CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

MARCH 2025 SEMESTER SESSION

SUBJECT CODE	:	**LKB20303**
SUBJECT TITLE	:	**DYNAMICS OF OFFSHORE PLATFORM**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF ENGINEERING TECHNOLOGY (OFFSHORE) WITH HONOURS**
TIME / DURATION	:	**2.00 PM – 4.30 PM (2 HOURS 30 MINUTES)**
DATE	:	**21 JUNE 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read **CAREFULLY** the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **TWO (2) sections**; section A and section B
4. Answer **ALL** questions for Section A. For Section B, answer **THREE (3)** questions.
5. Please write your answer in the **OMR** form and answer booklet provided.
6. Please answer all question in English **ONLY**.

THERE ARE 11 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (40 marks)

INSTRUCTION: Answer ALL questions

Please use the OMR provided.

1. State which of the following is **NOT** considered a major ocean.

   A. Pacific
   B. Indian
   C. Antarctic
   D. Southern

2. Identify which vertical zone of the marine environment extends from 1000 to 4000 meters depth.

   A. Epipelagic
   B. Mesopelagic
   C. Abyssopelagic
   D. Bathypelagic

3. The Pelagic zone refers to:

   A. The seabed and ocean floor environment.
   B. The open water column of the ocean, away from the bottom.
   C. The zone between high tide and low tide.
   D. Areas of the ocean affected by freshwater inflows.

4. State which of the following marine organisms are classified as floaters.

   A. Plankton
   B. Benthos
   C. Nekton
   D. Crustaceans

5. Identify the Littoral zone includes all the following except:

   A. Supralittoral
   B. Sublittoral
   C. Eulittoral
   D. Bathypelagic

6. State which of the following correctly describes the *Neritic zone* in the marine environment.

   A. It covers the water mass of the continental shelf up to 200 meters depth.
   B. It includes the deep-sea trenches and abyssal plains.
   C. It extends from the continental slope and covers the entire ocean.
   D. It is the region of the ocean found at depths greater than 6000 meters.

7. State the primary driver of surface ocean circulation.

A. Tides
B. Density differences
C. Wind
D. Salinity gradients

8. Identify which factor does **NOT** affect the density of seawater.

A. Temperature
B. Salinity
C. Pressure
D. Wind speed

9. In the Northern Hemisphere, the Coriolis effect causes moving objects to deflect:

A. To the left
B. To the right
C. Upward
D. Downward

10. State the unit used to express sea surface salinity

A. °C (degrees Celsius)
B. g/m^3
C. PSU (Practical Salinity Unit)
D. m/s^2

11. Identify which ocean layer is characterized by a rapid change in temperature with depth.

A. Thermocline
B. Halocline
C. Pycnocline
D. Mixed layer

12. State the average salinity of seawater?

A. 3.5%
B. 35 ppt
C. Both A and B
D. None of the above

13. The speed of sound in seawater is approximately:

A. 343 m/s
B. 1200 m/s
C. 1500 m/s
D. 5000 m/s

14. Identify which percentage of Earth's water is contained in the oceans.

A. 70.0%
B. 97.2%
C. 85.3%
D. 90.1%

15. Identify which of the following best explains why the ocean is salty.

A. It has dissolved solids from land and air sources.
B. It contains suspended sediments.
C. It absorbs gases from the atmosphere.
D. It is exposed to solar radiation.

16. State which is the average salinity of seawater.

A. 25 o/oo
B. 30 o/oo
C. 35 o/oo
D. 40 o/oo

17. Identify which of the following processes increases seawater salinity.

A. Iceberg melting
B. Runoff
C. Evaporation
D. Precipitation

18. State the term for the layer of rapidly changing salinity with depth.

A. Thermocline
B. Pycnocline
C. Isocline
D. Halocline

19. Show which ion is the most abundant in seawater.

A. Magnesium (Mg^{2+})
B. Chloride (Cl^-)
C. Calcium (Ca^{2+})
D. Bicarbonate (HCO_3^-)

20. State which of the following best defines latent heat.

A. Heat required to raise a substance's temperature
B. Heat needed to change a substance's state
C. Heat lost during conduction
D. Heat gained through radiation

21. Find what is the primary driver of surface ocean currents.

A. Salinity differences
B. Earth's gravity
C. Wind and solar heating
D. Plate tectonics

22. Show which current is known for keeping Europe warmer than expected.

A. Gulf Stream
B. Benguela Current
C. North Pacific Current
D. Canary Current

23. State the causes of coastal upwelling.

A. Surface evaporation
B. Surface water being pushed away from shore by wind
C. Seafloor tectonic activity
D. Heat from underwater volcanoes

24. Find which of the following is **NOT** a recognized major ocean gyre.

A. North Atlantic
B. Arctic
C. South Pacific
D. Indian

25. State which oceanographic event is associated with abnormally warm water off the coast of Peru.

A. El Niño
B. La Niña
C. Thermocline rising
D. Ekman convergence

26. State which condition is typically associated with La Niña.

A. Heavy rainfall in the Americas
B. Warmer conditions in the Pacific
C. Drier conditions in the Americas and more hurricanes in the Atlantic
D. Calm ocean conditions worldwide

27. Identify which of the following is **NOT** a fixed type of offshore platform.

A. Jacket platform
B. Gravity-based structure
C. Tension Leg Platform
D. Concrete Gravity Structure

28. Identify which offshore platform operates using buoyancy that exceeds its weight, balanced by tension in vertical moorings.

A. Semi-submersible
B. Jack-up rig
C. Tension Leg Platform
D. Spar platform

29. State the main force exerted on offshore platforms due to wave movement.

A. Gravitational force
B. Torsional force
C. Electromagnetic force
D. Hydrodynamic force

30. A compliant tower is best suited for:

A. Water depths less than 50m
B. Shallow, high-current zones
C. Arctic offshore drilling
D. Deep water oil exploration while avoiding resonance

31. The FPSO platform is primarily used for:

A. Processing and refining oil onshore
B. Floating seismic survey
C. Production, storage, and offloading of crude oil
D. Underwater repair operations

32. Identify which of the following is **NOT** a new generation offshore platform.

A. Buoyant leg structure (BLS)
B. Triceratops
C. Floating Storage and Regasification Unit (FSRU)
D. Gravity-based structure

33. State the main design philosophy of new-generation offshore structures.

A. Maximize oil output
B. Use recycled materials
C. Minimize wave height impact
D. Form-defined function to alleviate ultra-deepwater loads

34. The main purpose of sea dikes is to:

A. Stabilize navigation channels
B. Protect low-lying areas against flooding
C. Retain sediments at inlets
D. Store excess seawater

35. Identify which coastal structure is specifically designed to retain land and prevent it from sliding.

A. Bulkhead
B. Revetment
C. Groin
D. Jetty

36. Identify the function of detached breakwaters:

A. Preventing sediment deposition
B. Absorbing all wave energy completely
C. Reducing wave height and protecting the shoreline
D. Creating artificial reefs for marine life

37. State the vertical distance between the crest and trough of a wave.

A. Wavelength
B. Wave period
C. Wave height
D. Wave velocity

38. Identify the type of waves generated by seismic activity.

A. Wind-generated waves
B. Swell waves
C. Seismic waves
D. Tsunami waves

39. State the characteristic of swell waves.

A. They are more regular and travel far from the generating area
B. They have short wavelengths
C. They are caused by underwater landslides
D. They are typically irregular and form near the shore

40. Identify the process occurs when a wave changes direction due to varying water depths.

A. Reflection
B. Refraction
C. Breaking
D. Attenuation

SECTION B (60 marks)

INSTRUCTION: Answer ONLY THREE (3) questions.

Please use the answer booklet provided.

QUESTION 1

a) Wave is a disturbance on the surface of a body of water, caused by the movement of wind across the standing water, creating disturbances that travel in a circular path.

With the aid of a diagram, sketch the wave fundamental parameters. (4 marks)

b) Wave breaking is a complex phenomenon in which the surface of the wave folds or rolls over and intersects itself.

Describe three (3) types of waves breaking (6 marks)

c) The table here gives the record of wave heights for a short duration at Balingian in operating condition for a duration of 10 hours

Determine the:

i. Significant wave height,
ii. Root-mean square wave height and the
iii. Maximum wave height if this wave occurs. (10 marks)

Wave Height, H_w (meter)	Number of waves, n
5-6	50
4-5	80
3-4	140
2-3	230
1-2	350
0-1	500

QUESTION 2

a) Spar platforms are less affected by wind, waves, and currents, making them suitable for deepwater production. They can operate successfully in severe environments and are designed for both dry tree and subsea production

Determine the Response Amplitude Operator (RAO) of Surge, Heave, and Pitch for the classic spar as shown in Figure 1 with the given data below:

(20 marks)

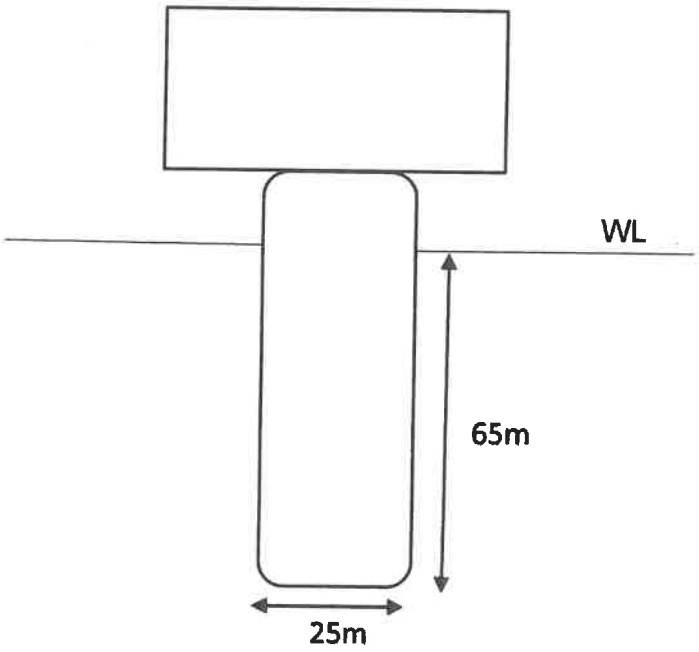


Figure 1: Side view of classic SPAR Platform

Hull Diameter: 25 meter

Draft: 65.5 meter

Radius of gyration about x axis, Y_y: 22 meter

Surge stiffness, K_{surge} :110 kN/m

Pitch Stiffness, K_{pitch} :$190x10^3$ kN.m/rad

Inertia coefficient, C_m :1.8

H_{max} : 8 meter

T_{ass} : 10 seconds

Damping Ratio, ξ : 8%

Surge force = 45,000 kN

Heave force = 12,000 kN

Pitch moment = 2.2x106 kN.m

QUESTION 3

Determine the Response Amplitude Operator (RAO) of Heave, Surge, and Pitch for a typical Semisubmersible platform as shown in Figure 2 below with the given data below:

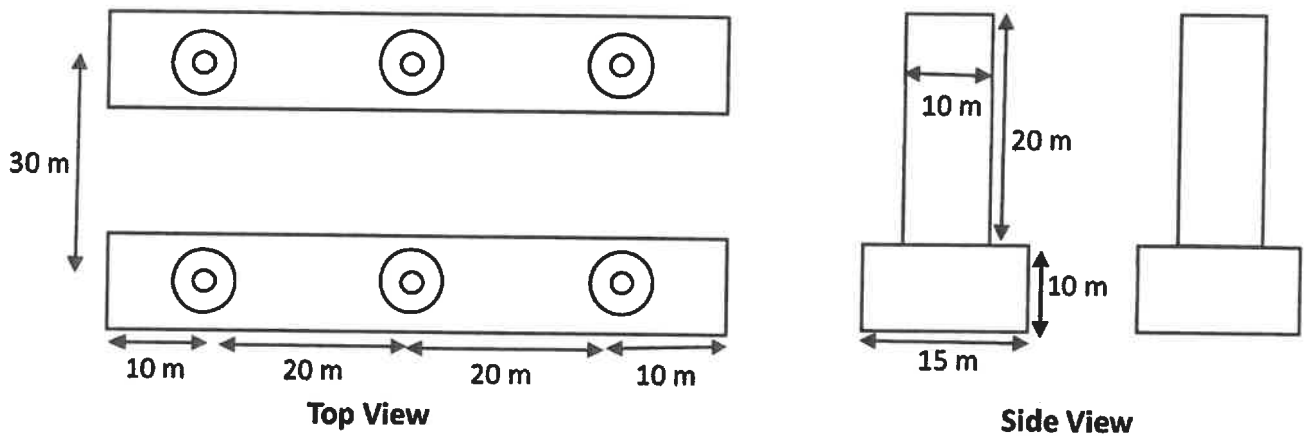


Figure 2: Top and side view of semisubmersible

Draft: 30.5 m

Radius of gyration about x axis, Υ_y : 24 m

Surge stiffness, Ksurge: 260 kN/m

Pitch Stiffness: 600 x 10^3 kN.m/rad

Inertia coefficient, C_m: 1.8

H_{max}: 8 m

T_{ass}: 10 s

Damping ratio, ξ: 8%

Surge force: 45,000 kN

Heave force: 12, 000 kN

Pitch moment : 2.2 x 10^6 kN.m

QUESTION 4

a) The superposition of waves refers to the principle that when two or more waves meet at a point, the resultant displacement is equal to the sum of the displacements of the individual waves.
Describe constructive interference and destructive interference of waves. (4 marks)

b) Standing waves are formed when waves traveling in opposite directions interfere constructively and destructively, resulting in stationary points of maximum and minimum displacement.
List two (2) types of standing waves. (4 marks)

c) The rise and fall of water caused by friction of the wind on the water surface is called a wave. A wave is a disturbance on the surface of the body which is travelling in a forward direction.
Basic properties define the behaviour of a wave – anything that reflects, refracts, diffracts and interferes is labelled a wave. Describe the following:

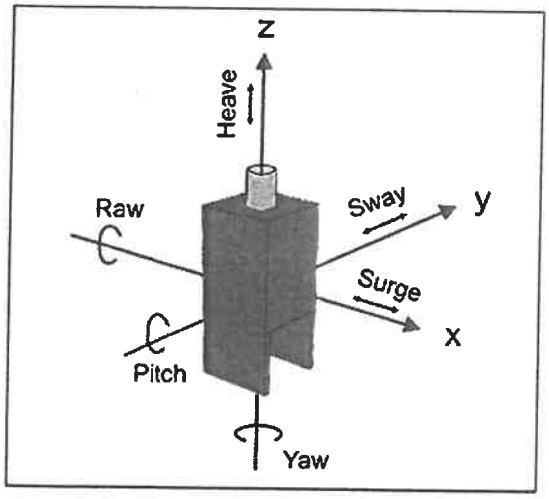
i. Reflection wave (2 marks)
ii. Refraction wave (2 marks)
iii. Diffraction wave (2 marks)

d) A mechanical wave is a disturbance that is created by a vibrating object and subsequently travels through a medium from one location to another, transporting energy as it moves.
State the differences between standing waves and travelling waves? (6 marks)

END OF QUESTIONS

FORMULAE:

FREE FLOATING BODY MOTIONS



$$RAO_{surge} = \frac{F_{surge}/(\frac{H}{2})}{[(k_{surge} - m_{surge}\,\omega^2)^2 + (C\omega)^2]^{1/2}}$$

$$RAO_{heave} = \frac{F_{heave}/(\frac{H}{2})}{[(k_{heave} - m_{heave}\,\omega^2)^2 + (C\omega)^2]^{1/2}}$$

$$RAO_{pitch} = \frac{M_{pitch}/(\frac{H}{2})}{[(k_{pitch} - m_{pitch}\,\omega^2)^2 + (C\omega)^2]^{1/2}}$$