

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, April, 2019

Computational Fluid Dynamics

B. Tech. in Mechanical Engineering, Semester VI

Roll No.....

Course Code : ME639

Time: 3 hours

Max. Marks: 60

Instructions to students:

Do not write anything other than your roll number on question paper.

Assume suitable data wherever required and mention it clearly.

Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

- Q.1 Two infinite parallel plates are placed on a slope which makes an angle θ with horizontal. The gap between two plates is $2H$. A steady incompressible flow fills the entire gap between the plates. The pressure at inlet and exit section of the flow is equal to atmospheric value. Assuming fully developed flow, determine the velocity field between the plates and shear stress value at top and bottom walls. 10 (LO1,2)
- Q.2 Citrus fruits are very susceptible to cold weather, and extended exposure to subfreezing temperatures can destroy them. Consider an 8-cm-diameter orange that is initially at 15°C . A cold front moves in one night, and the ambient temperature suddenly drops to -6°C , with a heat transfer coefficient of $15 \text{ W/m}^2 \cdot ^\circ\text{C}$. Using the properties of water for the orange and assuming the ambient conditions to remain constant for 4 h before the cold front moves out. Formulate the physical domain and mention the governing equation and boundary conditions. Discretize the governing equation with second order of approximation in space. 10 (LO2)
- Q.3 Consider a hot infinite plate of finite thickness $2L$, that is suddenly exposed to a cold fluid at T_c . The initial temperature of the plate is T_i ($T_i > T_c$). The heat transfer coefficient is moderate and thermophysical properties are constant. Set up the finite difference equation by taking four grid points in a computational domain by explicit scheme. Develop an expression for the maximum time step that can be used by using the stability criteria. 10 (LO2)
- Q.4 Consider the square of 1 m^2 . The left face is maintained at 100°C and the top face at 500°C , while the other two faces are exposed to an environment at 100°C with $h = 10 \text{ W/m}^2 \cdot ^\circ\text{C}$ and $k = 10 \text{ W/m} \cdot ^\circ\text{C}$. Compute the temperature of the various nodes (assume grids) and heat flows at boundaries. 20 (LO3)
- Q.5 Consider a flow with pressure gradient between two infinite horizontal parallel plates of which the bottom one is stationary and the top one is moving with a uniform velocity, U . Derive a first order accurate expression for the boundary condition for vorticity at upper wall. 10 (LO2,3)