Semester 1 2022/2023 — Done by: Phanipha Lee

MT2003 Maritime Technology

**1 (a)**

| | **Advantages** | **Disadvantages** |
|---|---|---|
| **Methanol**<br><br>Is produced in large quantity through a two-step catalytic process | • Currently used in a multitude of sectors<br><br>• Can be implemented within the shipping sector with relative ease<br><br>• Using e-methanol and bio-methanol is 100% renewable. | • Difficulties in acquiring sustainable and cost-effective carbon sources<br><br>• Green methanol has high production costs. |
| **Hydrogen**<br><br>Natural gas or Water produced using energy derived from fossil fuels or renewable energy | • Emerging green H2 would lead to nearing zero carbon emissions<br><br>• Main option as an energy carrier in fuel cells<br><br>• Multiple application across sectors, which can increase the rate of research | • H2 production & storage is costly, requiring cryogenic storage.<br><br>• Still an immature technology in the shipping sector but has high potential as an alternative fuel |

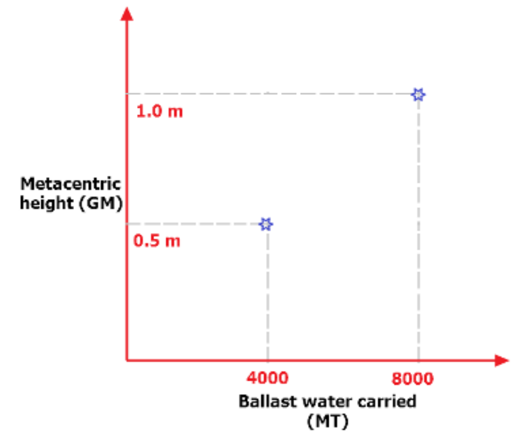
**1 (b)**

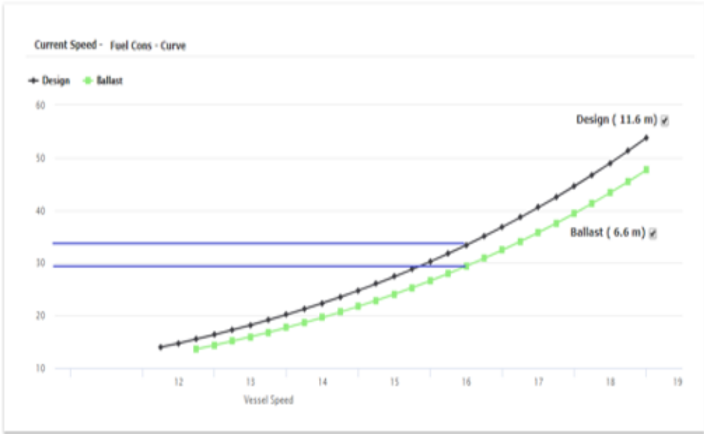
| **2-stroke engines** | **4-stroke engines** |
|---|---|
| In 2 stroke engines, when the piston is near the top dead centre, the compressed or *trapped air is injected with fuel*. | In 4 stroke engines, when the piston is near the top dead centre, the compressed or *trapped air is injected with fuel*. |
| Combustion takes place and the *piston moves downwards*. | Combustion takes place and the *piston moves downwards*. This is called a power stroke. |
| During the downward stroke of *expansion*, the exhaust *valve opens*. Exhaust gas moves out through the exhaust valve with *pressure*. As the pressure in the chamber drops further, the *remaining exhaust gas is unable to flow through the exhaust valve*. | During the downward stroke of *expansion*, the exhaust *valve opens*. Exhaust gas moves out through the exhaust valve with *pressure*. As the pressure in the chamber drops further, the *remaining exhaust gas is unable to flow through the exhaust valve*. |
| Then the pressurised intake / *scavenging air floods the cylinder liner* through the scavenge ports of the cylinder liner. | Then the piston moves up all the way to push the *remaining exhaust gas out* of the cylinder. That is called an exhaust stroke. |
| Part of the intake/scavenge air *pushes out the remaining exhaust gases* through the opened exhaust valve. This scavenging or cleaning of exhaust continues. | After that, the piston starts moving *downwards*. The exhaust valve closes and the *inlet valve opens* to draw the intake air. This is called an intake stroke. |
| The piston then moves upwards and moves above the scavenge ports and the exhaust valve closes. The trapped air is then compressed until the *piston moves again near the top dead centre* and the cycle continues. | Once the whole cylinder chamber is full of intake air, the piston moves up. The *inlet valve closes*. The intake trapped air is then compressed until the piston moves *again near the top dead centre* and the fuel is injected on the compressed air and the cycle continues. |

**1 (c)**

| **4-stroke engines** | |
|---|---|
| Advantages | Disadvantages |
| • Better gas exchange, efficient combustion<br>• Good power to weight ratio<br>• Compact design<br>• Mainly used as auxiliary engines or small / medium sized main engines<br>• Isochronous (run at same RPM)<br>• Suitable for CPP (Controllable Pitch Propeller)<br>• Suitable for producing electricity (Run as Generator) | • For main propulsion, reduction gear is required<br>• Cannot run with unit cut-off |

**2 (a)**

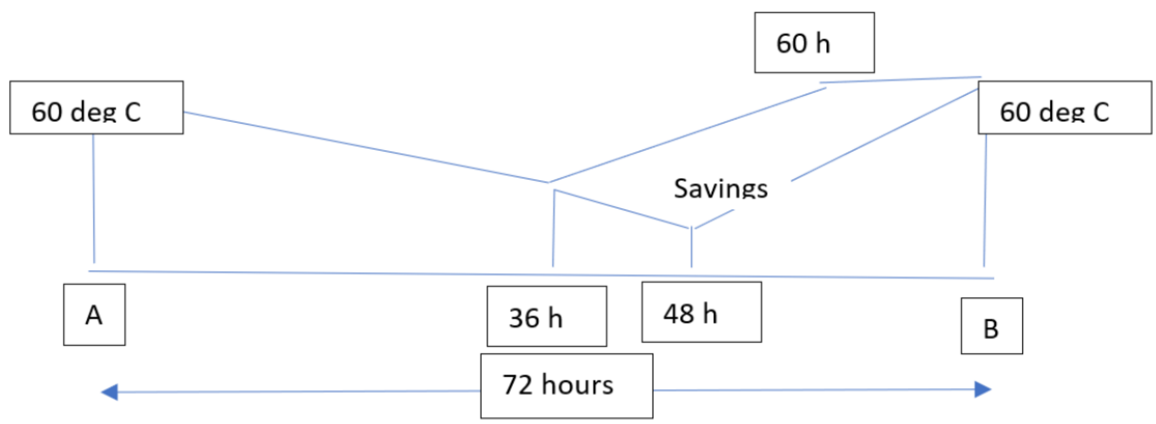



| | |
|---|---|
| Tonnes Per Centimetre Immersion (TPC) = 100<br><br>8000MT - 4000MT = 4000MT (GM is lowered)<br>So for a 4000MT difference, immersion = 0.4m<br><br>*(Tonnes/cm immersion → 100MT = 1cm, 4000MT = 40 cm = 0.4m)* | Here for a draft change of 5m, excess fuel = 5 MT/day<br>Therefore, 0.4 m, excess fuel = 0.4 MT/day<br><br>**Savings:**<br>200 days at sea X 0.4 MT/day = 80 MT<br><br>**Co2 Emission:**<br>3g X 80 MT/year = 240 MT/year |

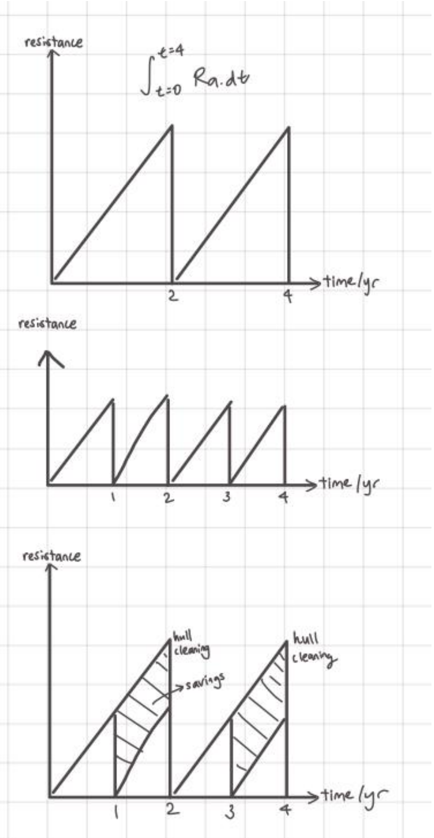
**2 (b)**

**Cargo Heating**




1. A cargo is loaded at port A and it is to be discharged at port B after 72 hours at the same temperature of 60 deg C.
2. If the heating is ON after 36h and then it reaches 60 deg C and maintains the temperature at 60 deg until reached point B, there will be a lot of heating energy wasted.
3. Instead, if the heating is ON after 48 hours and the temperature attained 60 deg exactly after 72 hours, it will be the optimum.
4. Between these two scenarios, the area highlighted as SAVINGS is the saved energy for the latter option.
   *area under curve = total energy consumption*

**2 (c)**

| **Hull & Propeller Cleaning (Optimisation)** | |
|---|---|
| <br>Σ (Potential saving) = $\int_{t=0}^{t=5} Ra.dt \ - 2\int_{t=0}^{t=5} ra.dt$<br>$$R_f = fSV^n \quad (1)$$<br>in which $f$ is the coefficient of frictional resistance<br>$S$ is the wetted surface in square feet<br>$V$ is the velocity in knots<br>$n$ is a number nearly equal to 2.<br>*Rf is proportional to fuel consumption* | • Graph (i) shows the added resistance (the triangle) to the hull if cleaned every 2 years, (ii) shows the added resistance to the hull when the frequency is increased to every 1 year<br>• Hence, graph (iii) shows the potential energy savings when hull and propeller cleaning is made more frequent<br>• Clean Hull = Less frictional resistance (less WSA) = Less Fuel consumption<br>Optimum cleaning frequency is a balance between not doing or delaying the cleaning and potentially getting a fuel penalty or cleaning it, increasing maintenance cost. |

**3 (a)**
Each Maintenance x No. of Turbocharger x Cycle Saved
$20,000 x 3 x 2 = $120,000

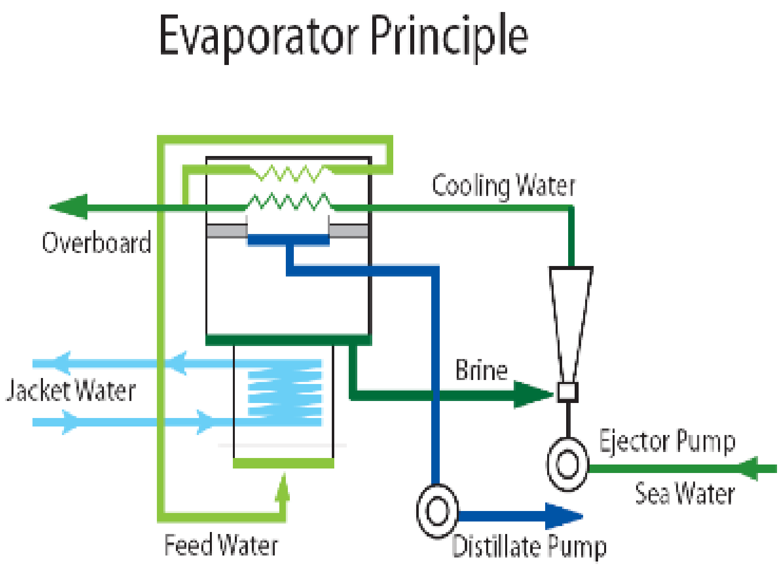
Price of each Turbocharger x No. of Turbocharger
$5000 x 30 = $15,000

Each Vessel Savings:
$120,000 - $15,000 = **$105,000/vessel**

Total Savings:
$105,000 x 20 vessels = **$2,100,000**

**3 (b)**

**Fresh Water Generator**

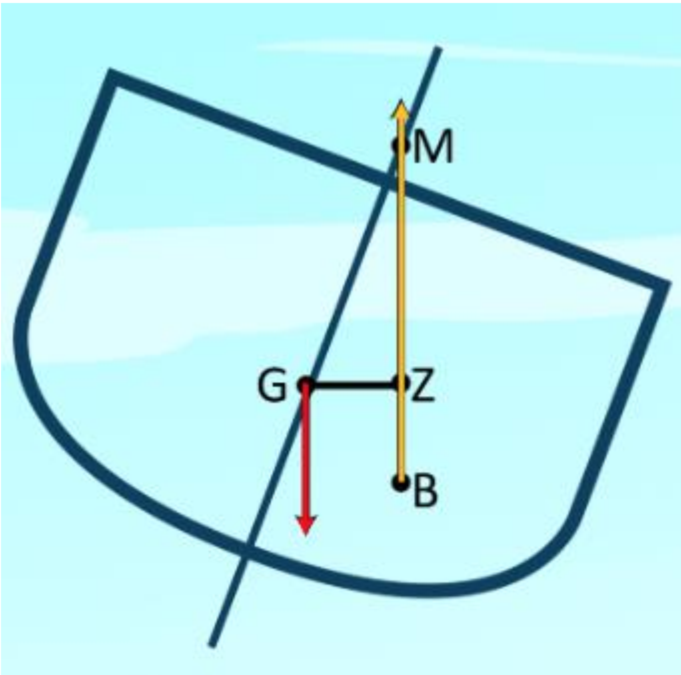


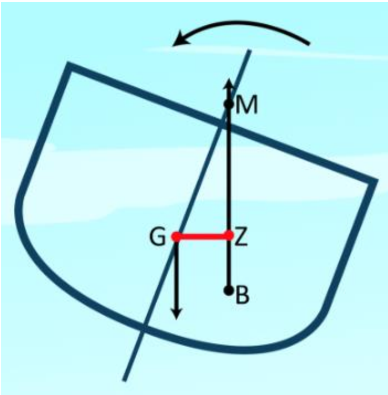
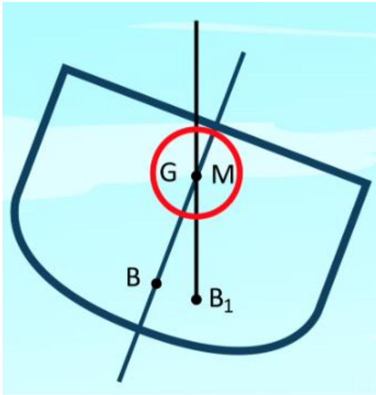
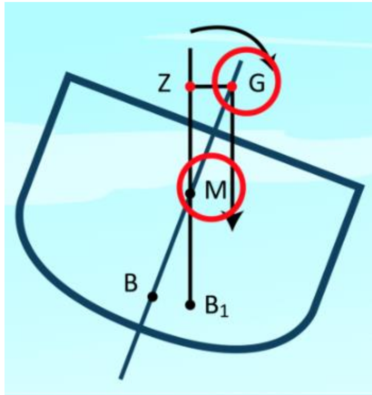

1. Sea water is supplied from the ***ejector pump***. Part of this sea water is used as feed water to the ***FWG evaporator chamber*** and the remaining ones for the ***condenser to cool the evaporated moistures***.
2. ***Jacket*** cooling water from the engine outlet is used to **heat up the sea water feed** before it goes to the **central heat exchanger**.
3. When the ejector pump discharge water passes through the ***eductor***, it **removes the trapped air from the evaporator chamber and creates vacuum;** at the same time, it also ***removes the excessive brine (salt)* deposit from the chamber**.
4. Owing to the vacuum creation, the boiling point of water drops to around ***35 deg C*** and hence, the ***jacket cooling water inlet of 82 deg C*** is **sufficient to boil** the sea water in the evaporator chamber.
5. Once boiled, the moistures, mostly ***fresh water, are collected in the condenser,*** which is then **cooled by the ejector pump** discharged water and the fresh water is then **collected by the distillate pump**

**3 (c)**
To ensure the ***propeller shaft alignment*** with the ***engine*** as the propeller is ***subjected to upward water thrust*** when in the water.

**4 (a)**

| | |
|---|---|
| **Centre of Gravity (CG)** | • Longitudinal position of CG with respect to any reference point on ship: **longitudinal centre of gravity (LCG)**.<br>• Reference point of locating it is either forward of after perpendiculars<br>• Vertical distance between keel and CG = **KG** |
| **Centre of Buoyancy (CB)** | • Longitudinal position of CB with respect to any reference point on ship: **longitudinal centre of buoyancy (LCB)**.<br>• Reference point of locating it is either forward of after perpendiculars<br>• Vertical distance between keel and CG = **KB** |

| **The Stability Triangle** | |
|---|---|
|   | When a ship is inclined, the **centre of buoyancy** *shifts off centreline* while the **centre of gravity** remains in the same location.<br><br>The forces of buoyancy and gravity are *equal* and *act along parallel lines*, but in **opposite directions**, *resulting in a rotation* called a **couple** (two moments acting simultaneously to produce a rotation).<br><br>This rotation *returns the ship* to where the forces of buoyancy and gravity **balance out**. |

| **Positive Stability** | **Neutral Stability** | **Negative Stability** |
|---|---|---|
|  |  |  |
| The **metacentre** is located *above* the ship's **centre of gravity.**<br><br>As the ship is inclined, **Righting Lever (GZ)** is created which brings the vessel back to its original, vertical position. | The **metacentre** and ship's **centre of gravity** are in the *same location* (coincides).<br><br>There is **no** Righting Lever (GZ).<br><br>Vessel remains at an *angle of loll*.<br><br>**! CROSS OVER CAUTION !** | The ship's **centre of gravity** is located *above* the **metacentre**.<br><br>As the ship is inclined, **Upsetting Level (GZ)** is created which tends to capsize the ship. |

**4 (b)**

1. ***Inspections*** of physical structures and ***patrolling*** of security rounds
2. ***Routine*** inspections for ***maintenance*** of buoys, pipes, docks, breakwater cranes, roof-ships and other structures that are ***conventionally difficult to access***
3. ***Stock measurement*** to calculate (bulk) ***volumetric mass inventory***
4. ***Detection*** of ***irregular*** situations, leaks or abnormalities through (thermal and gas) ***sensors***, as supplemental emergency support without the need to expose people to the affected areas
5. Measurement and control of ***environmental*** aspects, ***detection of contamination*** and tracking and monitoring those responsible for the environmental breaches
6. ***Mapping*** and surveying
7. Generating ***audio-visual records*** of inspection for the ***authorities*** or for historical archives

**Potentially negative repercussions:**

- Control & protect airspace
- Violations of security, terrorist attacks.

**Examples of Drone Technology in Maritime:**

- "Agency by Air" supply ships with small spare parts, documents, supplies or even consumables for 3D printers
- Traffic control and monitoring in port
- Supervise operations and risk detention in terminal operations
- Environmental Control: Routine slight surveillance with video recording/orthophotos

**4 (c)**

**Uses of AIS: Surveillance Tool**

a. *Shore authorities* establish automated AIS stations to monitor the **movement of vessels** through their shores.
b. *Coast stations* can also use the AIS channels for **shore to ship transmissions**, critical information on **tides**, **non-tariff measures NTMs** and located **weather** conditions.
c. Monitor movement of **HAZMAT** (hazardous cargoes)
d. Control of **commercial fishing** operations in territorial waters.
e. Useful in supplementing SAR operations whereby **Maritime Rescue and Coordination Centre MRCC** can use AIS information to assess the availability of other vessels in the vicinity of the incident.