

AI-Menoufia University

Department of Mechanical
Power Engineering
ME 523 Final Exam

(100 Points)

Combustion Systems
and Measurements
Time: 3 Hours

Answer the following. State your assumptions clearly. Use sketches, charts, tables, or otherwise illustrations as required.

1) Discuss the differences between the paraffins C_nH_{2n+2} , olefins and naphthenes, C_nH_{2n} , and aromatics, C_nH_{2n-2} , as hydrocarbon fuels used in internal combustion engines with regard to heating value, fluidity, viscosity, volatility, or otherwise requirements controlling engine performance. What additives are usually used with respect to enhancing the performance, (e.g., knock retardants, antioxidants agents, etc.) (20 Points)

2) The exhaust gas analysis of octane burned with air gave the following composition of the products on a *dry* basis is given below. Calculate the actual (A/F) ratio and the excess air used in the combustion process. (20 Points)

CO ₂	CO	O ₂	N ₂
9%	1.3%	7.8%	81.9%

3) A mole of carbon monoxide is burned with 200% theoretical air in a steady flow process at atmospheric pressure and 25 °C, while the products leave at 2200 K. Determine the extent of reaction λ and the amount of heat transferred Q. Assume the initial number of moles of the reactants equal the respective stoichiometric coefficients ν . (20 Points)

4) Propane, C_3H_8 , is burned with 300% excess air at 25 °C, calculate the adiabatic flame temperature T^* . Find also the explosion pressure if the process takes place at constant volume. Use T^* as the flame temperature per 1 kg-mole of the fuel. (20 Points)

5) A natural gas has the compositions by volume below is burned with 100% excess air. Find the air to fuel ratio, the molal analysis of the products, and the dew point if the pressure is 100 kPa.

CH ₄	C ₃ H ₈	C ₂ H ₆	C ₄ H ₁₀	O ₂	N ₂
55%	17%	16.1%	6.8%	2%	3.1%

(Allowed JANAF Tables, Psychometric Charts, Steam Tables, c_p Tables, Properties of Ideal Gases Tables)