P P SAVANI UNIVERSITY

Fifth Semester of B. Tech. Examination

December 2021

SEME3041 Thermal Engineering

13.12.2021, Monday **Time: 9:00 a.m. To 11:30 a.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	Answer the Following (Any Five):	**[05]**
(i)	What are the different types of air compressors?	
(ii)	What causes an air compressor to overheat?	
(iii)	How does a compressor unloader valve work?	
(iv)	when the cross-section of the nozzle decreases continuously from entrance to exit, A nozzle is said to be a _____.	
(v)	Explain internal efficiency of nozzle.	
(vi)	The critical pressure ratio for initially wet steam is	
(vii)	Which cycle is most suited for Jet propulsion?	
Q - 2 (a)	Derive equation of maximum discharge through a nozzle or critical pressure ratio.	**[05]**
Q - 2 (b)	A convergent-divergent nozzle is required to discharge 350 kg of steam per hour. The nozzle is supplied with steam at 8.5 bar and 90% dry and discharges against a back pressure of 0.4 bar. Neglecting the effect of friction, find the throat and exit diameters.	**[05]**

OR

Q - 2 (a)	Explain super saturated flow (or) metastable flow in steam nozzle.	**[05]**
Q - 2 (b)	An impulse turbine which is to develop 175 kW with probable steam consumption of 11 kg per kW-hour is supplied with dry saturated steam at 10 bar. Find the number of nozzles each of about 6 mm diameter at the throat that will be required for the purpose and estimate the exact diameters at the throat and exit of the nozzles. The condenser pressure is 0.15 bar. Neglect the effect of friction in nozzles. Assume index of expansion as 1.135.	**[05]**
Q - 3 (a)	Explain slip factor, power input factor and pressure co-efficient of centrifugal compressor. What is the relation of these parameters with the compressor efficiency?	**[05]**
Q - 3 (b)	Explain Surging and Chocking of centrifugal compressor.	**[05]**

OR

Q - 3 (a)	With a suitable sketch explain the working principle of screw compressor.	**[05]**
Q - 3 (b)	A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency 88% when running at 14000 rpm and inducing air at 25°C. Curved vanes at inlet give the air a prewhirl of 18° to axial direction at all radii and the mean diameter of eye is 245mm. The absolute air velocity at inlet is 120 m/s. Impeller tip diameter is 580mm, Calculate slip factor.	**[05]**
Q - 4	**Attempt any one.**	**[05]**
(i)	How is a turbojet engine different from a turbofan engine?	
(ii)	What is meant by pulse detonation engine? How is it different from a jet engine?	

SECTION – II

Q – 1 (a) Explain Closed cycle gas turbine with P-v and T-s Diagram. Also derive an expression for efficiency. **[07]**

Q – 1 (b) In constant pressure open cycle gas turbine air enters at 1 bar and 20 ^{0}C and leaves the compressor at 5 bar. Using following data **[08]**

Temperature of gas entering the turbine = 680 ^{0}C
Pressure loss in combustion = 0.1 bar
Compressor efficiency = 85 %
Turbine Efficiency = 80 %
Combustion Efficiency = 85 %
Specific Heat = 1.024 KJ/Kg K
$\Gamma = 1.4$
Calculate

1. Quantity of air circulation if plant develops 1065 KW
2. Heat Supplied

Thermal Efficiency

OR

Q – 1 (a) What are the methods to improve the efficiency of gas turbine cycle? Explain any one of them with necessary diagrams. **[07]**

Q – 1 (b) A gas turbine unit has a pressure ratio 6:1 and maximum cycle temperature is 610 ^{0}C. The isentropic efficiency of the compressor and turbine are 0.80 and 0.82 respectively. Air enters the compressor at 15 ^{0}C & 1 bar and at a rate of 16 kg/s. Determine **[08]**

1. Pressure and Temperature at all silent points
2. Work Output
3. Work Ratio

Take $C_p = 1.005$ KJ/kg K and $\gamma = 1.4$ for Compression.
Take $C_p = 1.11$ KJ/kg K and $\gamma = 1.333$ for Expansion.

Q - 2 (a) What is Compounding? Explain working principle of pressure compounding with neat sketch. **[07]**

Q - 2 (b) The following data refers to a Parson 's Rection turbine. **[08]**

Speed of the turbine = 1500 rpm
Mean diameter of rotor = 1 m
Stage efficiency = 80 %
Blade outlet angle = 20^0
Speed Ratio = 0.7
Determine the available isentropic enthalpy drop in the stage.

OR

Q - 2 (a) Derive condition for maximum efficiency for reaction turbine and the expression for maximum efficiency. **[08]**

Q - 2 (b) In an impulse turbine the mean diameter of blade is 1.05 m and the speed is 3000 rpm. The nozzle angle is 15^0.The ratio of blade speed to steam speed is 0.42 and the ratio of relative velocity at the outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3^0 less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagram for the blades and determine the following. **[07]**

1. Tangential thrust of the blade
2. Axial thrust of the blades
3. Resultant thrust of the blades
4. Power developed in the blades
5. Blading Efficiency

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