BITS, PILANI-DUBAI
SECOND SEMESTER 2011-2012
ME C332 PRIME MOVERS AND FLUID MACHINES
Comprehensive Exam DATE: 14-06-12
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.

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1. Define Unit speed and Specific speed of a turbine and explain the use of these parameters. A turbine develops 7500kW under a head of 27 m at 300 rpm. What is the specific speed of the turbine? What would be its normal speed and output under a head of 20 m? **3**

2. A pelton turbine works under a head of 400m and running at a speed of 600rpm.Calculate the power developed and the hydraulic efficiency of the turbine taking the discharge through the turbine as 300 liters per second. The jet is deflected through the bucket by an angle of 165°. Take the Cv for the nozzle is 0.97, the blade speed ratio is 0.46 and the frictional coefficient is 0.92 **5**

3. Explain the purpose of air vessel in reciprocating pump. A reciprocating pump is fitted with an air vessel in the delivery side of the pump. The diameter and stroke of the piston is 30cm and 45cm respectively. The crank rotates at 60rpm.The delivery pipe is 15cm in diameter and 50m long. Determine the power saved in overcoming friction in the delivery pipe by the air vessel. Take the frictional factor f=0.02. **5**

4. Derive an expression for the minimum power required for a reciprocating air compressor to compress the air in N stages. Assume perfect inter cooling between the stages and same index for polytropic compression and expansion. **4**

5. Prove that the velocity triangles are similar for Parson's reaction turbine and show that the maximum efficiency for such a turbine is $[2\cos^2\alpha 1 / (1+ \cos^2\alpha 1)]$, where $\alpha 1$ is the angle at which the steam enters the blades. **4**

6. The inlet condition of the steam to a convergent –divergent nozzle is 10 bar and 250 °C. The exit pressure is 50 kPa and the throat pressure is 2 bar. Assuming friction less flow up to the throat and a nozzle efficiency of 90% determine the mass flow rate through the nozzle for a throat area 30 cm^2 and also determine the exit area of the nozzle. **5**

7. 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. **5**

8. Free air of $20m^3$/min is compressed from 1 bar to 2.2 bar. Find a. the indicated power required if the compression is carried out in roots blower. b.if the compression is carried out in vane blower. Assume that there is 25% reduction in volume before the backflow occurs and c. the isentropic efficiency in each case. Take γ =1.4 for air. **4**

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BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2010-2011

ME C332 PRIME MOVERS AND FLUID MACHINES

TEST 2(Open book)

DATE: 20-05-12

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

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

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1. Super saturated expansion occurs in a nozzle supplied with steam at 30 bar and 350°C (v_1=0.09053m^3/kg). The discharge takes place against the exit pressure of 5 bar (T_{sat}=151.86 °C). Taking the index of expansion as 1.3 and for a steam flow rate of 300kg/min determine the exit area and the degree of under cooling at the exit. **4**

2. Give an expression in terms of the nozzle angle for the optimum blade speed ratio (ρ_{opt}) for a three stage impulse turbine with axial discharge in the final stage. Also state the corresponding maximum efficiency and maximum work obtained from the speed ratio.
At a stage of a Parson's reaction turbine the velocity of steam striking the moving blades is 350m/sec and the mean rotor diameter is 1.6m.The blade speed ratio (ρ) is 0.8.Determine the blade inlet angle if the blade outlet angle is 20°. Find the diagram efficiency. Also find the percentage increase in diagram efficiency if the rotor is designed run at the best theoretical speed the exit angle being 20 °. **6**

3. A single acting reciprocating pump has a plunger diameter of 300mm and a stroke of 420mm.The suction pipe is 190mm in diameter and 8m long. The water surface in the sump from which the pump draws water is 3m below the pump cylinder axis. If the pump is working at 25 rpm find the pressure head on the piston at the beginning, middle and end of the suction stroke. Take f=0.1 and Hatm = 10m of water. **5**

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BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2010-2011

ME UC332 PRIME MOVERS AND FLUID MACHINES

TEST 1

DATE: 01-04-12

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

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1. a. What is kinematic similarity in model testing and what are the conditions to be satisfied for achieving the kinematic similarity?

   b. The pressure drop when a fluid is flowing in a pipe line is dependent on the following parameters. The tube length l, hydraulic diameter d, the average height of the bumps on the surface measured in micrometers ε, fluid density ρ and viscosity μ and the average velocity v of the fluid. Using the principle of dimensional analysis and π theorem establish a functional relation between the parameters. **5**

2. a. What is dimension less specific speed in hydraulic turbines and give the range of its values for different (Pelton, Francis, Kaplan) turbines.

   b. The following data were obtained from a test on a Pelton wheel. Head at the base of the nozzle=32m, discharge of water from penstock in to the nozzle=0.18m^3/sec, area of the nozzle jet = 7500 sq.mm, discharge of water from the nozzle=0.18m^3/sec, power available at the output of the shaft=44kW, mechanical efficiency=94%.Calculate the power lost in the nozzle, power lost in the runner and power lost in mechanical friction. **5**

3. Estimate the main dimensions (D1, D2, B1, B2, α, θ, β) of a Francis turbine to suit the following conditions. Head 100m, power 2.5MW, speed 500 rpm. hydraulic efficiency 0.9, overall efficiency 0.85, flow ratio 0.15 , ratio of wheel width to wheel diameter at inlet 0.1, outer diameter twice the inner diameter and velocity of flow is constant. **5**

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QUIZ2

30-04-2012

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

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

Name: **Id No. :**

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1 What do you mean by manometric head of a centrifugal pump?

2. What do you mean by connecting the centrifugal pumps in series and parallel? When the series connection is used and when the parallel connection is used?

3. A duplex reciprocating pump has a piston dia of 10cm and a stroke of 12cm and runs at 1500rpm, find out the discharge of the pump in liters per second.

4. 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 7m, 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.

5. What is priming in case of a centrifugal pump?

6. Draw the indicator diagram of a reciprocating pump neglecting and taking in to acceleration and frictional effects in to consideration.

7. How is the maximum starting speed of the centrifugal pump is determined?

8. What is the use of air vessels in reciprocating pumps?

9. Name two types of casings used in a centrifugal pump.

10. Draw the Head Vs Discharge curves at different speeds for the centrifugal pump.

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A

QUIZ1

13-03-2012

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

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

Name: **Id No. :**

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1 Determine the dimensions of shear stress and dynamic viscosity.

2. How the specific speed of a hydraulic pump is defined? Give the expression for the same in terms of Q, N and H.

3. A turbine uses a discharge of 20litres per second when running under a head of 150m. Find the discharge of the turbine when it is running under a head of 50m.

4. Define specific discharge of a turbine and give an expression for the same in terms of Q, D and H.

5. Define Froude number. Give an expression and the application of the number.

6. A pelton turbine produces 20 MW while running at a speed of 1000rpm. If the overall efficiency of the turbine is 80%, calculate the discharge through the turbine.

7. Draw the inlet and outlet velocity diagram for a fast runner and represent the various velocity components and the angles in case of a Francis turbine.

8. Define hydraulic and mechanical efficiency of the hydraulic turbines.

9. Explain how the quantity of water flowing through the Francis turbine can be varied.

10. State the name of the turbine you will recommend for the following cases.
High head and small qty of water –
Medium head and medium qty of water –
Small head and large quantity of water –