1. TPP uses Rankine cycle with reheating and has net power of 80 MW. Steam enters high pressure turbine stage with pressure 10 MPa and temperature 500°C. The pressure and temperature of the steam at low pressure turbine stage entrance are 1 MPa and 500°C. The pressure in the condenser is 10 kPa. Isentropic turbine and pump efficiencies are 80% and 95%. Calculate: (*a*) enthalpies in all process points, (b) mass flow rate of working media, (c) thermodynamic efficiency of the plant, (d) specific steam consumption. (1.5 points)

2. Gas turbine works using simple Brayton/Joule cycle with compression ratio of 12. The temperature of air at compressor entrance is 300 K and gas temperature at turbine entrance is 1200 K. Compressor and turbine isentropic efficiencies are 0.8 and 0.85, respectively. Calculate temperatures in all relevant process points, turbine and compressor specific work, the heat per unit mass of working media entering the process, thermodynamic efficiency of the process without and with regenerative HX having efficiency of 0.9. Air properties are fixed and can be used for both air and combustion gases (c_p=1.005 kJ/kgK, k=1.4). (1.5 points)

3. NPP has electrical power of 1000 MWe and total efficiency of 35%. Initial first cycle fuel loading is 90000 kg U. The duration of the cycle is 12 months (03 days per month). The capacity factor of the plant in that period is 0.92. Calculate cycle burn-up of the fuel and mass of UO2 fuel that has be replaced after first cycle assuming that all required fissions were in uranium-235. Fuel enrichment is 3.75% and fission yield is 200 MeV. (1.5 points)

4. Rankine cycle works with superheated steam and one regenerative feedwater HX of open type. The pressure and temperature of the steam at turbine entrance are 30 bar and 400 C. The condenser pressure is 0.1 bar. The regenerative HX works at 5 bar and uses turbine extraction steam for heating. Calculate: (a) cycle efficiency and specific steam consumption, (b) the change of thermodynamic efficiency and steam consumption if regenerative HX is not used. The influence (power) of condensate and feedwater pump can be neglected. Draw process in T-s and h-s diagrams and corresponding functional schemes. (1.5 points)

5. In combined gas and steam TPP the exhaust gases of gas turbine are used for steam boiler heating. Compression ratio in gas cycle is 8, inlet air temperature is 15 C and maximum temperature in the process is 800 C. Before entering steam boiler the exhaust gases are additionally heated in a separate combustion chamber to reach 800 C. At the steam boiler exit the gases are having temperature of 100 C. The steam at the steam turbine entrance has pressure and temperature of 60 bar and 600 C, respectively. The condenser pressure is 0.05 bar. Calculate air flow in gas turbine and steam flow in steam turbine to obtain total mechanical power of 190 MW. Calculate thermodynamic efficiency of combined plant and AFR of the gas turbine. Draw functional scheme and T-s diagram of the combined plant. All processes are ideal (isentropic). Air cp is 1.005 kJ/kg-K, and cp of exhaust gases is 1.11 kJ/kg-K. Corresponding adiabatic exponents are 1.4 and 1.33. The fuel heating value is 43.3 MJ/kg. The change in working media mass flow rate i gas turbine due to presence of fuel/combustion products can be neglected. (4.0 points)