

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0207

Roll No.

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B.Tech.

(SEM. III) THEORY EXAMINATION 2011-12
THERMAL AND HYDRAULIC MACHINES

Time : 3 Hours

Total Marks : 100

Note :— (i) Attempt **all** questions.

(ii) All questions carry equal marks.

(iii) Use of Steam tables and Mollier charts is permitted

(iv) Assume suitably any relevant data, if missing.

1. Attempt any **two** out of the following : (10×2=20)

(a) The following data belong to a closed system which undergoes a thermodynamic cycle consisting of four processes :

Process	Heat transfer kJ/min	Work transfer kJ/min
1-2	zero	-1000
2-3	40000	zero
3-4	-4000	-26000
4-1	12000	-10000

Is the data consistent with the first law of thermodynamics? Justify your answer. If yes, then calculate :

(i) net rate of work output

(ii) efficiency of the cycle

(iii) change in internal energy for each process.

(b) Draw a graph showing the efficiency of Pelton wheel against Bucket Velocity under theoretical and actual conditions. Give reasons for the difference. How is cross-sectional area of jet controlled ?

(c) An inward flow hydraulic reaction turbine has outer and inner diameters of wheel as 1 m and 0.5 m respectively. Vanes are radial at inlet and discharge is radial at outlet. Water enters the Vanes at an angle of 10° . Assuming the velocity of flow as constant equal to 3 m/s, determine the speed of the turbine and Vane angle at the outlet. Draw the velocity triangle.

5. Attempt any **two** out of the following : (10×2=20)

(a) A single acting reciprocating pump has the following data :

stroke = 300 mm

piston diameter = 125 mm

suction pipe length = 5 m

diameter of suction pipe = 75 mm

suction head = 3 m

atmospheric pressure = 10.23 m (abs) of water

vapour pressure = 2 m (abs)

Calculate the minimum speed at which the pump can run without causing separation during suction stroke.

(b) Draw a labelled diagram for the layout of a centrifugal pump. State the functions of the volute casing of a centrifugal pump.

(c) Explain the following terms as related to pumps :

(i) manometric efficiency,

(ii) slip

(iii) priming

(iv) volumetric efficiency and

(v) backswept blade.

- (b) State and explain various laws of thermodynamics with suitable examples.
- (c) Steam at 17.92 bar and 0.95 dry is throttled to 14 bar and passed to an engine which expands it isentropically to 0.3 bar and exhausts at this pressure. Calculate :
- entropy per kg of steam entering the engine,
 - steam consumption of the engine in kg/kWh and
 - work done in flow process.
- Sketch the process on enthalpy–entropy chart.

2. Attempt any **two** out of the following : (10×2=20)

- (a) The mean diameter of the blade ring is 80 cm and the speed of rotation is 3010 rpm in a stage of an impulse turbine provided with a single row wheel. The steam issues from

the nozzles with a velocity of $300 \frac{\text{m}}{\text{s}}$ and the nozzle angle

is 20°. The rotor blades are equiangular. The relative velocity of the steam at outlet from the blades is 0.85 times the relative velocity of the steam entering the blades, due to friction in the blade channels. Calculate the power developed in the blades when the axial thrust on the blades is 141 N. Draw the velocity triangle.

- (b) What do you understand by governing of steam turbine ? What are the main methods of governing ? Describe any one method.

- (c) The following particulars relate to closed cycle gas turbine using air as the working medium :

Atmospheric temperature	= 25° C
Maximum temperature	= 869° C
Inlet pressure at compressor	= 1 bar
Final pressure of compressor	= 5 bar
Turbine efficiency	= 0.84
Compressor efficiency	= 0.81
Calorific value of fuel	= 41850 kJ/kg
Specific heat at constant pressure	= 1.005 kJ/kgK
Adiabatic index	= 1.4

Calculate :

- Compressor work
- Heat supplied
- Turbine work and
- Net work.

3. Attempt any **two** out of the following : (10×2=20)

- (a) A single acting, single stage compressor delivers 15 m³ of free air per minute at a pressure ratio of 8 : 1. The compressor runs at 300 rpm. Assuming that compression and expansion follow the law $pv^{1.3} = \text{constant}$

and clearance is $\left(\frac{1}{16}\right)$ of swept volume, calculate the

diameter and stroke of compressor. Stroke to bore ratio is 1.5. Pressure of air at suction is 1 bar.

- (b) Explain the phenomenon of surging in a centrifugal compressor with appropriate curves.

- (c) (i) Compare the Otto and Diesel cycle for same maximum pressure and temperature, showing it on P-V and T-S chart.

- (ii) An air standard diesel cycle has pressure and temperature at the beginning of compression as 1 bar and 35° C respectively. The compression ratio is 14. If cut off ratio is 2. Find the work done per kg of air and thermal efficiency.

4. Attempt any **two** out of the following : (10×2=20)

- (a) A jet of water flows smoothly on a stationary curved vane which turns it through 60°. The initial jet is 50 mm in

diameter and the velocity which is uniform, is $36 \frac{\text{m}}{\text{s}}$. As a

result of friction, the velocity of the water leaving the surface is $30 \frac{\text{m}}{\text{s}}$. Neglecting gravity effects, calculate

the force on the vane.