

INDIAN INSTITUTE OF TECHNOLOGY

Date 27th April, 2001 ~~FN/AN~~ Time : 2/3 Hrs. Full Marks 60 No. of Students 10

Autumn / Spring Semester, 192001 Deptt. Aerospace Engineering Sub. No. 114014

~~Fourth~~ Yr. B.Tech. (H) / B.Arch. (H) / M.Sc. Sub. Name Adv. Gas Turbine Theory

ANSWER ANY FOUR QUESTIONS

Instruction

1. (a) Describe the non-dimensional parameters for presenting the performance of aviation gas turbine engines.
(b) Explain corrected variables and the importance of these parameters for the designer.
2. Discuss the procedure to determine off- design performance of a single shaft gas turbine unit.
Explain the effect of load characteristics on the operating points.
3. Explain the method of displacing the equilibrium running line for turbo-jet engine.
4. When running at a low power condition a gas turbine with free power turbine operates at a compressor pressure ratio of 2.60. The combustion chamber pressure loss is 4 per cent of the compressor delivery pressure and the exhaust pressure loss can be ignored. The turbine characteristics are given below :

Gas generator turbine			Power turbine	
p_3/p_4	$m\sqrt{T_3}/p_3$	η_t	p_4/p_a	$m\sqrt{T_4}/p_4$
1.3	20.0	0.85	1.4	60.0
1.5	44.0	0.85	1.6	85.0
1.8	62.0	0.85	1.8	95.0

The non- dimensional flows are based on m in kg/s, p in bar and T in K, all pressures and temperatures being stagnation values.

Calculate the gas generator turbine pressure ratio at this condition. Assuming the compressor characteristic to be known, indicate briefly how you would calculate the turbine inlet temperature.

5. An axial compressor has an overall pressure ratio of 4.0 and mass flow of 3 kg/s. If the polytropic efficiency is 88% and the stagnation temperature rise per stage must not exceed 25 k. Calculate the number of stages required and the pressure ratio of the first and last stages. Assume equal temperature rise in all stages. If the absolute velocity approaching the last rotor is 165 m/s at an angle of 20° from the axial direction, the work done factor is 0.83, the velocity diagram is symmetrical, and the mean diameter of the last stage rotor is 18 cm, calculate the rotational speed and the length of the last rotor blade at inlet the stage. Ambient conditions are 1.01 bar and 288 K.