National Exams May 2012

## 04-Agric-A4, Fluid Flow

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   A Casio or Sharp approved calculator is permitted.

3. Four (4) questions constitute a complete exam paper.
   The first four questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. All questions require calculation.

Choose either 1a or 1b

1a. A wide channel flow undergoes a hydraulic jump from 40 cm to 140 cm. Estimate (a) V1; (b) V2; (c) the critical depth; and (d) the percent dissipation.
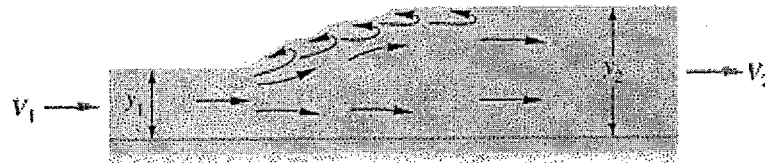
Figure for Question 1a

1b. Uniform water flow in a wide brick(For brickwork, take n = 0.015) channel of slope 0.02° moves over a 10 cm bump as in the figure below. A slight depression in the water surface results. If the minimum water depth over the bump is 50 cm, compute (a) the velocity over the bump and (b) the flow rate per meter of width.
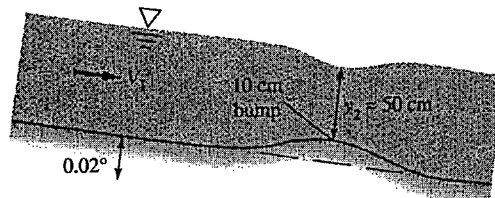
Figure for Question 1b.

2. The three arm lawn sprinkler shown below receives water at 20°C through the center at a volume of 2.7 m³/hr. If collar friction is negligible, what is the steady rotation rate in rev/min for:
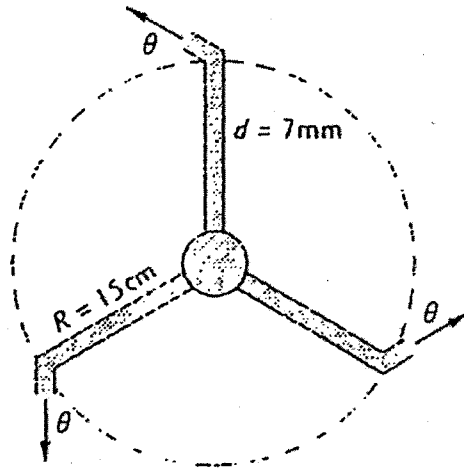
a) θ=0°
b) θ=40°

Figure for Question 2.

3. For the series-parallel system of the figure below, all pipes are 8-cm-diameter asphalted cast iron($\varepsilon \approx 0.12$ mm). If the total pressure drop p_1-p_2 = 750 kPa, find the resulting flow rate Q m³/h for water at 20°C(ρ = 998 kg/m³ and μ = 0.001 kg/m·s). Neglect minor losses
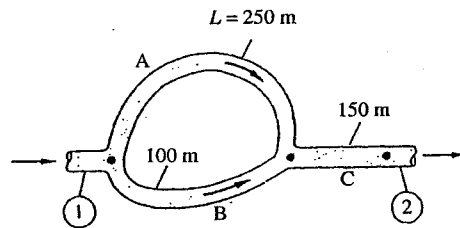

Figure for Question 3.

Choose either 4a or 4b

4a A centrifugal pump with backward-curved blades has the following measured performance when tested with water at 20°C:

Q, gal/min:	0	400	800	1200	1600	2000	2400
H, ft:	123	115	108	101	93	81	62
P, hp:	30	36	40	44	47	48	46

(a) Estimate the best efficiency point and the maximum efficiency. (b) Estimate the most efficient flow rate, and the resulting head and brake horsepower, if the diameter is doubled and the rotation speed increased by 50%.

4b. It is proposed to run the pump of the figure below at 880 r/min to pump water at 20°C through the system as shown in the below figure. The pipe is 20 cm diameter commercial steel. What flow rate in ft^3/min? Is this an efficient application? For water, take ρ = 998 kg/m^3 and μ = 0.0010 kg/m·s. For commercial steel, take ε = 0.046 mm.

Figure for Question 4b.