ME 322 – Mechanical Engineering Thermodynamics
EES Exam 2
Spring 2022

This is a non-collaborative take-home exam. Submit your own work.

Please read the following statement:

Article II, Section 1 of the University of Idaho Student Code of Conduct states,

> *Cheating on classroom or outside assignments, examinations, or tests is a violation of this code. Plagiarism, falsification of academic records, and the acquisition or use of test materials without faculty authorization are considered forms of academic dishonesty and, as such, are violations of this code. Because academic honesty and integrity are core values at a university, the faculty finds that even one incident of academic dishonesty seriously and critically endangers the essential operation of the university and may merit expulsion.*

I have read and understand the above statement.

_____ _____
Signature Date

_____ _____
Printed Name (no points, but make sure this is legible) Exam Score

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EXAM INSTRUCTIONS – PLEASE READ THIS CAREFULLY

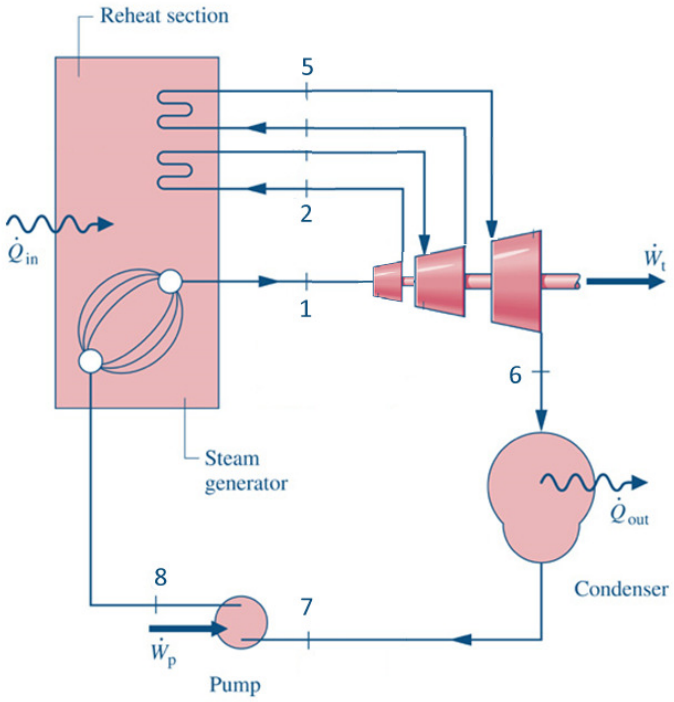
You will have several days to complete this exam. You may use your notes, the online course resources, your computer (EES, Google, etc.) and pretty much any non-human resource you can find. If you have questions, send them to me (I will have limited email access over the break).

You must write your own code. Working with other students or sharing code is not allowed and will result in a zero on the exam, and notification to the Dean of Students.

Print your EES code, and make sure it has all the following:

- **Equations (not the formatted equations)**
- **Solution (using Key Variables if asked)**
- **Arrays (where necessary)**
- **Parametric Tables (where necessary)**
- **Plots (where necessary)**

Double Reheat Steam Cycle



A steam power cycle that incorporates two reheat legs is shown in the figure above. Steam from the boiler enters the first turbine stage at 1600 psia and 1100 °F. The steam leaves the first turbine stage at P[2] and then enters the reheat section of the boiler where it is reheated back to 900 °F (assume no pressure drop). The steam then enters the second turbine stage, and leaves at P[4] to a second reheat where it increases temperature to 750 °F. It enters the third turbine stage where it expands to 1 psia. The working fluid is a saturated liquid at 1 psia when it leaves the condenser. Each stage of the turbine has an isentropic efficiency of 85% and the pump has an isentropic efficiency of 90%. The net power output of the cycle is 200,000 hp.

1) If P[2] = 300 psia, and P[4] = 125 psia, write EES code that does the following:
   a. Complete array table for all 8 states (P, T, h, s, x, and v)
   b. **Key Variables**: m_dot [lbm/hr], W_dot_pump [hp], Q_dot_in [Btu/hr], and net thermal efficiency [dim or %]

2) Build a parametric table that explores ranges for both P[2] and P[4] as a means to maximize plant efficiency. Initially, explore P[2] from 300 psia to 100 psia in increments of 50 psia (5 values). At each value of P[2], explore P[4] from 125 psi to 25 psia in increments of 25 psia (5 values). To explore all possibilities, you will have a parametric table that has 25 runs in it. From this analysis, what P[2] and P[4] should be used for optimal efficiency?
   Remember: Q_dot_in includes more than just the heat in between states 8 and 1

   Optimal P[2] _____[psia] Optimal P[4] _____[psia] η_{net} _____ [dim or %]

   a. For the optimal values, plot all eight state points on a T-s diagram (label each point)
   b. Make sure to print your full parametric table