UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

OCTOBER 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	:	**9.00 AM – 11.30 AM (2 HOURS 30 MINUTES)**
DATE	:	**27 JANUARY 2026**

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 ONLY **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. What percentage of the Earth's surface is occupied by the ocean?
   A. 50%
   B. 72%
   C. 60%
   D. 80%

2. The open ocean photic zone extends from:
   A. The continental shelf to 200 meters depth
   B. The continental slope and covers the entire ocean
   C. The shoreline to the point of the continental shelf
   D. The surface to the abyssal plains

3. The average salinity of seawater is about:
   A. 25%
   B. 35%
   C. 45%
   D. 55%

4. The deep or vertical circulation of the oceans is driven by:
   A. Wind
   B. Density differences
   C. Tidal forces
   D. Coriolis effect

5. Which group of marine organisms are known as "swimmers"?
   A. Plankton
   B. Phytoplankton
   C. Nekton
   D. Benthos

6. Surface currents in the ocean are primarily generated by:
   A. Solar heating
   B. Moon's gravitational pull
   C. Earth's magnetic field
   D. Continental drift

7. Ekman Transport causes surface currents to move at an angle to the wind of:
   A. 15 degrees
   B. 30 degrees
   C. 45 degrees
   D. 90 degrees

8. The Gulf Stream is known for:
   A. Being one of the coldest currents in the ocean
   B. Flowing from the Arctic Ocean to the Gulf of Mexico
   C. Keeping Europe warmer than it otherwise would be
   D. Being the slowest current in the Atlantic Ocean

9. La Niña conditions typically result in:
   A. Wetter conditions in North and South America
   B. Drier conditions in North and South America
   C. More hurricanes in the Pacific
   D. Higher temperatures worldwide

10. The main source of sodium in the ocean comes from:
   A. Evaporation of seawater
   B. Continental weathering
   C. Marine organism excretion
   D. Atmospheric deposition

11. At what speed do gravitational waves travel?
   A. Speed of sound
   B. Speed of light
   C. Half the speed of light
   D. Twice the speed of light

12. Which of the following is NOT a source of gravitational waves?
    A. Binary neutron star mergers
    B. Black hole mergers
    C. Supernovae explosions
    D. Solar flares

13. What is the main purpose of an interferometer in gravitational wave detection?
    A. To measure electromagnetic interference
    B. To create gravitational waves
    C. To detect changes in space-time curvature
    D. To observe distant galaxies

14. When was the first direct detection of gravitational waves?
    A. 2005
    B. 2020
    C. 2015
    D. 2010

15. Which type of offshore platform is designed to float near the water surface?
    A. Fixed platforms
    B. Gravity platforms
    C. Tension leg platforms
    D. Jacket platforms

16. What is significant factor influencing wave-structure interaction?
    A. Color of the structure
    B. Wave characteristics
    C. Time of day
    D. Air temperature

17. Semi-submersible platforms are primarily used for:
    A. Permanent living quarters
    B. Recreational activities
    C. Exploratory drilling
    D. Wave energy conversion

18. Which force is NOT typically exerted by waves on offshore platforms?
    A. Hydrodynamic pressure
    B. Impact forces
    C. Gravitational pull
    D. Drag forces

19. Wave climate analysis is essential for:
    A. Predicting fashion trends
    B. Coastal engineering and marine planning
    C. Land agriculture
    D. Urban development

20. In the design of offshore platforms, environmental considerations include:
    A. Wave climate and storm events
    B. Interior design trends
    C. Office politics
    D. Fashion influences

21. What is the primary focus of fluid loading analysis on offshore structures?
    A. Aesthetic design
    B. Structural integrity, safety, and stability
    C. Cost reduction
    D. Environmental impact

22. What is the main purpose of hydrodynamic design in offshore structures?
    A. Increasing weight
    B. Reduce the impact of fluid loading
    C. Enhance visual appeal
    D. Increasing weight

23. What is the role of numerical modeling and analysis in offshore structures?
    A. To enhance aesthetic design
    B. To simulate hydrodynamics forces
    C. Reducing material costs
    D. To increase weight

24. What is the primary challenge posed by offshore wind conditions?
    A. Increased temperature
    B. Significant lateral loads
    C. Reduced visibility
    D. Increased salinity

25. Which type of force is exerted by waves on offshore structures?
    A. Buoyancy forces
    B. Impact loads
    C. Drag forces
    D. Lift forces

26. Which type of offshore structure is used for well completions and pipeline systems?
    A. Fixed platforms
    B. Floating structures
    C. Subsea structures
    D. Offshore wind turbines

27. What is the purpose of finite element modeling in offshore structures?
    A. To enhance visual appeal
    B. To simulate structural behavior
    C. To reduce weight
    D. To increase weight

28. What is the main goal of structural reinforcement in offshore platforms?
    A. Increasing weight
    B. Enhance structural integrity
    C. Reduce weight
    D. Enhance visual appeal

29. What is the primary consideration in the hydrodynamics design of offshore structures?
    A. Increasing weight
    B. Reduce fluid loading impact
    C. Enhance visual appeal
    D. Reducing weight

30. What is the main purpose of advanced computational fluid dynamics (CFD) models?
    A. To enhance visual appeal
    B. To simulate hydrodynamic forces
    C. To reduce weight
    D. To increase weight

31. What is the formula for group velocity?
    A. $Vg = d\omega / dk$
    B. $Vg = dk / d\omega$
    C. $Vg = \omega / k$
    D. $Vg = k / \omega$

32. What is the group velocity of a wave?
    A. The speed at which the phase of the wave propagates in space
    B. The speed at which the energy of a wave group propagates
    C. The speed at which the wave travels in a vacuum
    D. The speed at which the waves bounce off a surface

33. What is the formula for wave velocity?
    A. $v = \lambda \times f$
    B. $v = \lambda / f$
    C. $v = f / \lambda$
    D. $v = \lambda + f$

34. What is the wavelength of a wave?
    A. The distance from one point on the wave to the corresponding point on the next cycle
    B. The number of waves passing a point in one second
    C. The height of the wave
    D. The speed of the wave

35. What is a transverse wave?
    A. A wave where the medium vibrates perpendicular to the direction of wave motion
    B. A wave where the medium vibrates parallel to the direction of wave motion
    C. A wave that does not require a medium
    D. A wave that travels in a vacuum

36. What is constructive interference?
    A. When waves from two sources meet to produce a wave of different amplitude
    B. When wave cancel each other out
    C. When waves bounce off a surface
    D. When waves bend around an obstacle

37. What is refraction?
    A. Bouncing of a wave off an object
    B. Bending of a wave as it travels from one medium to another
    C. Spreading of waves around a slit
    D. Interference of two waves

38. Which type of wave does not need a medium to travel through?
    A. Mechanical waves
    B. Electromagnetic waves
    C. Sound waves
    D. Water waves

39. What is the medium wave propagations?
    A. The material through which a wave transfer energy
    B. The energy source of the wave
    C. The frequency of the waves
    D. The amplitude of the waves

40. What is wave?
    A. A disturbance that carries energy through matter of space
    B. A solid object
    C. A type of gas
    D. A liquid substance

SECTION B (Total: 60 marks)

INSTRUCTION: Answer only THREE (3) questions.
Please use the answer booklet provided.

Question 1

In 2042, an offshore engineering company planned a new deepwater field development off the coast of Terengganu. The project team needed to decide whether to use a fixed platform, a compliant tower, or a Tension Leg Platform (TLP) based on water depth, environmental loads, and cost. During a design review meeting, the lead engineer, Ir. Hadi, asked the junior engineers to compare platform types, visualize structural layouts, and understand potential failure mechanisms. He emphasized that knowing these differences was crucial for safe design and operation in harsh sea conditions. Before finalizing recommendations, he posed the following questions:

(a) What are the differences between fixed platforms and compliant platforms?

(10 marks)

(b) Draw a neat sketch of a guyed tower and mark the components.

(6 marks)

(c) How does failure occur in TLP?

(4 marks)

Question 2

A deepwater oil company planned to deploy new offshore facilities in the South China Sea. The engineering team had to evaluate different floating structures capable of withstanding harsh marine conditions. During a technical briefing, the project manager, Ts. Syafiq, highlighted the importance of understanding environmental forces, structural behavior, and key components before finalizing the selection. To prepare the junior engineers, he asked them to study the main factors affecting offshore structures, the load-carrying mechanism of semi-submersibles, and the design and components of SPAR platforms, including the classical form. This knowledge would ensure the structures remain stable, safe, and efficient in deepwater operations.

(a) What are the main factors affecting offshore structures in a marine environment?

(4 marks)

(b) Explain the structural action of a semi-submersible.

(6 marks)

(c) What are the major components of SPAR?

(4 marks)

(d) Explain the form of classical SPAR

(6 marks)

Question 3

A team of offshore engineers was tasked with designing a new platform off the coast of Terengganu. During the preliminary design review, the lead engineer, Ir. Hanafi, emphasized that accurate wave load estimation was critical to ensure the platform's stability and safety. He reminded the team that Airy's wave theory is widely used for predicting wave forces and that they must also consider additional forces arising from variable submergence of structural members. To prepare for the deck elevation calculation and overall design, he asked the junior engineers to review the theory, understand how variable submergence affects forces, and apply the principles to determine the required deck height above the seabed.

(a) Why is Airy's wave theory commonly used?

(4 marks)

(b) How are the additional forces due to variable submergence accounted for in Airy's theory?

(6 marks)

(c) The topsides of an offshore structure must be sufficiently high above the crest of the design wave. Calculate the level of the deck (underside) above the seabed for the following design data:
Water depth 50m
Tidal variation =/- 2.5m
Subsidence plus foundation settlement = 2m
Maximum wave height, H_{max} = 30m (crest to trough)
You may assume by using Airy wave theory
(Assume: storm surge = 2m and airgap = 1.5m and fill in)

(10 marks)

Question 4

In 2040, an offshore fabrication yard in Kuantan was preparing to test a newly fabricated steel mast for a platform. The engineering team needed to ensure that the mast could safely withstand operational vibrations and dynamic loads during service. The lead engineer, Ir. Syazwan, instructed the junior engineers to model the mast as a single-degree-of-freedom (SDOF) system to analyze its dynamic behavior. They were also required to check the steel members and connections against design codes to confirm structural safety. Finally, the team had to calculate the mast's natural frequency to predict its response to harmonic excitations and avoid resonance during operation.

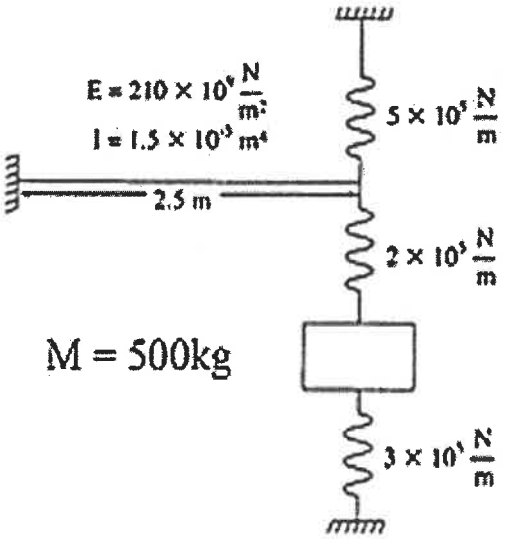
(a) Sketch the basic vibratory system with SDOF.

(5 marks)

(b) How to check the safety of the steel structure?

(6 marks)

(c) Find the natural frequency of the system



(9 marks)

END OF QUESTION PAPER