Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_

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**End Semester Examination – Nov/Dec – 2017**

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| **Code :** | **17ME3027** | **Duration :** | **3hrs** |
| **Sub. Name :** | **ADVANCED FLUID MECHANICS** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | Make use of appropriate and relevant assumptions and derive the Bernoulli’s equation for flow along a streamline in both the tangential and perpendicular directions. | CO1 | 10 |
| b. | An incompressible steady-flow pattern is given by  and . What is the most general form of the third component,  which satisfies continuity? | CO2 | 10 |
| (OR) | | | | |
| 2. | a. | Derive the continuity equation in three-dimensional Cartesian coordinate system using differential analysis. | CO2 | 10 |
| b. | An incompressible fluid flows past an impermeable flat plate. The plate has a width equal to **b** perpendicular to the paper. Consider a CV above the flat plate. The fluid enters the control volume with a uniform velocity profile  and a cubic polynomial exit profile  where . The vertical coordinate y varies from zero at the plate to  at the top surface of the control volume. Compute the volume flow rate Q across the top surface of the control volume. | CO2 | 10 |
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| 3. | a. | Derive the Navier-Stokes equation for an incompressible viscous flow. | CO3 | 10 |
|  | b. | A constant-thickness film of viscous liquid flows in laminar motion down a plate inclined at angle . The velocity profile is . Find the constant C in terms of the specific weight and viscosity and the angle. | CO3 | 10 |
| (OR) | | | | |
| 4. | a. | A fully-developed flow is induced between two infinite parallel plates, placed at a distance H apart, when one of them, say the upper plate, is moving steadily with speed V relative to the other. Assuming that there is a non-zero pressure gradient and zero gravity in the x-direction, determine the velocity-field between the two plates. Also assume parallel flow and the x-y plane is parallel to both the infinite plates. | CO2 | 12 |
|  | b. | Derive the integral form of the momentum equation using the Reynolds Transport Theorem. | CO3 | 8 |
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| 5. | a. | The velocity components of an incompressible, two –dimensional velocity field are given by the equations Show that the flow is irrotational and satisfies conservation of mass. | CO4 | 10 |
|  | b. | A flow field is represented by the stream function  . Find the corresponding velocity field. Show that this flow field is irrotational and obtain the potential function. | CO4 | 10 |
| (OR) | | | | |
| 6. | a. | The stream function for an incompressible, two-dimensional flow field is  where and  are constants. Is this an irrotational flow? Explain? | CO4 | 10 |
|  | b. | Deduce the velocity components of the irrotational region of flow obtained by superposition of a line sink and line vortex. | CO4 | 10 |
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| 7. | a. | A 6-mm-diameter electrical transmission line is exposed to windy air. Determine the drag force exerted on a 120-m-long section of the wire during a windy day when the air is at 1 atm and 15° C and the wind is blowing across the transmission line at 40 km/h. The properties of air at 1 atm and 15° C are  kg/m3 and  1.470  10-5 m2/s. | CO5 | 12 |
|  | b. | In flow over cylinders, why does the drag coefficient suddenly drop when the flow becomes turbulent? Isn’t turbulence supposed to increase the drag coefficient instead of decreasing it? Elaborate with neat sketches. | CO5 | 8 |
| (OR) | | | | |
| 8. |  | Deduce the velocity components of a flow using a suitable complex potential and hence prove the condition for the existence of a uniform flow. | CO5 | 20 |
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|  | | **Compulsory:** |  |  |
| 9. |  | Water with a free stream velocity of 2 m/s flows past a flat plate of length L = 10 cm. Find the thickness of the velocity boundary-layer at a location x = 5 cm. At the same location, find the fluid velocity at a distance y = 0.0225 cm away from the surface. Calculate drag on the plate per meter depth into the plane of the paper. For water  kg/m3,  m2/s. | CO6 | 20 |

ALL THE BEST