GANPAT UNIVERSITY
B.Tech. Semester VII- Mechanical Engineering
Regular Examination December 2013
TURBOMACHINERY (2ME701)

Time: 3 Hours **Total Marks: 70**

Instruction:
(1) Figure on right indicated full marks.
(2) This question paper has two sections and attempt each section in a separate answer book.
(3) Use of steam table and Mollier diagram is permitted.

SECTION-I

Q. 1 (a) With help of S.F.E.E. prove that $C_2 = 44.72\sqrt{h_1 - h_2}$. Neglect initial velocity of steam. Where C_2 is outside velocity of steam from nozzle ($h_1 - h_2$) is heat drop in nozzle. (6)

(b) A nozzle expands steam from 14 bar and 300 ^{0}C to 6 bar. If the flow rate is 1 kg/s, find the throat and exit area. What should be the coefficient of velocity if the exit velocity is 550 m/s? (6)

OR

Q. 1 (a) Derive the general Euler's expression for a Turbo machine. (6)

(b) A steam turbine diaphragm contains 78 convergent nozzles of rectangular section, having 0.255 plate thickness. Direction of flow at exit is 18 ^{0} to the plane of the diaphragm and mean diameter of the nozzle ring is 125 cm. The steam is supplied at 7 bar and 250 ^{0}C. The stage pressure is 4.2 bar. Calculate the height of nozzles at exit to pass 7.55 kg/s of steam. Nozzle efficiency is 90 %. (6)

Q. 2 (a) Explain the types and classification of steam turbine. (5)

(b) A De-Laval steam turbine is supplied with dry steam and works on a pressure range from 10 to 0.3 bar. The nozzle angle is 23 ^{0} and the blade leaving angle is 30 ^{0} the mean blade speed is 300 m/s. If there is 10 % loss due to friction in the nozzle and if the steam velocity is reduced by 18 % during its passage through the blades, find the end thrust on the shaft per power developed by the wheel. (6)

OR

Q. 2 (a) Why compounding of impulse turbine is necessary? What are various methods of reducing rotor speed? Explain anyone method with neat diagram (5)

(b) The following particulars refer to a stage of a Parson's steam turbine comprising one ring of fixed blades and one ring of moving blades. Mean diameter of blade ring = 70 cm, Steam velocity at exit from blades = 160 m/s, R.P.M. = 3000, Blade outlet angle =20^0, steam flow through blades = 7 kg/s. Draw the velocity diagram and find the following: - (a) Blade inlet angle, (b) Tangential force on ring of moving blades, (c) Power developed in stage. (6)

Q. 3 Explain any **three** of the following short notes. (12)

(a) Mixed flow turbines.
(b) Bypass governing of steam turbines.
(c) Various methods of fixing blades on rotor.
(d) Bleeding and reheating related to steam turbines.

SECTION II

Q. 4 (a) What are the methods of improving the thermal efficiency of simple open cycle gas turbine? Explain any one. (5)

(b) An open cycle gas turbine plant works between the fixed temperature limits of 300 K and 1500 K, the absolute pressure limits being 1 bar and 14 bar. The isentropic efficiency of compressor and turbine are 0.85 and 0.86 respectively. Estimate the actual thermal efficiency and power developed by the plant. The calorific value of fuel is 42500 kJ/kg, $\eta_{comb} = 0.99$, $\eta_m = 0.98$, $\eta_{generator} = 0.985$ and mass of air used = 510 kg/s. (7)

Q. 4 (a) What do you mean by binary-vapor cycle and in what case is required? (5)

(b) In a gas turbine plant the air at 10 ^{0}C and 1 bar is compressed to 12 bar with compression of 80 %. The air is heated to 1500 ^{0}C in combustion chamber and generator, during the process of heating fall of pressure is 0.2 bar. The air is then expanded in the turbine and is supplied to regenerator having effectiveness of 0.75. The pressure dropped within regenerator is 0.2 bar. If isentropic efficiency of turbine 85%, Determine thermal efficiency of the plant. (7)

Q. 5 In a combined power and process plant the boiler generates 21000 kg/h of steam at a pressure of 17 bar and temperature 230 0C. A part of the steam goes to a process heater which consumes 132.56 kW, the steam leaving the process heater 0.957 dry at 17 bar being throttled to 3.5 bar. The remaining steam flows through an h.p. turbine which exhausts at a pressure of 3.5 bar. The exhaust steam mixes with the process steam before entering the l.p. turbine which develops 1337.5 kW. At the exhaust, the pressure is 0.3 bar and steam is 0.912 dry. Draw the line and T-s diagram of the plant and determine (a) the steam quality at the exhaust of the h.p. turbine (b) the power developed by the h.p. turbine (c) the isentropic efficiency of the h.p. turbine. (11)

OR

Q. 5 An open cycle gas turbine is equipped with intercooling, regeneration and reheat arrangements. The H.P. turbine is used for compressor drive and L.P. turbine for output. The specific output of the installation is 132 kW/kg/s and overall thermal efficiency of 32 %. Following data refer to this installation. (11)

Pressure ratio in each compressor stage = 2.5, Isentropic efficiency in each compressor stage = 0.86, Isentropic efficiency in H.P. turbine = 0.87, Isentropic efficiency in L.P. turbine = 0.84, Pressure loss in air side of heat exchanger = 6 % of entry pressure, Pressure loss in intercooler = 3 % of entry pressure, Pressure loss in reheater = 6 % of entry pressure, Turbine inlet temperature for both = 1020 K, Atmospheric temperature = 288 K, Atmospheric pressure = 1.0132 bar.

Calculate the permissible pressure drop on gas side and effectiveness of heat exchanger.

Q. 6 (a) Explain working of a turbo jet engine with the help of diagram. (6)

(b) Define and explain the following for turbo jet engine. (6)

(1) Thrust
(2) Propulsive power
(3) Propulsive efficiency
(4) Thermal efficiency

*******END OF PAPER*******