UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: May 2026

Module Number: MN6306

Module Name: Shipboard Power and High Voltage Applications (C-18)

[Three Hours]

Instructions to candidates:

1. Answer **any 3 questions** from **Part A** and **All questions** from **Part B**. Each question carries **14** marks.
2. Use **separate answer books** for **part A** and **Part B** and submit them separately.
3. The maximum mark allocation for each section of the questions is shown.
4. Start your answers to each question on a fresh page.
5. This paper carries only 70% of the total module marks.
6. Non-programmable calculators may be used.
7. Drawing and sketches should be clear, neat, and in approximate proportion.
8. Do not use red ink.

Part A

Q1 a) Briefly explain the advantages of a High Voltage application of a large passenger vessel.

[03Marks]

b) Draw and explain Azipod propulsion unit of a High Voltage ship.

[03 Marks]

c) A 3 phase 6 MW ships load on a 440 V system supplied by 3 x 2 MW, 0.8 Lagging power factor diesel generator units require the main switchboard fault level to be about 90 kA. Another similar system at High Voltage of 6.6 KV supply with fault level of about 9 kA. Find the each Generator Circuit breaker capacity together with system cabling capacity to handle a full load line current (FLC).

[08 Marks]

Q2 a) Name the main types of secondary rechargeable types of batteries used on board. State their terminals, electrolyte and explain how to find their state of charge.

[06 Marks]

b) What is the general meaning for duty cycle of a 350 AH, 24 Volt lead acid battery?

[03 Marks]

c) After the 10 Hour duty cycle what are the cell voltages, and terminal voltage of a Lead Acid & Alkali batteries?

[05 Marks]

Q3 a) Briefly explain the 3 hazards of a High Voltage power system.

[04 Marks]

b) What is earthing down and why is it essential before commencement of repairs with high voltage systems? What are the types of such systems?

[06 Marks]

c) Explain who are "Competent Person" and "Authorized Person".

[04 Marks]

Q4 a) Explain the advantages of a Separately excited alternator.

[05 Marks]

b) If 2 Alternators are running in synchronized condition and suddenly if one alternators excitation fails, what is the outcome?

[04 Marks]

c) Name the components which are responsible for Active Power and Reactive Power shared between 2 alternators running in parallel.

[05 Marks]

Part B

Q5 A real single-phase transformer has core loss and magnetization loss modelled using resistance and reactance of 400 Ω and 200j Ω respectively. The total impedance of primary and secondary windings referred to the primary side is $0.2 + j0.8\ \Omega$. The secondary side of the transformer is connected to an inductive load of $6 + j4.5\ \Omega$ referred to primary side. Primary side is connected to a 200 V constant power supply. This transformer has turns ratio $N_p/N_s = 0.1$; Answer the following questions showing your answers in complex number format.

i) Draw the equivalent circuit of the transformer explained above and mark the voltages and impedances on the circuit.

[3.0 Marks]

ii) Find the no-load current I_0 of the transformer and state any assumptions.

[3.0 Marks]

iii) Find the total primary current when the above-mentioned load is connected.

[2.0 Marks]

iv) Find the load voltage referred to the primary.

[2.0 Marks]

v) Find the load voltage referred to the secondary (i.e. Secondary terminal voltage once the load is connected).

[2.0 Marks]

vi) Is the secondary terminal voltage lagging or leading the primary applied voltage and by how much?

[2.0 Marks]

Q6 a) A 3-phase synchronous generator has the following nameplate information:

Star connected, 1500 kVA, 15000 V, rated full load current 150 A, Winding resistance per phase 0.5 Ω, Synchronous impedance per phase 4 Ω.

i. Obtain the open circuit phase voltage when the power factor is 0.75 lagging.

[03 Marks]

ii. Obtain the percentage regulation when the power factor is 0.75 lagging.

[02 Marks]

iii. Obtain the percentage regulation when the power factor is 0.75 leading.

[02 Marks]

b) There are two major types of synchronous generators. Name and compare these two types of synchronous generators. Present your answer using a table or point form sentences (do not write paragraphs).

[07 Marks]