Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII • EXAMINATION – SUMMER 2013

Subject Code: 181904 Date: 10/05/2013

Subject Name: Thermal Engineering

Time: 10:30 am TO 01:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Show that the maximum discharge of fluid through a nozzle takes place when the ratio of the fluid pressure at the throat to the inlet pressure is $\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$ where n is the index of adiabatic expansion. **07**

(b) Explain the metastable flow of steam through a nozzle and the significance of Wilsonôs line. **07**

Q.2 **(a)** What is the principle of operation of steam turbines? And what is the difference between impulse and reaction turbines. **07**

(b) What is compounding? Describe various ways of compounding impulse and reaction turbines with merits and demerits. **07**

OR

(b) Dry saturated steam with an initial pressure of 11 bar is expanded to 1.5 bar through a convergent divergent nozzle. The flow rate of steam is estimated as 2 kg/sec. area of cross-section of nozzle as its throat is 1 cm2. If the efficiency of nozzle is 88%. Find the numbers of nozzles and exact throat and exit area. Take the index of expansion as 1.2. **07**

Q.3 **(a)** Sketch the velocity diagram of a single stage impulse turbine and determine the expression for the force, workdone, diagram efficiency, gross stage efficiency and axial thrust. **07**

(b) The data pertaining to an impulse turbine is as: Blade speed: 300 m/s; isentropic enthalpy drop in nozzles: 450 kJ/kg; nozzle efficiency: 0.9; nozzle angle: 20º; blade velocity coefficient: 0.85; blade exit angle: 25º.Calculate for a mass of 1 kg/sec **07**

(a) The inlet angle of moving blades,
(b) The axial thrust,
(c) The driving force on the wheel,
(d) The diagram power,
(e) The energy lost in blades due to friction,
(f) The diagram efficiency.

OR

Q.3 **(a)** Prove that the diagram or blade efficiency of a single stage reaction turbine is given by **07**

$\eta_{bl} = 2 - \frac{2}{1 + 2\rho\cos\alpha - \rho^2}$ where $R_d = 50\%$ and $C_{f1} = C_{f0}$

Further prove that maximum blade efficiency is given by $(\eta_{bl})_{max} = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$

(b) Describe the process and purpose of reheating as applicable to steam flowing through a turbine. **07**

Q.4 **(a)** Derive an expression for the thermal efficiency of a gas turbine plant, and show that it is independent of the mass of air circulated in it. **07**

(b) In a constant pressure open cycle gas turbine air enters at 1 bar and 20ºC and leaves the compressor at 5 bar. Using the following data: **07**

Temperature of gases entering the turbine =680 ºC, pressure losses in the combustion chamber =0.1 bar, $\eta_{compressor}$ = 85%, $\eta_{turbine}$ = 80%, $\eta_{combustion}$ = 85%, ɔ =1.4, and c_p = 1.024 kJ/kg K for air and gas. Find

(i) The quality of air circulation if the plant develops 1065 kW.

(ii) Heat supplied per kg of air circulation.

(iii) The thermal efficiency of the cycle.

Mass of the fuel may be neglected.

OR

Q.4 **(a)** Prove that optimum pressure ratio for maximum specific output for a gas turbine plant is given by $r_p\,(\text{optimum}) = \left\{\eta_{turbine} \times \eta_{compressor} \cdot \frac{T_3}{T_1}\right\}^{\gamma/2(\gamma-1)}$ **07**

(b) What are the main requirements of a gas turbine combustion chamber? Are these requirements mutually compatible? Explain it. **07**

Q.5 **(a)** Draw a schematic diagram of a ñPulse Jet Engineò and describe its operation. What are the advantages and disadvantages of Pulse Jet Engine? **07**

(b) Write a short note with schematic diagram on : ñTurbo Jet Engineò **07**

OR

Q.5 **(a)** Explain brief note on Back Pressure Turbine with neat sketch and Enthalpy-Entropy diagram. **07**

(b) Write a short note on methods of attachment of blades to turbine rotors. **07**

****