Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

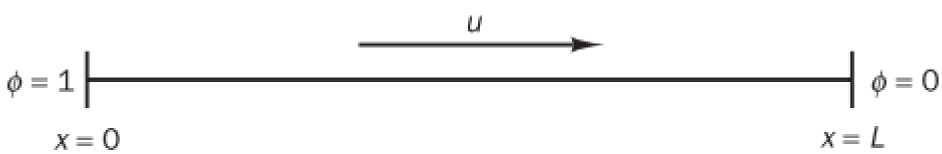
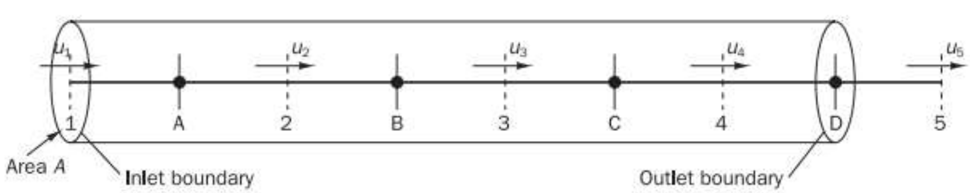
Programme Name: B.Tech-ADE& Mechanical **Semester : VIII**
Course Name : Computational Fluid Dynamics **Time : 03 hrs**
Course Code : GNEG-403 **Max. Marks : 100**
Nos. of page(s) : 03
Instructions : Attempt all questions.Q8 and Q11 are having internal choice.

SECTION A(20 Marks)

S. No.		**Marks**	**CO**
Q1	What is the physical meaning of divergence of velocity? State it clearly.	**4**	**CO1**
Q2	Show that second order Wave equation is a hyperbolic in nature. Also, signify the meaning of being hyperbolic in nature. $$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$$	**4**	**CO2**
Q3	Using polynomial approach drive the finite difference expression for the derivative at the boundary (one sided difference).	**4**	**CO3**
Q4	Assess the Central Differencing Scheme on the following properties Conservativeness, Boundedness, Transportiveness and Accuracy.	**4**	**CO4**
Q5	Consider a one dimensional steady state heat conduction equation without external source. Apply the Galerkin weak formulation and obtain second order accurate for linear element.	**4**	**CO5**

SECTION B(40 Marks)

Q6	Deduce Energy equation in the conservation form.	**10**	**CO1**
Q7	Consider a function $\emptyset(x, y) = e^x - y^2$. Consider the point(x,y)=(1,1). a) Calculate exact value of $\frac{\partial \emptyset}{\partial x}$ and $\frac{\partial \emptyset}{\partial y}$ at this point. b) Tabulate percentage difference in the result of $\frac{\partial \emptyset}{\partial x}$ and $\frac{\partial \emptyset}{\partial y}$ with respect to exact value, when solved using first order forward difference, first order backward difference and second order central difference. Take $\Delta x = \Delta y = 0.01$	**10**	**CO3**
Q8	Comprehend $k - \varepsilon$ and $k - \omega$ turbulence model in details. **OR** Comprehend Large eddy simulation for turbulence modeling in detail.	**10**	**CO4**
Q9	Compare SIMPLE and SIMPLER algorithm with the governing equations. Also, draw flow chart for both of the algorithm.	**10**	**CO5**

SECTION-C			
Q10	A property ϕ is transported by means of convection and diffusion through the one-dimensional domain sketched below. Using five equally spaced cells calculate distribution of ϕ as a function of x while using QUICK scheme for the following cases. Case 1- u=0.1 m/s. Case 2- 2.5 m/sec. Compare the results obtained with analytical solution. The following data apply L= 1 m, ρ= 1 kg/m^3, r=0.1 kg/m. s. Take Analytical formulation $\frac{\emptyset-\emptyset_0}{\emptyset_L-\emptyset_0}=\frac{\exp\left(\frac{\rho u x}{\Gamma}\right)-1}{\exp\left(\frac{\rho u L}{\Gamma}\right)-1}$ Take Governing Equation $\frac{d}{dx}(\rho u\emptyset)=\frac{d}{dx}\left(\Gamma\frac{d\emptyset}{dx}\right)$ 	**20**	**CO4**
Q11	Consider steady, one-dimensional flow of a constant density fluid through a circular duct with constant cross section. Take the staggered grid as shown in figure given below. Use SIMPLE algorithm and predict pressure at different pressure nodes. Also, obtain corrected velocity field at velocity nodes. **Use following data** **Density=1 kg/m3. Duct area Constant, d=1, boundary conditions u1= 10m/s, pd= 0 pa, initial guessed velocity u_2^*=8m/s, u_3^*=11m/s and u_4^*=7 m/s. Compare the computed result against the exact solution of u2=u3=u4=10 m/sec.**  **OR**	**20**	**CO5**

A planar two-dimensional nozzle is shown in figure given below. The flow is steady and frictionless and the density of the fluid is constant. Use the backward staggered grid with five pressure nodes and four-velocity node. The stagnation pressure is given at the inlet and the static pressure is specified at the exit. Using, SIMPLE algorithm, write down the discretized momentum and pressure correction equations and solve the unknown pressure and velocities at the nodes. Check whether the computed velocity field satisfy continuity and evaluate the error in computed pressure and velocity field by comparing with the exact solution.

Use following data

Density=1 kg/m3. Duct area Constant, L=2 m,

P0=10 Pa, pE=0 Pa. mass flow rate= 1 kg/sec.