UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2017

Module Number: CE 6254 Module Name: Coastal Engineering

[Three Hours]

[Answer all questions, each question carries TWELVE marks]

Q1. Discuss the following with the aid of sketches if necessary:

(i) Generation, propagation and breaking of ocean waves

(ii) Spring and Neap tides

(iii) Coastal Zone Management in Sri Lanka showing the limits of the coastal zone and stating the duties and functions of the Coast Conservation and Coastal Resource Management Department.

[4 marks X 3]

Q2. Answer the questions (a) and (b) using the Figure Q2.

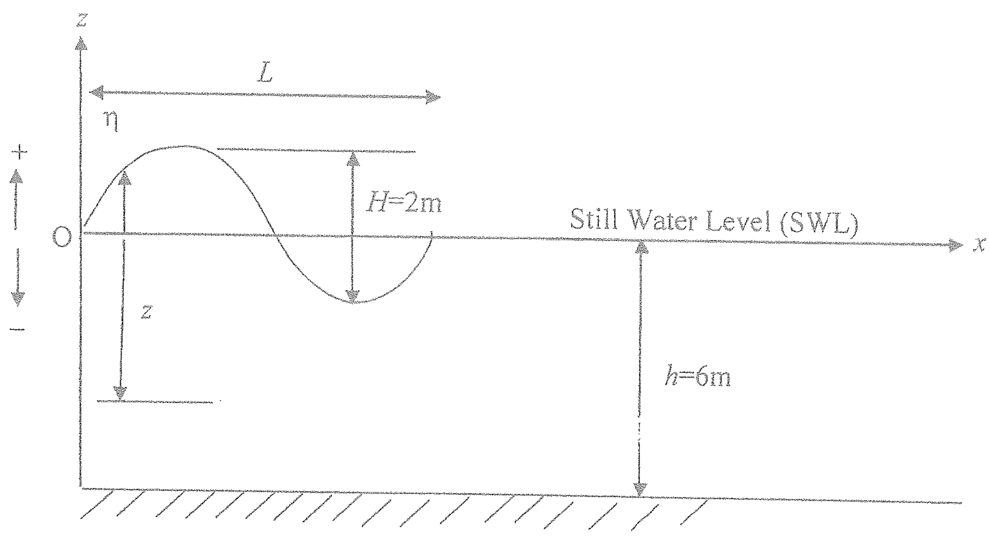

Figure Q2

(a) What are the assumptions made in deriving linear (Airy) wave theory ?

[3 marks]

(b) Linearised form of the velocity potential of a surface gravity ocean wave, written in usual notation, is given by:

$\phi = \frac{gH}{2\omega}\frac{\cosh k(z+h)}{\cosh(kh)}\sin(kx - \omega t)$ -------- Eq. 2.1

(i) Starting with the velocity potential (ϕ) derive relationships for vertical orbital velocity, w and horizontal orbital velocity, u and horizontal acceleration, a_x of progressive water waves.

[6 marks]

(ii) If, wave height, H=2 m, wave period, T=8 seconds and water depth, h=6 m calculate the peak values of u, w and a_x at the sea bed (Wave table is provided).

[3 marks]

Q3.

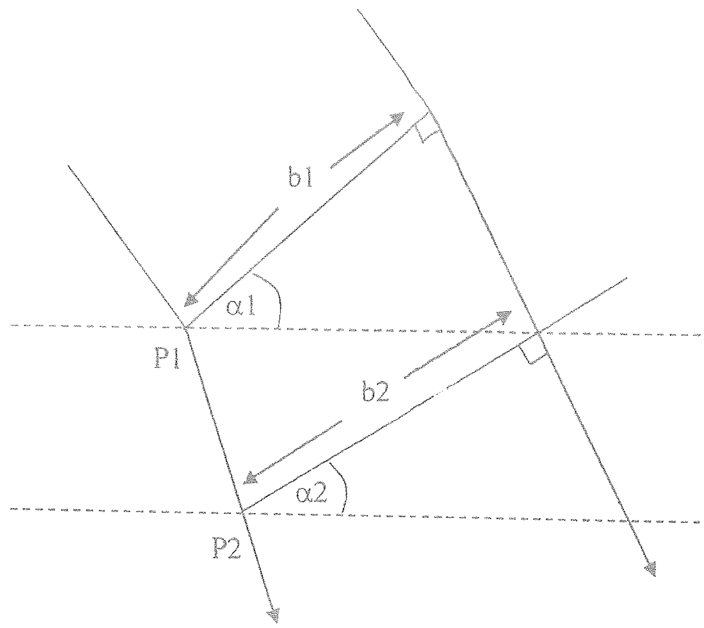

Figure Q3

(a) (i) Define ocean wave refraction and shoaling.

[2 marks]

(ii) Starting with the energy flux transmitted by water waves between two wave orthogonals having a width b, i.e. $P=C_gEb$ where, $E=(1/8)\rho g H^2$ and Cg = Group velocity, derive the relationship, $H_2/H_1=K_s.K_r$ taking refraction and shoaling into account. As shown in Figure Q3, H_1 is the wave height at point P1 seaward and H_2 is the wave height at point P2 at a nearshore location. Ks and K_r are shoaling and refraction coefficients, respectively. Clearly state the assumptions made in the derivation.

[4 marks]

(b) A wave of H=2 m height and wave period, T=8 sec in h=10 m water depth (at point P1) approaches the shore having straight and parallel sea bed contours at α_1=30 deg angle with the bed contours. What is the wave height at 6m water depth (at point P2) ?. Assume wave period, T remains constant during wave transformation (wave table is provided).

Group velocity is given by; $Cg=C * n$ where, C is the speed of individual waves (celerity), deep water wave celerity, $C_0=L_0/T$, $C=L/T$.

[6 marks]

Q4. Figure Q4 shows a plan of a harbour basin protected by a rock breakwater. Rock armour is placed as the cover layer on breakwater arm segments AB, BC, DE and EF. CD is a concrete quay wall with a vertical face. Diffraction coefficient, K_d is indicated by the contours shown within the harbour basin. The water depth of the basin is h=10 m.

(a) Define wave diffraction.

[3 marks]

(b) Explain why reflected wave height is less in front of a rock breakwater than a vertical concrete sea wall.

[3 marks]

(c) If wave height at the harbour mouth is H=2 m, calculate the incoming wave height (H_{inc}) at the rock breakwater (BC) and vertical quay wall (CD).

[3 marks]

(d) Estimate the maximum reflected wave heights in front of BC and CD on the harbour basin side, making appropriate assumptions for typical K_r values for rock breakwater and vertical quay wall, where, K_r is the reflection coefficient, $K_r=H_r/H_{inc}$.

[3 marks]

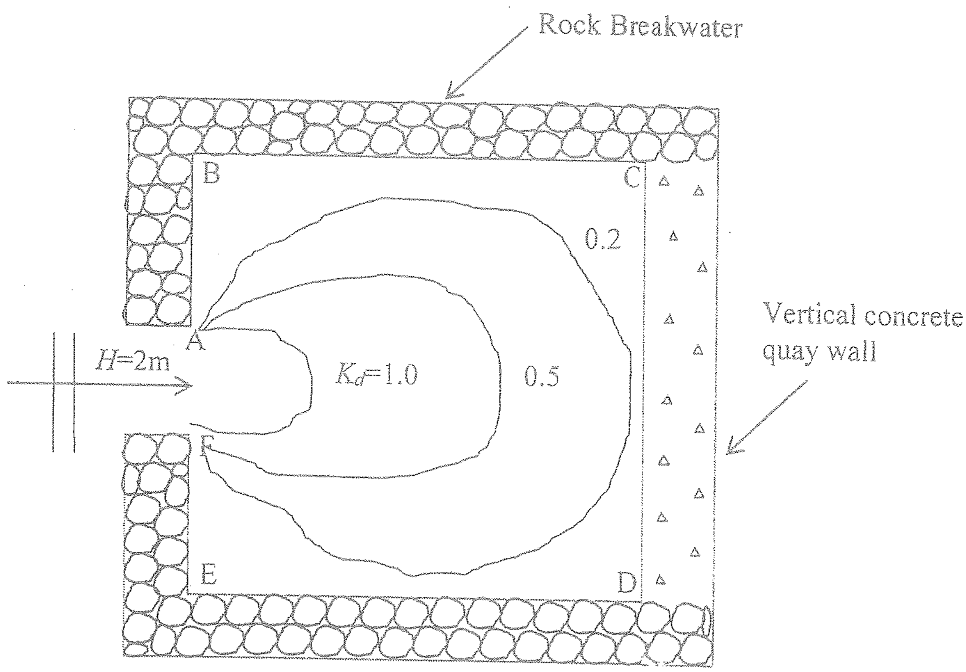

Figure Q4

Q5. (a) Name (i) hard (ii) soft coastal protection methods.

[3 marks]

(b) With the aid of sketches, explain beach planform evolution near two hard coastal structures named in (a). Mark the direction of dominant wave approach and longshore current/drift direction on the same sketch.

[3 marks]

(c) Hard coastal structures constructed to solve an erosion problem may shift the problem down coast. Explain this statement giving reasons.

[2 marks]

(d) (i) Name two criteria to satisfy hydraulic similarity in a physical model.

[2 marks]

(ii) If the geometric length scale ratio between a prototype and a physical model, $N_L = \frac{Lp}{Lm}$ and time scale ratio $N_T = \frac{tp}{tm}$ in usual notation, obtain a relationship for time scale ratio for a simple pendulum whose period T (seconds), is given by:

$T = 2\pi \left(\frac{L}{g}\right)$ ---------- Eq. 5.1

where, L is length of the pendulum and g is gravitational acceleration.

[2 marks]

APPENDIX:

Table 1. Wave table

h/L0	h/L	Sinh(2πh/L)	Cosh(2πh/L)	n	C_g/C_0
0.050	0.09416	0.6267	1.1802	0.8999	0.4779
0.051	0.09520	0.6344	1.1843	0.8980	0.4811
0.052	0.09623	0.6421	1.1884	0.8961	0.4842
0.053	0.09726	0.6499	1.1926	0.8943	0.4873
0.054	0.09829	0.6575	1.1968	0.8924	0.4903
0.055	0.09930	0.6652	1.2011	0.8905	0.4932
0.056	0.1003	0.6729	1.2053	0.8886	0.4960
0.057	0.1013	0.6805	1.2096	0.8867	0.4988
0.058	0.1023	0.6880	1.2138	0.8849	0.5015
0.059	0.1033	0.6956	1.2181	0.8830	0.5042
0.060	0.1043	0.7033	1.2225	0.8811	0.5068
0.061	0.1053	0.7110	1.2270	0.8792	0.5094
0.062	0.1063	0.7187	1.2315	0.8773	0.5119
0.063	0.1073	0.7256	1.2355	0.8755	0.5143
0.064	0.1082	0.7335	1.2402	0.8737	0.5167
0.065	0.1092	0.7411	1.2447	0.8719	0.5191
0.095	0.1366	0.9677	1.3917	0.8187	0.5693
0.096	0.1375	0.9755	1.3970	0.8170	0.5704
0.097	0.1384	0.9832	1.4023	0.8153	0.5716
0.098	0.1392	0.9908	1.4077	0.8136	0.5727
0.099	0.1401	0.9985	1.4131	0.8120	0.5737
0.1000	0.1410	1.006	1.4187	0.8103	0.5747
0.1010	0.1419	1.014	1.4242	0.8086	0.5757
0.1020	0.1427	1.022	1.4297	0.8069	0.5766
0.1030	0.1436	1.030	1.4354	0.8052	0.5776
0.1040	0.1445	1.037	1.4410	0.8036	0.5785