

BITS, PILANI-DUBAI
SECOND SEMESTER 2009-2010
ME C332 PRIME MOVERS AND FLUID MACHINES
Comprehensive Exam DATE: 26-05-10
DURATION: 3hrs MAXIMUM MARKS: 35 WEIGHTAGE: 35%

Notes: Steam 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.

1. Define, give expression and explain the significance of the following Non dimensional numbers Euler number, Froude number and Mach number **3**
2. A Pelton wheel has to be designed for the following data. Power to be developed=6000kW. Net head available=300m, speed=550 rpm, ratio of jet diameter to wheel diameter=1/10 and overall efficiency=85%. Find the number of jets, diameter of the jet, diameter of the wheel and the quantity of water required. Assume C_v for the nozzle=0.98 and speed ratio=0.46. **5**
3. A single acting single cylinder reciprocating pump of 325mm diameter and 400 mm stroke has suction and delivery pipes 15cm in diameter. Their lengths are 6m and 70m respectively. The suction and delivery heads are 4.5m and 50m respectively. Calculate the minimum absolute pressure of the pump at two instants during suction and delivery and based on that calculate the maximum permissible speed of the pump in order to avoid separation. Take atmospheric pressure = 10.3 m of water and vapor pressure = 2.2 m of water. **5**
4. Explain how centrifugal pumps are classified. State the fundamental equation of the centrifugal pump and explain the various terms. **4**
5. A three-stage single acting air compressor delivers 1.5 m^3 of free air per min at 100 bar. The ambient conditions are 1.03 bar and 20°C . The suction conditions are 0.98 bar and 30°C . Assuming perfect intercooling find the indicated power of the compressor. If the clearance is the 5% of the stroke in all cylinders and common stroke is equivalent to the diameter of the lowest pressure cylinder find the diameters and strokes of all the cylinders. Take the index of compression and re-expansion is 1.32 for all the cylinders and speed of the compressor as 300 rpm. Neglect the pressure losses between the stages. **5**
6. Steam at 20 bar and 500°C expands isentropically to a pressure of 50kPa in a convergent –divergent nozzle. Calculate the mass flow per unit area
 - a. assuming equilibrium flow and
 - b. assuming super saturated flow.For super saturated flow assume that the process follows the law $PV^{1.3}=C$. **5**
7. Derive an expression for the maximum efficiency of the single stage impulse steam turbine considering and neglecting velocity coefficient for friction K from the fundamentals. **4**
8. Free air of $20 \text{ m}^3/\text{min}$ is compressed from 1 bar to 2.2 bar. Find the power required a. if the compression is carried out in roots blower, b. if the compression is carried out in vane blower. Assume there is 25% reduction in volume before the back flow occurs and c. the isentropic efficiency of each case. **4**

**BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2008-2009**

ME C332 PRIME MOVERS AND FLUID MACHINES

TEST 2(Open book)

DATE: 09-05-10

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

(Text book, photo copy of bound EDD notes, hand written class notes and steam tables are allowed)

1. Dry saturated steam enters a steam nozzle at a pressure of 25 bar and is discharged at a pressure of 2bar. If the dryness fraction of discharge steam is 0.96, what will be the final velocity of steam neglecting the initial velocity? If 10% of heat drop is lost in friction find the % reduction in the final velocity. **5**

2. Define the term “Degree of reaction” as applied to a reaction turbine. Show that for a parson’s reaction turbine, the degree of reaction is 50%. In a parson’s reaction turbine stage the mean rotor diameter is 1.5m. The absolute velocity of the steam is 350m/sec as it enters the main blades of the stage. If the blade outlet angle is 20° and the rotor is designed to run the best theoretical speed find diagram efficiency and the rotor speed. **5**

3. Determine the size of the cylinder of a double acting compressor of 36.765 kW of indicated power in which air is drawn at 1 bar and compressed to 16 bar according to $PV^{1.25} = C$. The compressor runs at 300 rpm and the piston speed is 180 m/min. Take the clearance ratio as 5%. Also calculate the isothermal efficiency of the compressor. **5**

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SECOND SEMESTER 2009-2010

ME UC332 PRIME MOVERS AND FLUID MACHINES

TEST 1

DATE: 28-03-09

DURATION: 50 MINUTES

MAXIMUM MARKS: 15

WEIGHTAGE: 15%

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1. Define Unit speed and Specific speed of a turbine and explain the use of these parameters. A turbine develops 7460kW under a head of 24.7 m at 135 rpm. What is the specific speed of the turbine? What would be its normal speed and output under a head of 19.5 m? **4**
2. A Francis turbine runner with an overall efficiency of 80% is required to develop 150kW. The head is 8m. The speed ratio is 0.96 and the flow ratio is 0.36. The speed of the turbine is 150rpm and the hydraulic losses in the turbine are 22% of the available energy at the turbine inlet. Determine
- a. the guide blade angle and the vane angle at the inlet
 - b. the diameter of the wheel and the width of the wheel at inlet
 - c. the dimensions and angles of the runner at the outlet assuming that the inner diameter of the wheel is half the outer diameter of the wheel and constant velocity of flow. **6**
3. Draw the main characteristics of Pelton wheel and explain the salient points. With inlet and outlet velocity triangles of a Pelton wheel runner blade derive an expression for the hydraulic efficiency. Find the condition for the maximum efficiency and prove that the max efficiency is $(1+k \cos\beta)/2$. **5**

QUIZ 2

Answer all the questions (5*2 = 10 marks)

Id No. :

1. A single cylinder double acting reciprocating pump lifts 100 liters of water per second against a static head of 40m. If the slip is 5% estimate the coefficient of discharge of the pump. Also calculate the minimum power required to run the pump.
2. Find out whether separation will occur or not in the reciprocating pump if the atmospheric pressure is 10.3 m of water, the suction head is 6m, the maximum values of acceleration head and the frictional head in the suction are 3.3m and 3m of water respectively. The vapor pressure head for water may be taken as 2.6m of water. If separation is to be avoided what is the maximum permissible suction lift allowed in this case.
3. What is the need of priming in case of a centrifugal pump? How is it done?

4. A centrifugal pump has an impeller of inner diameter 0.8m and an outer diameter of 1.6m. Determine the minimum starting speed of the pump if the manometric head of the pump is 32m.
5. Define and give expressions for the manometric, mechanical and overall efficiency of the centrifugal pump.



QUIZ1

DURATION: 20 MINUTES MAXIMUM MARKS: 10 WEIGHTAGE: 5%

Id.: _____

1. How the specific speed of a hydraulic pump is defined? Give the expression for the same in terms of Q , N and H .
2. Define Euler number. Give the expression and application of the number.
3. A turbine which produces 100kW when it is running under a head of 200m. Find the power developed by the same turbine when it runs under a head of 500m.

4. Water at 15°C flows at 4m/s in a 150mm pipe. At what velocity must oil at 30°C flow in a 75mm pipe for the two flows to be dynamically similar. Take ν for water at 15 °C as $1.145 \times 10^{-6} \text{ m}^2/\text{s}$ and that of oil at 30 °C as $3 \times 10^{-6} \text{ m}^2/\text{s}$.
5. A pelton turbine produces 10 MW when it is working under a head of 500m and is running at 300rpm with overall efficiency of 0.8. Calculate the discharge of the turbine.