Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – June 2023

Programme Name: M Tech (NAOE)

Semester: II

Subject Code: PG11T2201

Subject Name: Dynamics of Marine Vehicles

Date: 29.05.2023	Max Marks: 60
Duration: 03 Hrs	Pass Marks: 30

General Instructions

(i) All Sections (A, B & C) are to be attempted.

(ii) Options, if any, are specified in respective section.

Section A:

(10 MCQs of 01 Mark Each = 10 Marks)

1. The heave natural period is function of

(a) wavelength (b) wave period (c) waterplane area (d) midship area

2. What is the average height of the one-third highest waves '$h_{1/3}$' in terms of moment of the spectrum 'm_o'

(a) $2.0\sqrt{m_o}$ (b) $3.0\sqrt{m_o}$ (c) $4.0\sqrt{m_o}$ (d) $5.0\sqrt{m_o}$

3. The motion spectrum is defined as the product of

(a) Wave spectrum and Encounter spectrum

(b) Wave spectrum and RAO

(c) Encounter spectrum and RAO

(d) Directional spectrum and Encounter spectrum

4. Identify the active roll stabilization device

(a) Skeg (b) Bilge keel (c) ART (d) Active fins

5. The virtual radius of gyration in pitch motion is ____ time the length

(a) 0.25 (b) 0.15 (c) 0.45 (d) 0.35

6. Identify the experiment which should be conducted for determining the higher order hull derivatives

(a) Z-test (b) free running test (c) straight line test (d) PMM test

7. The tactical diameter of the turning circle to less than ____ the length of the vessel

(a) 5 (b) 10 (c) 3.5 (d) 8

8. The maximum deflection of rudder angle is limited to _____ deg

9. Shallow water wave celerity is dependent on_____

(a) channel breadth (b) wave period

(c) water depth (d) None of the above

10. Under-balanced rudder represents centre of pressure is,

(a) aft of rudder axis (b) forward of rudder axis

(c) on rudder axis (d) None of the above

Section B:

(5 out of 7 Questions of 8 Marks Each = 40 Marks)

11. Write down the relationship between wave spectrum and encounter spectrum?

12. Explain the term "manoeuvrability" with respect to a ship. Describe with a sketch the control loop for controlling the path of a ship. Discuss the factos that affect the manoeuvrability of a ship.

13. A wave spectrum is given by:

ω (1/s)	0.5	1	1.5	2.0	2.5
$S_\zeta(\omega)$ (m^2-s)	0	3.293	0.702	0.181	0

Determine the significant wave height

14. Explain in brief how steering gear torque can be calculated.

15. Sketch the path of a ship executing a turning circle and with the help of the sketch explain the terms: advance, transfer, tactical diameter, radius of turning circle, drift angle and pivot point.

16. Describe the effects of restricted waters, shallow waters, ship-ship interaction & bank effects on vessel manoeuvring.

17. Outline a procedure for designing a rudder for a single screw ship.

Section C:

(1 out of 3 Questions of 10 Marks Each = 10 Marks)

18. Given below the Sea spectrum (Fig. 1a) & the heave RAO spectrum (Fig. 1b) of a vessel. The vessel acts as a low-pass filter.

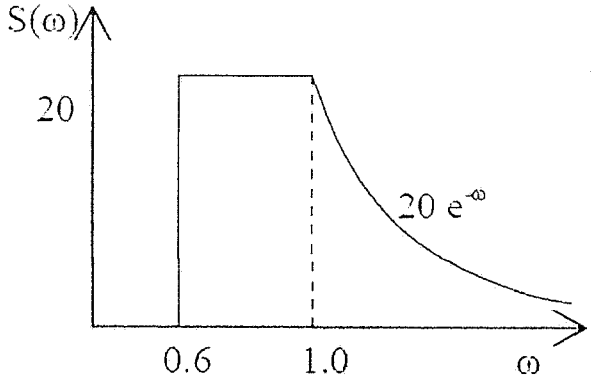

Fig.1(a) Sea Spectrum.

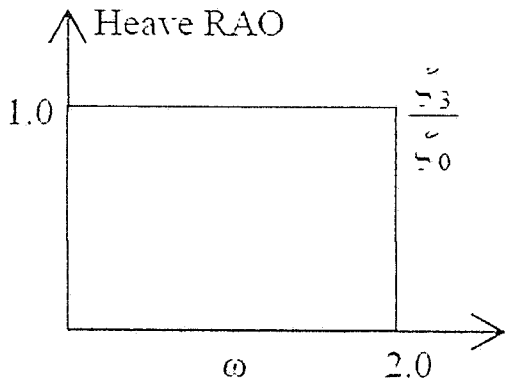

Fig.1(b) Heave RAO.

From the given data, for head & following seas at ship speed of 2 m/s, determine:

(a) Encounter spectrum **- 3 marks**
(b) Response Spectrum **- 3 marks**
(c) Average amplitude of Heave motion **- 2 marks**
(d) Significant heave amplitude **- 2 marks**

19. Assume a vertical cylinder of diameter 10 m, Length 14 m, draft 5 m, distance between centre of buoyancy and centre of gravity, BG = 1m, wavelength of deep water wave 20 m, wave height of 0.5 m. Roll moment of inertia about an axis through the centre of gravity is $0.15ML^2$, where M: Mass of the cylinder & L: Length of cylinder. Calculate the natural period of roll.

20. Calculate the force, torque and bending moment on the spade rudder shown, which is one of two working behind twin propellers. Assume a rudder angle of 35 degrees & a ship speed of 18 knots ahead. Assume the centre of pressure is 31% behind the leading for any section & force,

$F(N) = 21.1A_RV^2\delta_R$(where, A_R: Rudder area in sq.m; V: Ship speed in m/s; δ_R: Rudder angle in degrees).