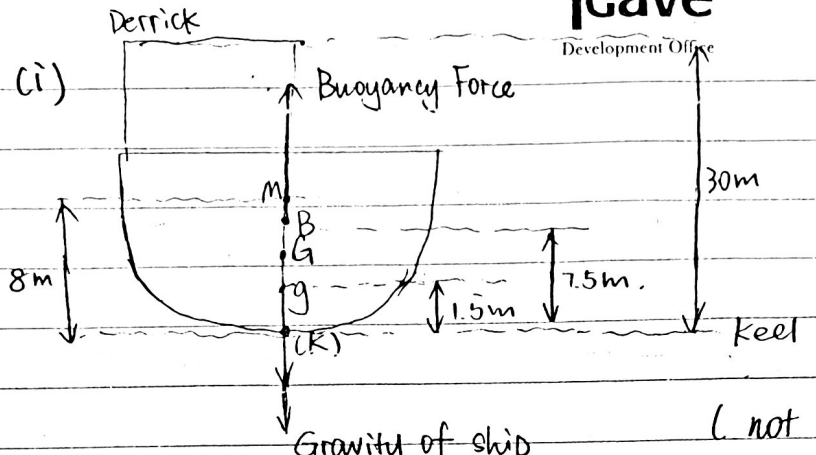
1. (a) (i)



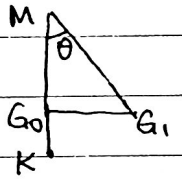
(not in proportion)

(ii) $KG \cdot M + m \cdot (L - kg) = M \cdot KG_0$

$7.5 \times 8000 + 60 \times (30 - 1.5) = 8000\, KG_0$

$KG_0 = 7.71375\,m$

(iii) $GG_1 = \frac{wd}{W} = \frac{60 \times 12}{8000} = 0.09\,m$



$G_0M = KM - KG_0 = 8 - 7.71375 = 0.28625$

$\tan\theta = \frac{G_0G_1}{G_0M} = \frac{0.09}{0.28625} = 0.3144$

$\theta = \arctan 0.3144 = 17.45^\circ$

(iv) Free surface effect. It arises when liquid in a container is partially full and free to move. It causes a reduction in GM, due to change in centre of gravity. Therefore transverse stability will be reduced. Free surface effect is independant of the location of the free surface within the ship, but length and breadth of the free surface. Given an angle of heel. GM will be further reduced, reducing transverse stability of ship.

(b) Moment caused by loading and discharging: $200 \times (100 - 80) - 200 \times (100 - 90) = 2000$

Change of trim = Moment / MCT1cm = 2000 / 250 = 8cm

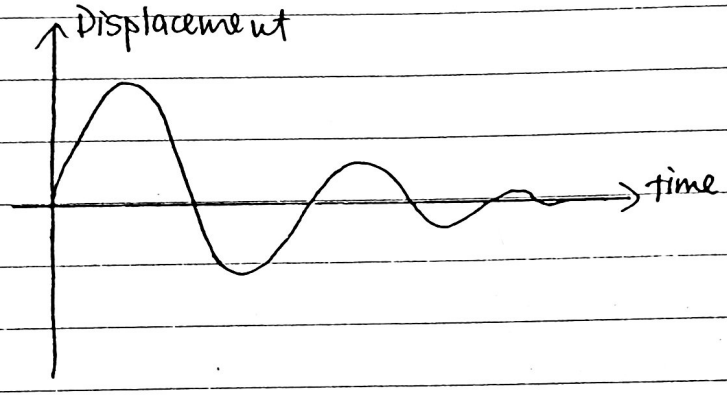
Final trim = 35 - 8 = 27cm

(c) (1) tank girders
(2) tank top (inner bottom)
(3) girders
(4) floor
(5) bracket floor
(6) longitunidals
(7) Strake

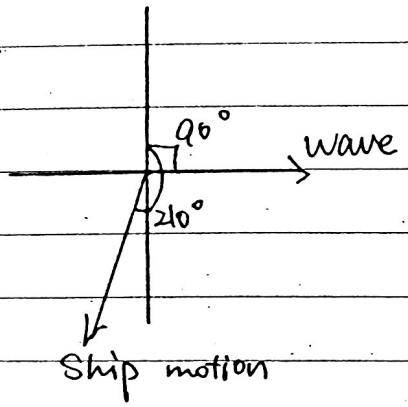
a.

2. The diagram exhibits simple harmonic motion (SHM).
A system will exhibit SHM when any displacement from its resting location causes it to experience a linear restoring force of movement.

Because of air resistance, damping exists. It dissipates the energy of the oscillating system to 0. This system allows several oscillations, so it is underdamped.



b.



$\mu = 120°$

$V = 20$ knots

$= 20 \times 0.514 = 10.28$ m/s

$\omega = \frac{2\pi}{T} = \frac{2\pi}{12} = \frac{1}{6}\pi = 0.5236$ Hz

$\omega_e = \omega - \frac{\omega^2}{V} g \cos\mu$

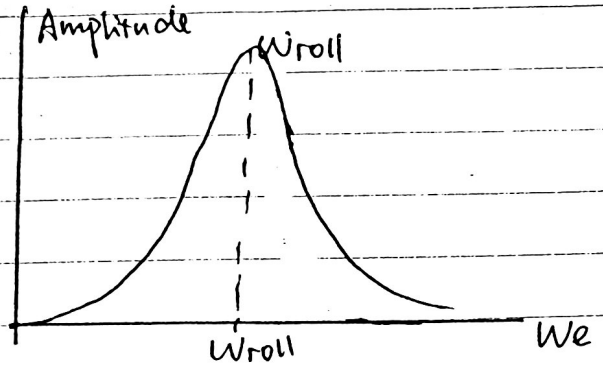
$= 0.5236 - \frac{0.5236^2}{10.28} \times 9.8 \times \cos 120°$

$= 0.6543$ Hz

$T_{roll} = \frac{2GB}{\sqrt{GM_T}} = \frac{2 \times 0.39 \times 10}{\sqrt{0.671}} = 9.5221$ s

$\omega_{roll} = \frac{2\pi}{T} = \frac{2\pi}{9.5221} \simeq 0.66$ Hz $\approx \omega_e$

When $\omega_{roll} = \omega_e$, resonance will happen.
When natural frequency coincides with encounter frequency, the SHM system ~~expre~~ experience maximum amplitude oscillations. Extreme motions occur, especially for rolling in this case.



in shipping
3. (a) Every professional should have some knowledge in maritime technology even if he/she is not involved in engineering work for the following reasons.

With good understanding of technical knowledge, he/she can communicate effectively and efficiently with engineers and other technical personnel regarding the following aspects

① Compliance of regulation. People in commercial sector should also beware about int'l regulations and conventions and express specific requirements to technical personnel.

② Requirements on ship design and building: with understanding of technical knowledge, he/she can communicate to shipyard about their requirements and specifications. He/she can also monitor performance of shipyard.

③ Reduce cost for operator by reducing resistance and improving engine efficiency

④ Ensure safety of operation on board.

With basics in technical knowledge, commercial personnel can communicate with technical personnel better, ensure performance of ship, and avoid from coming up ~~exc~~ unreasonable requirement to ~~sho~~ shipyard. Moreover, more knowledge means more opportunities for a professional.

(b) Water resistance exists. It can be reduced through the following ways:

① Smooth hull:

Do surface preparation in drydock, including high-pressure water jet, stripping, maintenance against rust.

Choose appropriate anti-fouling paint can reduce frequency of dry-dock

② Bulbous bow can reduce water resistance

③ Design of ship is important, and appendage should be minimized.

④ When ~~do~~ the ship is sailing, make use of routing to avoid adverse weather and take advantage of favourable weather.

Also, the ship operator should ensure the efficiency of engine and other equipment on board is high. Advanced models of engine should be chosen when the ship is designed and constructed to make use of the latest technology. Do periodical survey and maintenance to ensure the performance of the engine.

(c). Although shipowners and operators follow the regulation and send the ship for periodic survey and maintenance, there are still possibility that the ship breaks down during a voyage.

The officer on board should check what happened and seriousness first, estimate the consequence of the incident, and what can be done.

The officer should check if there are spare parts available. Evaluate the ship's mobility and find out if there are ships passing by and ask help from them.

The ship officer can also ask help from ashore. Then the ship manager onshore should find out if someone can fixed the problem. The ship manager should also liaise with ~~drydock~~ shipyard (maintenance services provider) and equipment supplier for plans and advise, then communicate to people on board.

To summarize, when ~~the~~ unexpected breakdown happens, the officer on board and the manager ashore shouldn't be panic. They should keep calm and try to communicate to other parties and get help from them

KEEP CALM & ACE THE EXAM!

4. (a) Before construction, the shipyard designs the ship for the buyer. After signing the contract, the construction starts.
First, the shipyard purchases the material. Usually, the material is purchased in advance.
Then, keel laying marks the official starting point of construction.
After that, do plate cutting according to computer marking.
Then, weld the plates and assembly them to the steel bock of the ship's hull.

(b) ① Direct drive slow speed diesel
② Geared drive medium speed diesel
③ Diesel electric
④ Steam turbine
⑤ Fan propel
⑥ Water jet
⑦ Z-drives / pods
⑧ Variable pitch propellers
⑨ Contra-rotating propellers

Now most large cargo ships (container, bulk, tanker) use 2 stroke slow speed diesels. Passenger / cruise ship tend to use 4 stroke medium speed diesels, usually in diesel-electric combinations. Smaller and specialized vessels may also use 4 stroke medium speed diesels, with gear gearbox.

(b) Station	Y	level	Prod 1	Multiplier	Prod 2
3	0	3	0	0.5	0
2	12	2	24	1	12
1	24	1	24	1	24
0	29	0	0	1	29
-1	26	-1	-26	1	26
-2	16	-2	-32	1	16
-3	0	-3	0	0.5	0

$Sum1 = -10$ $\quad$ $Sum2 = 107$

$MWL = 2h^2(Sum1) = 2 \times 2.5^2 \times (-10)$

$= -125$

$AWL = 2h(Sum2) = 2 \times 2.5 \times 107$

$= 535\ m^2$ — Area of waterplane

$LCF = MWL / AWL$

$= 535/(-125) = -4.28\ m$

Remider: the solution is only a guide for your revision, and it's not 100% accurate.

This course MT2003 is not that hard if you pay attention to lectures (esp. Mr. Teh's) and read through notes carefully and make sure you understand them.

If you can figure out all examples on lecture notes & tutorial questions, you should be okay with the calculation part.

GOOD LUCK!

(c). (i) Submerged volume = LBT

$50 \times 10 \times 3 = 1500\ m^3$

(ii)

$$TPC = \frac{\text{waterplane area} \times 0.01}{\rho}$$

$$= \frac{50 \times 10 \times 0.01}{1.012}$$

$= 4.9407$ Tonnes/cm

(iii) New draft = 3m + increased draft

Increased draft = $150 / 4.9407 = 30.36$ cm

$= 0.3036$ m

New draft = $3 + 0.3036$

$= 3.3036$ m

5. (a)

(i) Case A: Draft 8.65m. Deadweight 25500 tonnes

Case B: Draft 7.85m Deadweight 22300 tonnes

(ii) Max. allowed designed draft: 11m

Deadweight: 35000 tonnes for freshwater

36000 tonnes for sea water

(iii) 8.97m