Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2711103 **Date:18/05/2016**

Subject Name: ADVANCED FLUID MECHANICS

Time:02:30 pm to 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Gas Table is permitted.**

Q.1	**(a)**	Define following terms: Vorticity, Circulation, Velocity potential function and stream function, Irrotational flow, Internal stresses of fluid, Real fluid.	**07**
	(b)	Derive Navier – Stokes Equation and also give its exact solutions.	**07**
Q.2	**(a)**	Derive continuity equation for three dimensional fluid flows.	**07**
	(b)	Derive Euler's equation of motion with usual notations.	**07**
		OR	
	(b)	Explain principle of Superposition with suitable example. Also mention its application.	**07**
Q.3	**(a)**	Water is pumped from a lower reservoir to a higher reservoir by a pump that provides 25kW of useful mechanical power to the water. The free surface of the upper reservoir is 50 m higher than the surface of the lower reservoir. If the flow rate of the water is measured to be 0.03 m^3/s. Determine irreversible head loss of the system and the lost mechanical power during this process.	**07**
	(b)	Explain hydrodynamic theory of lubrication for low Reynold's number.	**07**
		OR	
Q.3	**(a)**	A volcano has erupted , spewing stones, steam and ash several thousand feet in to the atmosphere. After some time the particles begin to settle to the ground. Consider a nearly spherical ash particle of diameter 55µm, falling in air whose temperature is -50°C and whose pressure is 50 kPa. The density of the particle is 1300 kg/ m^3. Estimate the terminal velocity of this particle at this altitude. Take density as 0.8588 kg/m^3 & $\mu=1.474*10^{-5}$ kg/m.s.	**07**
	(b)	Explain exact solution to laminar boundary layer flow over a flat plate without pressure gradient.	**07**
Q .4	**(a)**	Show that a circle in ξ – plane displaced from the origin is mapped to an aerofoil in the physical z-plane via the Joukowski transformation. Also determine the magnitude of circulation required to satisfy the Kutta condition.	**07**
	(b)	What do you mean by transition to turbulence? List the factors affecting the transition and suggest its control.	**07**
		OR	
Q.4	**(a)**	Derive the equation showing the Rayleigh line. Draw Rayleigh lines on the h-s and p-v diagrams for atleast two different values of the mass flux.	**07**
	(b)	Describe compressible flow through convergent-divergent nozzle. How the shock wave occurs in the nozzle? Explain with figure.	**07**
Q.5	**(a)**	Derive Rankine - Hugoniot equation for normal shock wave.	**07**
	(b)	What is chocking in isentropic flow for Nozzle? Give the applications of isentropic flow.	**07**
		OR	
Q.5	**(a)**	Draw and labeled the airfoil and define following terms: camber, angle of attack, axial chord length, aspect ratio.	**07**

(b) Show that the upper and lower branches of a Fanno curve represent subsonic and supersonic flows respectively. Also prove that at the maximum entropy point Mach number is unity and all processes approach this point. **07**

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