Sample Midterm 2

Question 1 (25 points)

Multiple Choice – 5 questions, 5 points each

A jet with velocity V exiting from a pipe with diameter D causes a horizontal force, F, on a wall perpendicular to the jet. If the exiting velocity were to double to 2V with the same pipe, the new force on the wall would be

[ F/8 ] [ F/4 ] [ $F/2^{1/2}$ ] [ F ] [ $2^{1/2}F$] [ 2F ] [ 4F ] [ 8F ]

A pipe filled with an incompressible fluid has volumetric flow rate Q and mean fluid velocity V. If the flow rate doubles to 2Q what will be the new mean velocity?

[ V/8 ] [ V/4 ] [ $V/2^{1/2}$ ] [ V/2 ] [ V ] [ 2V ] [ $2^{1/2}V$ ]
[ 4V ] [ 8V ]

A student copying down the equations for an incompressible velocity field has written u = 0, v = cos(y), w = (can not read). Which of the following values for w would satisfy the incompressible mass continuity equation?

[ w=z sin(y) ] [w = z sin(z) ] [ w=y cos(y) ] [ w = cos(z) ] [w=-sin(y) ]
[w = -sin(z) ] [ w=-cos(y) ] [ w = -cos(z) ]

Water flows out of a rotating lawn sprinkler. When the volumetric flow rate is Q and the rate of rotation is $\omega$, the exiting fluid velocity relative to the rotating sprinkler is W. If the volumetric flow rate doubles to 2Q and the rate of rotation doubles to $2\omega$, the new relative fluid velocity will be
[ W/8 ] [ W/4 ] [ $W/2^{1/2}$ ] [ W ] [ $2^{1/2}W$] [ 2W ] [ 4W ] [ 8W ]

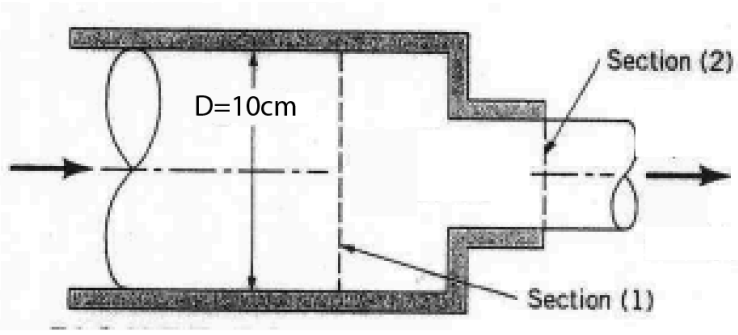
When an incompressible fluid flow can be represented by a stream function, conservation of volume is automatically satisfied

[Always] [Never] [Sometimes]

Question 2

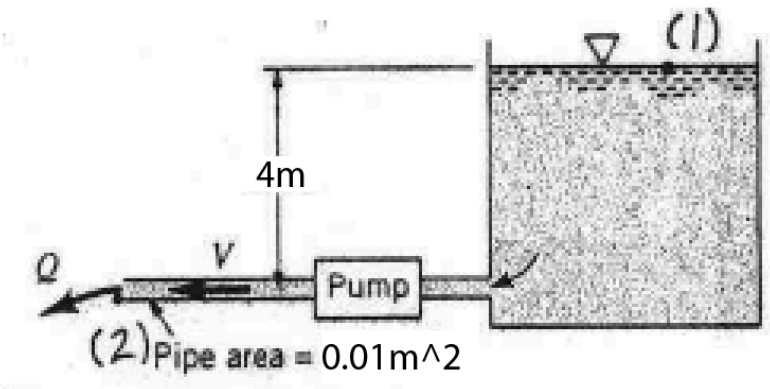
Water enters a horizontal, circular cross section sudden contraction nozzle as depicted in the figure. At section 1 the pressure is 520 kPa with a uniform velocity of 8 m/s and diameter 10 cm. The water exits the nozzle into the atmosphere at section 2 at a velocity of 32 m/s.

Determine: (i) The diameter of the exit of the nozzle
(ii) The anchoring force required to hold the nozzle in place




Question 3

Water is pumped from the large tank shown in the figure. The head loss in the pipe is known to be equal to $4V^2/2g$ and the pump head is $h_p=(20/3)-(4/27)Q^2$ , where hp is in meters and Q is in $m^3/s$. Determine the flowrate. It is discharged as a free jet.



Question 4

Flow between two parallel plates

(i) Departing from the full Navier Stokes Equations and Continuity Equation show that the flow between two parallel stationary plates is given by

$$u(y) = \frac{1}{2\mu}\frac{\partial P}{\partial x}\left(y^2 - h^2\right)$$

State all assumption and show clearly what terms you are disregarding with each assumption.

(ii) Using this solution, what would the volume flow rate of water be between two fixed plates separated by a distance of 10mm (and of unit width) subjected to a longitudinal pressure gradient of -1Pa/m.