UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

MARCH 2025 SEMESTER SESSION

SUBJECT CODE	:	**LCD12203**
SUBJECT TITLE	:	**MARINE MACHINERY**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**DET NAVAL ARCHITECTURE AND SHIPBUILDING**
TIME / DURATION	:	**2.00 PM - 5.00 PM** **(3 HOURS)**
DATE	:	**23 JUNE 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.

2. This question paper has information printed on both sides of the paper.

3. This question paper consists of TWO (2) section; Section A and Section B.

4. Answer ALL Section A and ONLY TWO (2) Section B.

5. Answer ALL questions in the answer booklet provided.

6. Answer all questions in English only.

THERE ARE 9 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the objective answer sheet provided.

Question 1

Controllable pitch propellers (CPP) is normally chosen as a mean of propulsion for better control of the propulsion system, fuel saving and cavitation reduction. Therefore;

(a)   Briefly explain the advantages of CPP application for marine vessels.

[8 marks]

(a)   State two types of Controllable Pitch Propeller System.

[4 marks]

(b)   Sketch the two types of Controllable Pitch Propeller System that you mentioned above and state the difference between the two systems with the aid of sketches.
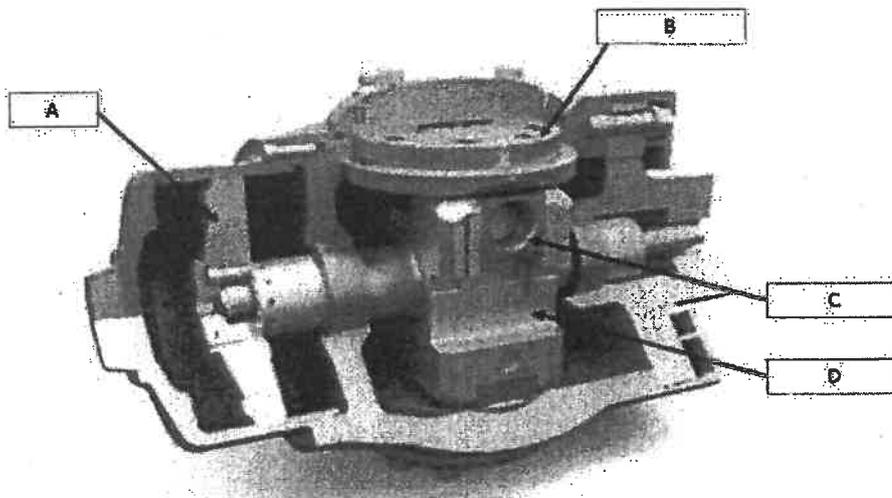
[4 marks]

Figure 1.1 CPP hub internal parts

(c) Name the parts A, B, C and D in the CPP hub as shown in the Figure 1.1 above.

[4 marks]

Question 2

(a)   Identify and list the components for a simplified boiler arrangement as shown in Figure 2.1. The components to be identified and listed are labelled (A), (B), (C) and (D).
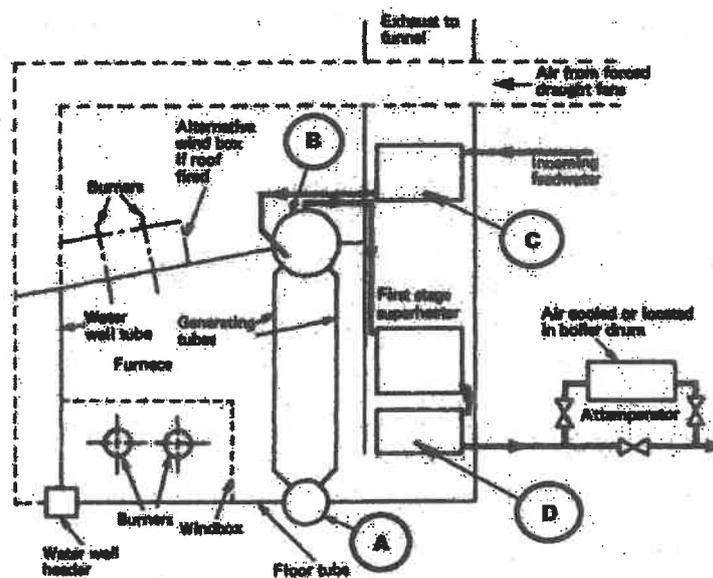
[4 marks]

Figure 2.1 Simplified water-tube boiler arrangement

(b)   Explain the function of the component labelled (C) as in Question 1 (a).

[2 marks]

(c)   Sketch a T-s diagram showing the process of reheater, superheater, high pressure turbine and low pressure turbine as shown in Figure 2.2. The sketch shall be complete with axis labels and process points from process 1 to process 7.
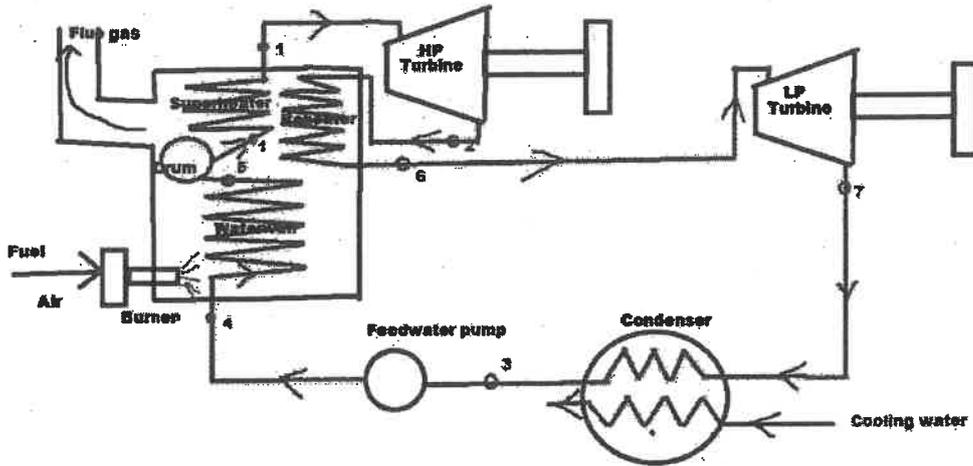
[8 marks]

Figure 2.2 A Rankine cycle with superheater, reheater, a HP turbine and a LP turbine.

(d)   Sketch the pressure compounding of a three-stage reaction turbine used in a marine steam turbine propulsion plant. The sketch shall include the velocity and the pressure profile from the early stage to the last stage of the moving blades and the fixed blades.

[6 marks]

Question 3

(a)   Identify and list the components for a four-stroke diesel engine as shown in Figure 3.1. The components to be identified and listed are labelled (a), (b), (c), (d), (e) and (f).

[6 marks]

(b)   With the aid of sketches, explain briefly the diesel's four-stroke cycle.

[8 marks]

(c)   Name and sketch a simple diagram two type of heat exchanger typically used for cooling the water jacket coolant and the lubrication oil of a four-stroke diesel engine.
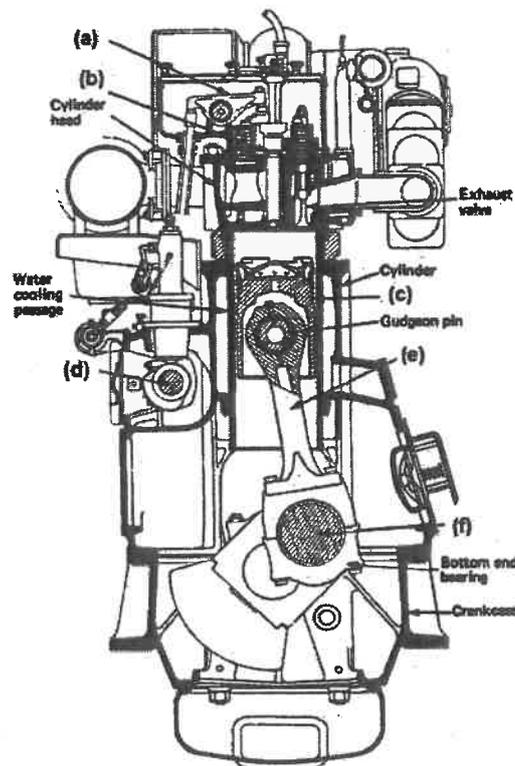
[6 marks]

Figure 3.1 Cross section of a four-stroke diesel engine

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO (2) questions.
Please use the answer booklet provided.

Question 4

A centrifugal pump has the following characteristics as listed in Table 4.1

Q (m³/hr)	0.0	23	46	69	92	115
H (m)	17	16	13.5	10.5	6.6	2
η (%)	0	49.5	61	63.5	53	10

Table 4.1 Centrifugal pump characteristics

The pump is used to pump water from a lower tank to a higher tank onboard a ship through a total length of 800 meter of pipe with 15 cm diameter. The difference between the water levels in the reservoirs is 8 meter. Neglecting all losses except friction and assuming f = 0.004, therefore: -

Therefore:

(a) Plot the values of the pump head, H with respect to the flow rate, Q in a graph paper using the centrifugal pump characteristics values as in Table 4.1.

(2 marks)

(b) Determine the system curve equation using the data given above.

(6 marks)

(c) Tabulate a table listing the pump head, hp in meter, the flow rate, Q in m³/s and the flow rate Q in m³/hr using the system curve equation as in (a).

(4 marks)

(d) Plot the values of the system curve as in (b) in the plot for the pump characteristics that you have made in (a). Mark the intersection point.

(3 marks)

(e) Read the required flow rate, required pump head and the pump efficiency from the pump chart using the intersections of the system curve that you have plotted in (c) with the pump curves from the pump chart given.

(3 marks)

(f) Determine the pump hydraulic power and the power required to drive the pump in W.

(2 marks)

Question 5

(a)   Sketch a schematic diagram of a gas turbine cycle with the components as listed below.

   (i)   Low pressure compressor

   (ii)   High pressure compressor

   (iii) Intercooler between the HP and LP compressor

   (iv)   Combustor

   (v)   High pressure turbine

   (vi)   Low pressure turbine

[6 marks]

(b)   Sketch a practical gas turbine cycle on a T-s diagram. The practical gas turbine shall consists of a single compressor, a combustor and a single turbine.

[2 marks]

(c)   A General Electric gas turbine unit has a pressure ratio of 11/1 and a maximum cycle temperature of 755 degrees Celsius. The isentropic efficiencies of the compressor and turbine are 0.82 and 0.85 respectively. The air enters the compressor at 17 degrees Celsius at a rate of 15.5 kg/s. Therefore calculate the followings:

   (i)   Compressor work input

[7 marks]

   (ii)   Turbine work output

[1 mark]

   (iii) Network output

[1 mark]

   (iv)   Power output to an electric generator geared to the turbine

[1 mark]

   (v)   Thermal efficiency

[2 marks]

Assume that $\gamma = 1.4$ in the compression process

$\gamma = 1.333$ in the expansion process

Question 6

(a) A medium speed diesel engine has a rated power of 7650 kW and has a weight of 153 tonnes. A cylinder of this medium speed four-stroke diesel engine, has a bore diameter of 20 cm and a stroke length of 40 cm. The combustion chamber of that cylinder has the same bore diameter of 20 cm and a clearance length of 2.5 cm. Therefore:

    i. Calculate the compression ratio of this cylinder.

            [6 marks]

    ii. Comment whether this compression ratio is adequate for this direct injection four-stroke diesel engine.

            [2 marks]

    iii. Calculate the power to weight ratio of this medium speed engine.

            [2 marks]

(b) A MAN 4-stroke diesel engine with six cylinder having a 610 mm bore and 990 mm stroke for each cylinder was run on test and the following data was collected. Duration of test 2 hours, average engine speed 128 RPM, brake torque 73.4 kNm, imep 6.76 bar, fuel consumption 462 kg, lower heating calorific value of fuel is 44,500 kJ/kg. From this information determine

    i. the indicated power developed   [3 marks]

    ii. the brake power   [3 marks]

    iii. the brake thermal efficiency   [2 marks]

    iv. the mechanical effciency   [2 marks]

END OF EXAMINATION PAPER

FORMULA SHEET

PUMP AND PIPING SYSTEM
System head loss

$$h_S \quad = \quad (z_2 - z_1) + \left(f \cdot \frac{L}{D} \cdot \frac{Q^2}{2 \cdot g \cdot A^2} \right)$$

Required fluid power

$$P \quad = \quad \rho \cdot g \cdot Q \cdot h$$

Required pump input power

$$\text{Pump input power} \quad = \quad \frac{P}{\eta_{Pump}}$$

PRACTICAL GAS TURBINE CYCLE

$$\frac{T_{2S}}{T_1} \quad = \quad \left(\frac{p_2}{p_1} \right)^{\frac{(\gamma - 1)}{\gamma}}$$

$$\eta_C \quad = \quad \frac{T_{2S} - T_1}{T_2 - T_1}$$

$$\frac{T_3}{T_{4S}} \quad = \quad \left(\frac{p_2}{p_1} \right)^{\frac{(\gamma - 1)}{\gamma}}$$

$$\eta_T \quad = \quad \frac{T_3 - T_4}{T_3 - T_{4S}}$$

Compressor work input $\quad = \quad c_p \cdot (T_2 - T_1)$
Turbine work input $\quad\quad = \quad c_p \cdot (T_3 - T_4)$

Heat supplied $\quad\quad\quad\quad = \quad c_p \cdot (T_3 - T_2)$

Net work output $\quad\quad\quad = \quad c_p \cdot (T_3 - T_4) - c_p \cdot (T_2 - T_1)$

Thermal efficiency $\quad\quad = \quad \dfrac{c_p \cdot (T_3 - T_4) - c_p \cdot (T_2 - T_1)}{c_p \cdot (T_3 - T_2)}$

(marine machinery)

Power output = Net work output x air intake flow rate

$$c_P = 1.005 \quad \frac{kJ}{kg.K} \quad \text{(compression process)}$$

$$c_P = 1.11 \quad \frac{kJ}{kg.K} \quad \text{(expansion process)}$$

Compressor isentropic efficiency

$$\eta_C = \frac{c_p \cdot (T_{2S} - T_1)}{c_p \cdot (T_2 - T_1)} = \frac{(T_{2S} - T_1)}{(T_2 - T_1)}$$

Turbine isentropic efficiency

$$\eta_T = \frac{c_p \cdot (T_3 - T_4)}{c_p \cdot (T_3 - T_{4S})} = \frac{(T_3 - T_4)}{(T_3 - T_{4S})}$$

$$\gamma = 1.4 \quad \text{(compression process)}$$
$$\gamma = 1.333 \quad \text{(expansion process)}$$

DIESEL ENGINE PERFORMANCE

$$V_{SW} = \frac{\pi \cdot bore^2}{4} \cdot stroke$$

$$IP = imep \cdot V_{SW} \cdot N' \cdot n$$

The brake power

$$bp = 2 \cdot \pi \cdot N \cdot T$$

Brake thermal efficiency

$$\eta_{THB} = \frac{bp}{m_{fuel} \cdot LCv}$$

Mechanical efficiency

$$\eta_{mech} = \frac{bp}{IP}$$