UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
MARCH 2025 SEMESTER SESSION

SUBJECT CODE   : **LKB30203**

SUBJECT TITLE   : **OFFSHORE HYDRODYNAMICS**

PROGRAMME NAME   : **BACHELOR OF ENGINEERING TECHNOLOGY**
(FOR MPU: PROGRAMME LEVEL)   **(OFFSHORE) WITH HONOURS**

TIME / DURATION   : **09.00 AM - 11.30 AM**
                          (2 HOURS 30 MINUTES)

DATE   : **25 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** question in Section A, and **THREE (3)** questions **ONLY** in Section B.

5. Please write your answers on the OMR sheet and answer booklet provided.

6. Answer **ALL** questions in English language **ONLY**.

THERE ARE 11 PAGES OF QUESTIONS, EXCLUDING THIS PAGE

SECTION A (40 marks)

INSTRUCTIONS: Answer ALL the questions.

Please use the OMR provided

1. State the primary characteristic of waves.

    A. They transfer matter

    B. They create vacuum

    C. They transfer energy without transferring matter

    D. They stop at boundaries

2. In a transverse wave, the particle displacement is:

    A. In a circular motion

    B. Perpendicular to the wave direction

    C. Parallel to the wave direction

    D. Random

3. Longitudinal waves propagate through:

    A. Oscillations perpendicular to wave direction

    B. Alternating regions of compression and rarefaction ·

    C. Rotational motion

    D. Constant amplitude

4. The distance between two consecutive crests in a wave is called:

    A. Frequency

    B. Period

    C. Amplitude

    D. Wavelength

5. Identify the amplitude of a wave represents.

    A. Strength or intensity of the wave

    B. Time between cycles

    C. Distance traveled

    D. Speed of the wave

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6. State which type of interference results in a larger wave amplitude

    A. Constructive interference

    B. Resonance

    C. Destructive interference

    D. Refraction

7. Identify the cause during diffraction.

    A. Waves are absorbed

    B. Waves reflect at the same angle

    C. Waves bend around obstacles

    D. Waves are destroyed

8. State the definition of wave refraction.

    A. Waves bouncing back from the surface

    B. Waves bending due to change in speed as they enter shallow water

    C. Waves colliding with each other

    D. Waves ceasing to exist

9. Identify the wave characteristics when shoaling happens.

    A. Decrease in wave frequency

    B. Bending of waves around obstacles

    C. Increase in wave height and decrease in wavelength in shallow water

    D. Destruction of waves

10. State which type of breaker occurs on very steep slopes.

    A. Spilling breaker

    B. Plunging breaker

    C. Surging breaker

    D. Rolling breaker

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11. State which of the following statements best describes the principle of buoyancy in the context of floating structures.

    A. It is the downward force exerted by gravity on a floating object.
    B. It is the upward force equal to the weight of the fluid displaced by the object.
    C. It is the force resisting the motion of a floating object due to water currents.
    D. It is the stabilizing moment that returns the object to equilibrium after tilting.

12. Identify which of the following is **NOT** a type of floating structure mentioned in the document.

    A. Floating bridges
    B. Floating production storage and offloading (FPSO) vessels
    C. Floating homes and hotels
    D. Floating docks and marinas

13. State which environmental force is specifically significant for floating structures located in cold regions.

    A. Wind forces
    B. Current drag
    C. Wave loads
    D. Ice impacts

14. Define the primary function of mooring systems in floating structures.

    A. To provide internal power to maintain position
    B. To allow rotation for wave alignment
    C. To secure the structure in place against environmental forces
    D. To reduce weight for better buoyancy

15. Dynamic positioning systems on floating structures are used primarily to:

    A. Enhance aesthetic design
    B. Eliminate the need for anchors and mooring lines
    C. Increase speed during navigation
    D. Store excess energy generated onboard

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16. State which aspect is analysed when assessing hydrostatic stability in floating structures.

    A. Resistance to current drag
    B. Ability to return to position after disturbance
    C. Weight distribution and its effect on balance
    D. Wave impact absorption

17. Define the added mass in the context of floating structures.

    A. The additional inertia from accelerating surrounding fluid along with the body
    B. The weight of water displaced by a floating body
    C. The structural weight of added components on a platform
    D. The increase in volume due to thermal expansion of materials

18. State which of the following best describes radiation damping.

    A. Energy lost through electromagnetic radiation
    B. Energy dissipated due to fluid viscosity
    C. Energy lost as surface waves generated by an oscillating structure
    D. Damping caused by thermal interactions with the environment

19. Identify which method is **NOT** typically used to calculate damping coefficients.

    A. Thermodynamic simulation
    B. Experimental tank testing
    C. Empirical correlations
    D. Numerical modelling

20. In potential flow theory, state which assumption is made about the fluid.

    A. It is compressible and turbulent
    B. It is viscous and has boundary layer effects
    C. It is inviscid, incompressible, and irrotational
    D. It flows only in laminar conditions

21. Identify the effect of added mass on the natural frequency of a floating structure.

    A. It increases the natural frequency
    B. It has no effect
    C. It doubles the natural frequency
    D. It decreases the natural frequency

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22. State which of the following best defines a single degree of freedom (SDOF) system in the context of floating structures.

    A. A system that only experiences translational motion
    B. A model with a single mass, spring, and damper representing one mode of vibration
    C. A structure fixed in all directions except rotation
    D. A system that can only be modelled using computational fluid dynamics

23. Define the cause when the damping ratio ζ\zeta$ is less than 1.

    A. The system returns to equilibrium without oscillating
    B. The system oscillates with decreasing amplitude (underdamped)
    C. The system immediately comes to rest
    D. The system experiences resonance

24. In a Single Degree of Freedom system, identify which parameters influence the natural frequency.

    A. Mass and damping
    B. Damping and external force
    C. Mass and stiffness
    D. Stiffness and external excitation

25. Identify which term describes the condition when the frequency of external excitation matches the system's natural frequency.

    A. Stability
    B. Harmonic damping
    C. Resonance
    D. Steady-state motion

26. Define the transient response of a Single Degree of Freedom system represents.

    A. The long-term steady behaviour of the system
    B. The response to thermal expansion
    C. The system's initial reaction to an external disturbance
    D. The system's output at equilibrium

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27. Identify which of the following best explains the mechanism of wave drift oscillation.

    A. First-order linear wave theory
    B. Interaction between wind and waves
    C. Second-order wave forces acting on the structure
    D. Friction between structure and seabed

28. State the importance of wave drift oscillation important in offshore engineering.

    A. It only affects small boats and vessels
    B. It determines the colour of the water
    C. It can cause significant instability in floating structures
    D. It reduces wave energy

29. Identify which motion is associated with 2nd-order wave drift oscillation.

    A. High-frequency oscillations
    B. Oscillations at the same frequency as incident waves
    C. Slowly varying, long-period motions
    D. Instantaneous jerks in motion

30. Define the factor that does **NOT** significantly influence wave drift oscillation

    A. Wave parameters (height, period, direction)
    B. Structural geometry
    C. Atmospheric pressure
    D. Mooring system configuration

31. Identify which method is **NOT** typically used for validating wave drift models.

    A. Tank testing
    B. CFD simulations
    C. Field measurements
    D. Remote sensing satellites

32. Identify the consequence of ignoring wave drift oscillation in mooring system design.

    A. Reduced costs
    B. Enhanced structural stability
    C. Resonance and potential failure
    D. Improved efficiency

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33. State which of the following is a recommended mitigation strategy for wave drift oscillation.

   A. Removing the mooring system
   B. Conducting detailed hydrodynamic analysis
   C. Increasing the wave frequency
   D. Changing water salinity

34. Identify the Six Degrees of Freedom (6DoF) system describe.

   A. Thermal expansion in materials
   B. Motion of a rigid body in two dimensions
   C. Motion of a rigid body in three-dimensional space
   D. Pressure variations in submerged tanks

35. State which of the following is **NOT** a translational degree of freedom.

   A. Surge
   B. Sway
   C. Heave
   D. Yaw

36. Define the type of motion is described by "pitch".

   A. Side-to-side tilting
   B. Forward and backward rocking
   C. Up and down motion
   D. Rotational twist about the vertical axis

37. Identify the hydrostatic restoring forces depend on.

   A. The material of the structure
   B. The mooring line length
   C. The water displacement and center of buoyancy
   D. The velocity of ocean currents

38. State which force opposes changes in a floating structure's orientation.

   A. Diffraction force
   B. Hydrostatic restoring force
   C. Current-induced drag
   D. Aerodynamic lift

39. Radiation damping occurs due to:

    A. Corrosion of underwater components
    B. Mooring system failure
    C. Waves generated by the floating structure's own motion
    D. Structural collapse

40. State which pair of motions is dynamically coupled in a floating structure.

    A. Surge and heave
    B. Sway and pitch
    C. Heave and roll
    D. Surge and yaw

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SECTION B (Total: 60 marks)

INSTRUCTIONS: Answer only THREE (3) questions.

Please use the answer booklet provided

QUESTION 1

1. Designing the optimal environment for wave energy conversion is a critical step in harnessing the power of the ocean's waves. This involves carefully studying the local wave climate, seafloor topography, and other environmental factors to identify the most suitable locations for wave energy converters (WECs).

    a) List two (2) concepts of harnessing energy from waves.   (2 marks)

    b) Describe three (3) factors that influence the performance of wave energy performance.   (6 marks)

2. Waves are a fundamental part of our universe, manifesting in various forms from the gentle ripples on a pond to the powerful ocean swells that shape our coastlines. Understanding the theories and principles governing waves is crucial for fields ranging from physics and engineering to telecommunications and beyond.

    a) Describe the definition of waves   (2 marks)

    b) With the aid of a diagram, explain the wave properties of amplitude, wavelength, frequency and speed.   (10 marks)

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QUESTION 2

a) Hydrostatics, the study of fluids at rest, is a fundamental principle governing the behaviour of floating structures. It describes the principles of buoyancy, displacement, and stability that determine how a structure will float and interact with the surrounding water.
Describe the definition of buoyancy, displacement, and stability.   (6 marks)

b) Accurately predicting the motion response of floating structures is crucial for their safe and efficient design. This involves understanding the complex interactions between the structure, the surrounding environment, and the mooring systems.
List four (4) motion response that influence the motions of floating structures.

(4 marks)

c) Hydrodynamic principles like buoyancy, drag, and lift determine how a floating structure will respond to environmental conditions. Applying these principles enables engineers to design stable, efficient, and safe floating platforms.
Define the key design considerations for floating structures.   (8 marks)

QUESTION 3

a) Examining the critical role of added mass and damping coefficient in understanding the dynamic behaviour of floating structures, such as offshore platforms, ships, and wave energy converters.
   i.   List the importance of hydrodynamic force on offshore platform.   (4 marks)
   ii.   Describe the concept of added mass on offshore structures.   (2 marks)
   iii. Describe the concept of damping on floating offshore platform.   (2 marks)

b) The combination of added mass and damping significantly impacts the natural frequencies of floating structures. This is crucial for understanding the dynamic behaviour and designing appropriate mooring and control systems.
State the impact of added mass and damping on natural frequency   (4 marks)

c) Describe the application of added mass and damping in offshore and coastal engineering.

(8 marks)

QUESTION 4

Wave drift oscillation is the steady, low-frequency motion of floating structures caused by the interaction between waves and the structure's geometry. Several key factors influence the magnitude and behaviour of wave drift oscillation in offshore structures.

  a) List two (2) types of wave drift oscillations.   (2 marks)
  b) State four (4) fundamental principles of wave drift oscillation.   (8 marks)
  c) Define the key factors influencing wave drift oscillations.   (6 marks)
  d) List four (4) implications of wave drift oscillation on moorings system. (4 marks)

END OF QUESTIONS

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