Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII (Old) EXAMINATION – WINTER 2019

Subject Code: 181904 **Date: 02/12/2019**

Subject Name: Thermal Engineering

Time: 02:30 PM TO 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of steam table and mollier diagram is permitted.**

Q.1	**(a)**	Derive an expression for mass flow rate of steam through the nozzle.	**07**
	(b)	A dry saturated steam at 2.8 bar is expanded through a convergent nozzle to 1.7 bar. The exit area is 3 cm^2. Estimate the exit velocity and the mass flow rate, assuming (i) isentropic expansion and (ii) assuming super saturated flow exists.	**07**
Q.2	**(a)**	Explain the effect of varying the back pressure in convergent divergent nozzle and state when maximum flow occurs in the nozzle.	**07**
	(b)	Differentiate clearly between Impulse and Reaction turbine. For an Impulse turbine, obtain expression for work done and axial thrust.	**07**
		OR	
	(b)	Starting from the fundamentals, show that for the maximum discharge through nozzle, the ratio of throat pressure to inlet pressure is given by $\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$, where 'n' is the index of isentropic expansion of steam through nozzle.	**07**
Q.3	**(a)**	Derive condition of maximum blade efficiency in case of 50 % reaction turbine.	**07**
	(b)	In a stage of impulse reaction turbine, steam enters with a speed of 250 m/sec at an angle of 30° in the direction of blade motion. The mean speed of the blade is 150 m/sec when the rotor is running at 3000 rpm. The blade height is 10 cm. The specific volume of steam at nozzle outlet and blade outlet are 3.5 m^3/kg and 4 m^3/kg respectively. The turbine develops 250 kW. Assuming the efficiency of nozzle and blades combinedly considered is 90 % and carryover coefficient is 0.8, find (a) the enthalpy drops in each stage, (b) degree of reaction and (c) stage efficiency.	**07**
		OR	
Q.3	**(a)**	Explain Regenerative feed heating with the help of sketch of steam power plant. How does the feed water heating increases efficiency of Rankine Cycle?	**07**
	(b)	The steam at 30 bar and 300° C is supplied to a three-stage impulse turbine. The condenser pressure is 0.1 bar. Find out the enthalpy drop per stage per kg of steam flow if the power developed in three stages is in the ratio of High:Intermediate:Lower = 1:1:2. The stage efficiencies are High stage = 0.8, Intermediate stage = 0.77 and Lower stage = 0.74. Take reheat factor = 1.05. Assume condition lint is straight. Also find the power developed in each stage, if the steam flow rate through the turbine is 500 kg/min.	**07**
Q.4	**(a)**	Explain Thrust, Thrust Power and Propulsive Power in context to jet propulsion.	**07**
	(b)	The pressure ratio of an open cycle constant pressure gas turbine plant is 6. The temperature range of the plant is 15 °C and 800 °C. Other data are: specific heat at constant pressure for air is 1 kJ/kg K, specific heat at constant pressure for gas is 1.075 kJ/kg K, Specific heat ratio is 1.4 for air and gases, calorific value of fuel is 43000 kJ/kg, efficiency of compressor is 0.85, efficiency of turbine is 0.90 and combustion efficiency is 0.95. Find (a) The thermal efficiency of the plant, (b)	**07**

Power develop by the plant if the circulation of air is 5 kg/sec. (c) Air Fuel ratio and (d) Specific fuel consumption. Neglect the losses in the system.

OR

Q.4 **(a)** Derive an expression for optimum pressure ratio for maximum work output in ideal Brayton Cycle. **07**

(b) A turbojet engine inducts 45 kg of air per second and propels an aircraft with a uniform flight speed of 880 km/h. The isentropic enthalpy change for nozzle is 188.37 kJ/kg and its velocity coefficient is 0.96. The fuel ratio is 0.012, the combustion efficiency is 0.95 and the lower heating value of the fuel is 44000 kJ/kg. Calculate (a) The thermal efficiency of the engine, (b) the fuel flow rate in kg/h and TSFC, (c) the propulsion power in kW, (d) the thrust power, € the propulsive efficiency and (f) the overall efficiency. **07**

Q.5 **(a)** Explain with neat sketch various method of attachment of blades to turbine rotor. **07**

(b) Explain with neat sketches, different methods used for improve efficiency and specific work output of open cycle gas turbine plant. **07**

OR

Q.5 **(a)** Derive an expression for the optimum intermediate pressure in an open cycle gas turbine with reheating. **07**

(b) List different methods of governing of steam turbines. Explain any one of them. **07**

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