1. Estimate, compare and comment on the thermal efficiencies of steam power plants operating on the Rankine cycle:

   Subcritical: live steam conditions $p_1=180$ bars, $T_1=550$ °C
   Supercritical: live steam conditions $p_1=300$ bars, $T_1=600$ °C
   Ultra-supercritical: live steam conditions $p_1=350$ bars, $T_1=750$ °C

   In all cases the condenser pressure is $p_2 = 0.04$ bar

2. Review Example 55.1 (pp. 1551-1554) in Ahearn’s chapter from Kutz ME Handbook, dealing with the exergy analysis of a steam power plant. Construct a spreadsheet summarizing the calculations and comment on the results.

3. Consider a gas turbine power plant operating on the Brayton cycle with the following operating characteristics:

   Compressor air intake temperature $T_1=300$ K and pressure $p_1=1$ bar
   Compressor pressure ratio $\beta = 17$
   Turbine inlet temperature $T_3=1600$ K
   Air mass flow rate $m = 400$ kg/s

   Assume the gas is air with isentropic exponent $k=1.4$, $c_p = 1.005$ kJ/kg K and determine:

   The power plant net specific work
   The power plant output
   The Brayton thermal efficiency
4.- Use the 2008 figures for the proportions of the world total energy consumption supplied by petroleum, coal and natural gas (35.8%, 26.7% and 23.5%, respectively) together with the corresponding heating values (approximately 45,000 kJ/kg, 30,000 kJ/kg and 50,000 kJ/kg, respectively) and estimate the total amount of CO₂ emissions produced by the combustion of these fuels during 2008. Assume the corresponding combustion reactions are, respectively:

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\begin{align*}
2C_8H_{18} + 25O_2 & \rightarrow 16CO_2 + 18H_2O \\
C + O_2 & \rightarrow CO_2 \\
CH_4 + 2O_2 & \rightarrow CO_2 + 2H_2O
\end{align*}
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