Printed Pages—4 **EME309**

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

PAPER ID : 0207 **Roll No.** | | | | | | | | | | |

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2010-11

THERMAL AND HYDRAULIC MACHINES

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt **all** questions.

(2) All questions carry equal marks.

(3) Use of steam tables and Mollier Charts is permitted.

(4) Be precise in your answers.

(5) Notations used have usual meaning.

(6) Assume any relevant data, if necessary.

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

(a) What do you mean by quasi-static process ? What are state functions ? How do state functions differ from path functions ? Give examples of each. How will you test whether any physical variable is a state function or not ?

(b) State and explain the various statements of Second Law of Thermodynamics with examples.

(c) Steam is supplied to a turbine at a pressure of 32 bar and a temperature of 410°C. It expands isentropically to pressure of 0.08 bar. What is the dryness fraction at the end of expansion and the thermal efficiency of the cycle ? Calculate the modified exhaust condition and thermal efficiency if the steam is reheated at 5.5 bar to a temperature of 395°C and then expanded isentropically to a pressure of 0.08 bar.

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

(a) The following particulars refer to a stage of Parson's steam turbine, comprising one ring of fixed blades and one ring of moving blades;

Mean diameter of blade ring = 70 cm

RPM = 3000

Steam velocity at exit from blades = 160 m/s

Blade outlet angle = 20°

Steam flow through the blades = 7 Kg/s

Draw the velocity diagram and find the following :

(i) blade inlet angle,

(ii) tangential force on the ring of moving blades and

(iii) power developed in a stage.

(b) What do you mean by governing of steam turbine? What is difference between throttle and nozzle control governing ?

(c) In a gas turbine plant, the air at 10°C and 1 bar is compressed to 12 bar with compression efficiency of 80 percent. The air is heated in the regenerator and combustion chamber till its temperature is raised to 1400°C and during the process, pressure falls to 0.2 bar. The air is then expanded in the turbine and passes to regenerator which has 75% effectiveness and causes a pressure drop of 0.2 bar. If the isentropic efficiency of the turbine is 85 per cent, determine the thermal efficiency of the plant. Assume addition of heat at constant pressure. Take ratio of specific heats as 1. and specific heat of working substance is 1.005 kJ/kg at constant pressure.

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

(a) Derive an expression for volumetric efficiency of a reciprocating compressor in terms of clearance and pressure ratio.

(b) Explain the phenomenon of surging and choking in centrifugal and axial compressors.

(c) Compare the efficiency of the Otto, the Diesel and the Dual cycles under the conditions of :

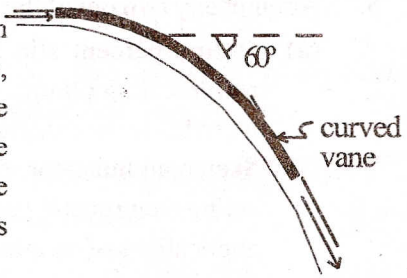
(i) equal compression ratio and heat input,

(ii) constant maximum pressure heat input, and

(iii) constant maximum pressure and temperature.

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

(a) A jet of water from a nozzle is deflected through an angle of 60° from its original direction by a curved vane when it enters tangentially (see figure 1) without shock with a velocity of 30 m/s and leaves with a velocity of 25 m/s. If the discharge from the nozzle is 0.8 kg/s, calculate the magnitude and direction of the resultant force on the vane if the vane is stationary.



(b) A pelton wheel driven by two similar jets transmits 3750 kW to the shaft when running at 375 rev min^{-1}. The head from the reservoir level to the nozzles is 200 m and the efficiency of power transmission through the pipelines and the nozzles is 90 percent. The jets are tangential to a 1.45 m diameter circle. The relative velocity decreases by 10 percent as water traverses the buckets, which are so shaped that they would, if stationary, deflect the jet through 165°. Neglecting windage losses, find :

(i) the efficiency of the runner and

(ii) the diameter of each jet.

The coefficient of velocity for the nozzle is 0.99.

(c) In an inward flow hydraulic reaction turbine, the supply head is 12 m and the maximum discharge is 0.28 m^3/s. The external diameter is twice the internal diameter and the velocity of flow is constant and equal to $0.15\sqrt{2gH}$. The runner vanes are radial at inlet and the runner rotates at 300 revolutions per minute. Determine :

(i) the guide vane angles,

(ii) the vane angle at exit for radial discharge,

(iii) widths of runner at inlet and exit

The vanes occupy 10 percent of the circumference and the hydraulic efficiency is 80 percent. Draw the velocity triangles.

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

(a) Define percent slip and separation with reference to reciprocating pumps. Why are reciprocating pumps also included in the category of positive displacement pumps ? Sketch an indicator diagram for a single cylinder, single acting reciprocating pump without air chambers. State the applications of reciprocating pumps.

(b) The impeller of a centrifugal pump has a diameter of 0.1 m and axial width at outlet of 15 mm. There are 16 blades swept backwards and inclined at 25° to the tangent to the periphery. The flow rate through the impeller is 8.5 m^3/h when it rotates at 750 revolutions per minute. Calculate the head developed by the pump when handling water. Draw the velocity triangle at outlet.

(c) What do you mean by cavitation ? Define Thoma's cavitation factor. Discuss the effects of cavitation on performance of pumps.