Project #1

It is required to design a gas-turbine power plant operates on the regenerative Brayton cycle with two stages of reheating and two-stages of intercooling. The working fluid is air. The air enters the first stage of the compressor at 300 K and 100 kPa. The first and the second stages of the turbine at 1600 K (maximum allowable temperature due to metallurgical reasons). The compressor and the turbine have an isentropic efficiency of 90 and 85 percent, respectively. The regenerator has an effectiveness of 80 percent. Assuming variable specific heats for air. The maximum compressor pressure ratio that can be found in the market is 45. It is required to design a compressor and turbine that

a. Maximize the thermal efficiency of the cycle.
b. Minimize the back-work ratio.

You need to decide the compressor size that achieves the aforementioned objectives and the split pressure ratio for the intercooling and the reheat. Support your results with analytical and numerical approaches. Plot the T-s diagram for the final design. Is minimizing the back-work ratio equivalent to maximizing the net work output? How would the results change if you assume cold-air standard assumptions?

Project #2

It is required to build a steam power plant operates on an ideal reheat–regenerative Rankine cycle with one reheater and one open feedwater heaters. The maximum steam temperature that the high- and low-pressure turbine can withstand is $600^{o}C$. Also, the maximum pressure in the cycle cannot exceed 290 bars due to metallurgical limitations. The minimum condenser pressure is 10 kPa. The minimum steam quality allowed after the turbine is 0.9. Steam is extracted from the turbine at intermediate pressure for the open feedwater heater. Select the maximum cycle pressure and the intermediate pressures for the reheat and open feed water heater that:

a) Maximize cycle efficiency.
b) Maximize the net work

Show the final cycle on a T-s diagram with respect to saturation lines. Report the corresponding fraction of steam extracted from the turbine for the open feedwater heater, the thermal efficiency. How would the results change if the open feedwater heater steam is extracted right after the reheat (Report maximum cycle pressure, reheat pressure, and cycle efficiency)? Support your results with numerical and/or analytical approaches.