Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII EXAMINATION – WINTER 2015

Subject Code:181904 **Date:16/12/2015**

Subject Name: Thermal Engineering

Time: 2:30pm to 5:00pm **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 tables, Mollier chart and calculator is permissible.**

Q.1	**(a)**	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**
	(b)	Dry saturated steam at pressure of 6 bar flows through nozzles at the rate of 4.5 kg/sec and discharges at a pressure of 1.6 bar. The loss due to friction occurs only in the diverging portion of the nozzle and its magnitude is 12% of the total isentropic enthalpy drop. Assume the isentropic index of expansion n=1.135, determine the cross-sectional area at the throat and exit of the nozzles.	**07**
Q.2	**(a)**	Explain with a neat diagram the working of a Binary Vapor cycle.	**07**
	(b)	Explain throttle control governing of steam turbine and compare it with nozzle control governing.	**07**
		OR	
	(b)	What do you understand by compounding of steam turbine? Explain the two stage pressure compounded impulse steam turbine with neat sketch.	**07**
Q.3	**(a)**	Define the blade efficiency and hence derive an expression for maximum blade efficiency for a single stage impulse steam turbine.	**07**
	(b)	The isentropic enthalpy drop across an impulse turbine nozzle is 132.5 kJ/kg. The nozzle efficiency is 92%. The nozzle angle is 16°. The relative velocity is reduced by 9% due to the friction in the flow over the blade. Assuming equiangular blade and optimum blade speed, determine the blade angles, power developed for a flow rate of 40 kg/min and the blade and stage efficiencies.	**07**
		OR	
Q.3	**(a)**	Explain "Reheat factor" and "Internal efficiency". Derive the relation between the stage efficiency, internal efficiency and reheat factor.	**07**
	(b)	A 50% impulse-reaction turbine runs at 3000 rpm. The angles at exit of fixed bladings and exit of moving bladings are 30° and 20° respectively. At a particular stage, the mean ring diameter is 0.7 m and the steam condition is 1.5 bar and 0.96 dry. Calculate:	**07**

(a) the required height of bladings to pass 50 kg/s of steam, and
(b) the power developed by the stage.

Q.4 **(a)** Draw the schematic diagram of an actual gas turbine cycle with inter-cooling, regeneration and reheating. Also draw the cycle on T-s diagram and write the equation of cycle efficiency. **04**

(b) A gas turbine power plant of 5 MW capacity is supplied with air at 15°C. The pressure ratio is 6. The maximum temperature is limited to 750°C. The compression is carried out in one stage and the expansion is carried out in two stages with reheating to the original temperature. The suction and exhaust pressure are 1 bar. Taking the following data: **10**

Cpa= 1 kJ/kg-K, Cpg= 1.15 kJ/kg-K, γ(air)= 1.4, γ(gas)= 1.33

η_c= 80%, η_{t1}= η_{t2}= 85%, C.V of fuel= 18500 kJ/kg

ε(effectiveness of heat exchanger)= 0.75

Determine the following:

(i) Cycle efficiency (ii) A:F ratio entering in the first turbine
(iii) Fuel consumption of the plant per hour.

OR

Q.4 **(a)** Explain the regenerative feed heating cycle for steam power plant with schematic diagram. **06**

(b) A high pressure boiler delivers steam at 90 bar and 480°C. The steam is expanded in the first section of the steam turbine to 12 bar and then passed on to reheater, where it is is reheated to the initial temperature. The expansion now takes place in the remaining section of steam turbine, down to the condenser pressure of 0.07 bar. Determine the work output and the efficiency of the ideal cycle for flow of 1 kg/sec of steam. **08**

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

(b) With the help of neat diagram, explain the working principle of rocket engines. What are the merits and demerits? **07**

OR

Q.5 **(a)** Explain with neat sketches, any three methods of blade fixation on the turbine rotor. **07**

(b) Explain with neat diagram the importance, working and application of back pressure steam turbine. When and why the steam is de-superheated? **07**

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