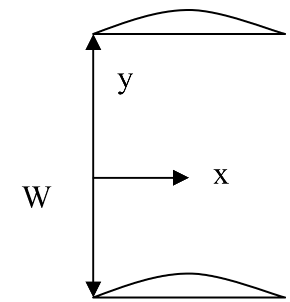
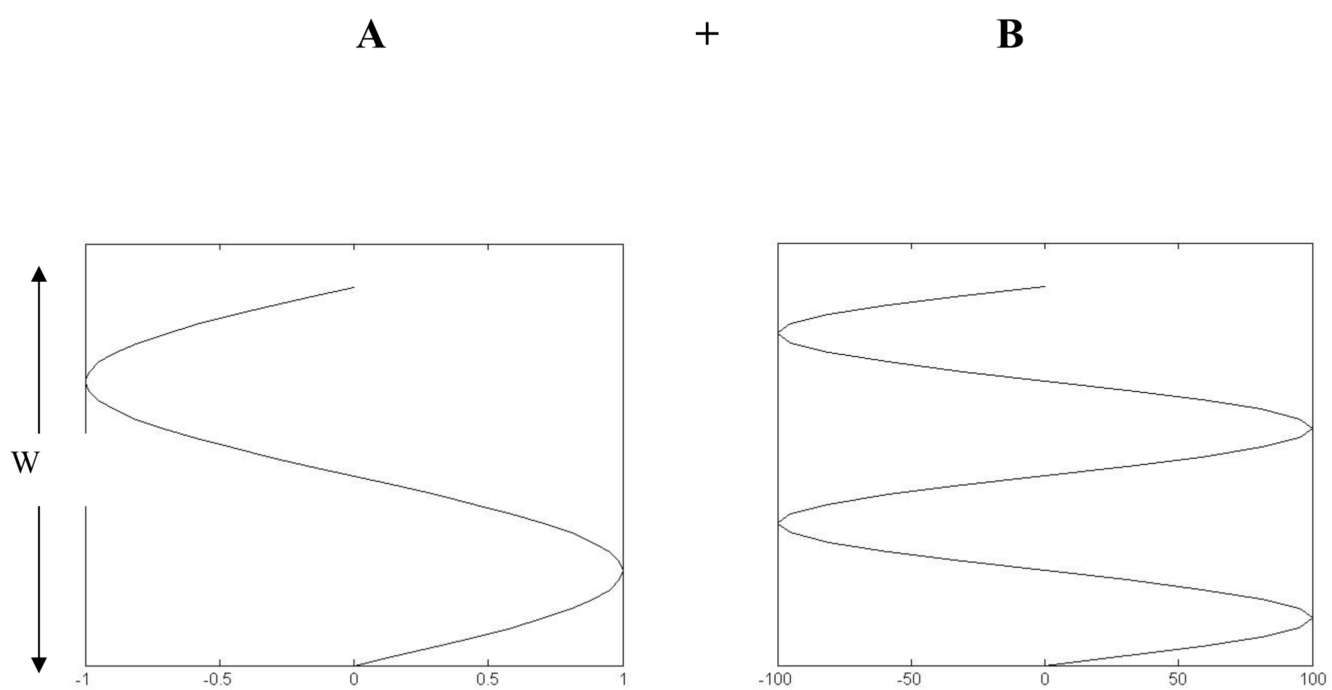


QUESTION #1

The pressure distribution at the entrance of a turbomachinery passage is periodic and can be decomposed into the sum of 2 periodic components A + B. Which component will have the largest magnitude at a given position upstream of y=0 (NOTE signals have different scales):



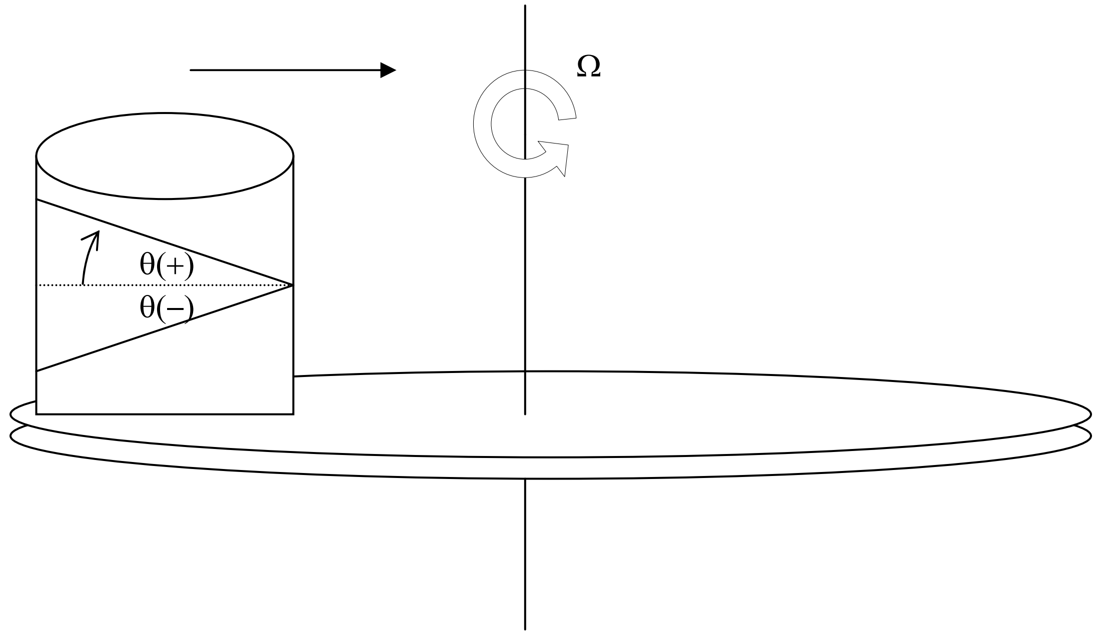
2.

3.

- For the last distribution, do you believe one component will always dominate over the other, or should there be a region of transition where the dominant component becomes less influential? If so, how is this region affected by a growth in magnitude of component B.

QUESTION #2

A water container is sitting near the outer edge of a turn table spinning steadily at a rate Ω. Determine the following:



1. Will the angle that the surface of the water forms with the horizontal be positive or negative (see figure)?

2. What will happen to such angle if the container position is changed to a location closer to the spinning axis? (more/less positive/negative?)

3. Will the angle change if the spinning rate is increased? Towards which direction (+ or –) ?

4. Will the original angle be the same if the container is filled with a fluid of lower density such as oil?

ANSWERS

QUESTION #1

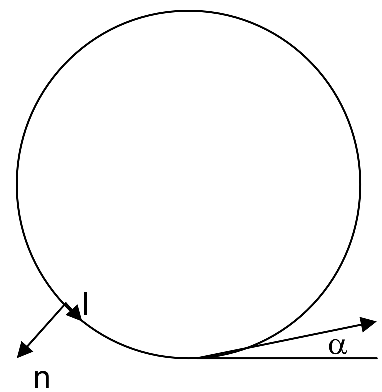
1. Signal A will be the one felt further upstream. Since both signals have the same most influential upstream frequency k=1, it will be that of higher magnitude (higher bk in the Fourier series) the one to decay less rapidly.

2. Signal A since k=1 as opposed to signal B where k=2.

3. Signal A. However due to the great difference in magnitudes from one case to the other, signal B will dominate in distances close to the passage. There will be a location where both signals will have the same influence. Then the k=1 harmonic will prevail. This region will be pushed upstream as the magnitude in B increases.

QUESTION #2

1. The angle will be more positive. The fluid undergoes a rotary motion, as described by a circular streamline. The reference angle α changes along the trajectory and a pressure gradient in the normal direction is produced. Since the surface must remain at the same pressure due to its direct exposure to the atmosphere, additional pressure must be built hydrostatically as the distance in the normal direction increases.



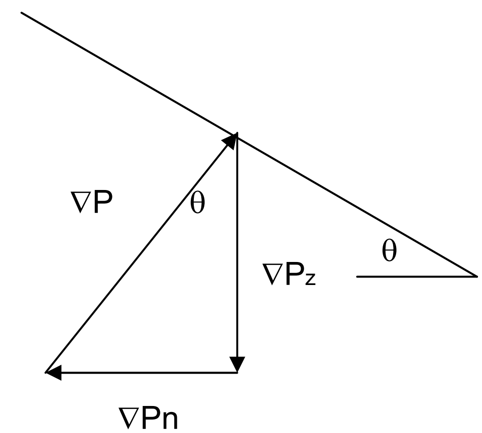
2. As the container is brought closer to the spinning axis, the velocity of the fluid will decay (u = ωr). From Equation 1, the pressure gradient in the normal direction will be lower and a lower hydrostatic compensation will be required. The angle will thus be less positive.

$$\frac{\partial P}{\partial n} = \rho u^2 \frac{\partial \alpha}{\partial l}$$

3. Same effect as in 2 but with opposite direction. The fluid's speed will be higher and so will be the gradient, more hydrostatic compensation and thus more positive angle.

4. The angle will not change if the density is changed. The direction of the resulting pressure gradient is perpendicular to the fluid surface and can be described as the vector sum of the gradient in the normal direction and the gradient in the z direction (see figure). From equivalence in angles, θ can be computed as:

$$\tan\theta = \frac{\nabla P_n}{\nabla P_z} = \frac{\rho u^2 \dfrac{\partial\alpha}{\partial l}}{\rho g} = \frac{u^2 \dfrac{\partial\alpha}{\partial l}}{g}$$



Where density plays no role.