Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2017

SUBJECT: GAS DYNAMICS [AAE 3102]

REVISED CREDIT SYSTEM
(21/12/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Describe the followings: **(05)**

a) Area Rule
b) Compressibility effect
c) Difference between total parameter and characteristic parameter
d) What is meant by flow get choked in Fanno flow diffuser Hodograph
e) Diffuser

1B. Derive the equation for Prandtl-Meyer function in supersonic flows and how rest of flow properties we can determine from this Prandtl-Meyer equation. **(05)**

2A. What is shock polar? Write down their properties. Explain through a neat diagram how to determine wave angle, deflection angle and attached (detached) shock waves from a given shock polar for a particular value of Mach number **(05)**

2B. Consider a supersonic fighter aircraft in a Mach 2 flow at 11km altitude and planform area of the wing is 18.21m^2. The weight of the aircraft is 9400kgf. Assume that all the lift of the airplane comes from the lift on the wing if then calculate the angle of attack of the wing relative to the freestream (use linearized supersonic equation) **(05)**

γ=1.4, R=287, ρ_∞=0.3648kg/m^3, T_∞=216.78K, 1kgf=9.8N

3A. Draw the diagrams of intersection of same and opposite families of shocks and define the concept of slip line. **(05)**

3B. Derive and explain the one dimensional flow with friction (Fanno Flow) and explain their physical properties in subsonic and supersonic flows. **(05)**

4A. Consider an airplane flying at standard sea level conditions and free stream velocity is 180km/hr. The flow accelerates over the wing and reaching a maximum velocity of 290km/hr. at some point on the wing. Then calculate the followings **(05)**

a) What is the percentage pressure change between this maximum point and free stream? (assume incompressible flow)
b) What is the percentage density change between this maximum point and free stream? (assume compressible flow, R=287J/kg.K)
c) What will be the critical Mach number of this same wing if it's travelling at sea level?

4B. Consider air enters a constant area duct at M_1=3.5, P_1=1.5atm, T_1=340K and ρ=1.225 kg/m^3. Inside the duct heat added per unit mass is q=4.2 x 10^5 J/Kg. Calculate the flow properties M_2, P_2, ρ_2, T_2, P_{02} and T_{02} at the exit of the duct. **(05)**

5A. Draw the schematic diagram of supersonic wind tunnel and explain their features **(05)**

5B. In supersonic flights why do we use conical nose section? Also draw the graphical representation of Total pressure, Static pressure and Temperature with Mach number just behind the normal shock wave. **(05)**