MEC 393: Fluid Mechanics II
Instructor: Professor J. Sesay
Midterm 2: May 08, 2025,
Open Book- To be submitted on Friday (May 09, 2025) before 1:00 PM
Answer all the questions (100 points).

1. Air enters a frictionless tube of constant cross-sectional area of diameter 16 cm. At inlet to the tube, air is at 600 K, 420 kPa, and 80 m/s. Combustion occurs by injecting hydrocarbon fuel with a heating value of 39,000 kJ/kg into the combustion chamber to initiate burning. Given that the exit Mach number to be 0.8. Take the specific heat at constant pressure to be 1.005 kJ/kg, k=14, and gas constant of air is 0.287 kJ/kgK. The hydrocarbon fuel has a heating value of 39,000 kJ/kg. Determine the missing values in the table below

Property	Value	unit
Inlet critical speed of sound, c		m/s
Inlet stagnation temperature T01		K
Inlet Mach number, Ma1		-
Exit temperature, T2		K
Exit pressure, P2		kPa
Exit velocity, V2		m/s
Mass flow rate of air		Kg/s
Exit stagnation temperature, T02		K
Heat added to the combustion tube		kW
Mass flow rate of the fuel		Kg/s

2. Consider an adiabatic duct of constant cross sectiona area of diameter 12 cm. Air enters the duct with with the following property values of 500 k, 250 kPa and 224 m/s. Assume the average friction factor of the duct to be 0.023 and the duct exit Mach number to be 0.9. Assume properties of air: specific heat to be 1.005 kJ/kgK, gas constant to be 0.287 kJ/kgK and K=1.4. Determine the missing values in the table below

Property	Value	unit
Inlet critical speed of sound, c		m/s
Inlet Mach number, Ma1		-
Exit temperature T2		K
Exit Pressure P2		kPa
Exit velocity V2		m/s
Length of the duct		m
Inlet stagnation temperature T01		K
Exit stagnation temperature, T02		K
Inlet stagnation enthalpy h01		kJ/kg
Exit stagnation enthalpy h02		kJ/kg
Stagnation pressure ratio p02/p01		