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Program/ Course: B. Tech. ME

Semester: 4th/ (2018)

Name of Subject: Applied Thermodynamics

Subject Code: PCME-107

Paper ID: 16196

Time Allowed: 03 Hours

Max. Marks: 60

NOTE:

1) Scientific calculator is allowed.
2) **Part A** and **B** are **compulsory**.
3) **Part C** has Two Questions **Q8** and **Q9**. Both are compulsory, but with internal choice.
4) Any missing data may be assumed appropriately.
5) Use of steam table is allowed.

SECTION- A

[Marks: 2 each]

Q1.

a) Enlist applications of gas turbine.
b) What are the losses in axial flow compressor?
c) Write the sources of leakage in condensers.
d) Draw a schematic diagram of closed cycle gas turbine along with reheater and intercooler. Also represent it on PV and TS coordinates.
e) 1 kg of air per second is taken into a root blower compressor at 1 bar and 27°C. The delivery pressure of air is 1.5 bar. Calculate the motor power required to run the compressor, if mechanical efficiency is 80%.
f) What are the losses in steam turbine?

SECTION- B

[Marks: 4 each]

Q2. An ideal single stage, single acting reciprocating air compressor has a displacement volume of 14 litter and a clearance volume of 0.7 litter. It receives air at a pressure of 1 bar and delivers it at a pressure of 7 bar. The compression is polytropic with an index of 1.3 and re-expansion is isentropic with an index of 1.4. Calculate the net indicated work of the cycle.

Q3. Why steam turbines are compounded? Explain any one method with neat sketch.

Q4. An axial-flow compressor draws air at 20°C and delivers it at 50°C. Assuming 50% reaction. Calculate the velocity of flow, if blade velocity is 100 m/s, work factor is 0.85. Take C_p = 1 kJ/kgK. Assume α=10° and β=40°, Find the number of stages.

Q5. A surface condenser is designed to handle 12000 kg of steam per hour. The steam enters at 8 kPa, 0.9 dry. The condensate leaves the condenser at the corresponding saturation temperature. Calculate the rate of cooling water, if cooling water temperature rise is limited to 12°C.

Q6. What are the methods for improving the thermal efficiency of gas turbine? Explain any one method in detail.

Q7. Discuss the construction and working of ram jet propulsion engine with neat diagram.

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SECTION- C [Marks: 12 each]

Q8. A reaction turbine with 50% degree of reaction running at 400 rpm develops 75 kW per kg of the steam. The exit angle of the blade is 20° and the steam velocity is 1.4 times the blade velocity. Determine

a. Blade velocity.
b. Blade inlet angle.

OR

A gas turbine unit has a pressure ratio of 6 and maximum cycle temperature of 610°C. The isentropic efficiency of the turbine and compressor are 0.82 and 0.8, respectively. Calculate the power output in kW of an electric generator, geared to the turbine, when air enters the compressors at 15°C at a rate of 16 kg/s.

Take C_p = 1.005 kJ/kgK and γ = 1.4 for compression process and C_p = 1.11 kJ/kgK and γ = 1.333 for expansion process.

Q9. Prove that the IP = $2 \times \left(\frac{n}{n-1}\right) m_a R T_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{2n}} - 1\right]$ is minimum power required to run two stage reciprocating compressor with perfect intercooling.

OR

A centrifugal compressor running at 12000 rpm delivers 600 m^3/min of free air. The air is compressed from 1 bar and 27°C to a pressure ratio of 4 with an isentropic efficiency of 85%. The blades are radial at the impeller outlet and flow velocity of 60 m/s may be assumed throughout constant. The outer radius of the impeller is twice the inner one and slip factor is 0.9. Calculate

a. Final temperature of air
b. Power input to compressor
c. Impeller diameter at inlet and outlet
d. Width of impeller at inlet

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