Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B. TECH (MECHANICAL/IP ENGG.) END SEMESTER EXAMINATIONS, NOVEMBER 2018

SUBJECT: JET PROPULSION AND ROCKET TECHNOLOGY

[MME 4011]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any may be suitably assumed.

1A. Explain the importance of an inlet diffuser in a gas turbine system. **2**

1B. Explain the variation of pressure, temperature and velocity of working fluid inside a turbojet with a neat sketch. **3**

1C. Explain the effect of injecting refrigerants to augment thrust in a gas turbine. **3**

1D. An aircraft is flying at an altitude of 9 km (ambient pressure = 30.8 kPa) at a speed of 500 km/hr and has the following characteristics: Exit Area of engine = 0.25 m^2, Fuel-Air ratio f = 0.02, Exit pressure of engine = 200 kPa, Exhaust gas velocity = 600 m/s. Calculate the momentum thrust, pressure thrust and total thrust if the engine has a constant mass flow rate of 40 kg/s and assume Inlet pressure is same as ambient pressure. Also calculate thrust power. **2**

2A. Explain the working and importance of a 2-spooled turbofan engine. **2**

2B. Explain the effect of Regeneration and Reheating on the Brayton cycle. **3**

2C. A two-spool turbofan engine consists of a low-pressure turbine (LPT) driving the fan and the low-pressure compressor (LPC). The high-pressure spool is composed of a high-pressure compressor (HPC) and the high-pressure turbine (HPT). The total pressure and total temperature during a sea level static test are as shown: **5**

Station	Fan Inlet	Fan Outlet	LPC outlet	HPC outlet	CC outlet	HPT outlet	LPT outlet
P_0 (kPa)	101.32	160	245.45	2392.48	2289	595.7	147.54
T_0 (°C)	15	62.7	109.3	501	1286	906	512

The fan and the turbine nozzles have isentropic efficiency of 0.9.
Efficiency of Combustion chamber (CC) = 0.96
Calorific value of fuel = 45,000 kJ/kg

γ_{air} = 1.4 γ_{gases} = 1.33
C_{pa} = 1.005 kJ/kgK C_{pg} = 1.147 kJ/kgK

Assuming all polytropic efficiencies to be 100% and taking nozzle choking conditions into account, find the thrust force if the total air mass flow rate is 280 kg/s.

3A. Derive a relationship between Mach number of flow, change in area and change in velocity of a rocket nozzle. **3**

3B. Explain the importance of divergence angle in rocket nozzles with suitable trials. **3**

3C. A rocket has the following data: **4**

Propellant flow rate = 5.0 kg/s	Ambient pressure = 1.013 bar
Nozzle exit diameter = 10 cm	Thrust chamber pressure = 20 bar
Nozzle exit pressure = 1.02 bar	Thrust = 7 kN

Determine the effective jet velocity, actual jet velocity, specific impulse and the specific propellant consumption.

Recalculate the values of thrust and specific impulse for an altitude where the ambient pressure is 10 mbar.

4A. Define the following: **2**
1) Sliver 2) Perforation 3) Burning Time 4) Deflagration limit

4B. What is unrestricted burning? Explain any two types of unrestricted burning configurations with neat sketches. **3**

4C. With a neat sketch, explain the working of a Liquid Propellant Turbopump Feed System. **3**

4D. What are Gelled Propellants? Mention any two advantages and disadvantages. **2**

5A. What are the basic sub-systems for a typical Electric Propulsion thruster? **2**

5B. With a neat sketch, explain the working of Electron Bombardment thrusters. **3**

5C. With a neat sketch, explain the working of a Solid Fuel Nuclear Rocket engine. **3**

5D. Explain the principle of working of a solar sail. **2**