SKMM 2433 APPLIED THERMODYNAMICS AND HEAT TRANSFER — Semester I 2015-2016
Test 1 — 60 minutes

1. Consider a regenerative steam power plant. Steam enters the high pressure turbine at 3 MPa, 500 °C. The high pressure turbine has an isentropic efficiency of 0.8. A fraction of the steam is extracted at 1 MPa to be mixed with feedwater in an open feedwater heater operating at the same temperature. The rest of the steam expands further in a low pressure turbine to 0.01 MPa before entering the condenser operating at the same pressure. The low pressure turbine has an isentropic efficiency of 0.85.
    a. Sketch the component arrangement showing the flows, and also sketch the T-s diagram for the system.
    b. Determine the fraction of steam extracted from the turbine.
    c. Is the steam exiting the low pressure turbine superheated or a mixture? If it is a mixture, find the quality.
    d. Find the thermal efficiency of the plant.
    e. If the mass flow rate in the boiler is 10000 kg/hour, what is the net power output of the plant? [kW]
2. What determines the maximum steam plant temperature and what determines the minimum steam plant pressure?In one type of nuclear power plant, heat is transferred to feedwater using a heat exchanger. Saturated steam at 5 MPa exits this heat exchanger and is then superheated to 600 °C. The steam enters the turbine, which has one (open type) feedwater heater extraction at 0.4 MPa. The condenser pressure is 7.5 kPa.
    a. Sketch the arrangement of major components of the steam cycle indicating the flows and properties
    b. Sketch the T-s diagram for this cycle.
    c. Determine the rate of heat supplied to produce a net power output of 1 MW.
    d. Determine the thermal efficiency of the cycle.
3. In a regenerative steam power plant, steam enters the high pressure turbine from the boiler at 50 bar, 600 °C. At 5 bar, some steam is extracted and sent to a closed feedwater heater. From the closed feedwater heater, the used steam is throttled and mixed in the condenser. The remaining steam in the turbine expands further to the condenser pressure of 0.1 bar. Both turbine stages have isentropic efficiencies of 0.9.
    a. Sketch the component arrangement showing the flows, and also sketch the T-s diagram for the system.
    b. Find the thermal efficiency of the plant.
    c. If the net power output is 2000 kW, find the mass flow rate in the boiler.
    d. Is the steam exiting the low pressure turbine superheated or a mixture? If it is a mixture, find the quality.