Menoufiya University
Faculty of Engineering
Shebin El-Kom
Academic Year 2014-2015

Department: Mech. Power Eng.
Year: Second year
Subject / Steam Tech. MPE 222
Time: 3 hours
Date: 31/5/2015

Please, answer the following questions: (Total Marks 100)

Question (1): (15 Marks)

A mass flow rate of steam equals 2 kg/s is expanding isentropically from 25 bar and 300 ℃ to 5 bar determine:

a) *The rate of heat transfer,* b) *The change in enthalpy,*

c) *The change in internal energy.*

Find *also the power developed in the following two cases:*

i) If the expansion occurs in a cylinder.

ii) If the expansion takes place in a turbine.

Question (2): (20 Marks)

In an ideal re-heating-regenerative cycle steam expands from 50 bar and 320 °C to 18 bar, where some steam is extracted for feed water heating and the remainder is reheated to the initial temperature. The steam expands after that to 2 bar, where additional steam is extracted again for feed water heating and the rest expands to the condenser pressure of 0.18 bar. If the first feed water heater is closed with cascade feeding through a steam trap to the second feed water heater, which is open. Calculate:

a) *masses of steam extracted,* b) *cycle efficiency.*

Question (3): (15 Marks)

Steam at a pressure of 10 bar and 95% dryness fraction is supplied through a convergent-divergent nozzle to the rotor of a turbine where the pressure is maintained at 0.12 bar. The specific steam consumption through the nozzle is 6 kg/hp.h and the power developed by the wheel is 150 hp, determine:

a) *Pressure at the throat using Zeuner's equation,*
b) *The number of nozzles needed if each nozzle has a throat diameter of 5 mm,*
c) *The exit diameter of the nozzle, if 10% of the overall enthalpy drop overcomes friction in the divergent part only.*

Question (4): (15 Marks)

In a four stage pressure compounded impulse turbine there is an enthalpy drop of 63 kJ/kg actually available per stage. The stage efficiency is 65 % for all stages. Steam is initially at 12 bar and 350 °C. Find:

a) *Terminal pressure of each stage,* b) *Reheat factor,*
c) *Internal efficiency of turbine,* d) *Average stage efficiency.*

Question (5): (15 Marks)

A steam turbine is governed by throttling, and the specific steam consumption at full load is 5.4 kg/kW.h. The nozzle box pressures at full load and ¼ load are 49 bar and 16.3 bar respectively. The temperature of steam leaving the boiler is 292°C. The condenser pressure is 0.05 bar. Draw the Willans lines and determine the following in case of no load, ¼ , ½ and ¾ loads:

a) *Specific steam consumption,* b) *nozzle box pressure.*

Determine also the turbine internal efficiency and the cycle efficiency at ½ and full loads.

Question (6): (20 Marks)

A surface steam condenser is to be designed for 120 MW plant when the steam is supplied at 150 bar and 500 °C and condenser pressure is 0.12 bar. The turbine isentropic efficiency is 85% and the mechanical and generator efficiencies are 95% each. The water side and steam side heat transfer coefficients are 2500 W/m^{2}K and 5000 W/m^{2}K respectively. The fouling factors on the water and steam sides are 0.00018 m^{2}K/W and 0.00009 m^{2}K/W respectively. The inlet and outlet temperatures of water are 25°C and 35°C. The velocity of water inside tubes is 2.87 m/s. The condensate is saturated water. Determine, using ε/NTU method:

a) *The steam and the cooling water mass flow rates,*
b) *The total number of tubes required,*
c) *The number of tubes per pass,*
d) *The number of tube passes,*

if the tubes have thin walls and of OD = 2.9 cm and the length of tubes is limited to 5 m.

With the Best Wishes