

AE 422 Flight Propulsion I (071)

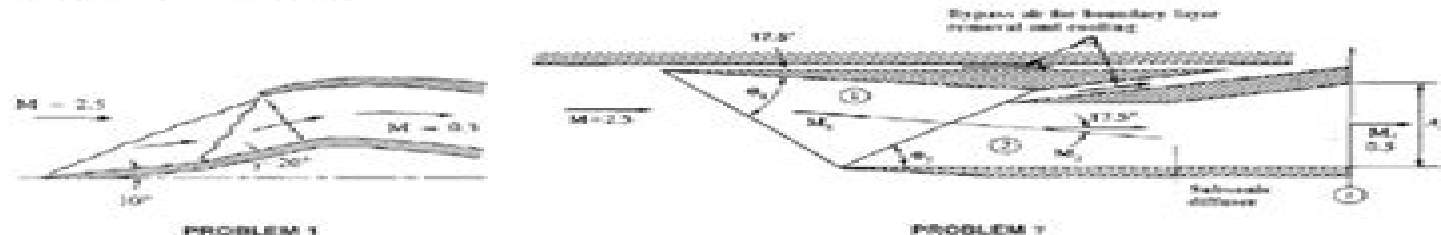
Homework No. 3

Assigned: 24-10-28H/05-11-07G

Due Date: 02-11-28H/12-11-07G

Problems 1, 7, 8, 15 of chapter 6

1. A two-dimensional or wedge-type diffuser consists of two external oblique shocks, a normal shock, and a subsonic internal section, as shown in the figure. Assuming no external losses other than shock losses, and assuming the subsonic section stagnation pressure loss is 3%, find the overall total pressure ratio at a flight Mach number of 2.5. Sketch the inlet shock system roughly to scale and label all angles.



7. A new supersonic passenger aircraft is being designed for flight Mach number 2.5 at an altitude where the ambient pressure and temperature are 9 kPa and 220 K, respectively. The engine inlet configuration shown below allows for double oblique shock deceleration followed by a zone of subsonic deceleration. The Mach number is 0.5 at the engine inlet plane (i). Losses in the subsonic diffuser are neglected. Determine:

- The Mach numbers M_1 and M_2 in the zones (1) and (2) shown on the drawing.
- the wave angles θ_1 and θ_2 , also shown on the drawing.
- the overall stagnation pressure ratio $p_{0i}/p_{0\infty}$.
- the overall static pressure ratio $p_i/p_{0\infty}$.
- the velocity ratio c_1/c_2 for the subsonic diffuser, and
- the cross-sectional area A_i (m^2) at the engine inlet plane if the engine mass flow rate is 500 kg/s.

8. A ramjet engine is to fly at a Mach number of 4 in an atmosphere whose temperature is 223 K. At entrance to the burner, the Mach number of the flow is 0.3. Combustion in the burner (whose cross-sectional area is constant) may be represented approximately as heating of a perfect gas with constant specific heat ratio. At the exit from the burner the temperature of the gas is 2462 K. Neglecting frictional effects in the burner and considering the flow to be one-dimensional throughout, estimate the Mach number of the gas leaving the burner. Determine also the stagnation pressure loss due to heating (i.e., calculate the ratio of outlet and inlet stagnation pressures).

15. The hot gas supply to a propulsion nozzle is at a pressure of 55 kPa and a temperature of 800 K. The ambient pressure is 15 kPa. If the ratio of specific heats is 1.33, approximately constant, and the molecular weight of the mixture is 30, determine the ratio of gross thrusts for two cases:

- The nozzle is converging-diverging with the area ratio for correct expansion to ambient pressure.
 - The nozzle is converging only.
- What is the nozzle-exit-to-throat area ratio for case (a)? The gross thrust is the contribution to engine thrust made by the exhaust nozzle only.

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Fundamentals of Engineering Thermodynamics Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, 2010-12-07 This leading text in the field maintains its engaging readable style while presenting a broader range of applications that motivate engineers to learn the core thermodynamics concepts Two new coauthors help update the material and integrate engaging new problems Throughout the chapters they focus on the relevance of thermodynamics to modern engineering problems Many relevant engineering based situations are also presented to help engineers model and solve these problems **Fundamentals of Engineering Thermodynamics Solutions Manual** Michael J. Moran, 1999-12-01

GAS DYNAMICS, Seventh Edition RATHAKRISHNAN, E., 2020-07-01 This revised and updated seventh edition continues to provide the most accessible and readable approach to the study of all the vital topics and issues associated with gas dynamic processes At every stage the physics governing the process its applications and limitations are discussed in detail With a strong emphasis on the basic concepts and problem solving skills this text is suitable for a course on Gas Dynamics Compressible Flows High speed Aerodynamics at both undergraduate and postgraduate levels in aerospace engineering mechanical engineering chemical engineering and applied physics The elegant and concise style of the book along with illustrations and worked out examples makes it eminently suitable for self study by students and also for scientists and engineers working in the field of gas dynamics in industries and research laboratories The computer program to calculate the coordinates of contoured nozzle with the method of characteristics has been given in C language The program listing along with a sample output is given in the Appendix NEW TO THE EDITION A new chapter on the Power of Compressible Bernoulli Equation Extra chapter end examples in Chapter 5 Additional exercise problems in Chapters 5 6 7 and 8 KEY FEATURES Concise coverage of the thermodynamic concepts to serve as a revision of the background material Introduction to measurements in compressible flows and optical flow visualization techniques Introduction to rarefied gas dynamics and high temperature gas dynamics Solutions Manual for instructors containing the complete worked out solutions to chapter end problems In depth presentation of potential equations for compressible flows similarity rule and two dimensional compressible flows Logical and systematic treatment of fundamental aspects of gas dynamics waves in the supersonic regime and gas dynamic processes TARGET AUDIENCE BE B Tech Mechanical Engineering Aeronautical Engineering ME M Tech Thermal Engineering Aeronautical Engineering Subject Guide to Books in Print, 1993 **Thermodynamics** Naseem Uddin, 2024-07-01 Thermodynamics Fundamentals and Applications offers a blend of theory and practical applications for a complete understanding of thermodynamics for various engineering applications Beginning with a basic introduction and principles of thermodynamics the book advances to more specialized topics like organic Rankine cycle gas mixtures equilibria and chemical reactions Exploring the first law of thermodynamics different types of energies and their practical applications in engineering devices the text covers enthalpy heat transfer and work interactions with a focus on macroscopic and

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