

Name: _____

EMBRY-RIDDLE AERONAUTICAL UNIVERSITY
Aerospace Engineering

AE 302 – Aerodynamics II
Sample Examination 3

Questions (4 points each)

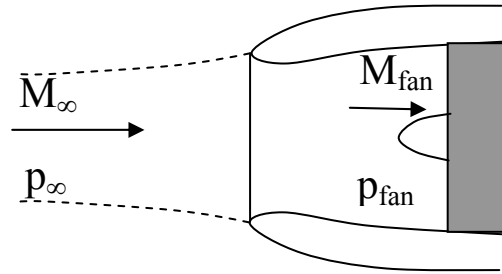
- 1) When the maximum possible flow rate is reached in a Laval nozzle, we say the flow is _____.
- 2) When the first set of waves in a jet exhaust are oblique shockwaves, we say the nozzle is (over-expanded, under-expanded, ideally expanded).
- 3) Write the equation for Newton's Law of Friction.
- 4) Is δ (greater than, less than, equal to) δ^* ?
- 5) If a laminar boundary layer velocity profile has a positive curvature, d^2u/dy^2 , at the wall, then the pressure gradient (favorable, adverse, zero)?
- 6) Drag is closest related to which thickness parameter?
- 7) Viscosity is primarily function of what other fluid property?
- 8) In an adiabatic flow, a gas with a higher Prandtl number will have a (warmer, cooler, same) wall temperature than one with a lower value.
- 9) The hypersonic boundary layer thickness on a cooled wall is (thicker than, thinner than, the same as) on an adiabatic wall.
- 10) The _____ equations are the boundary layer equations that have been averaged over time.

Problems (20 points each)

- 1) A rocket nozzle with an area ratio of 25 uses compressed air at 18.24 atm and $T=500^\circ\text{R}$ total conditions to generate thrust. Calculate the thrust this rocket produces at sea level ($p_{\text{atm}} = 1$ atm) if the throat diameter is 0.25 inches.

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- 2) A captured streamtube on a subsonic diffuser has an area ratio of 1.154 between the engine fan section and the freestream. If the freestream Mach number is 0.75 and the free stream temperature and pressure are 450°R and 1000 lb/ft^2 , find the velocity and pressure at the fan.



- 3) Your desk fan blows over a $8\frac{1}{2}$ " by 11" piece of paper on the edge of your desk.. If the air flow is 6 ft/sec, calculate the net friction force on the paper if the 11" side is perpendicular to the flow. Assume sea level standard conditions and laminar flow.