No.: MT2003 PYP, YR 2015 DEC Date:

Best of luck for your exam!
Lim Hanye.

Q1. (a) Slow speed engine is the type of engine has these advantages:
- Rotation speed 80-330rpm, no reduction gearbox is required
- Direct drive to FPP
- High output power capacity up to 80 MW.
- Reversible
- Best thermal efficiency (47% - 55%) and SFC = 170 KG only.
- Can burn low quality fuel with good part load efficiency
- Reliable (low technology requirement means lower wear & tear and maintaince requirement, hence, costs).

It used in large vessel such as dry bulk and container vessel although it still have disadvantages of longer starting and stop time and big cyclinder cycle needed.

(b) CH_4: 16 kg/kmol

O_2: 32 kg/kmol

100% excess air = 2× stoichiometric air (means exact amount of air to burn)

$\Rightarrow CH_4 + 2O_2 \xrightarrow{\text{burn}} CO_2 + 2H_2O$

16   32×2

$\Rightarrow$ Therefore, 1 kmol CH_4 need 2 kmol O_2 to burn

⇓

$$\frac{3600\ kg/hr\ CH_4}{16\ kg/kmol} = \frac{1}{2} \times \frac{\text{flow rate of } O_2}{32\ kg/kmol}$$

$\Rightarrow$ flow rate of O_2 = 14400 kg/hour

$\Rightarrow$ Stoichiometric air $= \frac{O_2}{23.3\%} = 61802.575$ kg/hr

$\Rightarrow$ 100% excess air

$\Rightarrow$ Flow rate of air = 61802.575 × 2 = 123605.15 kg/hr

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Q2 (a) Five Critical Temperature are:

- Cloud point: This is only apply to DMX distillate fuel (solified): It means the lowest temperature at which wax precipitates as fuel is cooled and this might result to filter blockage. At this point, wax start to crystallise out and clear fuel become opaque.
- Pour point: This is the temperature at which fuel just remain fluid so that fuel can still be pump around. Lower than this point fuel will gel.
- Solidifying point: It's the highest temperature at which fuel remains solid and required warm up.
- Flash point: lowest temperature that air/fuel mixture can be ignite by flame or spark, it's a safety measure to avoid risk. Fuel must be store at least 10 °C below. For engine room, flash point must higher than 60°C and for lifeboat must be higher than 43°C.
- Ignition point: Lowest temperature which air fuel mix will spontaneously ignite and maintain a frame for more than 5 seconds.

(b) From the graph, we are able to see that the fuel has density of 920 kg/m³ at 15°C. Therefore, we are able to find out that at 80°C, its density is 875 kg/m³
40 MW containership with fuel consumption of 180g/kWh and require 3 week 110% of 875 kg/m³ fuel oil

$\Rightarrow$ consumption = 40000 kW · 24h · 21 days · 0.18 kg/kWh · 110%
= 3991680 kg

Because keep at 875 kg/m³
$\Rightarrow$ Volume = 3991680 kg / 875 kg/m³ = 4561.92 m³.

Q3 (a) A central cooling system use a close fresh water circuit as coolant to reduce risk of corrosion compare to sea water. Sea water system is limited to a set of pumps, valves and filters. It consist of 3 main parts namely seawater circuit, high temperature circuit and low temperature circuit. Sea water pass valve, cooler and pump overboard. How many pump to open depends on central water temperature.

Advantages of central cooling systems are:

- Corrosion in the fresh water system is eliminated compared to sea water (provided chamical treatment is maintained.
- Component of the system (valves, pipes and coolers) in cantact with only fresh water, can be cheaper material
- Constant temperature of cooling water means easier cooler's control, which means compare to seperate system control valve can control mixing.
- Filters and coolers cleaning and maintance are reduced, lesser manpowered for maintance is needed so that cost of manpower can be saved.

Disadvantages of central cooling system:

- Over-heating of one mechinery will affect cooling capacity of other mechinery. Due to flow is constant so that you are not able to control single component in the whole system.
- Contamination of cooling water caused by one system will affect entire fresh water cooling circuit.
- Initial system design layout is expensive since O/L (outlet) of one syster will be I/L (inlet) of another.

(b) (i) $Q_{oil} = m \cdot c \cdot (T_1 - T_2) = 1\,kg/s \cdot 1400\,J/kg \cdot K \cdot (50-30) = 28\,kJ/s.$

(ii) $Q_{oil} = m_{water} \cdot C_{water} \cdot (T_{out} - T_{in}) \Rightarrow 28\,kJ/s = 0.5\,kg/s \cdot 4200\,J/kg \cdot s \cdot (T_{out} - 20°C)$

$\Rightarrow T_{out} = 33.33°C$

(iii) $Q = UA\Theta_m = 70\,W/m^2K \cdot A \cdot 17°C = 28\,kJ/s \Rightarrow A = 23.53\,m^2$

$Area = length \cdot 10mm \cdot \pi \cdot 200 = 2m \cdot \pi \cdot length = 23.53\,m^2 \Rightarrow length = 3.74$

$\therefore$ length of tube is 3.74m.

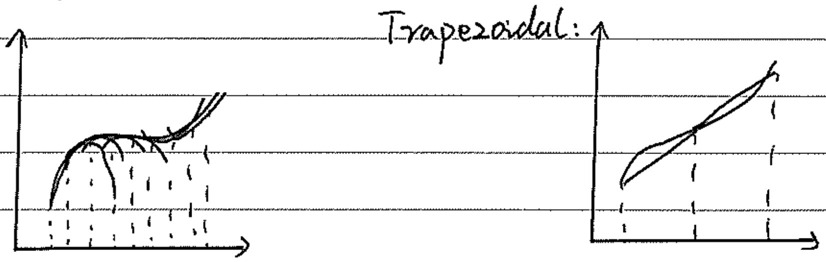
Q4 (a) $A_{wp} = 2 \times \frac{30}{3} \cdot (0.2 + 4 \cdot 2.5 + 12 \cdot 10 + 4 \cdot 15 + 2 \cdot 11 + 4 \cdot 4 + 0.3) = 2570\ m^2$

$I_T = \frac{2}{3} \times \frac{30}{3} \times (0.2^3 + 4 \cdot 2.5^3 + 2 \cdot 10^3 + 4 \cdot 15^3 + 2 \cdot 11^3 + 4 \cdot 4^3 + 0.3^3) = 123203.5667\ m^4$

$TPC = \rho_{seawater} \cdot A_{wp} \cdot 0.01m = 1025\ kg/m^3 \cdot 2570 m^2 \cdot 0.01m = 26342.5t$

(b) Simpson's rule is more accurute than Trapezoidal rule, because Simpson rule use parabola and lesser lines which nearer to actual curve

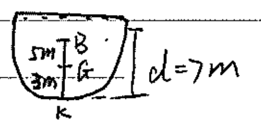
Simpson: Trapezoidal:



Usually for a shape of ship, there is curve up sectionand curve down section. Depending on ships shape, there is no correct answer for these two which one have higher value result but only can say simpson's rule is closer to real result. and only can be used if we have even sample points.

(This question is tricky and Im not sure whether my answer is correct

~~This question~~ Need to assume B = 15 !!! → (c)



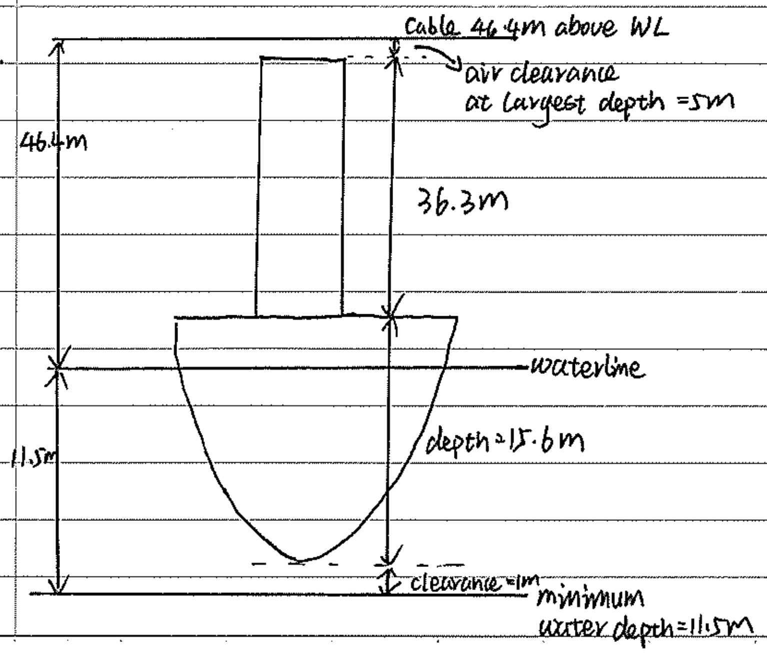
$\Rightarrow C_b = \frac{\nabla}{BTL}$, $BM_T = \frac{I_t}{\nabla} = \frac{I_t}{BTL \cdot C_b}$

$\because I_t = 123203.5667 m^4$, $B = 15 \cdot 2 = 30m$, $L = 30 \cdot 6 = 180m$

$\therefore BM_T = \frac{123203.5667}{15 \cdot 2 \cdot 7 \cdot 180 \cdot 0.6} = 5.43m$

$\therefore GM_T = (KB - KG) + BM_T = 5.43 + (5-3) = 7.43m.$

Q5.



ship total = 36.3m + 15.6m = 51.9m

largest draft = 11.5m − 1m = 10.5m

Air draft = 51.9m − 10.5m = 41.4m

∴ Clearance = 46.4 − 41.4 = 5m

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Q6. (a) Ship resistance are consist of:

- Water resistance which consist of fractional resistance (no static form, have dynamic friction), wave breaking resistance (sea is not clam) and wave making resistance (move in water create wave means loss of energy.
- Air resistance: much lesser than water resistance, it's negligible.

(b) The reasons are:

- Ships will slowly have wear and tear
- Fuel consumption will increase as engine efficiency reduced and fouling
- Over heating problem occur as system wear and tear.
- Anti fouling paint failure which increase resistance.
- Heating and cooling system break down
- Self-polishing paint wear off.
- Wear and tear of lub oil
- Wear and tear of cylinder liner, engine crank case and piston etc which cause inefficient combustion or crank case explosion.

(c) The ship build in Japan usually will be most expensive follow by Korea and China is least expensive.

The reason for the price different are:

- The types of ship they build. For example, dry bulk is popular in Japan
- Concept in people's mind that Japan has best quality and China has worse.
- Reputation of ship yard.
- Your barginning power and specific design requirement.
- How close you are with the shipyard.
- Shipping market and how urgent you are.
- Are you booking a series of ships.
- How your ordering can fit into shipyard's building schedule
- Shipyard capacity

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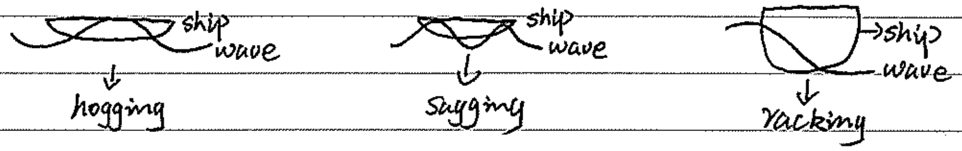
Q7 (a) If it's head sea which means ship will encounter sagging and hogging deformation.

If it's beam sea, deformation called racking will occur



(b) Ship structure overcome these deformation using high tensile steel or casting iron and also, use plating and stiffening longitudinally and transversly to enhance the strength of she ship. Net-work are welded together.

(c) (i) The factors are:

- After keel laying, change of width which affect origional plan for vessels.
- Put more heavy fire arms on higher deck which result in reduce of stability as G goes up and GM reduce
- Heavy oak cavings outfit in upper deck further move G center up and reduce GM.
- No room for ballast water to help stablize the ship.

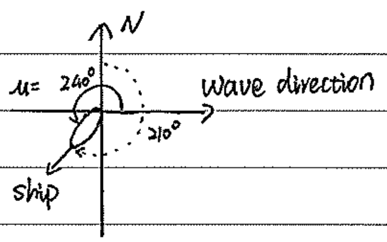
This Q is lack of one data that "C=0.38" ←

(ii) Assumption: the ship motion is assumed to be simple harmonic Motion and experience liner restoring force.

$T_{roll} = \frac{2C \times B}{\sqrt{GM_T}} \Rightarrow GMT = \left(\frac{2C \times B}{T_{roll}}\right)^2$, $\because C = 0.38$, $B = 5m$, $T = 10.5s$

$\therefore GM_T = \left(\frac{2 \times 0.38 \times 5}{10.5}\right)^2 = 0.131\ m.$

(iii)



$\Rightarrow W_e = W - \frac{W^2}{g} \cdot V \cdot \cos\mu$, $T = 12$ second, $W = \frac{2\pi}{T} = \frac{\pi}{6}$ rad/s

$W_e = \frac{\pi}{6} - \frac{(\frac{\pi}{6})^2}{9.8} \cdot 10\text{knots} \cdot \cos 240° = 0.66$ rad/s

$\therefore T_e = 9.52s$ $T_{roll} = 10.5s$

Therefore, wave period incounter is close to period of roll motion. Resonance will happen and its amplitude is huge compare to pitch and heave which might lead to [illegible]