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

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, June 2021

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

SECTION A

Instructions: This Section has 06 questions and all questions are compulsory. Select all the correct answer(s).

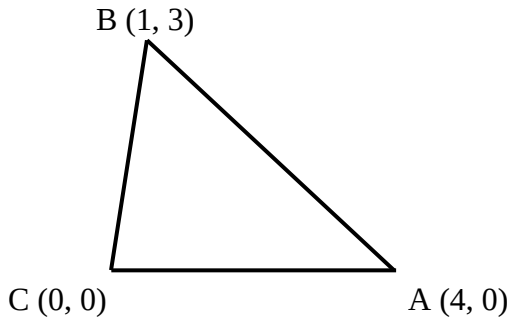
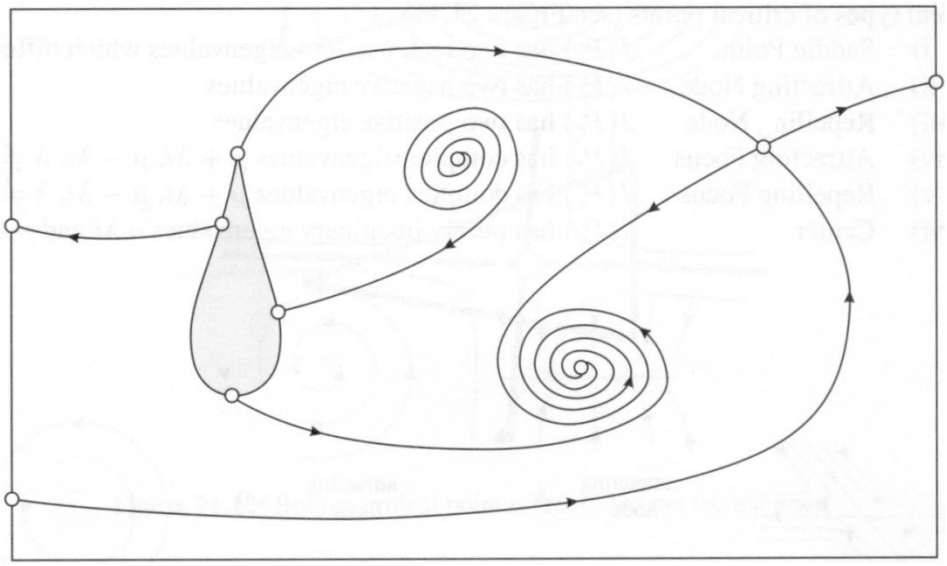
S. No.		Marks	CO
Q 1	The following visualization mapping can be used to visualize a scalar field in three dimensional space i. Iso-surface ii. Line Integral Convolution iii. Stream surface iv. Multiple frames of Iso-surface v. Volume Rendering	**05**	**CO1**
Q 2	The ambiguity on a face of a cuboid in the marching cube algorithm can be resolved using i. Asymptotic decider ii. Join or break iii. Slicing iv. Rotating the cuboid v. Marching tetrahedron technique	**05**	**CO1**
Q 3	For spot noise method for flow visualization, a circular glyph is scaled proportional to i. |V| in the direction of flow ii. |V| at 90° to the flow iii. 1+ |V| in the direction of flow	**05**	**CO2**

	iv. 1/(1+ |V|) at 90° to the flow v. 1+ |V| at 90° to the flow where |V| is the magnitude of velocity.		
Q 4	In the characterization of critical points using eigenvalues $a_1 + ib_1$ and $a_2 + ib_2$, of the Jacobian matrix $\frac{\partial \vec{U}}{\partial \vec{x}}$ i. a_1, a_2 positive represent attraction ii. a_1, a_2 negative represent attraction iii. a_1, a_2 opposite sign represent saddle iv. b_1, b_2 zero represent focus v. b_1, b_2 non-zero represent focus	**05**	**CO3**
Q 5	For the best visualization of symmetric tensor fields using glyphs, i. Cylindrical glyphs should be used to represent linear anisotropy ii. Ellipsoid glyphs should be used to represent planar anisotropy iii. Cuboidal glyphs should be used to represent intermediate cases of anisotropy iv. Ellipsoid glyphs should be used to represent isotropy v. Cylindrical glyphs should be used to represent planar anisotropy	**05**	**CO2**
Q 6	Intensity of diffuse reflection is proportional to i. Cosine of angle between surface normal and light source vector ii. Cosine of angle between surface normal and viewer vector iii. Square of distance between light source and object iv. Intensity of incident light v. Shininess of the object surface	**05**	**CO3**
SECTION B **Instructions: This Section has 05 questions and all questions are compulsory. Scan and upload the answers. The answer should be of short type (up to 200 words or equivalent numbers).**			
Q 7	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	**10**	**CO3**

	b) Eigenvector method		
Q 8	Explain the original Line Integral Convolution (LIC) algorithm for visualization of velocity fields. Also, explain how its speed can be enhanced with the FAST LIC algorithm.	**10**	**CO2**
Q 9	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 *back-to-front* compositing of local and background colours.	**10**	**CO2**
Q 10	Consider a CFD simulation of a steady state flow over an airfoil in ANSYS FLUENT®. Write down steps to visualize the following primitives 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 airfoil	**10**	**CO4**
Q 11	Consider a data file "result.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"	**10**	**CO4**

SECTION-C

Instructions: This Section has 02 questions and only 01 question needs to be answered. Scan and upload the answer. The answer should be of long type (up to 500 words or equivalent numbers).

Q 12	Consider the 2-D velocity filed represented on a triangular mesh element as shown in the 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**	**CO3**