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**SUBJECT CODE NO: E-322**
**FACULTY OF ENGINEERING AND TECHNOLOGY**
**B.E.(Mech) Examination Nov/Dec 2017**
**Turbo Machines**
**(REVISED)**

**[Time: Three Hours]** **[Max.Marks:80]**

Please check whether you have got the right question paper.

N.B i) Solve three questions from each section.
ii) Figure to the right indicates full marks.

**Section A**

Q.1 a) Explain how the principle of dimensional analysis is applied to the turbo machines & explain their significance. 07

b) Distinguish between a turbo machine & positive displacement machine. 06

Q.2 a) Show that the force exerted by a jet of water on moving inclined plate in the direction of jet is given by, 06
$f_x = \rho a(v-u)^2 \sin^2\theta$. Where,
a = area of jet, V = Velocity of jet,
$\theta$ = Inclination of the plate with the jet

b) A 8.5 cm diameter jet having a velocity of 35 m/s strikes a flat plate, the normal of which is inclined at $45^o$ to the axis of the jet. Find the normal pressure on the plate, when 07
i) The plate is stationary
ii) When the plate is moving with a velocity of 20m/s & away from the jet.
iii) Also determine the power & efficiency of the jet when the plate is moving.

Q.3 a) Obtain an expression for the force exerted by a jet of water strikes the curved plate at one end tangentially when the plate is unsymmetrical. 06

b) A square plate of uniform thickness & length of side 300mm hangs vertically from hinge at its top edge. When a horizontal water jet strikes the plate at it's centre, the plate is deflected and comes to rest at angle of $30^o$ to the vertical. The jet is 25 mm in diameter & has a velocity of 6 m/s. Determine the weight of the plate. 07
If the plate is not allowed to swing, what will be the force required at the lower edge of the plate to keep the plate in vertical position.

Q.4 a) Define specific speed of a turbine derive an expression for specific speed of a turbine from fundamentals. 06

b) What is cavitation? How can it be avoided in reaction turbines? What are the factors on which cavitation in water turbines depends explain in brief. 07

Q.5 A pelton wheel having gross head from the reservoir to the nozzle is 390 meters. The turbine has two runners with two jets per runner. All the four jets have the same diameter. The efficiency of power transmission through the pipe line & the nozzle is 91% & overall efficiency of 85%. The pelton wheel develops 95.64 kw shaft power at a speed of 200 rpm. 14
The velocity of the bucket is 0.45 times the velocity of the jet, coefficient of velocity is equal to 0.98.

**Determine :**

i) Total Discharge in $m^3$/sec.
ii) The diameter of wheel & jet
iii) Velocity of jet
iv) Size of bucket (width & depth)
v) The force exerted by a single jet on the bucket when blade angle at outlet is $15^o$.

## Section B

Q.6 a) What is the role of Net Positive suction head (NPSH) in centrifugal pump? 06

b) A centrifugal pump discharge 0.15 $m^3$/s of water against a head of 12.5m, the speed of the impeller being 600 rpm. The outer & inner diameter of impeller are 500 mm & 250 mm respectively. The vanes are bent at an angle of $35^o$ to the tangent at exit. If the area of flow remains 0.07$m^2$ from inlet to outlet flow velocity is also same at inlet to outlet. 07

**Calculate :**

i) Manometric efficiency of pump
ii) Vane angle at inlet
iii) Loss of head at inlet to impeller

When the discharge is reduced by 40% without changing the speed.

Q.7 In an impulse turbine the mean diameter of the blade is 1.15 m & the speed is 3500 rpm. The nozzle angle is $19^0$ the ratio of blade speed to steam speed is 0.42 & ratio of the relative velocity at outlet from blades to that at inlet is 0.84.The outlet angle of the blade is to be made $4^o$ less than the inlet angle. The steam flow is 10 kg/s. 13

**Calculate:**

i) Axial thrust,
ii) Tangential thrust,
iii) Resultant thrust,
iv) Power developed,
v) Bladding efficiency.

Q.8 a) Sketch Brayton cycle on p-y & T-S plot and derive a relation for it's thermal efficiency in terms of pressure ratio. 06

b) What is the difference between single stage & multistage pumps? Describe multistage pump with impeller in parallel and in series. 07

Q.9 The pressure ratio of an open-cycle gas turbine power plant is 5.6. Air is taken at 30$^{o}$C & 1 bar. The compression is carried out in two stages with perfect intercooling in between. The maximum temperature of the cycle is limited to 700$^{o}$C assuming the isentropic efficiency of each compressor stage as 85% and that of turbine as 90%, determine the power developed & efficiency of the power plant, if the air-flow is 1.2 kg/s. The mass of fuel may be neglected & it may be assumed that Cpa = Cpg = 1.02 kJ / kg.k & r = 1.41. 14

Q.10 **Write Short notes on <u>any three</u> of the followings.** 13

i) Pressure compounding of steam turbine
ii) Reaction turbine
iii) Stirling cycle
iv) Pump characteristics
v) Open cycle gas turbine