Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME – SEMESTER I (OLD) – • EXAMINATION – SUMMER 2016**

**Subject Code: 712103N** **Date:18/05/2016**

**Subject Name: Fluid Mechanics and Gas Dynamics**

**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.**

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|---|---|---|---|
| **Q.1** | **(a)** | Explain Source flow, Sink flow and Doublet with figures. | **07** |
| | **(b)** | Derive the continuity equation in Cartesian co-ordinates for multi dimensional fluid flow with usual notation. | **07** |
| **Q.2** | **(a)** | Write down the Navier-Stocks equations of motion for three-dimensional, unsteady, compressible and viscous flow, also explain the body and pressure forces. | **07** |
| | **(b)** | What is meant by stream function? State the properties of a stream function and prove each one of them. | **07** |
| | | **OR** | |
| | **(b)** | What is meant by velocity potential function? State and prove its properties. | **07** |
| **Q.3** | **(a)** | The velocity potential function for a flow is given by $\varphi = x^2-y^2$. Verify that the flow is incompressible and then determine the stream function for the flow. | **07** |
| | **(b)** | What is an aerofoil? Define with a sketch the various terms used in aerofoil geometry. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | The velocity component for a steady flow are given as $u = 0$, $v = -y^3-4z$, $w = 3y^2z$. Determine: (1) whether the flow field is one, two or three dimensional, (2) whether the flow is incompressible or compressible, and (3) the stream function for the flow. | **07** |
| | **(b)** | What is lift and drag co-efficient for an aerofoil? Write an expression for lift and drag. Show by a graph how the lift and drag co-efficient vary with angle of attack. | **07** |
| **Q.4** | **(a)** | Represent the Rayleigh flow on (h-s) diagram and explain the different Mach number regions for heating and cooling of gas flow in duct. | **07** |
| | **(b)** | Derive Rankine-Hugoniot equation for a normal shock wave. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Define stagnation temperature and critical temperature of a gas. Also derive the equation. $T/T^* =(2/\gamma+1)$ | **07** |
| | **(b)** | Starting from energy equation for flow through normal shock obtain relations $M^*_x M^*_y= 1$ | **07** |
| **Q.5** | **(a)** | Air flows steadily and isentropically in a converging-diverging nozzle. At the throat, the air is at 140 kPa (abs), and at 60 °C. The throat cross-sectional area is 0.05 $m^2$. At a certain section in the diverging part of the nozzle, the pressure is 70.0 kPa (abs). Calculate the velocity and area of this section. | **07** |
| | **(b)** | An agitator of diameter D requires power P to rotate at a constant speed N in a liquid of density ρ and viscosity μ. Show with the help of Pi theorem that | **07** |

$$P = \rho N^3 D^5 F(\rho N D^2/ \mu )$$

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | A normal shock wave takes place during the flow of air at a Mach number of 1.8. The static pressure and temperature of the air upstream of the shock wave are 100 kPa(abs) and 15 °C. Determine the Mach number, Pressure and Temperature downstream of the shock. | **07** |
| | **(b)** | Define geometric, kinmatic and dynamic similarities. Explain how the condition of dynamic similarity of a hydraulic model is satisfied in actual practice. | **07** |

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