UNIVERSITY OF BOLTON

SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING – RAK CAMPUS

BSc (HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2008/2009

HYDRAULICS

MODULE NO: BLT 1008

Date: Friday 29 May 2009 **Time: 5.00 pm – 7.00 pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions.

Answer THREE questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

A formula sheet is provided.

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1. a) Briefly explain what is meant by ‘gauge pressure’. If the pressure head in a water main is 50 metres of water, determine the gauge pressure in kN/m^2.

(5 marks)

b) A circular flat plate of mass 100 kg is used as a gate to close an opening in the sloping side of a water tank. The opening and the gate have a diameter of 550 mm. The gate is rigidly attached to a horizontal lever arm as shown in Figure Q1, and hinged as shown. The gate is kept closed against the water pressure partly by its own weight acting through its centroid and partly by the mass on the lever arm. Find the mass which must be placed on the lever arm so that the gate will open if the water reaches a level of 900 mm above the top of the gate. (Ignore the mass of the lever arm.)

(15 marks)

Total 20 marks

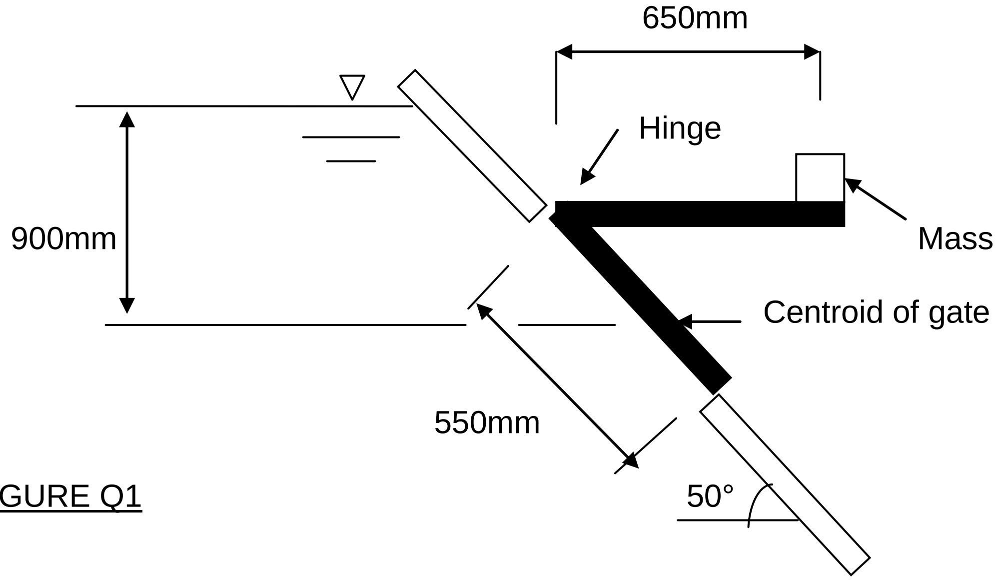

FIGURE Q1

Please turn the page

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2. A pipeline carrying water between two tanks has a Darcy friction factor λ = 0.022. The pipe is 850m long, the first 300m having a diameter of 375mm and the remainder a diameter of 225mm.

A flow control valve (k_L = 0.15 when fully open) is located 5m upstream of the lower tank. The difference in the tank water levels is 15m. If the entrance to and exit from the pipeline are sharp, the sudden contraction has a coefficient of contraction of 0.61, and the valve is fully open,

calculate a) the flowrate through the pipeline (12 marks)
b) the energy head losses in the system (4 marks)
and c) sketch an energy diagram of the situation. (4 marks)

Total 20 marks

3. a) Name the factors which affect the magnitude of frictional energy loss in a pipeline.
(4 marks)

b) A pipeline 375 mm in diameter and 12 km long transfers water between reservoirs with water levels 450 m AOD and 320 m AOD respectively. Determine the flowrate between the reservoirs

(i) using a pipe material with Darcy friction factor λ = 0.023.
(ii) using a pipe material with pipe wall roughness k_s = 0.03mm.

(8 marks)

HRS Tables are attached.

c) At a distance of 5 km from the upper reservoir, the pipe elevation is 290 m AOD. Determine the pressure in the pipeline at this point for each pipe material, ignoring ‘minor’ energy losses.
(8 marks)

Total 20 marks

Please turn the page

4. a) Explain the term ‘steady uniform flow’ as applied to flow in a rectangular open channel.

(4 marks)

b) Determine the flowrate in a 4 m wide rectangular channel when the uniform depth of flow is 0.65 m, the Chezy C value is 60 and the channel bed slope is 1 in 600.

(5 marks)

c) A trapezoidal channel has a Manning coefficient of 0.018 and side slopes of 1 vertical = 2 horizontal. When the steady uniform flowrate is 3.5 m^3/s, the depth of flow is 1.2 m and the mean velocity of flow is 0.7 m/s. Determine

(i) the horizontal base width of the channel. (4 marks)
(ii) the gradient of the channel bed. (7 marks)

Total 20 marks

END OF QUESTIONS

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EQUATION SHEET

$p = \rho g h$

$F = \rho g \bar{h} A$

$$x_P = \bar{x} + \frac{I_{CG}}{A\bar{x}} \qquad I_{CG} = \frac{\pi d^4}{64}$$

$Q = A_1 v_1 = A_2 \ v_2$

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \text{energy losses}$$

$$\frac{h_f}{L} = S_o \qquad h_f = \frac{\lambda L v^2}{2gd} = \frac{\lambda L Q^2}{12.1 d^5}$$

$$R = \frac{A}{P} \qquad Q = AC\sqrt{RS_o} \qquad Q = \frac{A}{n} . R^{2/3} S_o^{1/2}$$

$$H_L = K_L \frac{v^2}{2g} \qquad K_{L_{entry}} = 0.5 \qquad K_{L_{contraction}} = \left(\frac{1}{C_c} - 1 \right)^2$$

Please turn the page

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14 continued

ks = 0·030 mm
i = 0·004 to 0·1
ie hydraulic gradient = 1 in 250 to 1 in 10

Water (or sewage) at 15°C full bore conditions.
velocities in m/s
discharges in m^3/s

Gradient	Pipe diameters in mm: 350	375	400	450	500	525	600	675	700	750	800	825
0.00400 1/ 250	1.372 0.132	1.434 0.158	1.494 0.188	1.611 0.256	1.722 0.338	1.776 0.384	1.931 0.546	2.079 0.744	2.127 0.819	2.220 0.981	2.311 1.162	2.356 1.259
0.00420 1/ 238	1.409 0.136	1.472 0.163	1.534 0.193	1.653 0.263	1.767 0.347	1.822 0.394	1.982 0.560	2.133 0.763	2.182 0.840	2.278 1.007	2.372 1.192	2.417 1.292
0.00440 1/ 227	1.444 0.139	1.509 0.167	1.572 0.198	1.694 0.269	1.811 0.356	1.868 0.404	2.031 0.574	2.187 0.782	2.237 0.861	2.335 1.032	2.431 1.222	2.477 1.324
0.00460 1/ 217	1.479 0.142	1.545 0.171	1.610 0.202	1.735 0.276	1.854 0.364	1.912 0.414	2.080 0.588	2.239 0.801	2.290 0.881	2.390 1.056	2.488 1.251	2.536 1.356
0.00480 1/ 208	1.513 0.146	1.581 0.175	1.647 0.207	1.775 0.282	1.897 0.372	1.956 0.423	2.127 0.601	2.289 0.819	2.342 0.901	2.445 1.080	2.545 1.279	2.594 1.386
0.00500 1/ 200	1.546 0.149	1.616 0.178	1.683 0.212	1.814 0.288	1.938 0.381	1.999 0.433	2.173 0.615	2.339 0.837	2.393 0.921	2.498 1.103	2.600 1.307	2.650 1.416
0.00550 1/ 182	1.627 0.157	1.700 0.188	1.771 0.223	1.908 0.303	2.039 0.400	2.102 0.455	2.286 0.646	2.460 0.880	2.516 0.968	2.626 1.160	2.733 1.374	2.786 1.489
0.00600 1/ 167	1.704 0.164	1.780 0.197	1.855 0.233	1.998 0.318	2.135 0.419	2.201 0.477	2.393 0.677	2.575 0.922	2.634 1.014	2.749 1.215	2.861 1.438	2.916 1.559
0.00650 1/ 154	1.778 0.171	1.858 0.205	1.935 0.243	2.085 0.332	2.227 0.437	2.296 0.497	2.496 0.706	2.686 0.961	2.747 1.057	2.867 1.267	2.984 1.500	3.041 1.626
0.00700 1/ 143	1.850 0.178	1.933 0.213	2.013 0.253	2.168 0.345	2.316 0.455	2.388 0.517	2.596 0.734	2.793 0.999	2.856 1.099	2.981 1.317	3.102 1.559	3.162 1.690
0.00750 1/ 133	1.919 0.185	2.005 0.221	2.088 0.262	2.249 0.358	2.402 0.472	2.477 0.536	2.692 0.761	2.896 1.036	2.962 1.140	3.091 1.365	3.216 1.617	3.278 1.752
0.00800 1/ 125	1.986 0.191	2.074 0.229	2.161 0.272	2.327 0.370	2.485 0.488	2.562 0.555	2.785 0.787	2.996 1.072	3.064 1.179	3.197 1.412	3.327 1.672	3.390 1.812
0.00850 1/ 118	2.051 0.197	2.142 0.237	2.231 0.280	2.402 0.382	2.566 0.504	2.645 0.573	2.875 0.813	3.092 1.107	3.163 1.217	3.300 1.458	3.434 1.726	3.499 1.871
0.00900 1/ 111	2.114 0.203	2.208 0.244	2.300 0.289	2.476 0.394	2.645 0.519	2.726 0.590	2.962 0.838	3.186 1.140	3.259 1.254	3.400 1.502	3.538 1.778	3.605 1.927
0.00950 1/ 105	2.175 0.209	2.272 0.251	2.366 0.297	2.548 0.405	2.721 0.534	2.805 0.607	3.047 0.862	3.278 1.173	3.352 1.290	3.498 1.545	3.639 1.829	3.709 1.983
0.01000 1/ 100	2.235 0.215	2.334 0.258	2.431 0.306	2.617 0.416	2.795 0.549	2.882 0.624	3.131 0.885	3.367 1.205	3.443 1.325	3.593 1.587	3.738 1.879	3.809 2.036
0.01100 1/ 91	2.351 0.226	2.455 0.271	2.556 0.321	2.752 0.438	2.939 0.577	3.029 0.656	3.291 0.930	3.539 1.266	3.619 1.393	3.776 1.668	3.928 1.975	4.003 2.140
0.01200 1/ 83	2.461 0.237	2.570 0.284	2.676 0.336	2.881 0.458	3.076 0.604	3.171 0.686	3.444 0.974	3.703 1.325	3.787 1.458	3.951 1.746	4.111 2.066	4.189 2.239
0.01300 1/ 77	2.567 0.247	2.681 0.296	2.792 0.351	3.005 0.478	3.208 0.630	3.307 0.716	3.591 1.015	3.861 1.382	3.949 1.520	4.119 1.820	4.285 2.154	4.367 2.334
0.01400 1/ 71	2.670 0.257	2.788 0.308	2.903 0.365	3.124 0.497	3.335 0.655	3.437 0.744	3.733 1.055	4.013 1.436	4.104 1.579	4.281 1.891	4.454 2.239	4.538 2.426
0.01500 1/ 67	2.768 0.266	2.891 0.319	3.010 0.378	3.239 0.515	3.458 0.679	3.564 0.771	3.870 1.094	4.160 1.489	4.254 1.637	4.438 1.961	4.616 2.320	4.704 2.514
0.01600 1/ 62	2.864 0.276	2.990 0.330	3.113 0.391	3.350 0.533	3.576 0.702	3.686 0.798	4.002 1.132	4.302 1.540	4.399 1.693	4.589 2.027	4.773 2.399	4.864 2.600
0.01700 1/ 59	2.957 0.284	3.087 0.341	3.214 0.404	3.458 0.550	3.691 0.725	3.804 0.824	4.131 1.168	4.440 1.589	4.540 1.747	4.736 2.092	4.926 2.476	5.019 2.683
0.01800 1/ 56	3.047 0.293	3.181 0.351	3.312 0.416	3.563 0.567	3.803 0.747	3.919 0.848	4.255 1.203	4.574 1.637	4.677 1.800	4.878 2.155	5.074 2.550	5.170 2.764
0.01900 1/ 53	3.135 [illegible]	3.273 [illegible]	3.407 [illegible]	3.665 [illegible]	3.912 [illegible]	4.032 [illegible]	4.377 [illegible]	4.704 [illegible]	4.810 [illegible]	5.017 [illegible]	5.218 [illegible]	5.317 [illegible]