

University of Technology-Electromechanical Engineering Dept.

Final. Exam - 2013-2014

Class: 3rd Year – Electromechanical Eng.

Subject: Power Plants

Examiner; Ass.Prof. Dr.Shaker H.Aljanbi



Time: 3hr

Date: / /2014

Note: **Attempt 4 Questions only**

Q1:-The simple steam plant, takes steam from the boiler at **6Mpa** and **400⁰C** and in which the steam exhaust to condenser at **10 Kpa**. a) If there is a pressure drop of **20 bars** between boiler and turbine, and turbine has an isentropic efficiency of **85%**, determine the thermal efficiency of the cycle, and the efficiency ratio of the plant. b) Calculate the rate of oil consumption in **Kg /s**, when the net power output is **150 MW**, and the boiler has an estimated efficiency of **85%**, and the calorific value of the oil is **44500 kJ/kg**. c) Determine the flow rate of circulating water in **kg/s**, if each ton of circulating water receives **1000kJ** from the exhaust wet steam in the condenser.

Q.2) A certain factory has an average load of **1.5 MW** and requires **3.5 MW** for heating process (**fig.1**). It is proposed to install a single extraction steam turbine to operate under the following conditions; Initial pressure **1.5 MPa**; initial temperature **300 ⁰C**, and condenser pressure of **0.01MPa**. Steam is extracted between the two turbines at **0.3MPa, 0.96 dry**, and is isobarically cooled in heater to supply the heating load. The efficiency of **L.P** turbine is **80%** and the boiler efficiency is **85%** when using oil of a calorific value of **44 MJ/kg**.

If **10%** of boiler steam is used for the auxiliaries; calculate the oil consumption in **ton per day**. Assume that the condensate from heater at **0.3MPa**, and that from condenser mix freely in a hot well before being pumped to the boiler.

Q-3.A) From the first principle, show that for a simple impulse turbine the maximum blade efficiency is given by; $\eta_{max} = \cos^2 \alpha$, where α is a nozzle angle. Discuss this expression for variable values of angle and blade speed ratios. **[7Marks]**

B) Steam at **60 bar** and **450⁰C** is supplied to a turbine ,and expands to **0.065 bar**. The turbine is a two-row velocity compounded impulse stage, the blade speed ratio is **0.22**. The nozzle and fixed outlet angles are **20⁰**. The blades of the first row are symmetric. If the axial thrust of the second stage is to be **zero**, and there is **10%** drop in relative velocity in the fixed and moving blades, find the blade speed, blades angles and diagram efficiency. **[8Marks]**

Q4. A) Explain the function of blow-off-cock, fusible plug and stop valve in the fire tube boiler.

[5 Marks]

B) In a gas turbine plant, air is compressed through a pressure ratio of **6** from **15⁰C**. It is then heated to the maximum temperature of **750⁰C** and expanded in two stage each of expansion $\sqrt{6}$ the air being reheated between the stages to **750⁰C**. A heat exchanger allows the heating of the compressed air through **75 %** of the maximum range possible. Calculate the cycle efficiency and the net work output per kg of air. The isentropic efficiency of the compressor and turbine are **0.8** and **.85** respectively . Take $\gamma=1.4$ and $C_p=1.005 \text{ kJ/kg.K}$.

[10 Marks]

Q5;A) Discuss why the difference between the heights of first to last stage blade in gas turbine is smaller than that of steam turbine. **[4Marks]**

B) During operation of gas turbine, its element are subjected to mechanical stress and non-uniform temperature distribution. Explain briefly the procedures to avoid these negative effects. **[5Marks].**

C) Show mathematically, for a simple gas turbine plant, that the specific work output is maximum when the pressure ratio is such that the compressor and turbine outlet temperatures are equaled. **[6 Marks]**

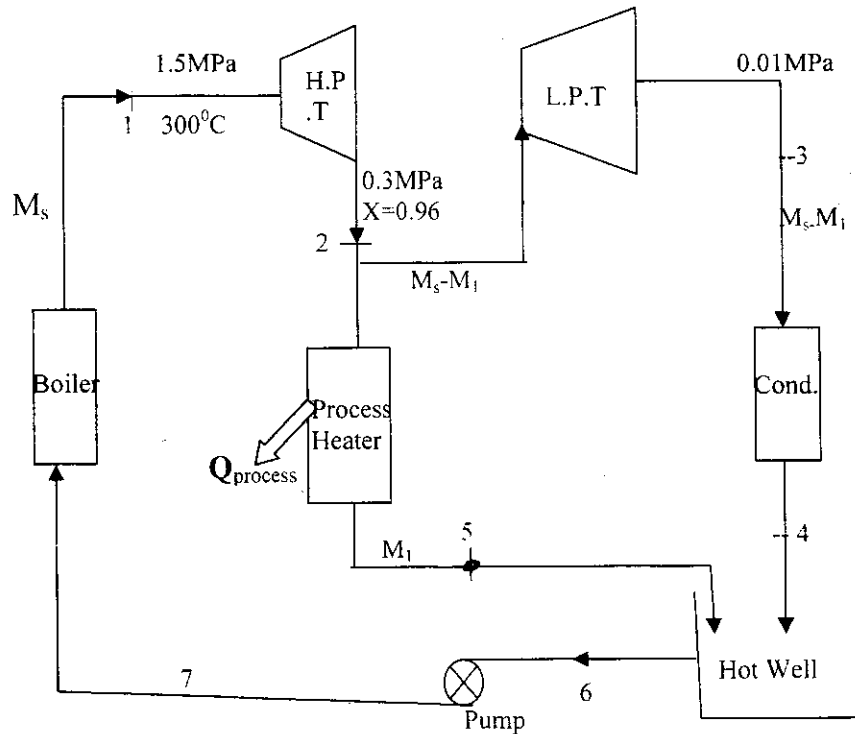


Fig.1

on the way to you