UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

B.Sc. DEGREE IN: ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

**MAIN EXAMINATION PAPER 2019**

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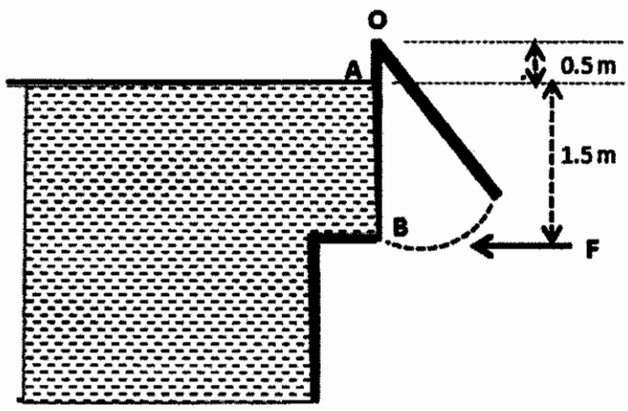
| TITLE OF PAPER | : | HYDRAULICS |
| COURSE CODE | : | EHS 320 |
| DURATION | : | 2 HOURS |
| MARKS | : | 100 |
| INSTRUCTIONS | : | READ THE QUESTIONS & INSTRUCTIONS CAREFULLY |
| | : | ANSWER **ANY FOUR** QUESTIONS |
| | : | EACH QUESTION **CARRIES 25** MARKS. |
| | : | WRITE NEATLY & CLEARLY |
| | : | NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM. |
| | : | BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER. |

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

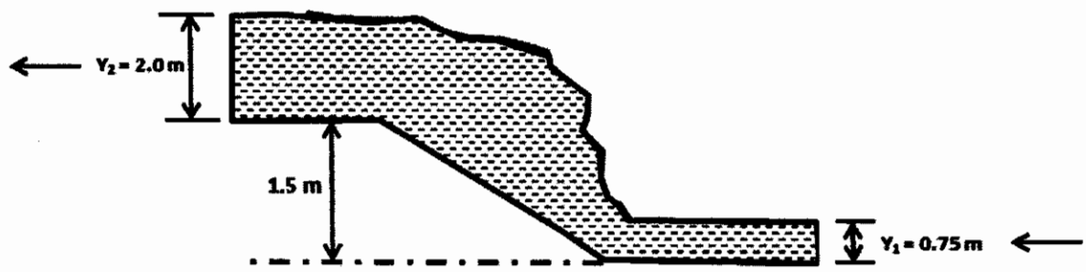
**QUESTION ONE** (25 Marks)

A vertical gate OB shown below is used to regulate the flow of water out of the channel. The channel has a width of 3 meters. The gate is hinged at O and hence rotates with respect to this hinge. The top water surface is located at level A and a force F is appled at the bottom of the gate B to close the gate. Determine the amount of this force F that is required to close the gate against the pressure of water in the channel.




**QUESTION TWO** (25 Marks)

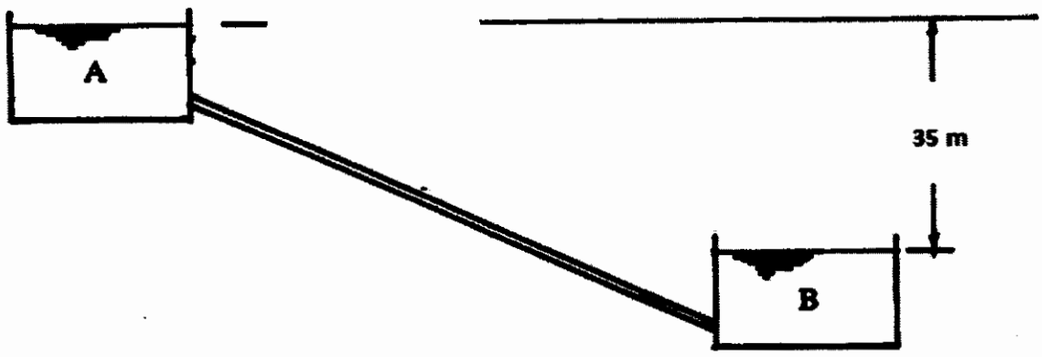
Water is flowing in an open channel that has a width of 5 meters. The discharge through the channel 35 $m^3$/sec. For the purpose of dissipating energy, the bed of the channel was raised by 1.5 m there by developing a hydraulic jump as shown in the figure below. Because of this, the depth of flow changed from 0.75 m upstream to 2.0 m depth downstream. Determine the energy that is dissipated in meters of water.



**QUESTION THREE** (25 Marks)

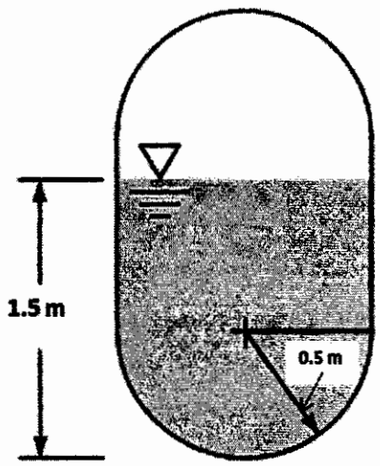
A 4 km long pipe line having a diameter of 250 mm delivers water between two reservoirs A and B. The elevation difference between the top water levels in the two reservoirs is 35 m as shown in the figure below. In addition to the major friction loss, consider the following three minor losses: Entry loss at A = $0.5\ V^2/2g$ ; Exit loss at B = $V^2/2g$ ; Downstream valve loss at B = $12\ V^2/2g$. Assume that the flow is fully turbulent for which the friction factor is 0.015.

Determine the discharge through the pipe. Taking the coefficient of dynamic viscosity of water as $0.9 * 10^{-3}$ N-sec/$m^2$, check if the assumption of turbulent flow was valid.



**QUESTION FOUR** (25 Marks)

The composite shaped concrete sewer pipe shown in the figure below is laid over a slope of 0.0006. The Manning's roughness coefficient of the entire sewer section is n = 0.013. Calculate the discharge through the channel in $m^3$/sec.




**QUESTION FIVE** (25 Marks)

It is shown using dimensional analysis that the discharge, Q, from a rotodynamic pump developing a total head, H, when running at angular speed of N rev/min is given by:

$$Q = ND^3 \emptyset \left[ \frac{D}{B} , \frac{N^2 D^2}{gH} , \frac{\rho N D^2}{\mu} \right]$$

Assume that pumps are operated at high speed such that the effect of viscous resistance is negligible as it is overcome by the high inertia forces of the moving water. Using this assumption, derive the formula for the specific speed of a pump series.