BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006-2007

ME UC332 PRIME MOVERS AND FLUID MACHINES

TEST 2

DATE: 11-03-07

DURATION: 50 MINUTES MAXIMUM MARKS: 30 WEIGHTAGE: 15%

(Photo copy of bound EDD notes by BITS-PILANI, class notes and steam tables are aloowed)

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1. A single acting reciprocating pump has a piston of 150mm diameter and a stroke of 250 mm. The level of the water in the sump is 5m below the center line of the pump and the storage reservoir is 30m above the center line of the pump. The suction and delivery pipes are 10m and 40m long and are 30mm in diameter. Estimate the max speed of the pump in order to avoid separation. Take vapor pressure of water as 2.5 m and atmospheric pressure as 10.3 m of water. **10**

2. Differentiate between the impulse and reaction steam turbines. Define diagram efficiency and show the effect of blade speed ratio on diagram efficiency with a suitable graph for a single stage impulse turbine. **5**

3. The inlet condition of the steam to a convergent –divergent nozzle is 3 MPa and 300 °C. The exit pressure is 500 kPa and the throat pressure is 1.5 MPa. Assuming friction less flow up to the throat and a nozzle efficiency of 85% determine the mass flow rate for a throat area 40 cm^2 and the exit area of the nozzle. **10**

4. In a single stage impulse turbine the blade angles are equal and the nozzle angle is 20. The velocity coefficient (due to friction) is 0.83. Find the maximum blade efficiency possible. **5**

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SECOND SEMESTER 2006-2007

III Year

ME UC332 PRIME MOVERS AND FLUID MACHINES

Comprehensive Exam DATE: 20-05-07

DURATION: 3hrs MAXIMUM MARKS: 40 WEIGHTAGE: 40%

Notes: Thermodynamic tables are allowed.

Highlight all your answers by enclosing in boxes. Assume any missing data suitably and mention the same at the appropriate place in your answer. All the parts of the same question should be answered together.

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1. a. State Buckingham π theorem and using it derive the six π terms that describe the problem in fluid mechanics. **4**

   b. Define and give expressions for the following specific quantities used in turbines: specific discharge, specific power and specific speed. **3**

2. A pelton wheel has a jet of 150mm in diameter and works under a head of 450m .The wheel to jet ratio is 16 and runs at 360rpm.The buckets deflect the jet through an angle of 165°.Calculate the force exerted by the jet on buckets, power output and wheel & overall efficiency. Take Cv for nozzle = 0.98, K=0.9, mechanical losses 3% of power supplied to the turbine. **6**

3. Explain the main and operating characteristics of three hydraulic turbines (Pelton, Francis and Kaplan). **4**

4. The impeller of a centrifugal pump is 1m diameter and 0.1m wide. It delivers 2 m^3 /sec of water through a height of 45 meters while running at 600 rpm. If the blades are curved backwards and the outlet angle is 30° calculate the manometric efficiency and power required to run the pump. Estimate the minimum speed to start the pump if the impeller diameter at inlet is 0.6m. **6**

5. a. Derive an expression for finding minimum power required for a multistage reciprocating compressor with N stages with perfect intercooling. **4**

   b. A single stage double acting compressor takes in air at 0.98 bar and 32°C and delivers at 6.32 bar. The clearance is 5% of the stroke volume. The compression and re expansion follows the law $pv^{1.32} = c$. The air handled by the compressor is 17 m^3/min. when measured at 1 bar and 15°C. Determine the indicated power required on the compressor in kW if the compressor runs at 500 rpm. Also determine the isothermal efficiency and the dimensions of the cylinder assuming stroke is 1.25 times the bore. Neglect the area of the piston rod. **6**

6. The velocity of steam leaving the nozzles of an impulse turbine is 1000 m/sec and the nozzle angle is 20°. The blade velocity is 500m/sec and the blade velocity coefficient is 0.7. For a mass flow rate of 1 kg/sec and symmetrical blading calculate the following, the blade inlet angle, the driving force on the wheel , the axial thrust, the diagram power and the diagram efficiency. **7**

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SECOND SEMESTER 2006-2007

ME UC332 PRIME MOVERS AND FLUID MACHINES

QUIZ

DATE: 12-04-07

DURATION: 30 MINUTES MAXIMUM MARKS: 10 WEIGHTAGE: 5%

Answer all the questions (10*1 = 10 marks)

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1. Which turbine will have more part load efficiency? (Kaplan or Francis)
2. How many blades are generally used in a Kaplan turbine runner?
3. Why the blades of the Kaplan turbine are twisted?
4. Draw the speed versus discharge curve at different gate openings of a Kaplan turbine
5. Give an expression for the acceleration head of a reciprocating pump in terms of length and area of the pipes, piston area, crank angle and crank radius.
6. The flow separation will occur whenever the net pressure is less than the vapor pressure in a fluid flow. Give the two instants in a reciprocating pump (the net pressure is minimum) wherein there is a possibility of separation.
7. Why the air vessels are fitted as close as possible to the cylinder in a reciprocating pump?
8. Name the two types of casings used in a centrifugal pump.
9. Write the fundamental equation (Euler's equation) for a centrifugal pump.
10. What is the use of connecting the centrifugal pumps in series and parallel? Or when the series connection is used and when the parallel connection is used?

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SECOND SEMESTER 2006-2007

ME UC332 PRIME MOVERS AND FLUID MACHINES

TEST 1

DATE: 11-03-07

DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

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1. Derive an expression for the thrust developed by a propeller which depends upon the angular velocity ω, approach velocity V, dynamic viscosity μ, density ρ, propeller diameter D and the compressibility of the medium measured by the local velocity of sound C. **6**

2. Define and give expressions for the following quantities.
   Unit discharge, Unit power and Specific speed **4**

3. Explain how hydraulic turbines are classified **3**

4. Draw the inlet and outlet velocity triangles for a Francis turbine runner blades incase of a slow runner, medium runner and fast runner. **3**

5. A Pelton turbine produces 25MW while running at 750rpm under an effective head of 1770m. Calculate the least diameter of the jet and the mean diameter of the runner.
   Assume $C_V = 0.98$, $\eta_o = 0.85$, the speed ratio $u/V1 = 0.46$. **4**

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