Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, May 2023

Course: Flow Visualization and Quantification | **Semester: II**

Program: M. Tech. Computational Fluid Dynamics | **Time : 03 hrs.**

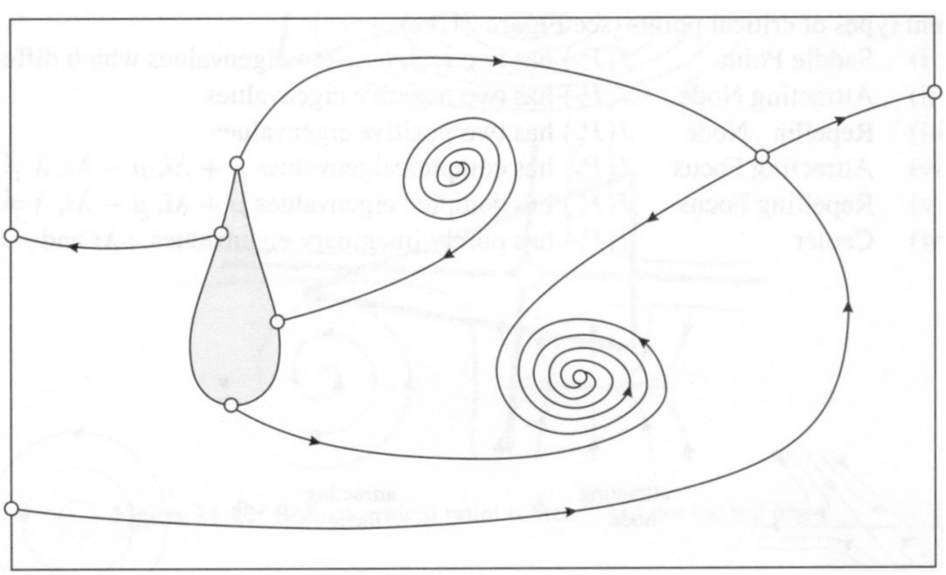
Course Code: ASEG 7045 | **Max. Marks: 100**

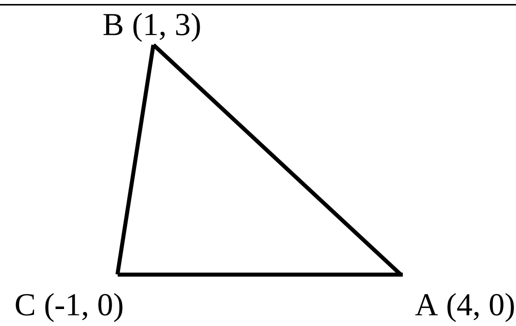
Instructions: Assume missing data appropriately. All the symbols used in the paper have their usual meanings.

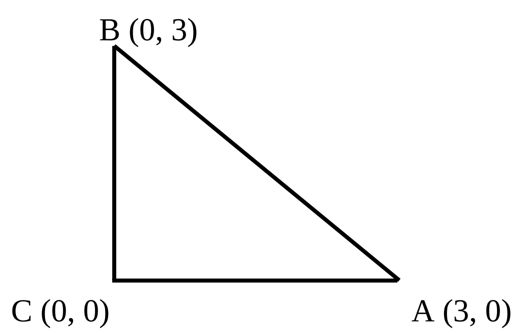
SECTION A

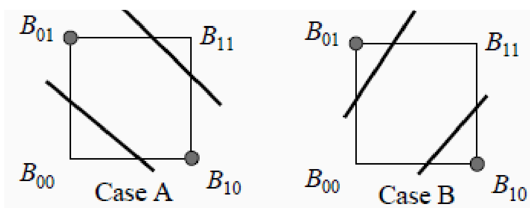
(5Qx4M=20Marks)

S. No.		**Marks**	**CO**
Q 1	Choose all correct answers. 50% negative marking for incorrect choice. i. Which of these visualization techniques can be used to visualize a scalar? a. Colour map b. Line Integral Convolution c. Spot noise method d. Volume rendering e. Contouring ii. Which of these operations does not fall under *data enrichment and enhancement*? a. Slicing b. Rendering c. Display d. Interpolation e. Noise filtering	**4**	**CO1**
Q 2	Choose all correct answers. 50% negative marking for incorrect choice. i. In the characterization of critical points using eigenvalues $a_1 + ib_1$ and $a_2 + ib_2$, of the Jacobian matrix $\frac{\partial \vec{U}}{\partial \vec{x}}$ a. a_1, a_2 positive represent attraction b. a_1, a_2 negative represent attraction c. a_1, a_2 opposite sign represent saddle d. b_1, b_2 zero represent focus e. b_1, b_2 non-zero represent a focus.	**4**	**CO3**

	ii. A vortex core can be identified to include a point where a. the angle between the velocity and its curl is very small. b. the angle between the velocity and its curl is very large. c. the magnitude of vorticity is very high. d. the second eigen value of the rate of strain tensor is negative. e. the second eigen value of the rate of strain tensor is positive.		
Q 3	List down the various Ray Traversal Schemes for obtaining pixel intensity through Ray Casting. Give examples for each as well.	**04**	**CO2**
Q 4	Consider the CFD simulation of steady state flow over a circular cylinder in ANSYS FLUENT. Write down steps to visualize the following using FLUENT or CFD-Post postprocessor. a. Pressure distribution over surface b. Separation points on the surface of cylinder	**04**	**CO4**
Q 5	The topological behavior of a flow around an airfoil is shown below. The critical points are represented by open circles. Name all the critical points shown and explain the behavior of the fluid flow near these singularities. 	**4**	**CO3**
SECTION B **(4Qx10M= 40 Marks)**			
Q 6	Consider the control volume as shown in the figure below. The values of a scalar at vertices A, B and C are 50.0, 80.0 and 100.0 respectively. Find the value of the scalar at a point inside the CV whose coordinate is (2, 2).	**10**	**CO1**

<table>
<tr><td></td><td>
</td><td></td><td></td></tr>
<tr><td>Q 6</td><td>Perform a Line Integral Convolution (LIC) of the texture intensity function f(x) with the kernel k(x) over a streamline length -2L to +2L.

f(x):
<table><tr><td>4</td><td>2</td><td>0</td><td>8</td><td>0</td><td>4</td><td>4</td><td>4</td><td>6</td><td>4</td><td>2</td><td>2</td></tr></table>
k(x):
<table><tr><td>1/4</td><td>½</td><td>1/4</td></tr></table></td><td>10</td><td>CO3</td></tr>
<tr><td>Q 8</td><td>Write a subroutine/code in a language of your choice to save the results of a CFD simulation on a structured 2 D grid for visualization in Tecplot ASCII format.
OR
Write a subroutine/code in a language of your choice to save the results of a CFD simulation on a structured 2 D grid for visualization in vtk format.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q 9</td><td>For a ray cast during volume visualization, derive an expression for the colour intensity on the Image plane obtained by a front-to-back compositing of local and background colours.</td><td>10</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>Consider the 2-D velocity filed represented on a triangular mesh element as shown in figure below.

</td><td>20</td><td>CO3</td></tr>
</table>

	The velocities at vertices A, B and C are $\{2, 2\}^T$, $\{-2, -2\}^T$ and $\{-2, 2\}^T$ respectively. Find the location and behavior of the critical point if one exists. Also, draw the representative streamlines.		
Q 11	Draw all the distinct topological cases for the marching square algorithm and thus list the steps for generation of *isolines* using this algorithm. Also, explicate the methods to resolve the contouring ambiguities that might arise during the process. ***OR*** a. Illustrate the conditions for formation of a hole during the Marching cube algorithms. Discuss various methods to resolve contouring ambiguity in the Marching cube or Marching square algorithms. b. Consider the following topological case for contour generation.  $B_{00} = 7$, $B_{10} = 3$, $B_{01} = 4$, $B_{11} = 10$ Suggest the correct choice of contour for a contour level of c = 5 and c = 6. Use asymptotic decider.	**20**	**CO2**