Individual assignment No 5

1. Nitrogen gas flows into a convergent nozzle at (200+N) kPa, (400+N) K and very low velocity. It flows out of the nozzle at (100-N) kPa, (300-N) K. If the nozzle is insulated (no thermal losses appear), find the outlet velocity.
2. A small, high-speed turbine operating on compressed air produces a power output of (N*100) kW. The inlet state is (400+N) kPa at (50+N) °C while the outlet state is (150–N) kPa at (30–N) °C. Assuming the velocities to be low and the process to be adiabatic, find the required mass flow rate of air through the turbine. If we consider turbine efficiency to be equal to (88-N/10) % and inlet parameters and outlet pressure to be the same, define final temperature on the outlet of turbine and mass flow rate at same power.
3. Wet steam with a pressure of 25 bar is throttled to a pressure of 1 bar. During this process, its temperature decreases to 110 ºC. Determine the quality of steam (dryness factor) before throttling and show the process in hs-diagram.
4. Water pump compresses boiling water (with quality equal to 0) from (10+N) kPa to (10+N/10) MPa with efficiency (80+N) %. Define the work of ideal adiabatic process, real process and by simplified equation: $l=v*(p_2-p_1)$.
5. Steam expands into steam turbine from (5+N/2) MPa and (300+N) °C to (5+N) kPa. Define technical work produced by steam during:
   a. Adiabatic expansion.
   b. Polytropic expansion with η_{oit}=(0,8+N/100).
   c. Polytropic expansion with η_{oit}=(0,8+N/100) and (50+N) kPa pressure losses in inlet valves.
   d. Two-staged polytropic expansion with η_{oit}=(0,8+N/100) and (50+N) kPa pressure losses in inlet valves of each stage and intermediate superheating at pressure (0,5+N/10) MPa to temperature (200+N) °C.