ثانية حديث

بسم الله الرحمن الرحيم

Mansoura University
Faculty of Engineering
Mechanical Eng. Dept.

2nd Year Electrical Eng.
Final Exam ,*Jan., 2012*
Time: ***1.5 hrs***

THERMAL POWER PLANTS

Part II

Steam Tables and Charts are Allowed. *Assume Any Reasonable Missing Data*

Answer the following questions:

1.a) By the aid of suitable diagrams, explain how the reheat cycle improves the basic simple Rankine cycle.

b) Steam enters the high-pressure turbine of a steam power plant that operates on the ideal reheat Rankine cycle at *20 MPa* and *600°C* and leaves as saturated vapor. Steam is then reheated to *550°C* before it expands to the condenser pressure of *10 kPa*. Heat is transferred to the steam in the boiler at a rate of *60 MJ/s*. Steam is cooled in the condenser by the cooling water from a nearby river, which enters the condenser at *30°C* and leaves at *40°C* . Show the cycle on a *T-s* diagram, and determine (*a*) the pressure at which reheating takes place, (*b*) the net power output, (*c*) the thermal efficiency and (*d*) the minimum mass flow rate of the cooling water required.

2.a) How the efficiency of the simple Rankine cycle is increased by using the regenerative cycle? Explain with the help of suitable diagrams.

b) A steam power plant operates on an ideal regenerative Rankine cycle with two open feedwater heaters. Steam enters the turbine at *10 MPa* and *600°C* and exhausts to the condenser at *5 kPa*. Steam is extracted from the turbine at *0.6* and *0.2 MPa*. Water leaves both feedwater heaters as a saturated liquid. The mass flow rate of steam through the boiler is *22 kg/s*. Show the cycle on a *T-s* diagram, and determine (*a*) the net power output of the power plant and (*b*) the thermal efficiency of the cycle.

3.a) In the steam power plants, what is the difference between ***cogeneration*** and ***combined cycle***? Draw the line-diagram for each.

b) With the aid of the schematic sketches, explain the theory of operation of the *4-stroke SIE*.

GOOD LUCK
Dr. Mostafa Awad

Part II : Hydraulic Machines (55 points)

Prob. 1 (15 points)

a) Show that in a Pelton wheel, where the buckets deflect the water through an angle β, the hydraulic efficiency of the wheel is given by

$$\eta_{hyd} = \frac{2U(V_1 - U)(1 - k\cos\beta)}{V_1^2}$$

where V_1 is the velocity of jet , U is mean blade velocity, and k is the output/input relative velocity ratio.

b) In a power station, a Pelton wheel produces 1250 kW under a head of 600 m. The loss of head due to pipe friction between the reservoir and nozzle is 45 m. The buckets of the Pelton wheel deflect the jet through an angle of 165°, while relative velocity of the water is reduced by 10% due to bucket friction. The wheel speed ratio is 0.46. The bucket circle diameter of the wheel is 890 mm. Find:

- The theoretical hydraulic efficiency,
- Speed of rotation of the wheel, and
- Diameter of the nozzle.

The actual hydraulic efficiency is 0.9 times that calculated above. Assume nozzle velocity coefficient, C_v= 0.98.

Prob. 2 (20 points)

(a) What is the function of the reaction turbine draft tube?. Define the draft tube efficiency.

(b) Show that in an inward flow Francis turbine, when the velocity of flow is constant and runner vane angle at entrance is 90°,

the best speed coefficient is $\frac{1}{\sqrt{2 + \tan^2\alpha}}$, and

the best flow coefficient is $\frac{1}{\sqrt{1 + \frac{2}{\tan^2\alpha}}}$

where α the angle of guide vane.

If turbine head is 20 m, runner outside diameter is 2 m, and $\alpha = 20°$, find the speed coefficient, flow coefficient and rotational speed of the runner.

Prob. 3 (20 points)

(a) Show the effect of blade exit angle on head of a centrifugal pump. On the same sketch identify regions of stabile and unstabile operation. Which type is more favorite in engineering applications and why ?.

(b) A centrifugal pump has the head-discharge characteristic as follows:

Q, lit/s	0	4	8	12	16	20	24
H, m	46.5	45.9	44.2	40.3	34	26	17

The pump is installed to pump water through a pipe 13 cm diameter having f=0.02. The static lift is 30 m, the suction pipe length is 100 m, and delivery pipe length is 700 m. Calculate the head and discharge under which the pump is working. Where the pump inlet should be placed to avoid cavitation if the required $NPSH_R$= 2.5 m. The absolute vapor pressure of water 0.035 bar.

Good Luck