THE UNIVERSITY OF MELBOURNE

SCHOOL OF ENGINEERING
(Dept. Civil and Environmental Engineering)
SEMESTER 1 ASSESSMENT 2010

400-306 Fluid Mechanics

Pass and Honours

Examination Duration: **Three (3) hours**

Reading Time: **15 minutes**

Authorised Materials

- Any officially approved calculator

Instructions to Students

- Candidates may attempt **ALL Seven (7)** questions
- All questions are of the value indicated at the end of the question
- Question 7 is considered to be of a greater level of difficulty
- Maximum possible marks are 80 with an additional 20 marks based on the practical report and class test.

Paper to be lodged with the Baillieu Library

1) What is the gauge pressure at the centre of pipe A in Fig Q1? Take the density of the oil as $900\,kg/m^3$ and that of mercury as 13.6 times that of water.

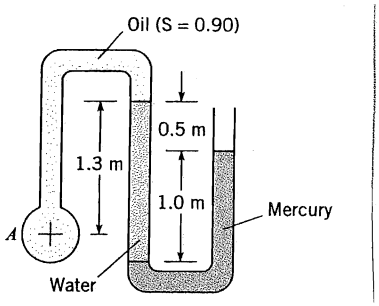

Fig Q1

(14 marks)

End of question

2) Determine the force P necessary to just start opening the rectangular gate, $2m$ wide and $5m$ long, as shown in Fig Q2. Neglect the weight of the gate. (Include in your solution a drawing of the pressure block, and either indicating how you are dividing it to obtain the locations and magnitudes of all the resultant forces or alternatively show how you are dividing the rectangle into strips for integration. Also state about which point you are taking moments.)

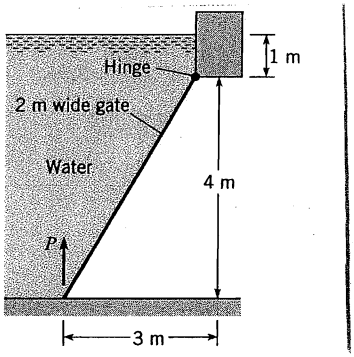

Fig Q2

(14 marks)

End of question

Examination continues on next page

3) At a distance $10m$ upstream of a simple sluice gate of the same width as the channel, both $5m$, water flows at a depth of $1.5m$, while downstream of the sluice (at the *vena contracta*) the depth is $0.4m$. Determine the flow.

(14 marks)

End of question

4) As part of the pump testing two centripetal pumps are arranged to operate in dynamically similar conditions both pumping water. If the smaller pump has a size of $0.25m$ and is operating with a flow of $0.05\ m^3/s$ at a head of $20m$, determine the expected flow in the larger pump of size $0.50m$ when it is also operating to produce a head of 20m. What is the expected ratio of the rotational speeds of the impellors of the two pumps and what are the power requirements?

(14 marks)

End of question

Examination continues on next page

5) For the system shown the discharge of water is $0.20\,m^3/s$ through the nozzle of diameter $0.1m$ into the atmosphere. The pipe diameter downstream of the pump is $0.30m$ and that upstream of the pump is $0.5m$. Suppose the elevations marked are x=$1.0m$, y=$2.0m$ and z=$7.0m$.
(i) Neglecting head losses what is the pressure at point just downstream of the pump?
(ii) If the total head change across the pump is $5m$, what is the pressure at a point just upstream of the pump?
(iii)If the friction coefficient in the pipe downstream of the pump is 0.025, what typical length of pipe could be used downstream of the pump and still not change the pressure at the point just downstream of the pump by more than 10%?

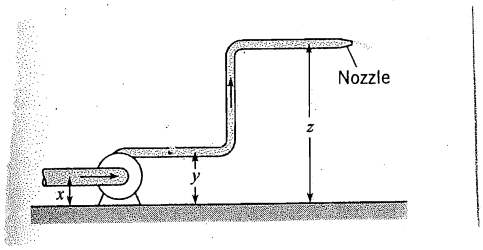

Fig Q5

(14 marks)

End of question

6) A thermally driven power station takes steam at $200deg\ C$ and discharges heat to a cooling pond operating at $50deg\ C$. What is the maximum possible efficiency of the power station?

(14 marks)

End of question

Examination continues on next page

7)(Harder) A single pipe of diameter $0.25m$ runs from an open reservoir containing water with a surface elevation of $20m$ to a point with an elevation of $15m$ over a length of $200m$ and then down to an elevation of $0m$ through another $200m$ of the same pipe (ie total pipe length is $400m$) where it discharges into the atmosphere.

(i)Ignoring minor losses, sketch clearly the hydraulic gradline (ie pressure head plus elevation head) and calculate the flow if the friction coefficient is 0.03 for the sections of pipe filled with water.

(ii)Write down appropriate equations that govern any time dependent surge-like behaviour in the pipe. (Note this question is concerned with mass surge **not** water hammer). Define clearly and symbols used.

(You may take the atmospheric pressure to be equivalent to $10m$ head of water and the vapour pressure of water to be $0.1m$ head of water).

(16 marks)

End of question

End of examination paper