UBC MECH327 Assignment 6

One method of increasing the output of an internal combustion engine is turbo-compounding, in which the exhaust gases are expanded in an isentropic turbine to produce useful work as shown below. The engine can be modeled using an ideal Otto air standard cycle, with a compression ratio of 8:1. The engine is operating such that the maximum in-cylinder pressure is 8 MPa and the initial mixture temperature and pressure are 320 K and 90 kPa, respectively. Assume constant specific heat capacities of the working fluid at 300 K.

1. On the supplied Ts diagram, draw the corresponding air standard cycle for the turbo-compounded system (system (ii)). The isobars and isochores are intentionally not labelled on the diagram and correspond to:

$p = 10$ kPa, $v = 8$ m^3/kg, $T = 278.7$ K.
$p = 90$ kPa, $v = 1$ m^3/kg, $T = 313.6$ K.
$p = 1$ MPa, $v = 0.125$ m^3/kg, $T = 435.5$ K.
$p = 8$ MPa, $v = 0.0313$ m^3/kg, $T = 872.5$ K.

Identify the proper isoline for each process.

2. Find the 1st law efficiency of the engine (system (i))

3. Find the 1st law efficiency of the turbo-compounded engine (system (ii))

4. Find the additional work per unit mass of air provided by the turbine in system (ii)

5. Compare the total exergy destruction of the heat rejection process for each of the air standard cycles.