UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2015

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

[Three Hours]

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

Q1. (a) Explain why linear wave theory is not applicable in shallow water (i.e., when $h/L<1/20$) ?.

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

(i) Contribution of Sir George Biddel **Airy** and Sir George Gabriel **Stokes** for the development of wave theories.

(ii) Spring and neap tides

(iii) Coastal Zone Management in Sri Lanka

[3 marks X 4 =12 Marks]

Q2.

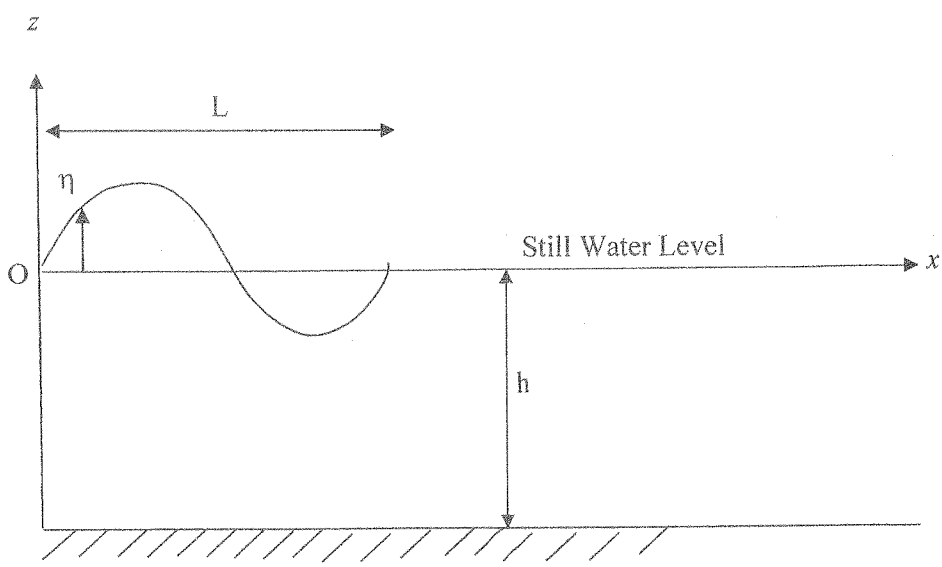

Figure Q2

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

[3 marks]

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

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

Calculate vertical orbital velocity, w and horizontal orbital velocity, u of progressive water waves.

[3 marks]

(c) Prove wave kinetic energy per unit width, $E_k = \frac{1}{16}\rho g H^2 L$.

$$E_k = \int_{x=0}^{x=L}\int_{-h}^{\eta}\rho\frac{(u^2+w^2)}{2}\,dz\,dx \quad \text{---------- Eq. 2.2}$$

[6 marks]

Q3.

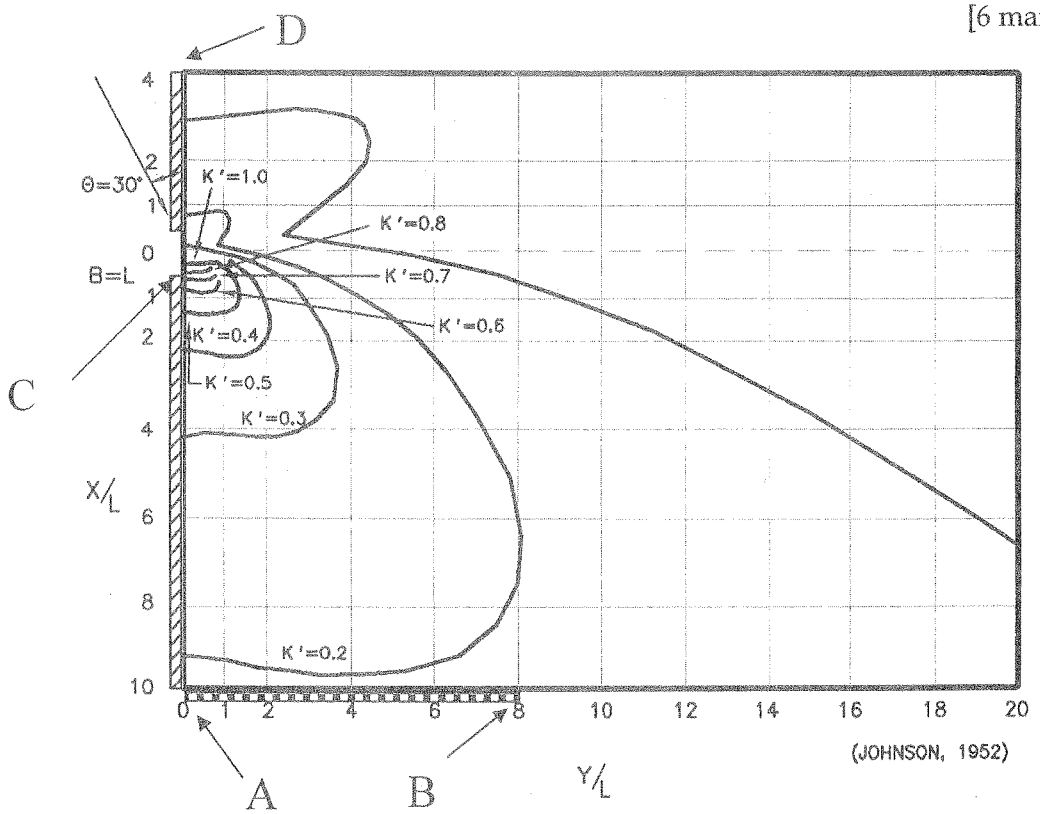

Figure Q3

(a) Explain the following coastal processes with the aid of sketches if necessary (i) refraction (ii) shoaling (iii) diffraction

[3 marks]

(b) Figure Q3 shows the contours of wave diffraction coefficient K' inside the basin of a fishery harbour. Water depth at harbour entrance and in the basin is h=6m. The wave height and period of waves reaching the harbour entrance at an angle of 30 deg with the breakwater AD, are Hs=1.8m and T=8 seconds respectively.

(i) A quay wall to moor boats is proposed along either (1) AB or (2) AC. Explain which quay wall is most suitable giving reasons for your choice. Assume tolerable wave height Hs<0.4m for safe birthing of vessels. [3 marks]

(ii) Calculate local wave length, L at the harbour entrance.

[2 marks]

(iii) Calculate incident wave height at position X=575m and Y=230m.

[2 marks]

(iv) Assuming the quay wall AB is a vertical concrete wall, calculate the reflected wave height corresponding to incident wave in (iii) ?.

[2 marks]

Q4. (a) Describe how waves are generated, grow and spread in the ocean distinguishing swell waves from sea waves ?. [4 marks]

(b) Can a deep water wave with a wave length of L=14m ever be more than H=2m high ?. Give reasons for your answer.

[2 marks]

(c) Explain how (i) wave set up occur (ii) longshore currents are generated.

[4 marks]

(d) Explain why a ripple formed due to throwing of a stone on to the surface of a still water tank disappears after some time ?.

[2 marks]

Q5. (a) Name (i) hard (ii) soft approaches that can be used as coastal protection methods.

[3 marks]

(b) Figure Q5.1 shows the plan view of a single groyne constructed to promote sediment accretion on the west (left) side of the structure. Shoreline change on the left side of the groyne 1, 5 and 10 years after construction is shown in the figure.

(i) Show on a sketch the direction of longshore sediment transport and probable wave direction ?.

[1 mark]

(ii) Sketch the shoreline change on the east (right) side of the groyne 1, 5 and 10 years after the construction.

[2 marks]

(iii) Calculate the longshore sediment transport rate in m^3/yr assuming the depth of closure of the beach is 3m and height above still water level is 2m. Equilibrium beach slope is 1:10 (see Figure Q5.2).

[6 marks]

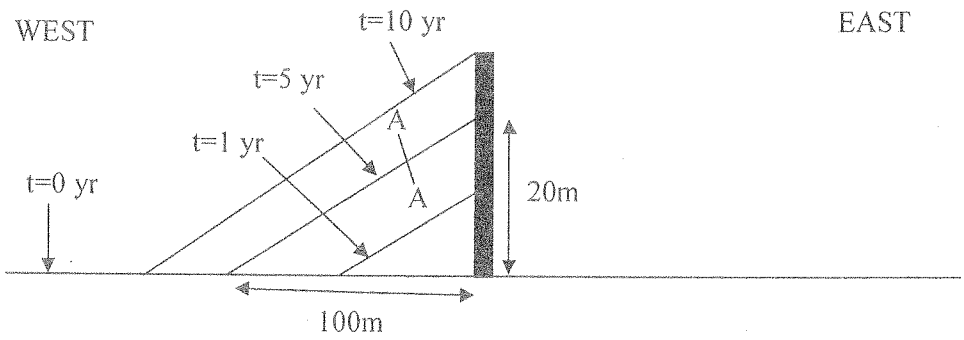

Figure Q5.1: Beach plan

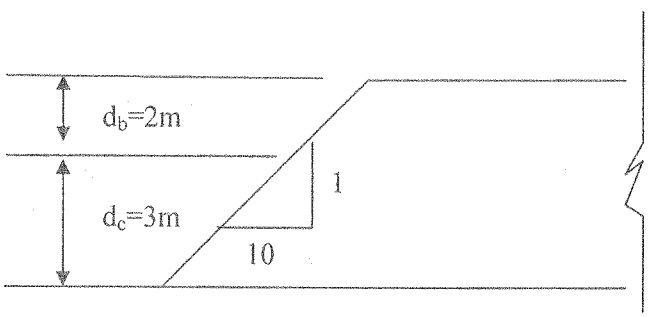

Figure Q5.2: Beach profile (section) at A-A

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
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

Wave Table (Contd.)

h/L0	h/L	Sinh(2πh/L)	Cosh(2πh/L)	n	C_g/C_0
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