University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2025
Program: M.Sc. in Civil Engineering

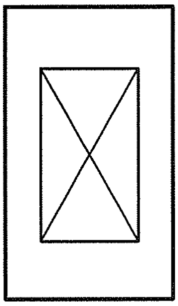
Course Title: Advanced Design of Concrete Structures | Course Code: CE 6108
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 100

Answer all the questions

QUESTION 1 [20 MARKS]

a. The mid span section of the beam of Jetty platform is shown in the **Figure 1**. **Develop formulation** to design the beam for flexure. The mid-span moment of the beam is 800 kN.m. Design the beam for mid-span moment using developed formulation. [10 Marks]

b. The mid-span positive moment at short span of the slab **Panel S1** is 22 kN.m as shown in **Figure 2**. In accordance to ACI 318/BNBC2020, the required minimum thickness of the slab is 190 mm to control the deflection. However, the requirement of client is to minimize the thickness within the limit of 150 mm. Apply the provision of EC2 to optimize the thickness and design the slab for moment in accordance to BNBC 2020. The basic span depth ratio of slab (EC2) for end span is 26. [10 Marks]



Beam size: 400 mm x 1200 mm
Void size: 200 mm x 600 mm
Figure 1. Mid-Section of beam at Jetty.

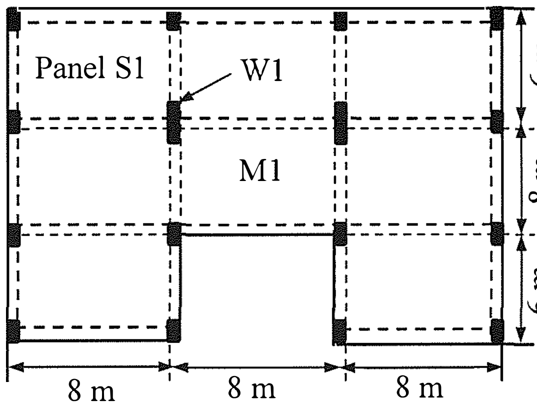


Figure 2. Beam supported slab floor plan.

QUESTION 2 [20 MARKS]

a. The transfer girder of a residential condominium is supported by corbel with bearing pad (simply supported). The girder will support an elevated / floating column (at centre of girder) having design load of 4500 kN. The span of the girder is 4 m. Design the girder as deep beam with reinforcement details. Assume required data to design the transfer girder. [10 Marks]

b. A column of RC structure is supported by pile foundation. The dead and live load of the column are 2500 kN and 1000 kN respectively. The capacity of 600 mm diameter bore pile is 1000 kN. Design the pile cap in accordance to BNBC2020 and EC2. The depth of pile cap could be considered as 900 mm. [10 Marks]

QUESTION 3 [20 MARKS]

The floor of an academic building (Live load 2.9 kN/m^2) is constructed with waffle slab. The floor carries 2 kN/m^2 dead load due to random wall. The interior panel of the waffle is 10m x 10m. Design the slab as **waffle (column strip only)** in accordance to BNBC 2020. Check for punching shear of the waffle. Column size could be assumed as 600 mm x 750 mm. Assumed required data to design.

[20 Marks]

QUESTION 4 [20 MARKS]

The floor slab layout plan of a 12-storeyed academic building (Live load 2.9 kN/m^2) is shown in **Figure 3**. The structure is constructed with frame structure (column and shear wall), the slabs are supported by beams. The floor carries 2 kN/m^2 dead load due to random wall. Design the shear wall W1 (ground floor) as shown in the **Figure 3**. The design moment and shear force of the shear wall at ground floor are 900 kN.m and 1000 kN respectively. Assume required data to design. [20 Marks]

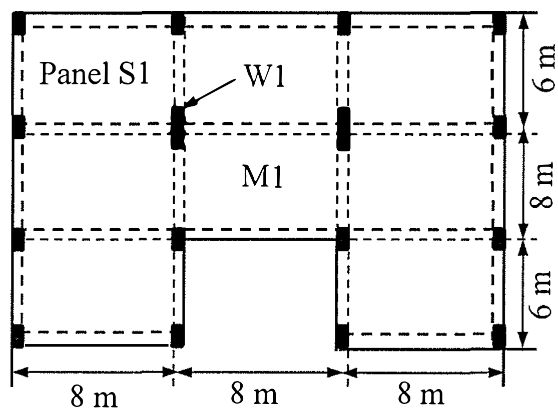


Figure 3. Floor plan of 12 storeyed academic building.

QUESTION 5 [20 MARKS]

Design the foundation of the structure stated in **Question 3 and Figure 3** as Mat with Box. The bearing capacity of the soil could be considered as 220 kN/m^2. Design the **Mat "M1"** only (shown in **Figure 3**). Assume required data to design. [20 Marks]

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2025
Program: M.Sc. Engineering (Civil)

Course Title: Structural Dynamics I — Course Code: CE 6115

Time: 3 hours — Credit Hour : 3.0 — Full Marks: 100

ANSWER ALL QUESTIONS. Assume any missing data reasonably.

Question 1 [13 Marks]

Frame structure ***abcd*** shown in ***Fig.1*** is subjected to a dynamic load, $w = 10t$ (*k/ft*). Use the *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***c*** at time $t = 0.10$ sec

[Given: $EI = 10^4$ *k-ft*^{2}, $\mu = 0.005$ *k-sec*^{2}*/ft*^{2}, *Damping ratio of the system = 5%*].

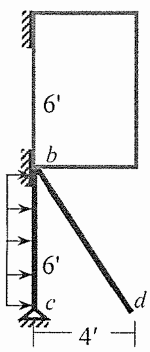


Fig.1

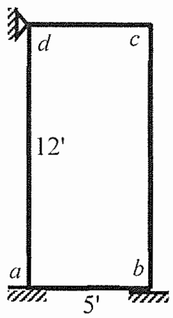


Fig.2

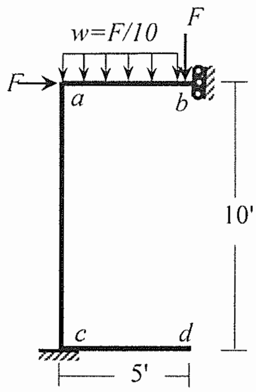


Fig.3

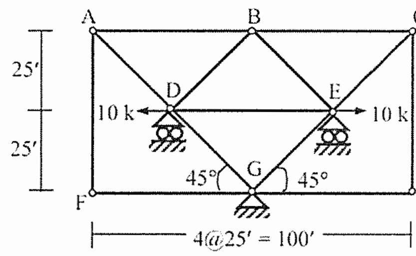


Fig.4

Question 2 [10 Marks]

Calculate 1st natural frequency of the frame ***abcd*** shown in ***Fig.2*** using consistent mass matrices (neglecting axial deformation).

[Given: $EI = 10^4$ *k-ft*^{2}, $\mu = 0.005$ *k-sec*^{2}*/ft*^{2}]

Question 3 [10 Marks]

Use Stiffness Method (neglecting axial deformations) to calculate the value of ***F*** required to cause buckling of the frame ***abcde*** loaded as shown in ***Fig.3***

[Given: $EI = 40 \times 10^3$ *k-ft*^{2}].

Question 4 [10 Marks]

For the truss shown in ***Fig.4***, modulus of elasticity E = 30000 ksi, cross-sectional area A = 2 in^2, mass per unit length $\mu = 1.5\times10^{-6}$ k-sec^2/in^2 for each member. Ignore the zero-force members and calculate its approximate natural frequencies.

Question 5 [15 Marks]

Consider an undamped two-degree-of-freedom system with masses $m_1=m_2=2$ tons and stiffness $k_1=4000$ kN/m and $k_2=2000$ kN/m. Using the principles of modal analysis,

(i) formulate the eigenvalue problem and determine the first and second natural frequencies of the system

(ii) determine the corresponding mode shapes and

(iii) assuming the damping ratios of the first and second modes are 5% and 8% respectively, construct the modal damping matrix in modal coordinates

Question 6 [15 Marks]

A two-degree-of-freedom (2-DOF) undamped shear building system consists of two lumped masses connected by story stiffnesses. The mass of the first floor is 2 tons, and the mass of the second floor is also 2 tons. The stiffness of the first story is 4000 kN/m, while the stiffness of the second story is 2000 kN/m. The dynamic characteristics of the structure are known: the first natural frequency is 4.47 rad/s with a corresponding mode shape of $\phi_1 = [1;\ 1.62]^T$, and the second natural frequency is 18.36 rad/s with a corresponding mode shape of $\phi_2 = [1;\ -0.62]^T$. Initially, the structure is at rest with zero displacement and zero velocity. At time (t = 0), constant step forces of 25 kN are suddenly applied simultaneously at both floors, such that $f_1(t) = f_2(t) = 25$ kN for $t \geq 0$. Using the modal superposition method, determine the time-dependent displacement response of the two-floor system.

Question 7 [15 Marks]

A (10′ × 10′ × 10′) overhead water tank is filled with water and supported by a circular RC column of 20″ diameter. Response Spectra for 5% damping shown in ***Fig.5*** , $k_{column} = 3EI/L^3$ and the total weight of the systems to be concentrated in the water tanks [Given: $E_c = 400 \times 10^3$ k/ft^2].

Use the (i)BNBC response spectrum for Dhaka (Z = 0.15, S = 1.0)

(ii)El Centro earthquake data (Z = 0.313)

(iii) Kobe earthquake data (Z = 0.553)

to calculate the elastic peak deformation, base shear and bending stress in the column.

Question 8 [12 Marks]

A 10-ft-long vertical cantilever made of a standard steel pipe supports a 4,000 lb weight at its tip. The pipe has an outside diameter of 4.500 in., a second moment of area I = 7.23 in^4, and an elastic modulus E = 29,000 ksi. The structure is subjected to the El Centro ground motion, and the following response spectrum curve is provided in ***Fig.6*** for a damping ratio $\zeta = 2\%$.

(i) Calculate the lateral stiffness k of the cantilever using the formula $k = 3EI/L^3$. Using the lumped weight of 4,000 lb, determine the mass m of the system and hence compute the natural vibration period.

(ii) determine spectral displacement ***D***, pseudo-velocity ***V*** and pseudo-acceleration *A* from the response spectrum curve and verify the pseudo-velocity *V* and pseudo-acceleration *A* using the formula.

(iii) Compute the peak equivalent static force. Using this force, determine the maximum bending moment at the fixed base of the cantilever.

(iv) Briefly explain, in no more than five sentences, why the pseudo-acceleration A is not equal to the true peak acceleration of the mass, and state under what conditions the two values are approximately equal.

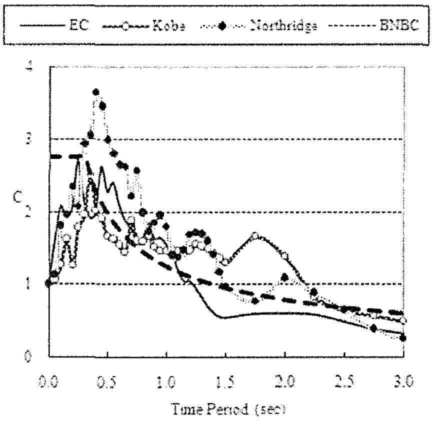


Fig 5: Response Spectra for 5% damping

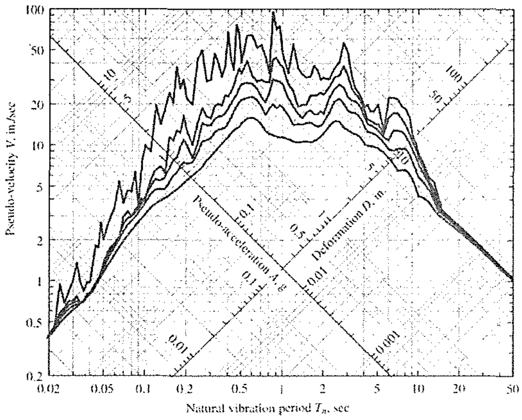


Fig 6: Combined *D–V–A* response spectrum for El Centro ground motion; $\zeta = 0, 2, 5, 10$, and 20%.

University of Asia Pacific
Department of Civil Engineering
Final Examination (Fall 2025)
Program: M.Sc. Engineering (Civil)

Course Title: Principles of Earthquake Engineering
Credit Hour: 3.0
Time: 3.0 Hours

Course Code: CE 6701
Full Marks: 100

---

1. Explain different steps of Deterministic Seismic Hazard Analysis (DSHA). **(10)**

2. Determine the site-specific cumulative intensity-frequency relation based on the following data,

- ❖ Annual intensity-frequency relations of the seismic zones, $\log(\nu) = a - bI$ which are defined by co-efficients a and b.
- ❖ Maximum possible epicentral macro-seismic intensities, I_{max}.
- ❖ Attenuation values ΔI of intensities for distance of the seismoactive zones to the site. **(20)**

Seismic zone	a	b	I_{max}	ΔI
1	1.57	0.516	X	1.0
2	0.055	0.335	X	1.3

3. What are the counter measures to mitigate liquefaction of foundation? **(10)**

4. How does the local site condition affect the propagation of seismic waves? **(10)**

5. What kind of property the seismic zone coefficients of BNBC are indicative of? What are the major drawbacks of the seismic hazard maps developed for Bangladesh? **(10)**

6. Write down the factors affecting the seismic bearing capacity. **(10)**

7. Measure the factor of safety and liquefaction potential index at a depth of 3 meters for the site soil of a proposed construction for a 7.5 magnitude earthquake producing a PGA of 0.2g. The soil is coarse sand with a saturated unit weight of 20 kN/m^3. The field SPT-N and D_{50} values with depth are given below. **(15)**

Depth (m)	N - value	D_{50}
1.5	2	0.8
3	3	0.9

8. A CPT sounding was conducted at a proposed construction site. The groundwater table is located at the ground surface. The saturated unit weight of soil is 17 kN/m^3. The site is expected to experience a design earthquake with magnitude 7.5 and PGA 0.25g. The CPT results at 1 meter depth are: q_c = 3.5 MPa; f_s = 55 kPa. Determine the factor of safety against liquefaction. **(15)**

University of Asia Pacific
Department of Civil Engineering
Final Examination: Fall 2025
Program: M.Sc. Engineering (Civil)

Course Title: Coastal Engineering		Course Code: CE 6620
Time: 3 hours	Credit Hour: 03	Full Marks: 80

Please keep your answers brief and succinct (directly to the point) & Show all calculation steps. Round final answers to 2 decimal places.

1. **a)** Briefly describe the wave pressures and forces acting on a vertical breakwater subjected to both non-breaking and breaking waves with relevant equations. Illustrate the pressure distributions and force diagrams with suitable sketches. **8**

b) Briefly explain the responses of the following coastal structures with nearshore sediment transport with relevant figures. **12**

- **i)** Groins
- **ii)** Seawall
- **iii)** Offshore breakwater

c) Briefly describe the key factors affecting the armor unit size in rubble mound structures. **6**

d) What are the common sources and sinks of sediment for sediment budget analysis? Describe briefly. **8**

e) What are the key parameters and design considerations required for the design of a sediment bypassing system? **6**

2. **a)** A vertical cylindrical steel pile with a diameter of 0.4 m is installed in a coastal zone with a water depth of 8 m near Chattogram Port. For an incident wave with a height of 2 m and a period of 8 s, **determine:** **15**

I) The horizontal wave force acting on the pile, and

II) The overturning moment around the mudline, when the pile is located at the midpoint between the wave crest and the still water level during wave passage.

Please clearly state all assumptions and coefficients used.

b) A rubble mound breakwater is proposed for coastal protection at Kutubdia Island. The breakwater head has an armor slope of 1V:2.5H and is located in a design water depth of 6.6 m. The seabed slope in front of the structure is 1:30. The deep-water design significant wave height and wave period are 4.0 m and 7.3 s, respectively. Assume: **15**

Refraction coefficient K_r=1.0,
Minor overtopping under design conditions,
Specific gravity of quarry stone S_r=2.65, and
Specific gravity of concrete armor units S_r=2.40.

Determine the required armor unit size for:

I) Angular quarry stones, and

II) Tetrapod armor units.

Supplementary information is given in Figure 1 and Table 1.

c) A train of waves has a height of 1.5 m and an approach angle of 25 degree at the breaker line. The average beach slope in the surf zone is 1:25. Estimate the alongshore flow rate in the surf zone. Also, estimate the volumetric longshore sediment transport rate if the sediments are typical beach sands. The CERC (1984) equation is given. Please assume reasonable coefficient values as per the best practice. **10**

Figure 1: Raleigh distribution for wave heights. (CERC, 1984)

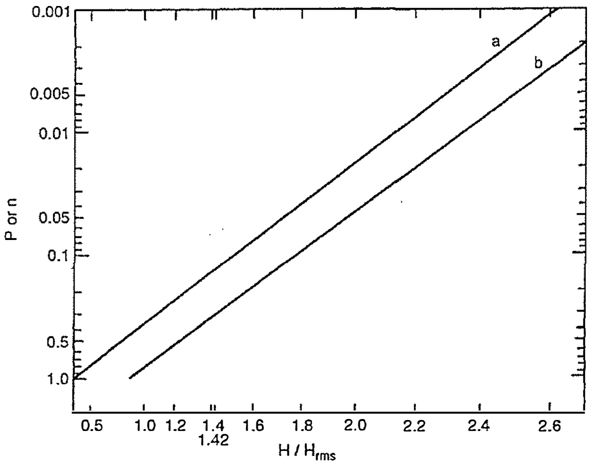


Table 1: Suggested KD values for different armor unit (CERC, 1984)

Unit	Trunk		Head	
	Breaking	Nonbreaking	Breaking	Nonbreaking
Quarrystone—smooth rounded	1.2	2.4	1.1	1.9
Quarrystone—rough angular	2.0	4.0	1.6	2.8
Riprap	2.2	2.5	—	—
Dolos	15.8	31.8	8.0	16.0
Tetrapod	7.0	8.0	4.5	5.5
Tribar	9.0	10.0	7.8	8.5

Appendix 1: Useful Formula

$$Q = K\sqrt{\frac{g}{\gamma}}\frac{H_b^{5/2}\sin 2\alpha_b}{16(s-1)a'}$$

$$F = \frac{C_d}{8}\rho g D H^2 n \cos^2(-\sigma t) + C_m \rho g \frac{\pi D^2}{8} H \tanh(kd)\sin(-\sigma t)$$

$$M = \frac{C_d}{8}\rho g D H^2 n \cos^2(-\sigma t) d\left[\frac{1}{2} + \frac{1}{2n} + \left(\frac{1}{2} + \frac{1-\cosh 2kd}{2kd\sinh 2kd}\right)\right]$$

$$+ \frac{C_m}{8}\rho g \pi D^2\ Hd \tanh kd \sin(-\sigma t)\left[1 + \frac{1-\cosh kd}{kd\sinh kd}\right]$$