Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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II SEMESTER M.TECH (THERMAL SCIENCES & ENERGY SYSTEMS)
END SEMESTER EXAMINATION, APRIL 2017
SUBJECT: STEAM AND GAS TURBINES (MME 5274)
REVISED CREDIT SYSTEM

Time: 3 Hours **MAX. MARKS: 50**

Note: (i) Answer ALL the questions.
(ii) Use of thermodynamics data handbook is permitted.

1A Draw a conventional steam turbine blade profile (T6 aerofoil section). Explain the parameters affecting the blade performance. [05]

1B Steam expands in a set of nozzles from 10 bar, 300°C to 1bar. The convergent parts of the nozzles are sharp and frictionless. In the divergent portion, the frictional loss is 15% of isentropic enthalpy drop. If the steam flow rate is 1kg/s and initial velocity of steam is negligible, find the throat area of nozzle. If the exit diameter of the nozzle is 25mm find the number of nozzles required. [05]

2A Obtain the condition for maximum efficiency of reaction turbine. Hence, discuss the effect of working steam on stage efficiency of Parson's turbine. [05]

2B Dry saturated steam at 10 bar, is supplied to a single rotor impulse turbine. The condenser pressure being 0.5 bar. The nozzle efficiency is 0.94 and nozzle angle at rotor inlet is 18°. The rotor blades move at a speed of 450m/s and are equiangular. If the coefficient of velocity for the rotor blades is 0.92, find the specific power output, the rotor efficiency, the stage efficiency and the direction of exit velocity of steam. [05]

3A Explain the effects of blockage in the axial compressors. Mention the significance of work done factor to take care of blockage factors. [03]

3B Differentiate between Ramjet and pulse jet engines. [03]

3C A centrifugal compressor runs at 15,000 rpm and has 20 radially tipped blades with an outer tip diameter of 600 mm. The absolute velocity at compressor inlet is radial to ensure shock-less entry. The compressor has radial blades at exit such that exit meridional component is 135 m/s. and total to total efficiency is 70%. The stagnation conditions at inlet are 1 bar and 25°C. Find the Slip and Slip factor, the actual exit blade angle. What is the actual and isentropic temperature rise through the compressor? [04]

4A Explain (i) Free vortex design, (ii) Constant nozzle angle design as applicable to gas turbine blading. [05]

4B Calculate the total design thrust of a simple stationary turbo jet propulsion unit for which the data are as follows: [05]
Total head isentropic efficiency of the compressor = 80%
Total head isentropic efficiency of the compressor = 85%
Total head pressure ratio in the compressor including combustion chamber pressure loss = 4:1
Combustion efficiency = 98%
Mechanical transmission efficiency = 99%
Maximum cycle temperature = 1000K
Air flow rate = 20kg/s
Cp for air = 1.005kJ/kgK, Cp for gas = 1.156kJ/kgK,
ϒ for air = 1.4, ϒ for gas = 1.33. Ambient conditions can be assumed as 1bar and 15°C.

5A Write a note on (i) Cogeneration, (ii) Combined gas cycles. [03]
5B Write a note on cooled turbines. [02]
5C A 4500 kW gas turbine generating set operates with two compressor stages, the overall pressure ratio is 9:1. A high pressure turbine is used to drive the compressors, and a low-pressure turbine drives the generator. The temperature of the gases at entry to the high pressure turbine is 625°C and the gases are reheated to 625°C after expansion in the first turbine. The exhaust gases leaving the low-pressure turbine are passed through a heat exchanger to heat the air leaving the high pressure stage compressor. The compressors have equal pressure ratios and intercooling is complete between the stages. The air inlet temperature to the unit is 20°C. The isentropic efficiency of each compressor stage is 0.8, and the isentropic efficiency of each turbine stage is 0.85, the heat exchanger thermal ratio is 0.8. A mechanical efficiency of 95% can be assumed for both the power shaft and compressor turbine shaft. Neglecting all pressure losses and changes in kinetic energy [05]
Calculate: (i) Thermal efficiency, (ii) Mass flow in kg/s.
Neglect the mass of the fuel and assume the following :
For air : Cp_a = 1.005 kJ/kg K and γ = 1.4.
For gases in the combustion chamber and in turbines and heat exchanger, Cp_g = 1.15 kJ/kg K and γ = 1.333.