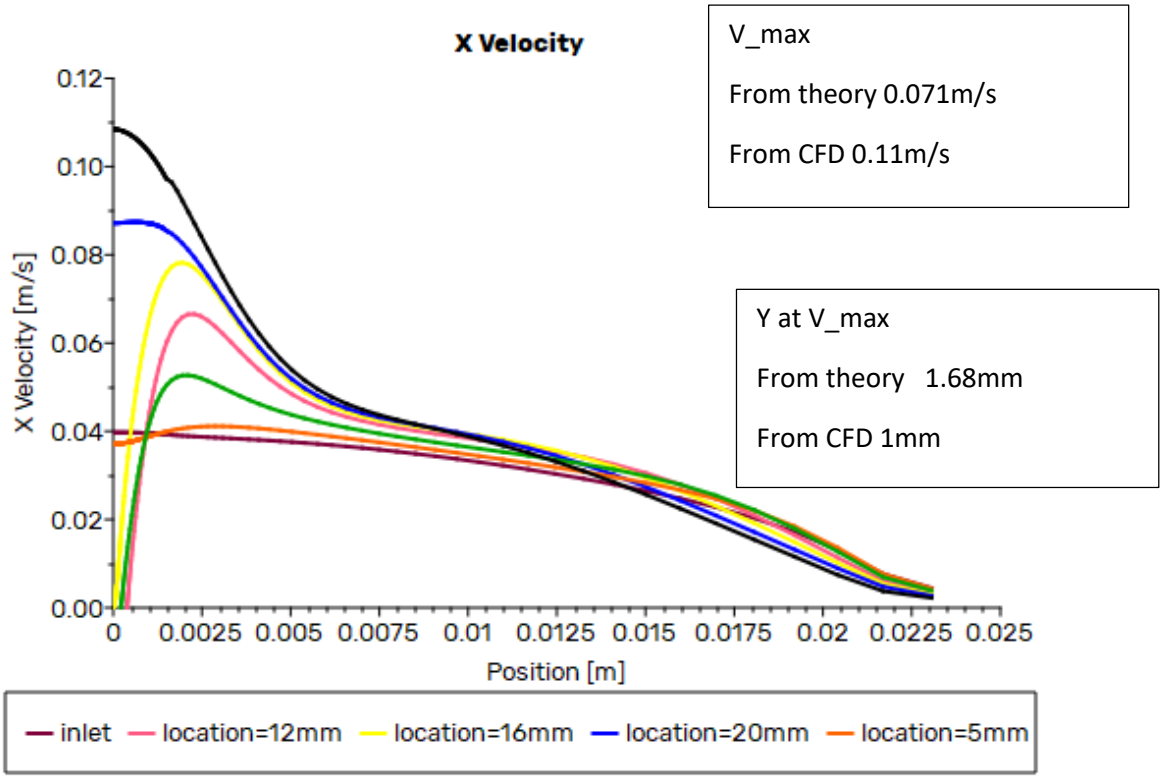




Static temperature contour



Velocity contour



V_max

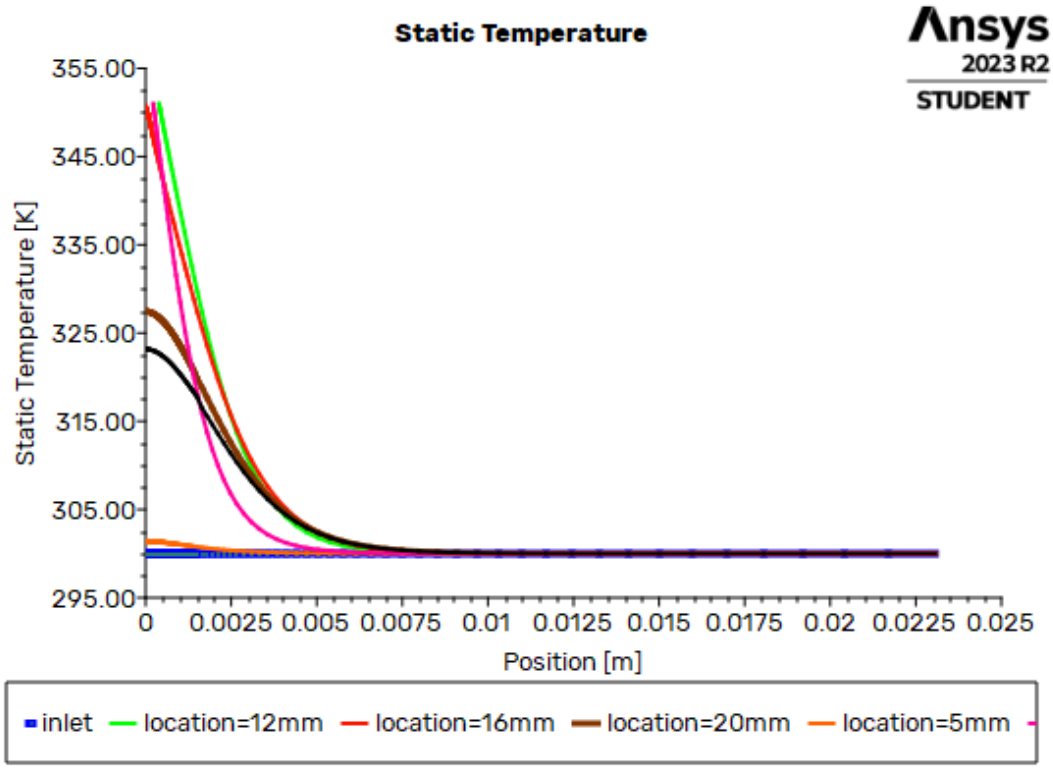
From theory 0.071m/s

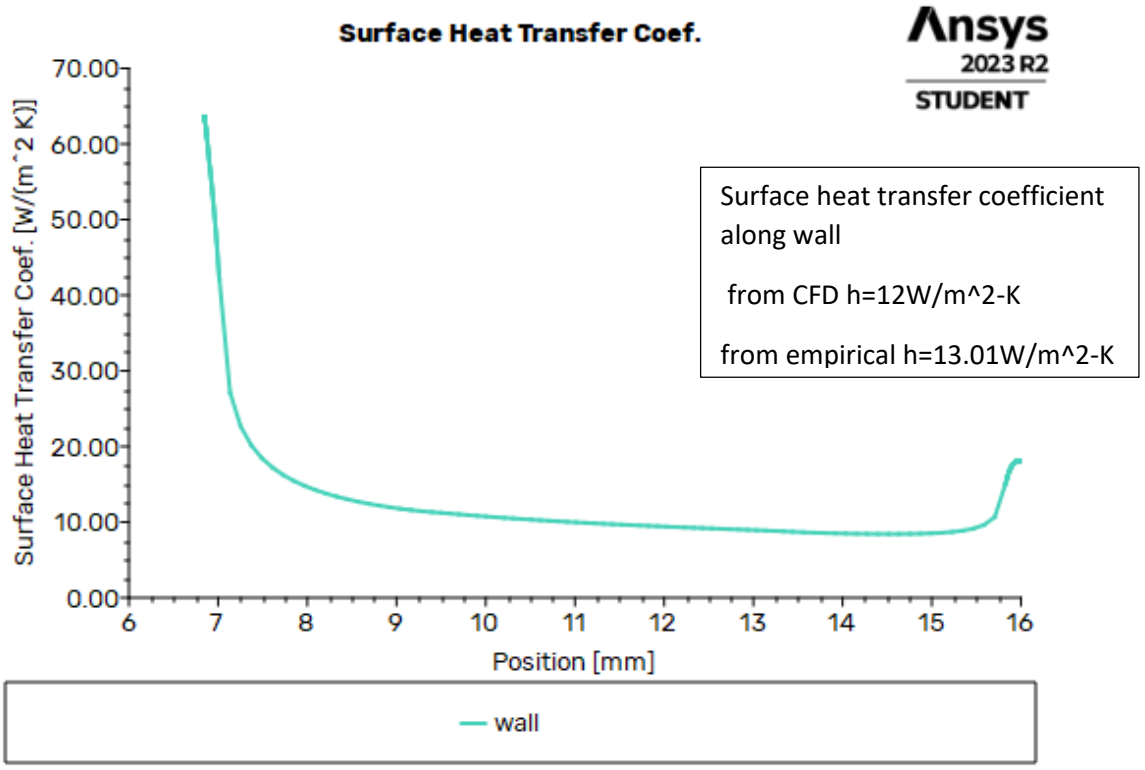
From CFD 0.11m/s

Y at V_max

From theory 1.68mm

From CFD 1mm





Surface heat transfer coefficient along wall

from CFD h=12W/m^2-K

from empirical h=13.01W/m^2-K