Question no. 1 (5 marks)

In a computer hard drive the disc is to rotate at 10,000 rpm, and the reader head is positioned 0.012 mm above the surface of the disc as shown. Estimate the shearing force on the reader head as a result of the air between the disc and the head. Assume that the disc velocity is the same over the whole area of the head and that the velocity profile in the gap is linear. Take viscosity of air as $1.9 \times 10^{-5}$ Pa.s. (5 marks)

3. Define cavitation and mention where it could happen. Sketch two possible pipe systems where cavitation can happen. (5 marks)

عرف ظاهرة التكهف (cavitation) وأذكر حالتين تؤدي لحدث هذه الظاهرة في شبكات المواسير. ووضح إجابتك بالرسم.
Question no. 2 (10 marks):

A homogeneous, 1.2 m-wide, 2.4 m-long rectangular gate weighing 400 kg is held in place by a horizontal flexible cable as shown in the figure. Water acts against the gate, which is hinged at point A. Friction at the hinge is negligible. Determine the tension in the cable.

Hint: For a rectangle, $I_{xc} = \frac{ba^3}{12}$ where $b$ is the width and $a$ is the height.
Water at 30°C flows from tank shown into the atmosphere. Assuming that water is inviscid, for what nozzle diameter $D$ will cavitation begin to occur? To avoid cavitation, should you increase or decrease $D$ from this by a horizontal value? Justify your answer. Water vapor pressure at 30°C is 4.24 kPa (absolute) and atmospheric Friction pressure is 101.3 kPa.
Question no. 4 (10 marks)

The pipe flow in the figure is driven by pressurized air in the tank. What gage pressure $P_1$ is needed to provide a water flow rate $Q = 60 \text{ m}^3/\text{h}$? Include viscous effects. For water $\rho = 1000 \text{ kg/m}^3$ and $\mu = 0.001 \text{ Pa.s}$.

Diagram:
- 90° regular threaded elbows
- 30 m
- 80 m
- Open jet
- Galvanized iron pipe $d = 15 \text{ cm}$

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Notes:
- (a) Discuss
- (b) Flow characteristics
- (c) If necessary
A pump having the characteristics below is to be connected to the system shown with \( L = 400 \text{ m}, f = 0.025, D = 0.1 \text{ m}, \) and static head of 12 m.

a) Draw the system curve. (4 marks)

b) Find the flow rate delivered by the pump and the power consumption. (3 marks)

c) If it is desired to reduce this flow rate to 7 Liter/s by installing a valve on the pipe, sketch the new system curve and find the new power consumption. (3 marks)