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

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER ONLINE PROCTORED EXAMINATIONS, DEC 2021

SUB: PE-III AERODYNAMICS OF ROCKETS AND MISSILES [AAE-4081]

REVISED CREDIT SYSTEM

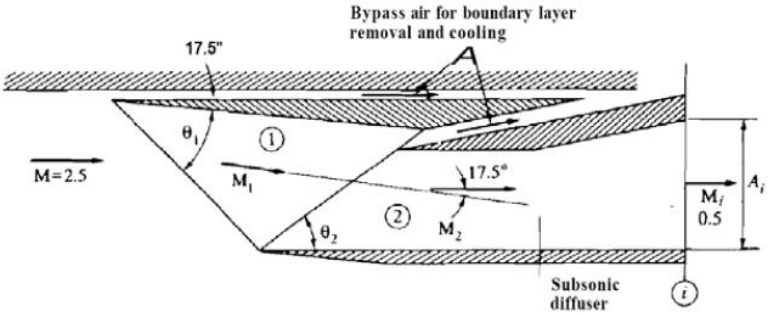
(24/12/2021)

Duration: 1 Hour 15 min | Max. Marks: 20

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any, may be suitably be assumed.
- Use of supplied data sheet is permitted

Q. No	Question	Max. Marks	CO	BT Level
1	With the help of neat diagrams discuss the concept of wind effective flow direction on rocket/missile body.	(04)	CO2	L2
2	Compare the specific fuel consumption of missiles turbojet and ramjet that are being considered for flight at Mach = 1.5 and 50,000 ft altitude. Ambient pressure and temperature 11.6 KPa and 205 K respectively. The turbojet pressure ratio is 12 and the maximum allowable temperature is 1400 K. For the ramjet the maximum temperature is 2500 K. For simplicity ignore aerodynamic losses in both engines. Conventional hydrocarbon fuels are to be used (Heating value of 45,000 KJ/Kg). Assume γ = 1.4 and C_p=1.0 KJ / (kg. K)	(06)	CO4	L4
3	What is boundary layer? Explain its role in hypersonic flow field.	(02)	CO5	L1
4	For the velocity profile for laminar boundary layer flows given as $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^3 + \left(\frac{y}{\delta}\right)^4$ obtain an expression for boundary layer thickness, shear stress, the drag force on one side of the plate, and coefficient of drag in terms of Reynolds number.	(04)	CO4	L3
4	A new supersonic missile is being designed for a flight Mach numbers 2.5 at an altitude where the ambient pressure and temperature are 9 KPa and 220 K respectively. The engine inlet configuration shown below allows for double oblique shock deceleration followed by a zone of subsonic deceleration.	(04)	CO3	L5



The Mach number is 0.5 at the engine inlet plane. Losses in the subsonic diffuser are neglected. Determine: (i) The Mach numbers M_1 and M_2 in the zones respectively shown on the drawing. (ii) The wave angles θ_1 and θ_2 also shown on the drawing. (iii) The overall stagnation pressure ratio and the overall static pressure ratio. (iii) The velocity ratio for the subsonic diffuser. And (iv) The cross-sectional area A_i (m^2) at the engine inlet plane if the engine mass flow rate is 500 Kg/S.