UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2016

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

[Three Hours]

[Answer **all questions**, each question carries TWELVE marks]

Q1. (a) Explain why non-linear wave theories should be used in the calculation of water wave kinematics in shallow water (i.e., when $h/L<1/20$).

[3 marks]

(b) Discuss the following with the aid of sketches if required:

(i) Contribution of Sir Isaac Newton to the development of theory on astronomical tides.

(ii) How diffraction, refraction and shoaling occur.

(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.

[3 marks X 3 =9 marks]

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

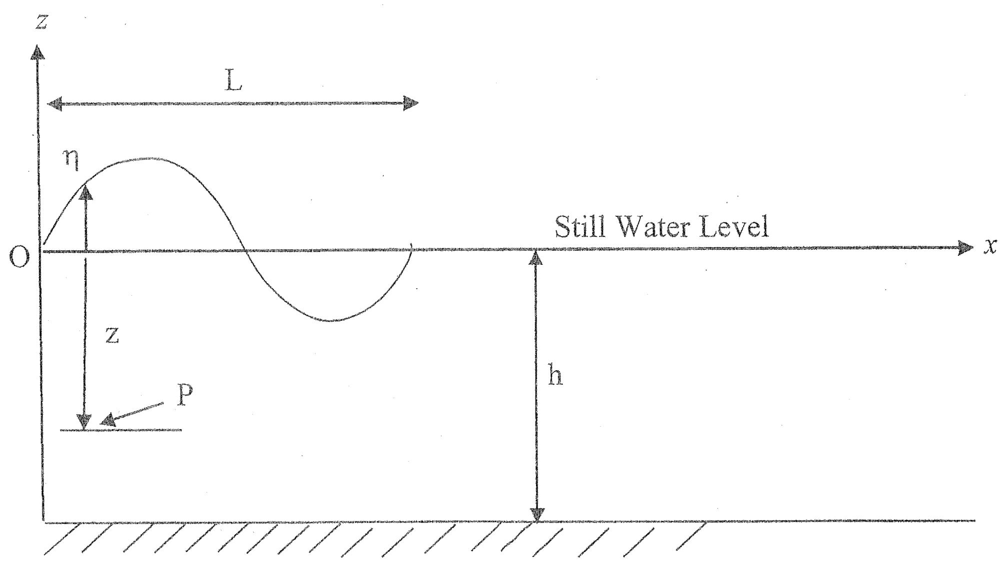

Figure Q2

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

[3 marks]

(b) Unsteady Bernoulli's equation is given below for the condition, $z=\eta$

$$\frac{P}{\rho} + \frac{1}{2}(u^2 + w^2) + g\eta + \frac{\partial \phi}{\partial t} = C(t) \quad \text{--------- Eq. 2.1}$$

Making appropriate assumptions obtain sea surface boundary condition

$$g\eta + \frac{\partial \phi}{\partial t} = 0 \quad \text{--------- Eq. 2.2}$$

when z=0 explaining the basis of your assumptions.

[3 marks]

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

$$\phi = \frac{gH}{2\omega}\frac{\cosh k(z+h)}{\cosh(kh)}\sin(kx - \omega t) \quad \text{--------- Eq. 2.3}$$

(i) Derive a relation for η in terms of x,z and t using equation 2.2.

[2 marks]

(ii) Obtain a solution for total pressure at point P with the aid of η derived in c(i) above.

[4 marks]

Q3.

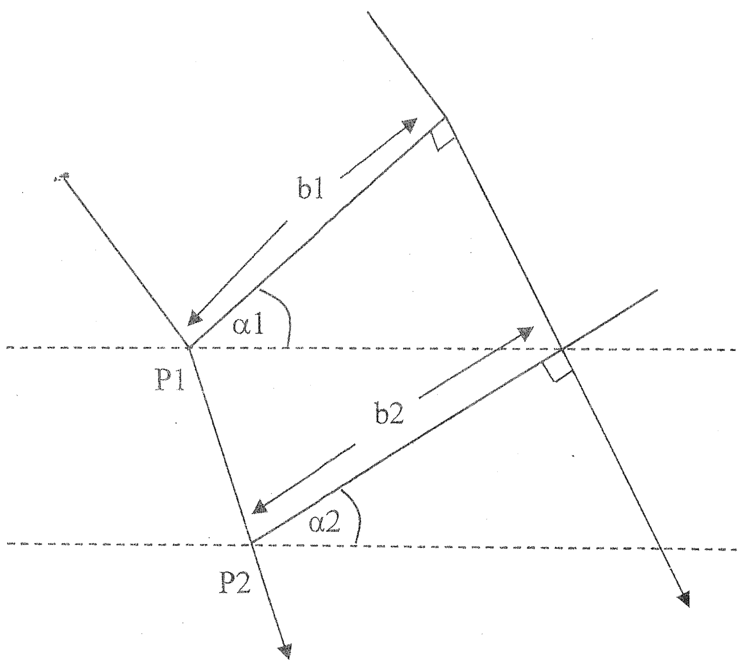

Figure Q3

(a) Starting with the energy flux transmitted by water waves across the width b, i.e. $P=C_gEb$ where energy, $E=(1/8)\rho gH^2$ 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.

[6 marks]

(b) A wave of H=1.5m height and wave period, T=10 sec in h=8m water depth approaches the shore having straight and parallel sea bed contours at a α_1=30 deg angle. What is the wave height at 6m water depth ?. 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, $C_0=L_0/T$.

[6 marks]

Q4. (a) State the conditions that should exist for the generation of ocean waves ?.

[3 marks]

(b) Describe how waves are generated, grow and disperse in the ocean distinguishing swell waves from sea waves ?.

[4 marks]

(c) The *i* th wave height obtained from a measured wave record is H*i* (m) and wave period, T*i* (sec) are given below in Table Q4. Calculate the significant wave height, H*s*(m) and corresponding significant wave period, T*s* (sec).

[3 marks]

Table Q4

i thWave,	Hi(m)	Ti(sec)
1	0.54	4.2
2	2.05	8.0
3	4.52	6.9
4	2.58	11.9
5	3.2	7.3
6	1.87	5.4
7	1.90	4.4
8	1.0	5.2
9	2.05	6.3
10	2.37	4.3
11	1.03	6.1
12	1.95	8.0

(d) With the aid of sketches explain wave orbital motion in deep, intermediate and shallow water.

[2 marks]

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

[3 marks]

(b) With the aid of a sketch explain beach planform evolution with time after the construction of a groyne. Mark the direction of wave approach and longshore current direction on the same sketch.

[3 marks]

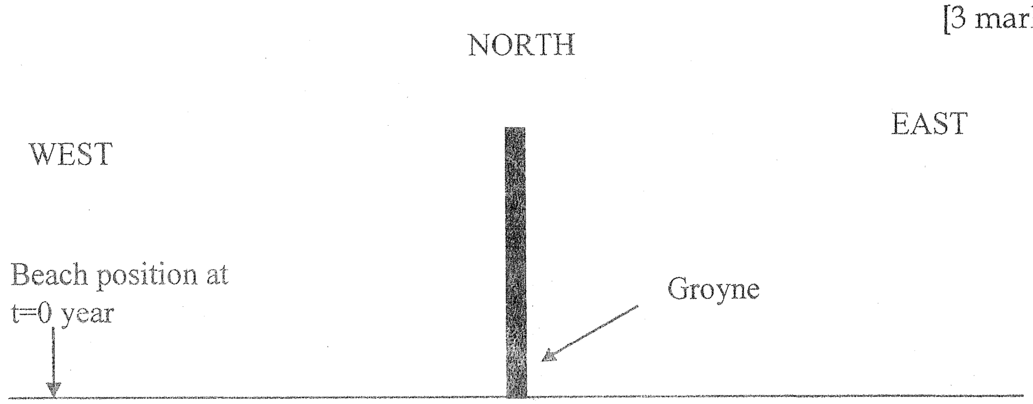

Figure Q5

(c) (i) Name two criteria to satisfy hydraulic similarity of a physical model

(ii) If the geometric length scale ratio, $N_L = \frac{Lp}{Lm}$ and time scale $N_T = \frac{tp}{tm}$
Obtain time scale for the dispersion relation:

$L = \frac{gT^2}{2\pi}\tanh\frac{2\pi h}{L}$

Calculate the time scale ratio (N_T) and model wave period if the wave period of the prototype is Tp=10 seconds and length scale ratio (N_L) is 15.

[4 marks]

(d) Explain why a rubble mound breakwater (i.e., rock) will have a smaller reflection coefficient than a vertical sea wall made of concrete caissons.

[2 marks]

APPENDIX:

Table 1. Wave table

h/L0	h/L	Sinh(2πh/L)	Cosh(2πh/L)	n	C_g/C_0
0.030	0.07135	0.4634	1.1021	0.9388	0.3947
0.031	0.07260	0.4721	1.1059	0.9369	0.4000
0.032	0.07385	0.4808	1.1096	0.9349	0.4051
0.033	0.07507	0.4894	1.1133	0.9329	0.4100
0.034	0.07630	0.4980	1.1171	0.9309	0.4149
0.035	0.07748	0.5064	1.1209	0.9289	0.4196
0.036	0.07867	0.5147	1.1247	0.9270	0.4242
0.037	0.07984	0.5230	1.1285	0.9250	0.4287
0.038	0.08100	0.5312	1.1324	0.9230	0.4330
0.039	0.08215	0.5394	1.1362	0.9211	0.4372
0.040	.08329	0.5475	1.1401	0.9192	0.4414
0.041	.08442	0.5556	1.1440	0.9172	0.4455
0.042	.08553	0.5637	1.1479	0.9153	0.4495
0.043	.08664	0.5717	1.1518	0.9133	0.4534
0.044	.08774	0.5796	1.1558	0.9114	0.4571
0.045	0.0883	0.5876	1.1599	0.9095	0.4607
0.046	0.08991	0.5954	1.1639	0.9076	0.4643
0.047	0.09098	0.6033	1.1679	0.9057	0.4679
0.048	0.09205	0.6111	1.1720	0.9037	0.4713
0.049	0.09311	0.6189	1.1760	0.9018	0.4746
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

h/L0	h/L	Sinh(2πh/L)	Cosh(2πh/L)	n	C_g/C_0
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
0.070	0.1139	0.7783	1.2672	0.8627	0.5300
0.071	0.1149	0.7863	1.2721	0.8609	0.5321
0.072	0.1158	0.7937	1.2767	0.8591	0.5341
0.073	0.1168	0.8011	1.2813	0.8572	0.5360
0.074	0.1177	0.8088	1.2861	0.8554	0.5380
0.075	0.1186	0.8162	1.2908	0.8537	0.5399
0.076	0.1195	0.8237	1.2956	0.8519	0.5417
0.077	0.1205	0.8312	1.3004	0.8501	0.5435
0.078	0.1214	0.8386	1.3051	0.8483	0.5452
0.079	0.1223	0.8462	1.3100	0.8465	0.5469
0.080	0.1232	0.8538	1.3149	0.8448	0.5485
0.081	0.1241	0.8614	1.3198	0.8430	0.5501
0.082	0.1251	0.8687	1.3246	0.8413	0.5517
0.083	0.1259	0.8762	1.3295	0.8395	0.5533
0.084	0.1268	0.8837	1.3345	0.8378	0.5548
0.085	0.1277	0.8915	1.3397	0.8360	0.5563
0.086	0.1286	0.8989	1.3446	0.8342	0.5577
0.087	0.1295	0.9064	1.3497	0.8325	0.5591
0.088	0.1304	0.9141	1.3548	0.8308	0.5605
0.089	0.1313	0.9218	1.3600	0.8290	0.5619