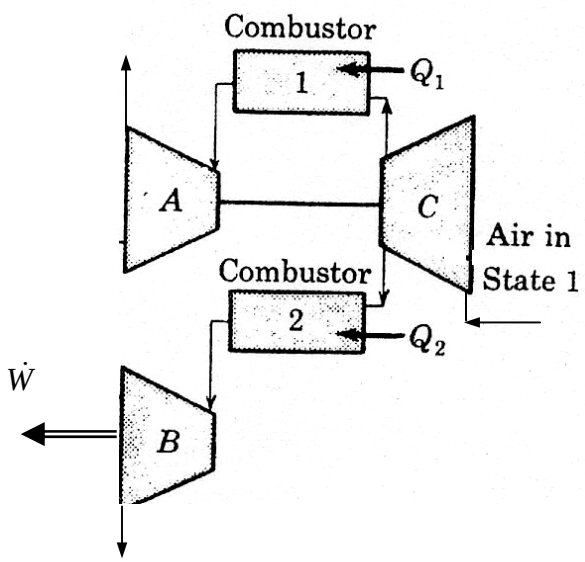
Unified Engineering Fall 2007
Thermodynamics & Propulsion Z. S. Spakovszky

(Add a short summary of the concepts you are using to solve the problem)

Problem T13

A gas-turbine unit consists of two turbines A and B, two combustors, and a single compressor C. Turbine A drives compressor C to furnish all air required while turbine B delivers 1.5 MW, the net power output $\dot{W}$. At state 1, p_1=100 kPa, T_1=300 K. The compressor pressure ratio is 5 and the inlet condition for each turbine is 500 kPa and 1000 K. Both turbines exhaust at 100 kPa. Assume that the working fluid is air with γ = 1.4 and R = 287 J/kgK.



a) Sketch the situation, introduce station labels, and determine the temperatures and pressures at all stations.

b) What is the mass flow through combustor 2?

c) Find the heat input rate $\dot{Q}_2$.

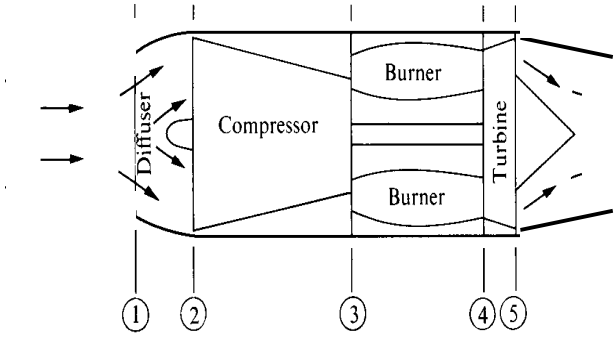
d) How much heat is added in combustor 1 $\dot{Q}_1$?

e) Determine the thermal efficiency for the entire unit.

(Add a short summary of the concepts you are using to solve the problem)

Problem T14

A jet aircraft is flying at an altitude of 4900 m, where the ambient pressure is approximately 55 kPa and the ambient temperature is –18 C. The velocity of the aircraft is 280 m/s and the stagnation pressure ratio across the compressor is 14. The maximum gas temperature in the engine is 1450 K. At the nozzle exit the air has been expanded to the ambient pressure. Assume that the air in the compressor can be modeled as an ideal gas with γ = 1.4 and R = 287 J/kgK. Use R=287 J/kgK and γ=1.3 for the combustion gas in the combustor, turbine and nozzle. The fuel mass flow can be neglected in this analysis and all components can be assumed ideal.



a) What are the stagnation states (relative to the aircraft) at the inlet, station 1?

b) Does the stagnation temperature and the stagnation pressure change from station 1 to station 2? Why or why not?

c) What is the stagnation temperature at combustor inlet, station 3?

d) Determine the thermal efficiency of this gas turbine engine.

e) What is the specific shaft work required to drive the compressor?

f) How much heat is added in the combustor per kg of air flow?

g) What are the stagnation states at turbine exit, station 5?

h) Determine the velocity (relative to the aircraft) of the air leaving the engine.