1. Course Learning Objectives

- **Analyze Gas Turbine Engines (Brayton Cycle):** Problem 1 required a multi-stage analysis of a gas turbine with intercooling and regeneration. This demonstrated my ability to apply the First and Second Laws of Thermodynamics to complex, multi-component power cycles.
- **Analyze Jet Propulsion Systems:** Problem 2 involved the thermodynamic modeling of a turbojet engine, specifically evaluating the performance of diffusers, compressors, turbines, and nozzles to calculate net thrust.
- **Interpret Thermal System Efficiency:** The requirement to determine the effectiveness of a regenerator tested my ability to move beyond rote calculation and develop a physical intuition for heat transfer limits within a system.

2. Solution Comparison and Error Analysis

Comparing my test against the solutions revealed both successes and significant technical oversight.

- **Problem 1 (Success):** I correctly determined that the initial regenerator design was ineffective because the turbine exit temperature (T4 = 556K) was lower than the compressor exit temperature (T2 = 585.7K). I successfully calculated the final efficiency of 53% for the modified two-stage system, which matched the solution's benchmarks.
- **Problem 2 (Mistake):** My calculation for the nozzle exit velocity resulted in **25.53 m/s**, which led to a negative net thrust of **-6,638,776 N**.
    - **The Error:** I made a mistake in the enthalpy balance at the nozzle. By using incorrect values from the gas tables or failing to account for the magnitude of the enthalpy drop across the nozzle, the resulting velocity was lower than the flight speed (250 m/s).
    - **Future Prevention:** I should have performed a "sanity check." A jet engine producing millions of Newtons of *negative* thrust is physically impossible for a functioning aircraft. Next time, I will double-check enthalpy and kinetic energy units and ensure that the exit velocity is higher than the flight velocity before proceeding with thrust calculations.

3. Assessment of Grade and Quality

- **Grade Estimation:** Based on the rubric provided, I would estimate a grade of 78/100.
    - **Strengths:** The technical writing was organized, utilized clear T-s diagrams, and the logic for Problem 1 was sound.
    - **Weaknesses:** The significant error in Problem 2’s final result directly impacts the "Calculations" and "Results" categories of the grading rubric.

- **Quality Insight:** The artifact demonstrates a high level of effort in diagramming and procedural layout, but it lacks the critical "results verification" step that separates a student solution from a professional engineering report.

4. Comprehensive Discussion

a. Issues & Troubleshooting: The main issue was calculating the state properties for the turbojet nozzle. I attempted to troubleshoot by re-reading the gas tables, but I ultimately missed a unit conversion or a sign error in the energy balance equation.

b. Steps Taken: I began by sketching the T-s diagrams for each cycle to visualize the energy transfers. I then solved for temperatures at each state point. If I were to change my process, I would solve the entire problem symbolically before plugging in numbers to catch unit errors earlier.

c. New Concepts Learned: I gained a deeper understanding of intercooling. Seeing how it lowers the compressor work and makes regeneration viable (by lowering T2) was a key "aha" moment.

d. Engineering Application: These concepts are essential for engineers designing Combined Cycle Gas Turbines (CCGT) for power grids or High-Bypass Turbofans for commercial aviation. For example, GE or Rolls-Royce engineers use these exact thermodynamic cycles to maximize fuel economy.

e. Future Application: I expect to use these principles when evaluating the efficiency of industrial HVAC systems or thermal power plants.

f. Professional Career Importance: This content is foundational. As an engineer, understanding the trade-offs between complexity (adding intercoolers/reheaters) and efficiency is vital for project cost-benefit analyses.

g. Future Use (Where/Why): I will use this skill set when performing energy audits or designing sustainable thermal systems, where every percentage point of efficiency gain translates to significant cost and carbon savings.

h. Application to Other Work: I have already started applying these energy balance concepts to my current work in thermal systems, particularly when assessing heat exchanger performance.

i. Success & Improvement: I improved the most in my ability to interpret T-s diagrams and connect them to physical components. My visualization skills are much stronger than they were at the start of the course.

j. Career Intersection: My career in thermal applications requires constant evaluation of thermodynamic efficiency. This course provides the mathematical framework to justify design changes to stakeholders.

k. Time Management: I spent approximately 6 hours on this test. I organized the time by tackling one cycle per evening. In the future, I will dedicate the final 2 hours purely to "sanity checking" results and verifying units to avoid the types of errors I made in Problem 2.