THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING – THIRD YEAR DEGREE
SECOND SEMESTER EXAMINATION - 2021

CE 324 – COASTAL ENGINEERING

DATE:	WEDNESDAY, 2 NOVEMBER 2021
ROOM:	SLT
TIME:	12:50 P.M.
DURATION:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Check that there are 5 different pages of this Examination Paper.
2. You have ten (10) minutes to read this Examination Paper.
3. This paper contains 6 questions. You are only allowed to answer any 4.
4. Write your name, student number and course on the front page of the answer booklet.
5. All answers must be written on the ANSWER SHEET provided. No other written material will be accepted.
6. Mobile phones, notes and notebooks are NOT allowed.

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DO NOT WRITE UNTIL YOU ARE TOLD TO START

Question 1: Wave Propagation (10 marks)

A. Briefly discuss the influence of water depth on wave characteristics (5 marks).
B. Given a wave with a period $T = 8\,sec$, in a water depth $d = 15\,m$, and a height $H = 5.5\,m$. Find the local horizontal and vertical velocities at an elevation $z = -5\,m$ below the SWL when $\theta = 60°$ (5 marks).

Question 2: Wave Transformation (10 marks)

A. Discuss the wave Dispersion process (4 marks).
B. A deep water wave has a period of 8.5 seconds and a height of 5 m and is travelling at 45° to the shoreline over a sandy seabed of bed slope 1 in 100. Assuming that the seabed contours are parallel, find the height, depth, celerity and angle of the wave when it breaks (6 marks).

Question 3: Irregular Waves (10 marks)

A. Short term wave statistics can be analyse using Time Domain analysis and Frequency Domain analysis. Clearly differentiate the two methods (4 marks).
B. Calculate the significant wave height and zero up crossing period using the SMB method (with and without the SPM modification) for a fetch length of 5 km and a wind speed of $U_{10} = 10\,m/s$(6 marks).

Question 4: Wave Forces (10 marks)

A. Briefly discuss the effects of seabed friction on waves (4 marks).
B. A vertical cylindrical pile having a diameter of 0.4 m is installed in water that is 10 m deep. For an incident wave having a height of 2 m and a period of 8 s, determine the horizontal force experienced by the pile, per unit length, at mean water level at:
   a. The peak of the waves (3 marks).
   b. The trough of the waves (3 marks)

Note: The kinematic viscosity of seawater may be taken as 1.5 × 10−6 m^2s^{-1} and the density as 1028 kg/m^3.

Question 5: Tides (10 marks)

A. Briefly discuss Neap and Spring Tides (4 marks).
B. Given the mass of the Earth as $5.98 \times 10^{24}\,kg$, the mass of the moon as $7.35 \times 10^{22}\,kg$, the major semi-axis of the lunar orbit around the Earth, is $3.84 \times 10^{8}\,m$, and the mean radius of the Earth, is $6.37 \times 10^{6}\,m$. Calculate the maximum magnitude of

the effect of the tide-generating forces on the Earth due to the Earth-Moon and Earth-Sun systems (6 marks).

Question 6: Sediment Transport (10 marks)

A. Briefly discuss Bed load Transport and Suspended load Transport (4 marks).

B. Given a particle of grain size $D_{50} = 0.4\,mm$ in sea water with density $\rho = 1027\ kg/m^3$ such that the sediment density $\rho_s = 2650\ kg/m^3$ and kinematic viscosity $v = 1.36 * 10^{-6} m^2/s$. If the skin friction shear stress and shear velocity are $4.875\ \mathrm{N/m^2}$and $0.069\ m/s$ respectively.

Calculate the Tidal current bed load sediment transport rate (6 marks).

Formula Sheet

$$n = \frac{H}{2}\cos(kx - wt)$$

$$L_0 = \frac{gT^2}{2\pi}$$

$$U_a = 0.71U_{10}^{1.23}$$

$$u = \frac{HgT}{2L}[\frac{\cosh k(z+d)}{\cosh kd}]\cos(kx - wt)$$

$$w = \frac{HgT}{2L}[\frac{\sinh k(z+d)}{\cosh kd}]\sin(kx - wt)$$

$$F = \frac{C_d \rho D \ {}^2 w^2}{(2)(2^2)}\cos(kx - wt)|\cos(kx - wt)| + \frac{C_M \rho \pi \ {}^2}{4}\frac{Aw^2}{2}\sin(kx - wt)$$

$$n(\theta) = \frac{Ms^4}{mr^3}\left(\frac{3cos^2(\theta) - 1}{2}\right)$$

$$\emptyset = \frac{q_b}{[g(s-1)D^3]^{1/2}}$$

$$D_* = [\frac{g(s-1)}{v^2}]^{\frac{1}{3}}D$$

$$\emptyset_{CR} = \frac{0.3}{1+1.2D_*} + 0.0055[1 - \exp(-0.02D_*)]$$

$$\theta_s = \frac{\tau_{0s}}{(\rho_s - \rho)gD}$$

$$gn(\theta) = \frac{GMs^2}{r^3}\left(\frac{3cos^2(\theta)-1}{2}\right)$$

Table 1: Recommended design values for *CD* and *CM*.

Reynolds number	C_M
$R < 2.5 \times 10^5$	2.0
$2.5 \times 10^5 < R < 5 \times 10^5$	$C_M = 2.5 - R/(5 \times 10^5)$
$R > 5 \times 10^5$	$C_M = 1.5$

Reynolds number	C_D
$R < 10^5$	1.2
$10^5 < R < 4 \times 10^5$	$1.2 < C_D < 0.6$
$R > 4 \times 10^5$	$C_D = 0.6–0.7$

Table 2: Functions of d/L for increments of d/L_0

d/L_0	d/L	$\frac{2\pi d}{L}$	K
0.01	0.040	0.253	0.968
0.028	0.069	0.432	0.9130
0.034	0.076	0.479	0.895
0.150	0.183	1.152	0.575

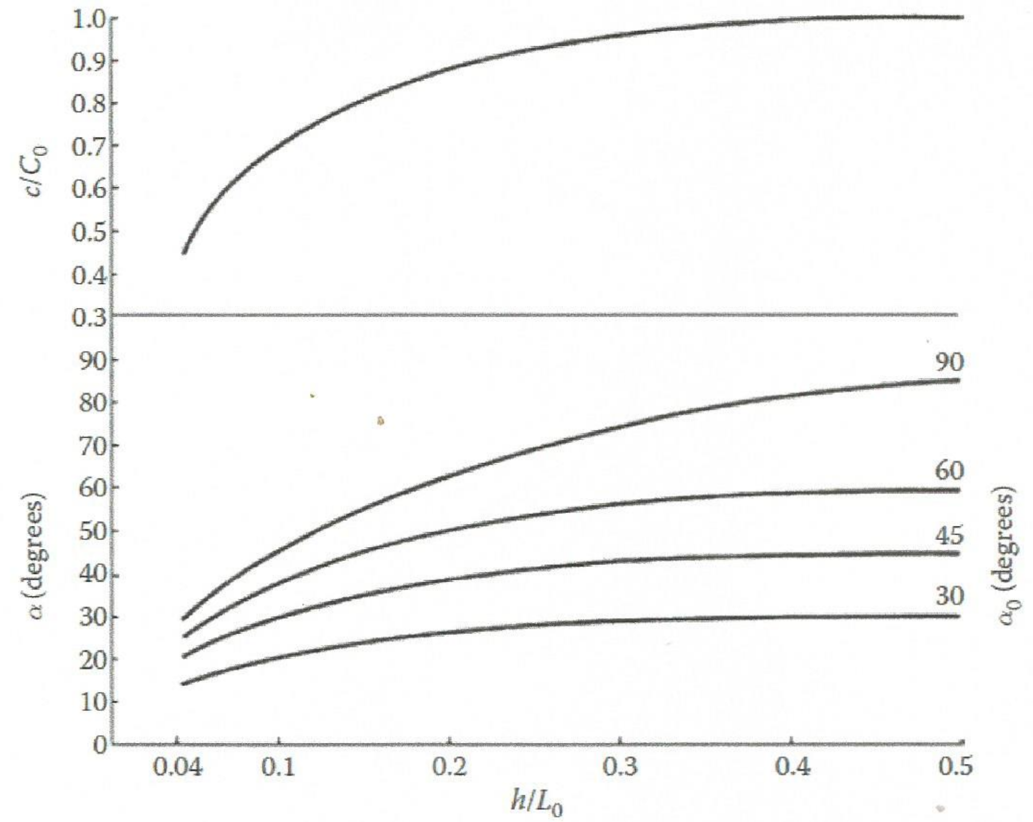

Figure 1: Variation of Waves celerity and angle with depth.