Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IV SEMESTER B.TECH (AERONAUTICAL/AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, JULY 2016

SUBJECT: AIRCRAFT PROPULSION [AAE 2202]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Make a neat sketch of Ramjet engine and label its parts. **(02)**

1B. Derive the thrust equation for a turbofan engine. **(03)**

1C. Indicate the following statements as true or false with justification. **(05)**

I. Flow separation problems are more critical for axial compressors compared to centrifugal compressors.
II. At lower speeds, the efficiency of a turbofan engine is higher than that of a turboprop engine.
III. Euler's equation is applicable for both turbines as well as compressors.
IV. Flame holders are inevitable part of an afterburner.
V. Propeller blades are designed for constant blade pitch.

2A. Draw the T-S diagram for a real turbine and derive the expression for its isentropic efficiency. **(02)**

2B. What is thrust augmentation? Describe briefly about afterburning. **(03)**

2C. Give reason for the following: **(05)**

I. Twisted blade design of axial flow fan
II. Limiting the tip speed of a propeller blade
III. Multi spooling of gas turbine engines
IV. Using turbofan engines in commercial aircrafts
V. Using variable area nozzle in an afterburner

3A. Air enters the compressor of a gas turbine engine with velocity 127 m/s, density 1.2 kg/m3 and stagnation pressure 0.9 MPa. Air exits the compressor with velocity 139 m/s and stagnation pressure 3.5 MPa. Assume that the ratio of specific heats is constant and equal to 1.4 **(03)**

I. What is the compressor pressure ratio?

II. If the polytropic efficiency of the compressor is 0.89, then find the isentropic efficiency of compressor

3B. The mass flow rate of air through an aircraft is 10 kg/s. The compressor outlet temperature is 400 K and the turbine inlet temperature is 1800 K. The heating value of the fuel is 42 MJ/kg and the specific heat at constant pressure is 1 KJ/KgK. If the burner efficiency is 93%, determine the mass flow rate of fuel. **(02)**

3C. A gas turbine engine flying at a speed of 900 km/h is operating under the following conditions: **(05)**

Stagnation temperature at the turbine inlet	1350 K
Stagnation pressure at the turbine inlet	10 bar
Static temperature at turbine exit	800 K
Velocity at turbine exit	200 m/s
Isentropic efficiency of turbine	0.96
Isentropic efficiency of nozzle	0.89
Nozzle exit area	0.0935 m^2

Find the stagnation pressure in the nozzle and thrust.
Take Ta = 226 K, Pa = 0.42 bar, Cp_g = 1.147 kJ/kgK, Y_g= 1.33.

4A. Briefly describe supercharging operation. **(02)**

4B. With a neat sketch, explain the parts of a centrifugal compressor. **(03)**

4C. A 50% reaction, axial flow compressor with 7 stages runs at a mean blade speed of 250 m/s. The pressure ratio developed by the machine is 12 and isentropic efficiency is 85%. Determine the blade and air angle if the axial flow velocity is 200 m/s. Condition at inlet are 1 bar and 300K. Assume work done factor as 0.8. **(05)**

5A. Derive Euler's Energy Equation for turbomachinery. **(04)**

5B. Write short notes on: **(06)**

i) Compressor stall and surge

ii) Transpiration cooling in turbine blades

iii) losses associated with axial compressors