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UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program/course: B.Tech, Mechanical | **Semester – V**
Subject: Turbo Machinery | **Max. Marks : 100**
Code : MHEG367 | **Duration : 3 Hrs**
No. of page/s: 3

NOTE: Assume suitable data if required.

Section- A

Answer all the questions. 20 M

Q1. What do you understand by governing of hydraulic turbines? How is governing accomplished in case of three main hydraulic turbine types? Explain. [5]

Q2. Differentiate between the following heads for a pump: Static head, Manometric head, Net positive suction head, Euler head. Clearly write the expressions for each. [5]

Q3. Distinguish between centrifugal and reciprocating compressors, clearly mentioning under what circumstances these can be used. [5]

Q4. What are the different ways by which thermal efficiency of a gas turbine power plant can be improved? Explain with schematic diagrams. [5]

Section- B

Answer all the questions. 40M

Q5. What assumptions make for an ideal compressor? For an ideal compressor, derive an expression for exit velocity at impeller tip in terms of total inlet head temperature and compression ratio. [10]

Q6. A model turbine is provided with a runner 2 m in diameter. It is found to develop 64 HP under a head of 100 m when running at a speed of 4,000 RPM. Calculate the specific speed for this model. It is required to build a similar turbine to develop 200 HP under a head of 120 m. Calculate the required diameter. Also calculate the unit speed of the model. [10]

Q7. Is it possible that a reciprocating compressor is operating between two different pressure ratios, yet not delivering any gas? Yes, or no: present a mathematical proof, beginning from the fundamentals. [10]

Q8. a) A single acting air compressor has a bore of 15 cm and the piston stroke is 25 cm. The crank speed is 600 RPM. Air taken from atmosphere (1 atm., 27 C) is delivered at 11 bars. Assuming isentropic compression, find the power required to drive the compressor, when its mechanical efficiency is 80%. The compressor has a clearance which is $1/20^{th}$ of the stroke volume. Also find the volumetric efficiency of the compressor. [10]

OR

b) A two stage reciprocating compressor with perfect intercooling delivers 8 kg/min of air at 36bar. The inlet pressure and temperatures are 1bar and 300K respectively. Assuming polytrophic process n=1.25 calculate (i) power required (ii) isothermal efficiency (iii) Heat transfer in each cylinder (iv) heat rejected in intercooler.

Section- C

Answer all the questions. 40M

Q9. A single-sided centrifugal compressor has the internal diameter of eye 15 cm. The compressor delivers air at the rate of 9 kg/s with a pressure ratio of 4.4 to 1 at 20,000 rpm. The axial velocity is 150 m/s with no pre-whirl. Initial condition of air are pressure 1 bar and temperature 20°C. Assuming adiabatic efficiency as 80%, the ratio of whirl speed to tip speed as 0.95 and neglecting all other losses, calculate [20]

- The rise of total temperature,
- Tip speed,
- Tip dia and
- External dia of eye.

Q10. a) Consider an open gas turbine installation working on Brayton cycle and provided with intercooling, regenerator and reheating systems. 15kg/s of air enters the low pressure compressor at 1 bar, 290 K and after compression to 4 bar is cooled upto 295 K. After subsequent compression to 8 bar in the high pressure compressor, the air passes through a regenerator which has an effectiveness of 80%. The air is next led to combustion chamber where it is heated upto 1250 K. The heated air enters the high pressure turbine where it expands to 4 bar. The air is then reheated to 1200 K before being expanded to 1 bar in the low pressure turbine. The exhaust passes through regenerator being discharged out of cycle. Assume that compression and expansion processes are isentropic and **mechanical** efficiency of turbine and compressor are 98% and 96%, respectively. [20]

Find out:

- Power Output
- Thermal Efficiency

(OR)

b) A double runner Pelton wheel is to operate at 30,000 kW generator under an effective head of 300 m at the base of the nozzle. Find the size of jet, mean diameter of runner, speed of turbine and specific speed of each wheel. Assume generator efficiency 93%, Pelton wheel efficiency 85%, coefficient of nozzle velocity 0.97, speed ratio 0.46 and jet ratio to be 12.