UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2018

Module Number: CE 6254 **Module Name: Coastal Engineering**

[Three Hours]

[Answer all questions. Questions in Part 1 carry ONE mark each and questions in Part 2 carry TWELVE marks each. Part 1 must be attached to the answer sheets.]

PART 1

Mark the correct box with a "X"

Q1. Two major parameters affecting wave generation are:

(i) Wave length ☐

(ii) Wind speed ☐

(iii) Wave period ☐

(iv) Fetch length ☐

(Mark two answers in Q1)

Q2. Wave shoaling can be defined as;

(i) Bending of waves ☐

(ii) An increase of wave length ☐

(iii) A reduction of water depth ☐

(iv) Increasing wave height as water depth reduces ☐

Q3. Ocean wave refraction is:

(i) Scattering of waves ☐

(ii) Bending of waves due to reducing water depth ☐

(iii) Bending of waves due to different mediums ☐

(iv) Increase in wave height ☐

Q4. Wave diffraction is:

(i) Increase in wave length ☐

(ii) Bending of waves due to reducing water depth ☐

(iii) Lateral transfer of wave energy along the crest ☐

(iv) Increase in wave height ☐

Q5. Wave celerity is:

(i) Speed of a group of waves ☐

(ii) Orbital velocity ☐

(iii) Speed of a single wave ☐

(iv) Wave phase velocity ☐

(Mark two answers in Q5)

Q6. Wave celerity (C) is given by:

(i) $(gT^2/2\pi)tanh(kh)$ ☐

(ii) $2\pi/L$ ☐

(iii) $2\pi/T$ ☐

(iv) L/T ☐

Q7. Wave number (k) is given by:

(i) $(gT^2/2\pi)tanh(kh)$ ☐

(ii) $2\pi/L$ ☐

(iii) $2\pi/T$ ☐

(iv) L/T ☐

Q8. Wave angular frequency (ω) is given by:

(i) $[(gk)tanh(kh)]^{1/2}$ ☐

(ii) $2\pi/L$ ☐

(iii) $2\pi/T$ ☐

(iv) L/T ☐

(Mark two answers in Q8)

Q9. Deep water wave length (L_0) is given by:

(i) $[(gk)tanh(kh)]^{1/2}$ ☐

(ii) $L/2\pi^2$ ☐

(iii) $gT^2/2\pi$ ☐

(iv) $2\pi/gT^2$ ☐

Q10. Significant wave height is defined as:

(i) Maximum wave height ☐

(ii) Average wave height ☐

(iii) Mean wave height ☐

(iv) Average of the highest 1/3rd of wave heights ☐

Q11. Linear wave theory is not valid in shallow water as;

(i) Wave celerity is high in shallow water ☐

(ii) Wave amplitude/water depth ratio is large ☐

(iii) Turbulence is high in shallow water ☐

(iv) Waves are not small amplitude any more ☐

(Mark two answers in Q11)

Q12. What are the main probability distributions of a wave energy spectrum

(i) Frequency spreading ☐

(ii) Wave height distribution ☐

(iii) Directional spreading ☐

(iv) Energy distribution ☐

(Mark two answers in Q12)

Q13. Wave setup is caused by;

(i) Longshore current ☐

(ii) Cross-shore current ☐

(iii) Momentum flux ☐

(iv) Radiation stress ☐

(Mark two answers in Q13)

Q14. Longshore drift is caused by;

(i) Longshore current ☐

(ii) Cross-shore current ☐

(iii) Wind induced current ☐

(iv) Tidal current ☐

Q15. Groyne is a structure constructed;

(i) Parallel to the beach ☐

(ii) Perpendicular to the beach ☐

(iii) Offshore ☐

(iv) Behind the beach ☐

Q16. Which one is a soft coastal defence method;

(i) Groyne ☐

(ii) Beach nourishment ☐

(iii) Seawall ☐

(iv) Revetment ☐

Q17. What will happen to the beach typically if a groyne is constructed?

(i) Accretion up coast and erosion down coast ☐

(ii) Accretion on both sides of the groyne ☐

(iii) Erosion up coast and accretion down coast ☐

(iv) Erosion on both sides of the groyne ☐

(In Q17 assume sediment move from up coast to down coast)

Q18. Spring tide is caused by;

(i) Sun, earth and moon in quadrature ☐

(ii) Sun, earth and moon in alignment ☐

(iii) The full moon ☐

(iv) Storm surges ☐

Q19. Which one has the longest wave length;

(i) Sea wave ☐

(ii) Swell wave ☐

(iii) Tidal wave ☐

(iv) Tsunami wave ☐

Q20. Sea level rise can

(i) Decrease tidal range ☐

(ii) Increase salinity intrusion in rivers ☐

(iii) Adversely affect agriculture and water supply ☐

(iv) Improve river water quality ☐

(Mark two answers in Q20)

Q21. Tide is generated by;

(i) The wind shear stress on sea surface ☐

(ii) Pressure drop in the atmosphere ☐

(iii) The gravitational pull of the Sun and Moon ☐

(iv) The momentum flux of wind waves ☐

Q22. The theories on astronomical tide developed after the classical work of

(i) Sir George Biddel Airy ☐

(ii) Sir George Stokes ☐

(iii) Sir Issaac Newton ☐

(iv) Claude-Louis Navier ☐

Q23. What coastal structure causes least reflection of incident waves?

(i) Vertical concrete seawall ☐

(ii) Vertical sheet pile wall ☐

(iii) Rock revetment ☐

(iv) Caisson breakwater ☐

Q24. Peak wave period is calculated from;

(i) Maximum zero up crossing wave period ☐

(ii) Maximum value of wave periods in a record ☐

(iii) Wave period at the peak of the energy spectrum ☐

(iv) Average of the highest 1/3rd of wave periods ☐

PART 2

Q1. (a) Using a definition sketch, show the limits of the coastal zone of Sri Lanka.

[3 marks]

(b) State the duties and functions of the Coast Conservation and Coastal Resource Management Department.

[3 marks]

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

[2 marks]

(d) If the geometric length scale ratio between a prototype and a physical model, $N_L = \frac{Lp}{Lm}$ and time scale ratio $N_T = \frac{tp}{tm}$ written in usual notation, obtain a relationship between the time scale ratio and geometric length scale ratio for small amplitude wave field using;

$$L = \frac{gT^2}{2\pi}\tanh(\frac{2\pi h}{L}) \text{ ------- Eq. 1.1}$$

where, L is wave length, h is water depth, T is wave period, g is acceleration of gravity.

[4 marks]

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

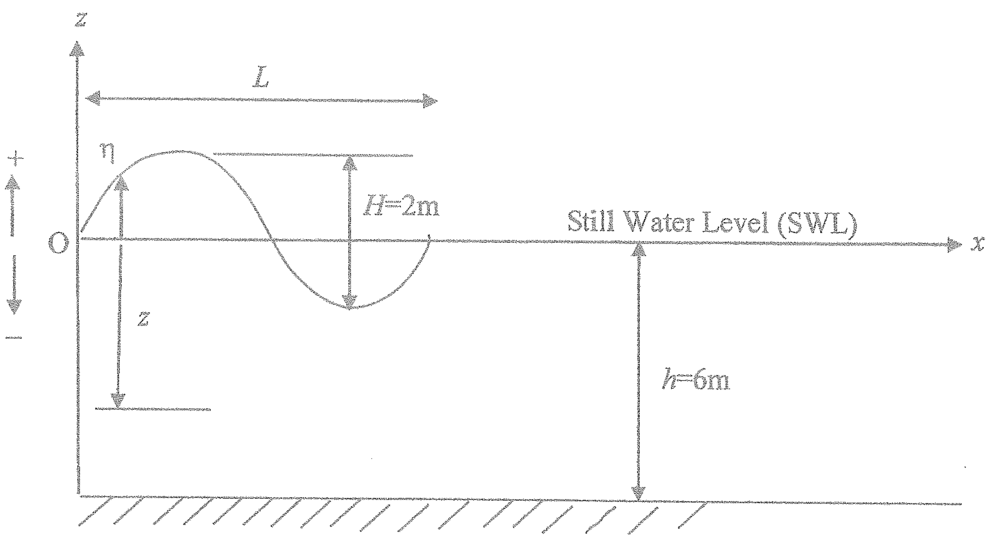

Figure Q2

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

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

(a) 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. If an oscillatory wave of period 8 sec and wave height

2 m propagates over water depth of 6 m, calculate the maximum horizontal orbital velocity and acceleration of a water particle at the seabed.

[6 marks]

(b) Starting from the first principles, derive the relationship for kinetic and potential energies of a progressive ocean wave to obtain total energy per unit width of crest (i.e., $E = (1/8)\,\rho g H^2$).

[6 marks]

Q3.

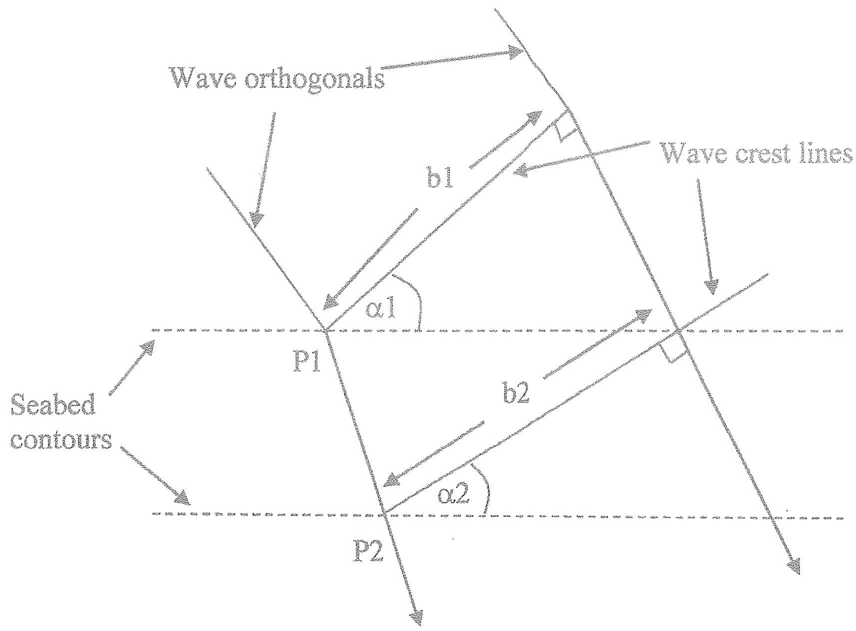

Figure Q3

(a) Starting with the energy flux transmitted by water waves across the width b, i.e. $P=C_g E b$ where energy, $E=(1/8)\rho g H^2$, derive the relationship, $H_2/H_1=K_s.K_r$ written in usual notation 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 an unknown wave height at point P2 nearshore. Clearly state the assumptions made in the derivation.

[6 marks]

(b) A wave of height 2 m and period 8 sec in 10 m water depth approaches shoreward over a uniformly sloping sea bed with nearly straight and parallel bottom contours. If the wave crest lines at this water depth make an angle of 30^0 with the depth contours, compute the wave height at 6 m water depth? Assume wave period, remains constant during wave transformation (wave table is provided).

Group velocity is given by; $Cg=C * n$, where, C is the wave celerity, deep water wave celerity, $C_0=L_0/T$.

[6 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
0.066	0.1101	0.7486	1.2492	0.8700	0.5214
0.067	0.1111	0.7561	1.2537	0.8682	0.5236
0.068	0.1120	0.7633	1.2580	0.8664	0.5258
0.069	0.1130	0.7711	1.2628	0.8646	0.5279
0.0950	0.1366	0.9677	1.3917	0.8187	0.5693
0.0960	0.1375	0.9755	1.3970	0.8170	0.5704
0.0970	0.1384	0.9832	1.4023	0.8153	0.5716
0.0980	0.1392	0.9908	1.4077	0.8136	0.5727
0.0990	0.1401	0.9985	1.4131	0.8120	0.5737
0.1000	0.1410	1.0060	1.4187	0.8103	0.5747
0.1010	0.1419	1.0140	1.4242	0.8086	0.5757
0.1020	0.1427	1.0220	1.4297	0.8069	0.5766
0.1030	0.1436	1.0300	1.4354	0.8052	0.5776
0.1040	0.1445	1.0370	1.4410	0.8036	0.5785