Total No. of Questions : 8]

SEAT No. :

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[6181]-233
B.E. (Mechanical Engineering)
TURBOMACHINERY
(2019 Pattern) (Semester-VII) (402043)

Time : 2 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.***
2) ***Figures to the right side indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Use of steam tables, Mollier chart and calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) Give classification of turbomachines with suitable example. **[6]**

b) Pelton wheel runner is having tangential velocity of 20 m/s. Head race and tail race level difference is 60 m. 10 m head is lost due to friction in penstock. Discharge through the nozzle is 0.03 m^3/s. Vane angle at outlet is 15°. Coefficient of velocity for the nozzle is 0.97. Assuming no friction loss over the buckets, evaluate **[8]**

i) Force exerted by jet on buckets

ii) Workdone per kg of water

iii) Power developed by the runner

iv) Hydraulic efficiency of turbine

OR

Q2) a) Derive expression for force exerted, rate of workdone and efficiency in case of jet striking on moving flat plate **[6]**

b) A Kaplan turbine developing 5.3 MW under head of 10 m with overall efficiency 90% is fitted with a draft tube having inlet diameter 3m and outlet diameter 4.5 m. Turbine is set at 1.6 m above tail race water level. A vacuum gauge inserted at a draft tube inlet indicates the reading of 4.45m of water. Determine the draft tube efficiency. **[8]**

Q3) a) What is compounding? Explain the need of compounding. Explain any one method of compounding in steam turbines. **[5]**

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b) Steam enters in a single stage impulse steam turbine at a velocity of 450 m/s and nozzle exit angle is 20°. Exit angle of the moving blade is 20°. Blade speed is 180 m/s and mass flow rate is 2.5 kg/s. Neglecting the friction losses over the blade, Evaluate **[7]**

i) Blade angle at inlet

ii) Workdone per kg of steam

iii) Diagram efficiency

OR

Q4) a) Derive condition for maximum diagram efficiency and expression for maximum diagram efficiency for impulse steam turbine. **[5]**

b) Parsons reaction steam turbine running at 1400 rpm with 50% degree of reaction. Turbine develops power of 75kW per kg per second of steam. Exit angle of the moving blade is 20° and steam velocity is 1.4 times the blade velocity. Evaluate, **[7]**

i) Blade speed

ii) Mean diameter of the rotor

iii) Inlet angle of the moving blade

Q5) a) Explain various heads in centrifugal pump with a neat sketch. **[5]**

b) The outer diameter of an impeller of a centrifugal pump is 400 mm and outer width is 50 mm. The pump is running at 800 rpm and is working against a total head of 15 m. The vanes are set backward at an angle of 40° at outlet. The manometric efficiency is 75%. Evaluate **[7]**

i) Flow velocity at outlet

ii) Absolute velocity of water leaving the vane

iii) Discharge through the pump

iv) Workdone by impeller on water per second

OR

Q6) a) Explain NPSH. How NPSH can be used to discuss cavitation phenomenon in centrifugal pump? **[5]**

b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm works against a head of 75 m. The velocity of the flow through the impeller is constant and equal to 3 m/s. The vanes are set back at an angle of 30° at outlet. If the outer diameter

of the of impeller is 600 mm and width at outlet is 50 mm, Evaluate **[7]**

i) Vane angle at inlet

ii) Workdone by impeller on water per second

iii) Manometric efficiency.

Q7) a) Explain Construction and working of axial flow compressor with a neat sketch. **[5]**

b) A centrifugal compressor used for supercharging an aircraft draws air at its inlet conditions of 0.8 bar, 7°C temperature and velocity of 100 m/s. It is compressed adiabatically in impeller up to 1.5 bar, 70°C temperature and velocity leaving impeller is 300 m/s. This air enters in to diffuser where its kinetic energy is completely converted in to pressure energy. Mass flow rate of air is 3 kg/s. Evaluate, **[7]**

i) Impeller power

ii) Isentropic efficiency based on static conditions

iii) Stagnation temperatures and pressures at compressor inlet and outlet

Assume γ =1.4, Cp=1.005KJ/kgK and R=300Nm/KgK.

OR

Q8) a) Explain surging and choking in a centrifugal compressor with a neat sketch. **[5]**

b) A rotary air compressor working between 1 bar and 2.5 bar has internal and external diameter as 300 mm and 600 mm respectively. Vane angle at inlet and outlet are 30° and 45° respectively. If the air enter the impeller at 15 m/s and at 280 K temperature, assuming flow velocity as constant find (i) speed of the impeller (ii) Mach number at inlet of impeller

(iii) work done per kg of air (iv) torque required if mass flow rate of air is 3 kg/s. **[7]**

Assume γ =1.4 and R=300Nm/KgK.

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