Name: **Enrolment No:**	UPES

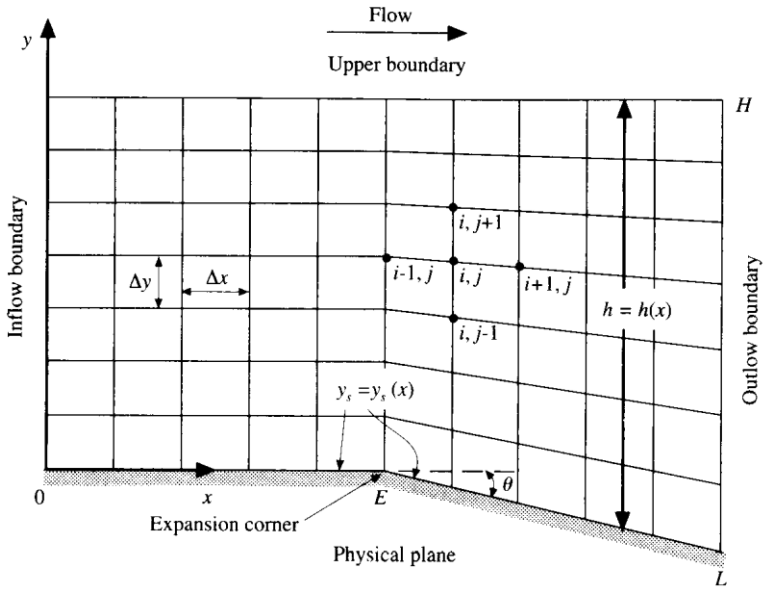
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

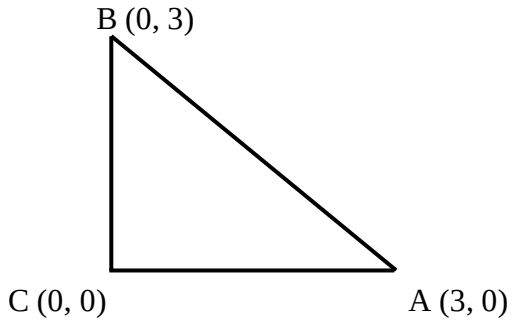
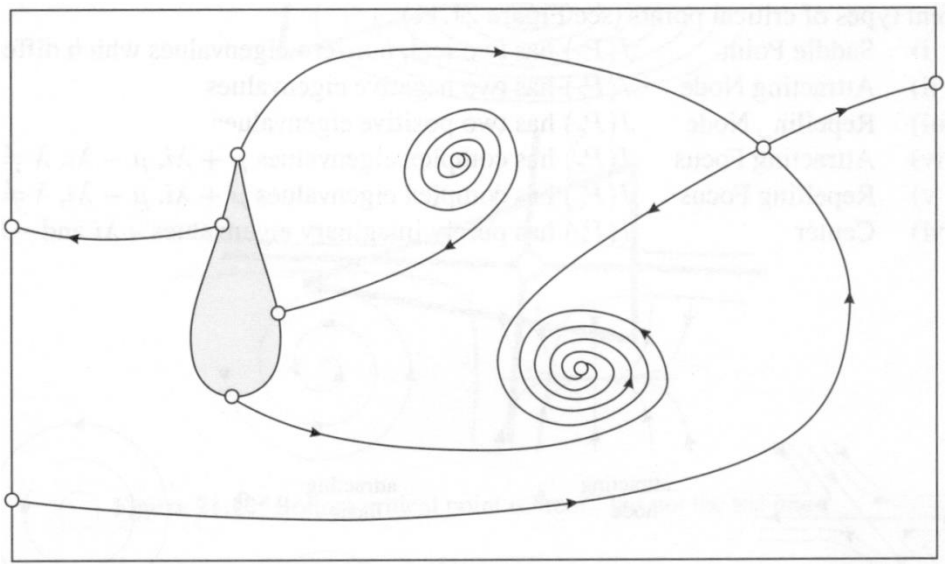
Course: Visualization of Advanced Fluid Flow and Flow Diagnostics **Semester: II**
Program: M. Tech. CFD
Time: 03 hrs. **Max. Marks: 100**

Instructions: The question paper has 03 pages.

SECTION A (5 x 4 =20 Marks)

S. No.		Marks	CO
Q 1	How are data classified based on the attributes of dependent and independent variables? Give an account of Brodlie's taxonomy of visualization mappings for various classes of data.	**4**	**CO1**
Q 2	What is particle advection? Define various characteristic lines that can be used to visualize a vector field through the particle advection method. Illustrate the concept using a vector data on a 2-dimensional 6 x 4 Cartesian grid.	**4**	**CO1**
Q 3	Consider a data file "heat.dat" with data provided in 3 columns. The first, second and third column store x-coordinates, y-coordinates and temperature respectively. Write Gnuplot script/command to a. Plot contours of temperature with 20 levels. The isolines should be joined with beta spline b. Write appropriate labels on axes with custom ranges. Give a title to the plot. c. Draw a colour map for the visualization of scalar temperature d. Save the plot as a "png" image with file name "plot.png"	**4**	**CO4**
Q 4	Draw a simple contour of the function $f(x, y) = x^2 + y$ over $[-3, 2] \times [-3, 2]$ for contour level $z = 4$.	**4**	**CO1**
Q 5	What is slicing? 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.	**4**	**CO3**

	SECTION B (4 x 10 = 40 Marks)		
Q 6	Discuss the use of ellipsoid glyph for the visualization of a symmetric tensor.	**10**	**CO2**
Q 7	Elucidate the various visualization mapping schemes for streamline generation through a velocity vector field. How can an adaptive time stepping method be used improve the accuracy of a first order Euler scheme?	**10**	**CO2**
Q 8	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**	**CO2**
Q 9	Explain the various algorithms for finding the presence and location of vortex in a fluid flow	**10**	**CO3**
	SECTION-C (2 x 20 =40 Marks)		
Q 10	Write a code to generate a 71 x 71 grid as shown in figure below and write to a file the grid data in an unstructured finite element format for the purpose of visualization using TECPLOT. Take appropriate length and height of the domain. Take $\theta=5^o$.  	**20**	**CO4**

Q 11	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) What are the various critical points in a vector field? How can these critical points be classified? Illustrate with examples. (b)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. 	**20**	**CO 3**

Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

Course: Computational Fluid Dynamics **Semester: VIII**
Program: B. Tech. ASE, ASE+AVE
Time: 03 hrs. **Max. Marks: 100**

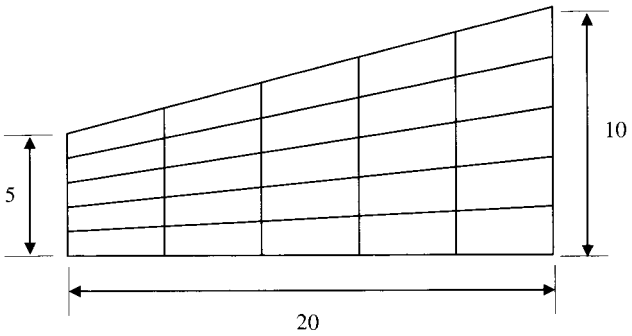
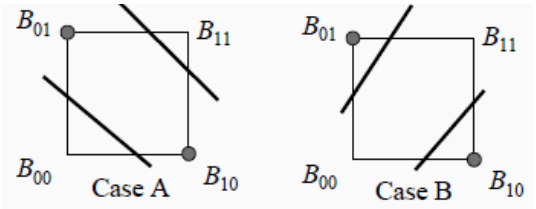
Instructions: The question paper has 03 pages.

SECTION A (5 x 4 =20 Marks)

S. No.		Marks	CO
Q 1	Explain briefly the various processes in the computer aided visualization pipeline.	**4**	**CO1**
Q 2	Sketch all unique topological cases for the marching square algorithm.	**4**	**CO1**
Q 3	Write a FORTRAN subroutine to generate scalar values against x, y-coordinates and write these in a file such that it can be read by Gnuplot for visualization of isolines.	**4**	**CO4**
Q 4	What are ellipsoid glyphs? Discuss how these glyphs can be used to visualize a symmetric tensor field.	**4**	**CO1**
Q 5	What do you mean by Ray Tracing? Give a brief account of various schemes for finding intensity of colour through Ray Traversal.	**4**	**CO2**

SECTION B (4 x 10 = 40 Marks)

Q 6	Why is the extraction of features important for flow visualization? Explain the λ_2 method for vortex extraction.	**10**	**CO3**
Q 7	Discuss methods for visualization of asymmetric velocity gradient tensor.	**10**	**CO2**
Q 8	What is ray casting? For a ray cast for volume visualization, derive an expression for the colour intensity on the Image plane obtained by a Front-to-Back compositing.	**10**	**CO2**
Q 9	Explain the original Line Integral Convolution (LIC) algorithm for visualization of vector fields. Also, explain how its speed can be enhanced with the FAST LIC algorithm. ***OR***	**10**	**CO3**

	Compare and contrast the Spot Noise Flow Visualization with Line Integral Convolution method for texture based visualization of velocity fields.		
	SECTION-C (2 x 20 =40 Marks)		
Q 10	Write a code to generate a 7 x 16 grid as shown in figure below and write to a file the grid data in a structured format (I, J, K) for the purpose of visualization using TECPLOT.  	**20**	**CO4**
Q 11	Explain the marching cube algorithm for isosurface generation in detail. Draw all distinct topological cases for a 3D case. OR (a) When does an ambiguity arise in the Marching Square contour generation algorithm? How can it be resolved? (b) Consider the following topological case for contour generation.  $B_{00} = 7, B_{10} = 3, B_{01} = 4, B_{11} = 10$ Which of the cases A and B is correct if we are drawing a contour for (i) 5 and (ii) 6?	**20**	**CO3**