Due Tuesday, February 9 at the break in class, i.e. at 1 p.m.

100 points

20-point penalty for each day it is late. There is no prorating. If the project is not turned in during the break on Tuesday the day it is due, it incurs the entire 20-point penalty. If projects are slid under my office door, they are dated/timed when they are found. No exceptions.

Start with the cycle from homework set #3, problem #4. To improve the thermal cycle efficiency, your boss has asked you to consider *three different options* that are within your boss' budget. These are (1) adding only a reheater to achieve 600 K, (2) adding only a closed feed-water heater (CFWH), and (3) adding only an open feed-water heater (OFWH).

(Maximum grade of C) For each of the three options listed above, examine and plot the influence of changing the intermediate pressure on (a) the thermal cycle efficiency and (b) the exergetic efficiency of the cycle. Use at least 10 intermediate pressures. Pick the option and intermediate pressure that you recommend to your boss. Then, for the recommended cycle, examine and plot the influence of changing the intermediate pressure on the second law efficiencies of each component.

(Maximum grade of B) For each of the three options listed above, examine and plot the influence of changing the intermediate pressure on (a) the thermal cycle efficiency, (b) the exergetic efficiency of the cycle, and (c) the second law efficiencies of each component. Use at least 10 intermediate pressures. Pick the option and intermediate pressure that you recommend to your boss. Then, for the recommended cycle, examine and plot the influence of changing the intermediate pressure on the exergy balance terms of each component.

(Maximum grade of A) For each of the three options listed above, examine and plot the influence of changing the intermediate pressure on (a) the thermal cycle efficiency, (b) the exergetic efficiency of the cycle, (c) the second law efficiencies of each component, and (d) the exergy balance terms of each component. Use at least 10 intermediate pressures. Pick the option and intermediate pressure that you recommend to your boss.

Hints:

- To assess the boundary temperature at which heat transfers for the heat exchange components, simultaneously solve the second law and exergy balance for the boundary temperature and the rate of entropy produced. The boundary temperature is a necessity in assessing the second law efficiency of the superheater, reheater and condenser.
- Use isentropic pump efficiencies of 0.95 and isentropic turbine efficiencies of 0.90.
- Use dead state conditions of 300 K and 100 kPa.

For the project report, include the following, in order:

1. The proper completed cover page/specification sheet. Do not change the format.
2. An executive summary in which your findings are concisely stated and your recommended design justified. This should be one page maximum, double-spaced with 12 point Times New Roman font.
3. Appendices
    A. Appendix A – reheat
        i. Schematic of the cycle, hand sketch of the T-s diagram, list of assumptions and hand-written equations used in a logical order. (It should be of similar appearance to the homework format). Use unlined printer paper or engineering paper.
        ii. Printout of EES formatted equations and calculations at an intermediate pressure of 30 bar.
        iii. EES generated state point T-s diagram (see the help file under miscellaneous folder in Canvas).
        iv. Plot of thermal cycle efficiency versus intermediate pressure.
        v. Plot of exergetic cycle efficiency versus intermediate pressure.
        vi. One plot including the second law efficiency of each component versus intermediate pressure. (Required for grades B and A consideration. Only required for grade C consideration if this is the recommended option.)
        vii. One plot for each component showing all exergy balance terms (heat related, work, sum of flow exergy in, sum of flow exergy out, and exergy destroy) versus intermediate pressure. The exergy balance terms should be presented per mass flow rate going into the first turbine. (Required for grade A consideration. Only required for grade B consideration if this is the recommended option. Not required for grade C consideration.)
    B. Appendix B – closed feed-water heater
        i. Schematic of the cycle, hand sketch of the T-s diagram, list of assumptions and hand-written equations used in a logical order. (It should be of similar appearance to the homework format). Use unlined printer paper or engineering paper.
        ii. Printout of EES formatted equations and calculations at an intermediate pressure of 30 bar.
        iii. EES generated state point T-s diagram (see the help file under miscellaneous folder in Canvas).
        iv. Plot of thermal cycle efficiency versus intermediate pressure.
        v. Plot of exergetic cycle efficiency versus intermediate pressure.
        vi. One plot including the second law efficiency of each component versus intermediate pressure. (Required for grades B and A consideration. Only required for grade C consideration if this is the recommended option.)

vii. One plot for each component showing all exergy balance terms (heat related, work, sum of flow exergy in, sum of flow exergy out, and exergy destroy) versus intermediate pressure. The exergy balance terms should be presented per mass flow rate going into the first turbine. (Required for grade A consideration. Only required for grade B consideration if this is the recommended option. Not required for grade C consideration.)

C. Appendix C – open feed-water heater
   i. Schematic of the cycle, hand sketch of the T-s diagram, list of assumptions and hand-written equations used in a logical order. (It should be of similar appearance to the homework format). Use unlined printer paper or engineering paper.
   ii. Printout of EES formatted equations and calculations at an intermediate pressure of 30 bar.
   iii. EES generated state point T-s diagram (see the help file under miscellaneous folder in Canvas).
   iv. Plot of thermal cycle efficiency versus intermediate pressure.
   v. Plot of exergetic cycle efficiency versus intermediate pressure.
   vi. One plot including the second law efficiency of each component versus intermediate pressure. (Required for grades B and A consideration. Only required for grade C consideration if this is the recommended option.)
   vii. One plot for each component showing all exergy balance terms (heat related, work, sum of flow exergy in, sum of flow exergy out, and exergy destroy) versus intermediate pressure. The exergy balance terms should be presented per mass flow rate going into the first turbine. (Required for grade A consideration. Only required for grade B consideration if this is the recommended option. Not required for grade C consideration.)