Name:

Enrolment No:

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

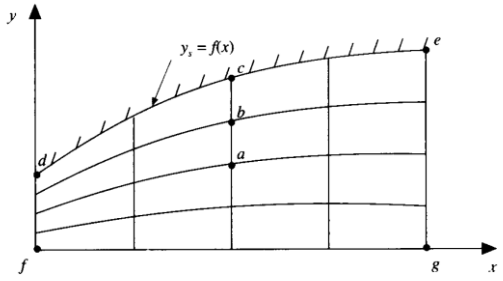
Course: Geometric Modeling & Grid Generation Techniques **(**ASEG7011) **Semester: II**
Program: M. Tech. CFD
Time: 03 hrs. **Max. Marks: 100**

Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point answers are expected.
The Question paper has three sections: Section A, B and C. Section C has internal choices.

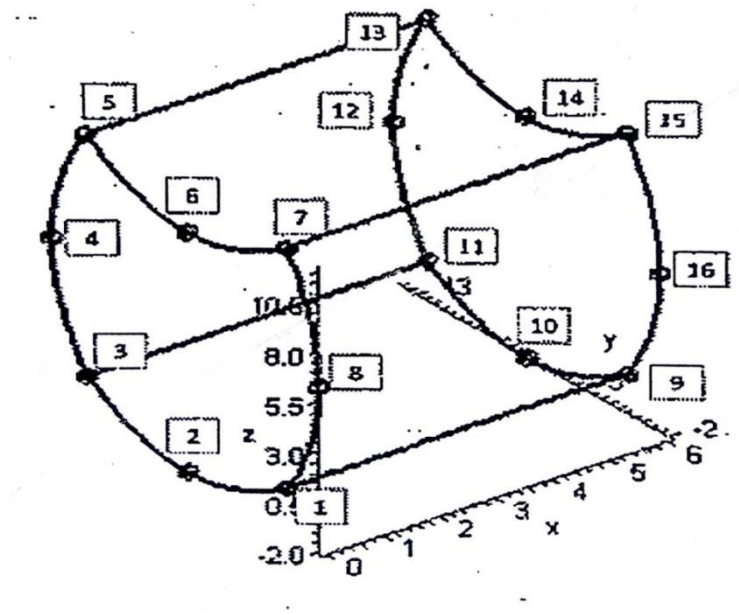
SECTION A [20 Marks]

S. No.		Marks	CO
Q 1.	What do you mean by Bottom-up and Top-bottom approach in geometric modelling?	**[04]**	**CO1**
Q 2.	Explain the discretization of a domain in to elements and what are the different types of nodes to represent the elements? Explain with proper diagram.	**[04]**	**CO3**
Q 3.	State the advantages in using Multi-block structured as compared to Single-block structures.	**[04]**	**CO2**
Q 4.	Differentiate between Manifold and Non-manifold Geometry.	**[04]**	**CO2**
Q 5.	Examine the types of grids with the following classification, a) O-type grid b) C-type grid c) H-type grid	**[04]**	**CO4**

SECTION B [40 Marks]

Q 6.	For a flow through a divergent duct as shown in fig. 1 in the physical plane. Use appropriate transformation to produce a rectangular grid in a computational plane.  Fig. 1 Section of a divergent duct in the physical plane	**[10]**	**CO3**

Q 7.	What are body-fitted grids? How does elliptic partial differential equation assist in generating the body-fitted grid?	**[10]**	**CO4**
Q 8.	Suppose that a physical domain is defined on the interval $0 \leq x \leq 1$ with an upper boundary given by $$y_{upper} = 1 + 0.2\, Sin(\pi x)$$ and a lower boundary given by $$y_{lower} = 0.1\, Cos(\pi x)$$ Devise a transformation that provides a uniform distribution of mesh points between the upper and lower boundaries. Use a simple normalizing transformation.	**[10]**	**CO2**
Q 9.	Explain the effects of the following terms on the measurement of grid quality. a) Skewness b) Smoothness c) Aspect ratio d) Resolution	**[10]**	**CO4**
SECTION-C [40 Marks]			
Q 10.	Investigate a two-dimensional unsteady flow with independent variables *x*, *y* and *t*. Transform the independent variables in the physical space (*x*, *y*, *t*) to a new set of independent variables in transformed space (ξ, η, τ), where $$\xi = \xi(x, y, t)$$ $$\eta = \eta(x, y, t)$$ $$\tau = \tau(t)$$ The above equations represent the transformation in a generic form. Find the relation so as to transform the first and second order derivative from the physical space to the transformed space. Furthermore, apply the derived relation to transform the Laplace's equation given below, $$\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$$	**[20]**	**CO3**

Q 11.	Explain the requirements imposed for an efficient grid generation based on following considerations; a) Grid size b) Grid Organization c) Grid Deformation d) Consistency with Geometry e) Consistency with Solution **OR** A three-dimensional geometry given in the figure below is a water tank, defined by 16 nodes as shown in the figure. Using Domain vertex method find the Lagrange Function for the following nodes: Node 1, 5, 7, 13 & 15. The coordinates of the nodes are given below. **Nodes / Physical Coordinates** 1 (0,0,0); 2 (0,6,-2); 3 (0,12,0); 4 (0,14,6); 5 (0,12,12); 6 (0,6,10); 7 (0,0,12); 8 (0,-2,6); 9 (6,0,0); 10 (6,6,-2); 11 (6,12,0); 12 (6,14,6); 13 (6,12,12); 14 (6,6,10); 15 (6,0,12); 16 (6,-2,6)  	**[20]**	**CO4**