Question Paper

Exam Date & Time: 08-Mar-2021 (02:00 PM - 05:00 PM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

THIRD SEMESTER B.TECH END SEMESTER EXAMINATIONS, MARCH 2021

INTRODUCTION TO AEROSPACE ENGINEERING [AAE 2157]

Marks: 50 **Duration: 180 mins.**

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1)		Differentiate between airships, free balloons and hot air balloons.	(3)
	A)		
	B)	What do you understand by the term Empennage in an aircraft? What are its functions?	(3)
	C)	Consider a hot air balloon which has a mass of 700 kg uninflated, the balloon, when inflated, has a volume of 2900m^3. The air inside the balloon has a temperature of T_{in}=120°C and outside T_{out}=20°C. The pressure inside and outside the balloon is atmospheric. Assume molar mass of the air is 28 g/mol. Determine, (i) The initial rate of acceleration (ii) Outside temperature at which the balloon would be neutrally buoyant. (iii) How much heat would be needed to heat up the air. (at constant pressure)	(4)
2)		Explain the different layers of International Standard Atmosphere (ISA) with help of a neat sketch.	(3)
	A)		
	B)	What do you understand by geometric and geopotential altitudes? Derive the relation between them.	(3)
	C)	Determine the pressure, temperature and density at an altitude of 15 km from the sea level.	(4)
3)		Define the terms: static pressure, dynamic pressure and total pressure.	(3)
	A)		
	B)	Define isentropic flow. Derive the isentropic relations for pressure, Temperature and density between two different points on a stream line in an isentropic flow.	(3)
	C)	In the combustion chamber of a rocket engine, kerosene and oxygen are burned, resulting in a hot, high-pressure gas mixture in the combustion chamber with the following conditions and properties: T_0 = 3144K, p_0 = 20 atm, R= 378 J/(kg)(K), and γ= 1.26. The pressure at the exit of the rocket nozzle is 1 atm, and the throat area of the nozzle is 0.1 m^2. Assuming isentropic flow through the rocket nozzle, calculate (a) the velocity at the exit and (b) the mass flow through the nozzle.	(4)
4)		Derive an expression for the coefficient of lift in terms of normal and axial coefficients.	(3)
	A)		
	B)	What is meant by Aerodynamic centre? Why do we always take moment about quarter chord point?	(3)

C) Consider a finite wing with an aspect of ratio of 7; the airfoil section of the wing is a symmetric airfoil with an infinite-wing lift slope of 0.11 per degree. The lift-to drag ratio for this wing is 29 when the lift coefficient is equal to 0.35. If the angle of attack remains the same and the aspect ratio is simply increased to 10 by adding extensions to the span of the wing, what is the new value of the lift-to-drag ratio? Assume that the span efficiency factors $e = e_1 = 0.9$ for both cases. (4)

5) Explain the working principle of a turbo jet engine with a neat sketch. (3)

A)

B) Draw the various forces acting on an aircraft during steady level coordinated turn. Also derive an expression for the rate of turn. (3)

C) An airplane weighing 180,000N has a wing area of 45 m^2 and drag polar given by $C_D = 0.017 + 0.05\ C_L{}^2$. Obtain the thrust required and power required for a rate of climb of 2,000 m/min at a speed of 540 km/h at 3 km altitude. (4)

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