Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Course: Flow Visualization and Post-Processing **Semester: II**
Program: M. Tech. CFD **Time: 03 hrs.**
Course Code: ASEG 7029 **Max. Marks: 100**

Instructions: Assume any missing data appropriately

SECTION A

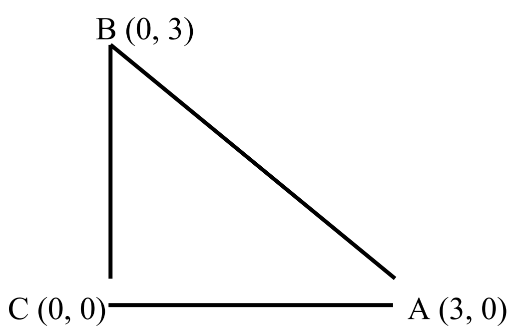
S. No.		Marks	CO
Q 1	Define slicing in context to data enrichment. Write down the interpolation functions to evaluate an off node value of a function over a 1D linear, 2D triangular and 3D tetrahedral mesh element.	**04**	**CO1**
Q 2	Identify the type of degenerate point for the following tensors. $T=\begin{bmatrix}1-2x & y\\ y & 1\end{bmatrix}$; $T=\begin{bmatrix}1+2x/3 & y\\ y & 1\end{bmatrix}$; $T=\begin{bmatrix}1+x & y\\ y & 1-x\end{bmatrix}$	**04**	**CO3**
Q 3	Explain the visualization of symmetric tensor field using hyperstreamlines.	**04**	**CO1**
Q 4	Sketch the schematic diagram of the Schlieren and Shadowgraph techniques for visualization of flow with variable density.	**04**	**CO2**
Q 5	List down the various Ray Traversal Schemes for obtaining pixel intensity through Ray Casting. Give examples for each as well.	**04**	**CO1**

SECTION B

Q 6	List down the importance of vortex extraction in fluid mechanics. Discuss the following algorithms for extracting vortex core from CFD data a) λ_2 method b) Eigenvector method ***OR*** Compare the ellipsoid, cubical and cylindrical glyphs for visualization anisotropy in visualization. How can these three be combined for an improved visualization of symmetric *rate of strain tensor*?	**10**	**CO3**

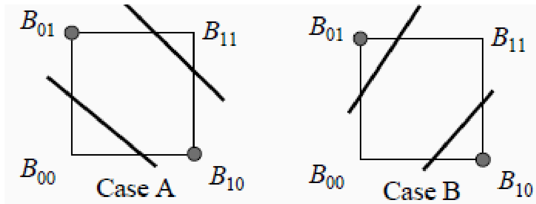
<table>
<tr><td>Q 7</td><td>What is ray casting? For a ray cast during volume visualization, derive an expression for the colour intensity on the Image plane obtained by a front-to-back compositing of local and background colours.</td><td>10</td><td>CO1</td></tr>
<tr><td>Q 8</td><td>Consider the CFD 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. Velocity vectors
b. Streamlines
c. Pressure distribution over surface
d. Contours of pressure
e. Separation point on the surface of cylinder</td><td>10</td><td>CO4</td></tr>
<tr><td>Q 9</td><td>Illustrate the various components of a typical ASCII Tecplot data file for visualization of a structured CFD simulation data.</td><td>10</td><td>CO4</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4" align="center">SECTION-C</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.



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.

 OR
a. Define critical points in a velocity field. Using appropriate sketches and examples, discuss the classification of critical points in a linear vector field in two- and three-dimensional flows?
b. Compare the spot noise and line integral convolution methods for visualization of velocity field.</td><td>20</td><td>CO3</td></tr>
<tr><td>Q 11</td><td>a. Illustrate the conditions for formation of hole during the Marching cube</td><td>20</td><td>CO2</td></tr>
</table>

	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 levels of $c = 5$ and $c = 6$. Use asymptotic decider.		

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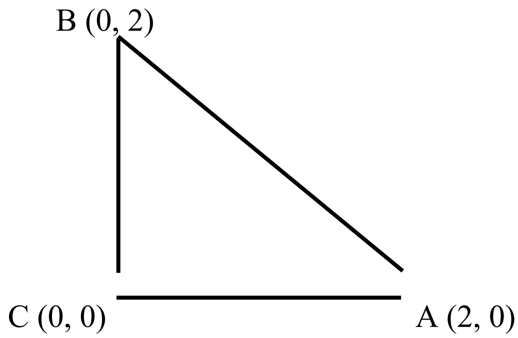
	SECTION A		
S. No.		**Marks**	**CO**
Q 1	Explain the visualization of scalars using colour mapping and transfer functions.	**04**	**CO1**
Q 2	What are the various types of degenerate points in two dimensional linear tensor field? Illustrate a method to identify these degenerate points.	**04**	**CO3**
Q 3	Discuss a strategy for visualization of an asymmetric tensor field by decomposition.	**04**	**CO1**
Q 4	Discuss methods to resolve the contouring ambiguity that may arise during isoline generation through marching square algorithm.	**04**	**CO2**
Q 5	Discuss various methods to extract the location of shock wave from CFD simulation data of a compressible flow.	**04**	**CO3**
	SECTION B		
Q 6	Explain the various algorithms for finding the presence and location of vortex in a fluid flow	**10**	**CO3**
Q 7	Explain, using the Phong's Illumination model, the effect of various factors on the intensity of a colour we see perceive. ***OR*** What is Compositing? Derive an expression for the colour intensity on the Image plane obtained by *back-to-front* compositing of a ray cast.	**10**	**CO1**
Q 8	Consider the simulation of a laminar flow through a pipe in ANSYS FLUENT. Write down steps to visualize the following primitives using the CFD-Post postprocessor. a. Velocity Vectors b. Velocity Magnitude Contours c. Velocity Profile at the Outlet d. Axial Variation of Pressure e. Skin Friction Coefficient	**10**	**CO4**
Q 9	Illustrate the various components of a typical VTK data file for visualization of	**10**	**CO4**

	structured and unstructured CFD simulation data.		
SECTION-C			
Q 10	Consider the 2-D velocity filed represented on a triangular mesh element as shown in Figure below.  The velocities at vertices A, B and C are $\{1, 1\}^T$, $\{-1, -1\}^T$ and $\{1, -1\}^T$ respectively. Find the location and behavior of the critical point if one exists. Also, draw the representative streamlines.	**20**	**CO3**
Q 11	Explain the marching cube algorithm for isosurface generation in detail. Draw all distinct topological cases for a 3D case. ***OR*** a. What are texture-based methods for flow visualization? Explain the Line Integral Convolution method for flow visualization. b. What are the demerits of the original Line Integral Convolution algorithm? Discuss the algorithms with improved performance over the original Line Integral Convolution algorithm.	**20**	**CO2**