Question 1:

Solution:

1. Let the velocity, pressure and area at the contraction entrance be , respectively. Similarly the velocity, pressure and area in the test section be , respectively. Then from continuity,

Since the contraction ratio is , hence

Applying Bernoulli’s equation between 1 and 2

Question 2:

Solution

1. For u and v to represent a possible incompressible flow it must satisfy the incompressible flow conservation of mass equation,

Then,

Similarly,

Substituting in the conservation of mass we get,

 Then u and v represent a possible incompressible flow.

1. The stream line ,

Solving this equation will give us the equation for the stream line.

Hence, we have two solutions,

The second solution represents a circle whose radius is equal to

1. The acceleration is given by,

Since,

At

Since (u,v)=(0,0), then

Question 3:

Solution:

1. Since the flow is steady and incompressible, then

The velocity at 1 is uniform then then flow rate is,

The flow rate at 2 is given by, if the vertical axis is in the y direction and the origin is at the middle of the tunnel, then the velocity at 2 is given by,

Then,

Hence,

1. The mass flow inside the tunnel is
2. The drag force, , is the force exerted by the air on the cylinder which is equal and opposite to the reaction force, , exerted by the cylinder on the air. Hence, applying the momentum equation,

Since the flow is in the x direction only, hence the x-momentum equation is given by,

Then,

Then the force exerted by the cylinder on the air is opposite to the flow direction, hence the drag force (the force exerted by the air on the cylinder is equal in magnitude and opposite in direction to the reaction force)

Hence the flow is trying to push the cylinder in the direction of the flow (positive x-direction).