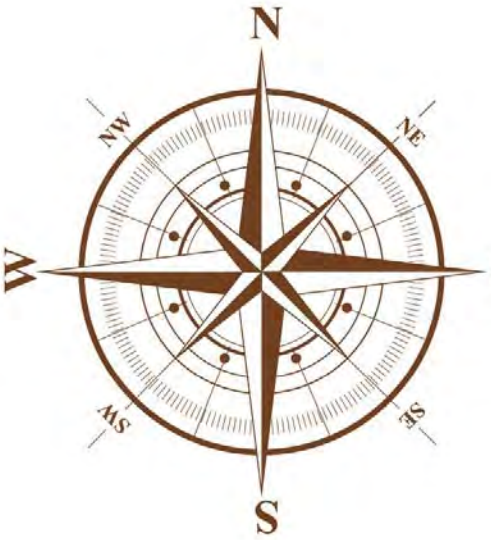

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EXAMINATION WORKBOOK

Candidate's Name ..... / .....
Surname Forenames

Date of Birth / / **Candidate's Number** | | | | | | | |

(From Examination Entrance Card - if in doubt ask Invigilator)

Subject ..... | .....
Number Title

Course of Study .....

College Attended .....

College of Examination .....
(where different from above)

Date of Examination / /

NOTES

1 Prior to the start of the examination you are required to complete the section above in BLOCK CAPITALS.

2 **Candidates must sign the declaration inside the front cover**

3 An additional workbook may be provided on request and care should be taken to ensure that this workbook is inserted in the main workbook.

Mark an X here if you have used additional workbook. ☐

Mark an X here if you have used a Worksheet ☐

Mark an X here if you have used graph paper. ☐

4 In the section "Questions attempted" below, circle the numbers of the questions you have attempted. Do not make entries in the Section "For Markers' use only".

Questions Attempted (Circle Numbers)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

For Markers' use only

Marks Awarded

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	SCRIPT TOTAL

Markers' Initials .....

INSTRUCTIONS TO CANDIDATE

General Information

Before the examination begins you should ensure that you have been provided with any ancillary material required for the examination. "*Materials to be supplied by examination centre*" are listed on the front sheet of the examination paper.

All mobile phones **MUST** be turned off and surrendered to the Invigilator during the period of the examination.

Completion of Examination Workbook

CANDIDATES SHOULD READ THE MARITIME AND COASTGUARD AGENCY POLICY REGARDING CHEATING IN EXAMINATIONS, THEN SIGN AND COMPLETE THE DECLARATION ON THE INSIDE FRONT COVER.

YOUR EXAMINATION SCRIPT WILL NOT BE MARKED UNLESS YOU COMPLETE AND SIGN THIS FORM.

Please write in **BLOCK CAPITALS** on the cover of your workbook your name, date of birth, Candidate Number, subject number and title, course of study, centre attended, centre of examination, if different, and date of examination. You should be in possession of a candidate examination card giving your candidate number. If you are not in possession of this card the information can be provided by the Invigilator.

If an additional workbook/graph paper/worksheet is used these must be included inside the original workbook. An 'X' should be inserted in the appropriate box under Note 3 on the workbook cover in such circumstances.

In the space provided in the section 'Questions Attempted' on the workbook cover you must ***circle the numbers*** of the questions you have attempted. Do not make any entries in the boxes indicated 'For Markers Use Only'.

Use **BOTH** sides of each sheet. The answers to **EACH NEW QUESTION** must start at the **TOP OF A FRESH PAGE** and the number of the question should be inserted at the top of each page. Use **ink** for all essential written matter, which should be contained within the feint ruled vertical lines. (While pencil may be used for diagrams and sketches, annotations to these should be in ink.). Please **DO NOT** use red ink.

YOUR EXAMINATION SCRIPT WILL NOT BE MARKED IF IT IS COMPLETED IN PENCIL AND/OR RED INK.

Show all necessary working in calculations, etc. (Rough work, not intended to be read by the marker, should be scored out.)

No part of this book is to be torn out. No writing is allowed on any other paper other than ancillary material/examination inserts. Please ensure you write your name and centre on all examination paper inserts.

Examination Room Conduct

All queries should be addressed to the Invigilator.

No candidate may enter the examination room later than **30 minutes** after the examination begins and no candidate may leave the examination room, except in the case of illness, during the first hour of an examination. Candidates may not leave an examination room during the last **fifteen minutes** of an examination.

Any candidate who leaves the examination room before the end of the examination must leave his or her examination paper with the Invigilator. Examination papers must not be removed from the examination room during the period of the examination.

All candidates must hand their workbook(s) to the Invigilator before leaving. Workbooks must not be removed from the examination room even if they have not been used.

JULY 2005

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is to transit a canal with a minimum clearance of 0.30m under a bridge, the underside of which is 20.24m above the waterline.

   Present draughts in fresh water (R.D. 1.000): Forward 5.22m Aft 6.38m

   The fore mast is 112m foap and extends 25.92m above the keel
   The aft mast is 37m foap and extends 26.94m above the keel.
   (Assume masts are perpendicular to the waterline throughout)

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the final draughts forward and aft in order to pass under the bridge with minimum clearance; (17)

   (b) the minimum weight of ballast to load in order to pass under the bridge with minimum clearance. (18)

2. A vessel is planning to enter drydock in dock water of relative density 1.015.

   Present draughts: Forward 3.00m Aft 3.80m KG 10.50m

   (a) Using the *Stability Data Booklet*, calculate the maximum trim at which the vessel can enter drydock so as to maintain a GM of at least 0.10m at the critical instant. Assume KM remains constant. (30)

   (b) Explain why it is beneficial to have a small stern trim when entering drydock. (5)

3. A vessel's loaded particulars in salt water are as follows:

   Displacement 16000 tonne Fluid KG 8.20m

   Using the *Stability Data Booklet*, compare the vessel's stability with ALL the minimum stability criteria required by the current Load Line Regulations, commenting on the result. (35)

JULY 2005

4. Sketch a vessel's curve of statical stability, showing the effects of EACH of the following:

   (a) increasing a vessel's draught; (10)

   (b) increasing a vessel's beam; (10)

   (c) symmetrical icing of masts and superstructure (ignore change in draught). (10)

5. List TEN items of the stability and stress data required to be supplied to ships under the current Load Line Regulations, stating for EACH how such information might be used. (30)

6. Describe a *Type 'A'* vessel under the current Load Line Regulations, including the flooding, stability and assumed damage requirements for a newly built vessel. (35)

NOV 2005

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel's present particulars are as follows:

   Forward draught 8.00m, Aft draught 9.00m in salt water.

   A total of 320t of cargo, Lcg 70.00m foap, is to be discharged immediately and then the vessel is to proceed to an upriver berth where the relative density of the dock water is 1.005.

   During the passage the following items of deadweight are consumed:

90t of Heavy Fuel Oil	from No. 3 D.B. Centre tank
18t of Diesel Oil	from No. 4 D.B. Port tank
18t of Diesel Oil	from No. 4 D.B. Starboard tank
12t of Fresh Water	from After Fresh Water tank

   Using the *Stability Data Booklet*, calculate the draughts fore and aft, on arrival at the upriver berth. (35)

2. A vessel is to load a cargo of grain (stowage factor 1.57m3/t).
   Initial displacement 6400t Initial KG 6.48m
   All five holds are to be loaded full of grain.

   The tween decks are to be loaded as follows:

No. 1 TD	Full
No. 2 TD	Part full – ullage 1.25m
No. 3 TD	Part full – ullage 3.00m
No. 4 TD	Full

   The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

   (a) With the aid of *Maximum Permissible Grain Heeling Moment Table* included in the *Stability Data Booklet,* determine whether the vessel complies with the minimum criteria specified in the *International Grain Code (IMO).* (30)

   (b) Calculate the ship's approximate angle of list in the event of the grain shifting as assumed by the *International Grain Code (IMO).* (5)

NOV 2005

3. (a) A vessel, initially upright, is to carry out an inclining test.

Present displacement 5700 t, KM 10.83m
Total weights on board during the experiment:
Ballast 370 t, Kg 3.47m. Tank full.
Bunkers 165 t, Kg 3.98m. Free surface moment 956 tm
Water 95 t, Kg 4.44m. Slack tank. Free surface moment 910 tm
Boiler water 19t, Kg 4.18m. Free surface moment 102 tm
Inclining weights 56 t, Kg 8.44m

A deck crane, weight 19t and still ashore will be fitted on the vessel at a Kg of 9.74m at a later date.

The plumblines have an effective vertical length of 7.85m. The inclining weights are shifted transversely 7.0m on each occasion and the mean horizontal deflection of the plumbline is 0.65m.

Calculate the vessel's Lightship KG. (30)

(b) Explain why a vessel's Lightship KG may change over a period of time. (5)

4. (a) A vessel's side compartment is flooded as a result of a collision. Sketch the vessel's statical stability diagram, showing the effects of the resulting reduction in freeboard and angle of list. (20)

(b) Describe the countermeasures that may be taken in the event of such flooding. (15)

5. (a) List the surveys required by the current Load Line Regulations for a vessel to maintain a valid Load Line Certificate. (5)

(b) List the items surveyed at a periodic Load Line Survey, describing the nature of the survey for EACH item. (30)

NOV 2005

6. (a) Explain the use of EACH of the following items of information as found in the *Stability Data Booklet*:

(i) *Plan showing Cargo Spaces, Storerooms and Tanks;* (2)

(ii) *Cargo Capacities* table; (4)

(iii) the FSM in the *Tank Capacities* table for fuel oil of a relative density less than FW. (4)

(b) A vessel has the following particulars:

Displacement 16250t KG 8.581m

Using the *Maximum KG* table contained in the *Stability Data Booklet,* determine whether the vessel complies with the minimum intact stability criteria specified in the current Load Line Regulations. (5)

(c) Sketch a supply vessel's statical stability diagram, showing how the GZ curve for the vessel calculated on a *free trim* basis may differ from that calculated on a *fixed trim* basis. (10)

MARCH 2006

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box shaped vessel floating on even keel in salt water has the following particulars:

   Length 170.00m Breadth 22.00m
   Draught: 9.20m KG 6.50m

   There is an empty forward end compartment, length 21.00m extending the full width of the vessel.

   Calculate the draughts forward and aft, if this compartment is bilged. (35)

2. A vessel, initially upright and on an even keel, has the following particulars:

   Draught (in salt water) 6.80m Breadth 20.42m KG 7.88m

   Further particulars of the vessel can be found in the *Stability Data Booklet*.

   The vessel's heavy lift derrick is to be used to discharge a 60 tonne tank from a centreline position, Kg 5.23m. The derrick head is 29.28m above the keel and 15.80m out of the centreline when plumbing overside.

   (a) Calculate the maximum list angle. (15)

   (b) Calculate the increase in draught when the vessel is at maximum list angle as calculated in Q2(a), assuming rectangular cross section midships. (8)

   (c) Calculate the maximum allowable KG prior to discharging the tank in order to limit the list angle to 5 degrees. (12)

3. A vessel is floating in dock water of R.D. 1.012.
   Present draughts are as follows:

   Forward (mean) 6.500m; Midships (port) 7.160m; Midships (starboard) 7.140m;
   Aft (mean) 7.700m

   The draught marks are displaced as follows:

   Forward: 2.40m aft of the FP.
   Aft: 3.60m forward of the AP.
   Midships: 1.96m aft of the amidship line.

   Using the *Stability Data Booklet* and Worksheet Q3, determine the vessel's displacement. (35)

MARCH 2006

4. With reference to the current Load Line Regulations:

   (a) define a *Type B* ship; (5)

   (b) explain, for a *Type A* ship, the corrections to be applied to the Tabular freeboard in order to obtain the Assigned freeboard, clearly indicating the reason why the freeboard has been increased or decreased in each case. (30)

5. (a) Describe the minimum damaged stability requirements for a passenger ship having sustained the damage assumed in the current regulations. (20)

   (b) Describe the additional stability requirements with respect to water on deck that must be satisfied by Ro-Ro passenger vessels as required under the *Stockholm Agreement*. (10)

6. (a) Describe how an initially unstable vessel regains an effective positive GM when lying at an angle of loll. (10)

   (b) Describe the dangers to a vessel at an angle of loll in a seaway. (12)

   (c) Distinguish between an angle of loll and an angle of list. (8)

(This Worksheet must be returned with your answer book)

DRAUGHT SURVEY REPORT

			metres
Draught Forward			
FP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed Trim}$		
Draught at FP			
Draught Aft			
AP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed Trim}$		
Draught at AP			
True Trim			
Draught (M) Port			
Draught (M) Star.			
Draught Midships Mean			
Amidship line correction	$\frac{\text{Dist. marks displaced}}{LBP} \times \text{True Trim}$		
Draught at Amidships			
Corrected Midship Draught	$\frac{d_{FP} + (6 \times d_M) + d_{AP}}{8}$		

TPC		LCF foap	

			tonne
Displacement			
1st Trim Corrn. (Layer)	$\frac{\text{Dist CF from Midships} \times \text{Trim} \times \text{TPC}}{LBP}$		
2nd Trim Corrn. (Form)	$\frac{50 \times \text{True Trim}^2 \times (MCTC_2 - MCTC_1)}{LBP}$		
Corrected Displacement			
Dock Water Displacement	$\Delta \times \frac{\text{R.D. Dock Water}}{1.025}$		

Candidate's Name ..... Examination Centre .....

JULY 2006

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box shaped vessel floating upright on an even keel in salt water has the following particulars:
Length$_{BP}$ 150.00m Breadth 28.00m Even keel draught 8.60m KG 9.20m
The vessel has two longitudinal bulkheads each 9.00m from the side of the vessel.

   Calculate the angle of heel if a midship side compartment 24.00m long is bilged. (35)

2. Worksheet Q2 - *Trim and Stability* provides data relevant to a particular condition of loading in a vessel in salt water.
The *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.

   By completion of the Worksheet Q2 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (15)

   (b) the draughts forward and aft. (20)

3. A vessel has the following particulars:
Displacement 17 000t Even keel draught 8.03m Maximum breadth 21.00m
KG 8.00m KM 8.35m KB 4.17m

   (a) Explain why this vessel will heel when turning. (5)

   (b) Calculate the angle and direction of heel when turning to starboard in a circle of diameter 500m at a speed of 17.5 knots. (20)
   Note: assume 1 nautical mile = 1852m, and g = 9.81 m/sec^2

   (c) Calculate the new maximum draught during the turn in Q3(b), assuming the midships cross-section can be considered rectangular. (10)

4. With reference to the *International Grain Code (IMO)*:

   (a) describe how the heeling arm curve is derived; (12)

   (b) state the minimum intact stability criteria required; (10)

   (c) describe the measures which may be taken to minimise grain heeling moments. (13)

TOVER

JULY 2006

5. (a) A vessel loads a packaged timber cargo on deck such that there is an increase in the vessel's KG and an effective increase in freeboard.

Sketch the vessel's GZ curve, showing the effect of loading this cargo. (14)

(b) Sketch how the GZ curve for a vessel with a zero GM is affected by EACH of the following:

(i) a rise in the vessel's KG; (8)

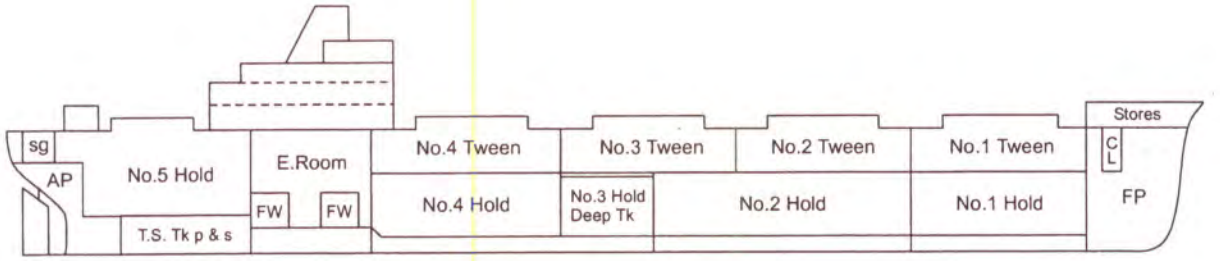
(ii) a reduction in the vessel's KG. (8)

6. (a) State the surveys required in order that an International Load Line Certificate remains valid. (5)

(b) List the items to be inspected during the surveys stated in Q6(a), stating the nature of the examination required for each. (25)

(This Worksheet must be returned with your answer book)

TRIM & STABILITY



CONDITION: LOADED – GENERAL CARGO

Compartment	Capacity m^3	Stowage Factor m^3/t	Weight t	KG m	Vertical Moment tm	Free Surface Moment tm	LCG foap m	Longitudinal Moment tm
All Holds	15875	1.94		4.86			68.1	
1 TD	1265	2.37		10.98			114.0	
2 TD	1332	2.53		10.42			95.6	
3TD	1406	2.49		10.33			74.0	
4 TD	1230	2.66		10.18			55.0	
Oil Fuel			856		1786	868		31020
Fresh Water			84		618	75		4550
Lightship			3831	8.21			61.66	
DISPLACEMENT								

HYDROSTATICS	True Mean Draught	LCB foap	LCF foap
	MCTC		
TRIM			KM_T
			KG
DRAUGHTS: F.	A.		GM

Candidate's Name .....

Examination Centre .....

NOVEMBER 2006

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is floating in salt water at draughts 7.80m forward, 8.24m aft. The vessel is to load cargo so as to finish on an even keel at a load draught of 8.68m. Two spaces available: No. 1 hold, Lcg 118m foap; No.5 hold, Lcg 15m foap

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the total weight of cargo to load; (15)

   (b) the weight of cargo to load in each compartment. (20)

2. A vessel is floating at an even keel draught of 7.25m in salt water. KG 7.20m. A midship rectangular deck 28.00m long and extending the full breadth of the vessel is flooded with salt water to a depth of 0.50m.
   Height of deck above keel 9.60m.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the fluid GM; (20)

   (b) the angle of loll. (15)

3. A vessel is floating in dock water of R.D. 1.016.
   Present draughts:
   Forward 7.50m; Midship (Port) 8.44m; Midship (Starboard) 8.38m; Aft 8.90m

   The draught marks are displaced as follows:
   Forward: 1.86m aft of the FP.
   Aft: 2.50m aft of the AP.
   (The midship draught marks are not displaced)
   The *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.
   By completion of the Worksheet Q3 and showing any additional calculations in the workbook, determine EACH of the following:

   (a) the vessel's displacement; (30)

   (b) the maximum cargo to load for a Summer Load Line Zone. (5)

   Note: assume no hog or sag in the Summer Load condition.

4. A vessel operating in severe winter conditions may suffer from non-symmetrical ice accretion on decks and superstructure.
Describe, with the aid of a sketch of the vessel's curve of statical stability, the effects on the overall stability of the vessel. (35)

5. Identify the stability problems associated with the design and operation of offshore supply vessels. (30)

6. (a) Explain how a vessel's still water rolling period is affected by changes in the distribution of weight aboard the vessel. (10)

   (b) Explain the term *synchronous rolling*, describing the dangers associated with it. (12)

   (c) Describe the actions that could be taken by the ship's officer when it becomes apparent that the vessel is experiencing *synchronous rolling*. (8)

(This Worksheet must be returned with your answer book)

DRAUGHT SURVEY REPORT

			metres
Draught Forward			
FP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}}$ x Observed Trim		
Draught at FP			
Draught Aft			
AP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}}$ x Observed Trim		
Draught at AP			
True Trim			
Draught (M) Port			
Draught (M) Star.			
Draught Midships Mean			
Amidship line correction	$\frac{\text{Dist. marks displaced}}{\text{LBP}}$ x True Trim		
Draught at Amidships			
Corrected Midship Draught	$\frac{d_{FP} + (6 \times d_M) + d_{AP}}{8}$		

TPC		LCF foap	

			tonne
Displacement			
1st Trim Corrn. (Layer)	$\frac{\text{Dist CF from Midships x Trim x TPC}}{\text{LBP}}$		
2nd Trim Corrn. (Form)	$\frac{50 \times \text{True Trim}^2 \times (MCTC_2 - MCTC_1)}{\text{LBP}}$		
Corrected Displacement			
Dock Water Displacement	$\Delta \times \frac{\text{R.D. Dock Water}}{1.025}$		

MARCH 2007

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is floating upright and is to load TWO weights using the ship's own derrick. The maximum allowable list is 4 degrees.
Initial draughts: 7.30m, forward and aft, in fresh water.
Derrick head 26.5m above the keel.
Two weights, each 42 tonne, are on the quay 17.5m from the vessel's centreline.
Stowage position on deck, Kg 12.0m, 7.2m either side of the vessel's centreline. The inboard weight is to be loaded first.

   Using the *Stability Data Booklet,* calculate the minimum initial GM. (35)

2. A vessel is planning to enter drydock in salt water.
Present draughts: Forward 4.00m Aft 5.60m KG 8.74m

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the maximum trim at which the vessel can enter drydock so as to maintain a GM of at least 0.15m at the critical instant. (28)
   Note: assume KM remains constant.

   (b) the weight of ballast to transfer from the aft peak to the fore peak in order to reduce the trim to the maximum allowable. (7)

3. A vessel's loaded particulars in salt water are as follows:
Displacement 18000 tonne Fluid KG 8.10m

   Using the *Stability Data Booklet*, sketch the vessel's statical stability curve and compare the vessel's stability with ALL the minimum stability criteria required by the current Load Line Regulations. Comment on the result. (35)

4. A vessel with a high deck cargo of containers will experience adverse effects due to strong beam winds on lateral windage areas.

   Explain, with the aid of a sketch of the statical stability curve, how the effects of steady and gusting winds are determined, stating the minimum stability requirements with respect to wind heeling under the current regulations. (35)

MARCH 2007

5. Discuss the stability problems associated with the design and operation of a conventional RoRo vehicle ferry. (30)

6. With reference to the current Load Line Regulations:

   (a) distinguish between a Type A vessel and a Type B vessel, explaining why they have different *tabular freeboards*; (15)

   (b) identify the additional corrections required when converting *basic freeboard* to *assigned freeboard*, explaining the reason for EACH correction. (15)

JULY 2007

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is to transit a canal with a minimum clearance of 0.40m under a bridge, the underside of which is 20.38m above the waterline.

   Present draughts in fresh water: Forward 5.42m Aft 6.56m
   The aft mast is 39m foap and extends 27.10m above the keel.
   The fore mast is 108m foap and extends 26.00m above the keel.
   (Assume masts are perpendicular to the waterline throughout)

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the final draughts forward and aft in order to pass under the bridge with minimum clearance; (17)

   (b) the minimum weight of ballast to load in order to pass under the bridge with minimum clearance. (18)

2. A vessel is floating upright in fresh water and is about to enter drydock.
   The vessel's particulars are:
   KG 8.37m Forward draught 4.89m Aft draught 6.71m

   (a) Using the *Stability Data Booklet*, calculate the vessel's effective GM at the critical instant. (25)

   (b) Describe methods of improving the initial stability if the GM at the critical instant is found to be inadequate. (10)

3. A box shaped vessel floating on an even keel in salt water has the following particulars:

   Length 130.00m Breadth 24.00m Draught 4.98m

   There is a midship watertight compartment of length 20.00m, height 7.20m, that extends the full width of the vessel and is filled with cargo of relative density 0.80 stowing at $1.70m^3$/tonne.

   If this compartment is bilged, calculate EACH of the following:

   (a) the final draught; (15)

   (b) the change in GM. (20)

JULY 2007

4. (a) The current Load Line Regulations require the master to be provided with stability particulars for various pre-worked conditions. Detail the information to be provided for a given service condition, describing how this information may be presented. (25)

(b) A vessel plans to depart from port at:

Displacement 19 000t KG 7.80m

During the ensuing voyage the vessel will consume 420t of fuel oil (Kg 0.60m) and 35t of fresh water (Kg 7.35m) from full tanks causing a free surface moment of 1721tm.

Using the *Maximum KG Table* in the *Stability Data Booklet*, determine the stability condition of the ship BOTH on departure and on arrival. (10)

5. (a) Explain why a vessel laden to the same draught on different voyages may have different natural rolling periods. (10)

(b) Explain the term *synchronous rolling*, describing the dangers associated with it. (12)

(c) State the actions to be taken by the ship's officer when it becomes apparent that the vessel is experiencing *synchronous rolling*. (8)

6. (a) Sketch the statical stability diagram for EACH of the following:

(i) an angle of loll condition due to a small negative GM; (5)

(ii) a listed condition due to an offcentre weight; (5)

(iii) the combined effect of a small negative GM and an offcentre weight. (5)

(b) An unstable vessel lying to an angle of loll to port has an empty double bottom tank subdivided into three watertight compartments (port, centre, starboard) of equal width. The tank must be ballasted to return the vessel to a safe condition.

Describe the sequence of actions that should be taken and the possible effects throughout each stage. (15)

NOVEMBER 2007

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is to load a cargo of grain (stowage factor 1.62m^3/t).
Initial displacement 6300 tonne Initial KG 6.50m
All five holds are to be loaded full of grain.
The tween decks are to be loaded as follows:

No. 1 TD	Part full – ullage 1.50m
No. 2 TD	Full
No. 3 TD	Full
No. 4 TD	Part full – ullage 2.75m

The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

(a) Using the *Maximum Permissible Grain Heeling Moment Table* included in the *Stability Data Booklet,* determine whether the vessel complies with the minimum criteria specified in the *International Grain Code (IMO).* (30)

(b) Calculate the ship's approximate angle of heel in the event of the grain shifting as assumed by the *International Grain Code (IMO).* (5)

2. (a) A box shaped vessel, length 90.00m, breadth 10.00m, depth 9.00m, is floating at a draught of 4.10m in salt water. Initial KG 3.70m.

Calculate the angle of loll if 580 tonne of cargo, Kg 7.80m, is loaded on deck. (25)

(b) Calculate the GM at the angle of loll in Q2(a). (10)

3. A box shaped vessel floating on even keel in salt water has the following particulars:

Length	160.00m	Breadth	22.00m
Draught	9.10m	KG	6.60m

There is an empty forward end compartment, length 20.00m extending the full width of the vessel.

Calculate the draughts forward and aft, if this compartment is bilged. (35)

4. Describe a Type 'A' vessel under the current Load Line Regulations, including the flooding, stability and assumed damage requirements for a newly built vessel. (35)

[OVER

5. Sketch a vessel's curve of statical stability showing the effects of EACH of the following:

   (a) an increase in freeboard; (10)

   (b) an increase in beam; (10)

   (c) an increase in free surface effect. (10)

6. List TEN items of the stability and stress data required to be supplied to ships under the current Load Line Regulations, stating how EACH item may be used. (30)

MARCH 2008

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel of length 152.00m, KG 8.28m, is floating upright in salt water at a True Mean Draught of 5.50m.

   The vessel has a rectangular double bottom of length 22.00m, breadth 16.00m, depth 2.00m, which is subdivided by a longitudinal centreline division into port and starboard tanks of equal dimensions.

   Using the *Stability Data Booklet*, calculate the angle of heel after partially filling the port side of this tank with 240 tonne of fuel oil, relative density 0.874. (35)

2. A vessel's present particulars are:

   Forward draught 7.60m, Aft draught 8.80m in salt water.

   A total of 300 tonne of cargo, Lcg 74.00m foap, is to be discharged immediately and then the vessel is to proceed to an upriver berth where the relative density of the dock water is 1.007.

   During the passage the following items of deadweight are consumed:

80t of Heavy Fuel Oil from	No. 3 D.B. Centre tank
22t of Diesel Oil from	No. 4 D.B. Port tank
22t of Diesel Oil from	No. 4 D.B. Starboard tank
15t of Fresh Water from	After Fresh Water tank

   Using the *Stability Data Booklet,* calculate the draughts fore and aft, on arrival at the upriver berth. (35)

3. A vessel's loaded particulars in salt water are as follows:

   Displacement 15000 tonne Fluid KG 8.10m

   Using the *Stability Data Booklet*, compare the vessel's stability with all the minimum stability criteria required by the current Load Line Regulations. (35)

4. (a) Describe the special factors affecting the assignment of timber loadlines. (15)

   (b) Describe the intact stability requirements for vessels assigned with timber loadlines. (20)

MARCH 2008.

5. (a) State the purpose of the inclining experiment. (5)

(b) Describe the precautions to be taken, by the ship's officer, before and during the experiment. (16)

(c) List the circumstances when the inclining experiment is required to take place on passenger vessels. (9)

6. A vessel is to use a ship's heavy lift derrick to load a locomotive from ashore.

Describe, with the aid of a sketch of the vessel's curve of statical stability, the effects on the overall stability of the vessel when the weight is first lifted from a position well away from the ship's centreline. (30)

JULY 2008

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel's present particulars are as follows:

   A vessel is floating in salt water at a Forward draught of 8.300m and Aft draught of 8.500m. KG 8.00m. Vessel upright.

   The vessel is to load bunkers (heavy fuel oil) into No. 3 DB port and starboard tanks and sail upright at a maximum draught of 8.500m.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the maximum weight of bunkers to load; (15)

   (b) the weight of ballast to transfer between the Aft Peak and the Fore Peak so that the vessel sails on an even keel. (20)

2. Worksheet Q2 - *Trim and Stability* provides data relevant to a particular condition of loading in a vessel in salt water.

   All holds and tween decks are to be filled with grain (S.F. 1.62m^3/t).

   The *Stability Data Booklet* provides the necessary data for the vessel.

   By completion of the Worksheet Q2 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (15)

   (b) the draughts forward and aft. (20)

3. A vessel is floating at an even keel draught of 8.600m in salt water. KG 7.40m

   A midship rectangular deck 29.00m long and extending the full breadth of the vessel is flooded with salt water to a depth of 0.40m.

   Height of deck above keel 11.75m.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the fluid GM; (20)

   (b) the angle of loll. (15)

JULY 2008.

4. Describe the general provisions of the current Load Line Regulations governing the ability of Type B vessels with reduced freeboard to withstand flooding due to damage, and the stability in the final condition after such damage. (30)

5. (a) State the minimum stability requirements for a vessel under the current Load Line Regulations. (10)

(b) At ballast draught a vessel complies in every respect with the stability requirements of the Load Line Regulations. At load draught, with the same GM, the vessel does not comply.

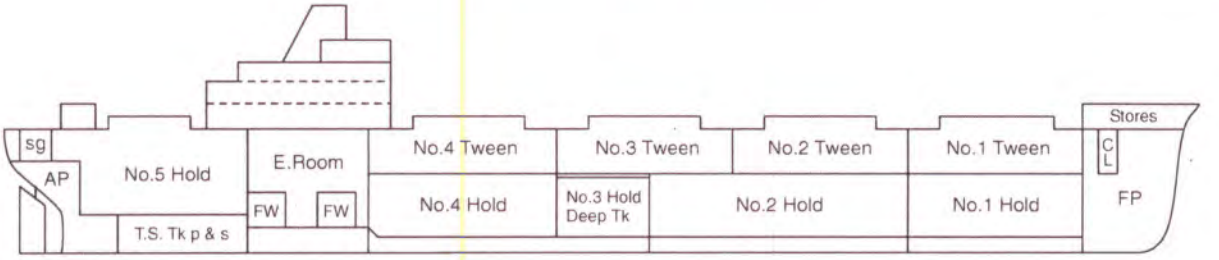
Explain, with the aid of a diagram, why the vessel no longer complies. (15)

(c) Sketch a vessel's GZ curve, showing the effect of free surface due to a tank becoming slack, on the curve. (10)

6. Discuss the stability problems associated with the design and operation of a conventional RoRo vehicle ferry. (30)

WORKSHEET Q2

TRIM & STABILITY



CONDITION: LOADED – GRAIN S.F. 1.62 m^3/t

Compartment	Grain Capacity m^3	Stowage Factor m^3/t	Weight t	KG m	Vertical Moment tm	Free Surface Moment tm	LCG foap m	Longitudinal Moment tm
All Holds		1.62		5.64			69.1	
1 TD		1.62		11.26			115.5	
2 TD		1.62		10.78			95.6	
3TD		1.62		10.59			74.1	
4 TD		1.62		10.57			51.7	
Oil Fuel			913		1917	2184		31042
Fresh Water			86		634	75		2550
Lightship			3831	8.21			61.7	
DISPLACEMENT								

HYDROSTATICS	True Mean Draught	LCB foap	LCF foap
	MCTC		
TRIM			KM_T
			KG
DRAUGHTS:			GM

Candidate's Name ..... Examination Centre .....

NOVEMBER 2008

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. (a) A vessel, initially upright, is to carry out an inclining test.

Present displacement 5530t. KM 10.75m

Total weights on board during the experiment:

Ballast	350t	Kg 3.52m	Tank full.
Bunkers	172t	Kg 4.01m	Free surface moment 897 tm
Water	93t	Kg 4.46m	Free surface moment 916 tm
Boiler water	16t	Kg 4.19m	Free surface moment 115 tm
Inclining weights	50t	Kg 8.60m	

A deck crane, weight 21t and still ashore, will be fitted on the vessel at a Kg of 9.90m at a later date.

The plumblines have an effective vertical length of 8.24m. The inclining weights are shifted transversely 7.3m on each occasion and the mean horizontal deflection of the plumbline is 0.68m.

Calculate the vessel's Lightship KG. (30)

(b) Explain why a vessel's Lightship KG may change over a period of time. (5)

2. A vessel is to load a cargo of grain (stowage factor $1.65m^3/t$).

Initial displacement 6200t Initial KG 8.50m
All five holds are to be loaded full of grain.

The tween decks are to be loaded as follows:

No. 1 TD	Full
No. 2 TD	Empty
No. 3 TD	Part full – ullage 1.50m
No. 4 TD	Full

The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

Using the KN tables to construct a GZ curve, determine whether the vessel complies with the minimum criteria specified in the *International Grain Code (IMO)*. (40)

NOV 2008.

3. A vessel has the following particulars:

Displacement 15000t Even keel draught 8.170m Maximum breadth 20.80m
KG 7.88m KM 8.33m KB 4.15m

(a) Calculate the angle and direction of heel when turning to port in a circle of diameter 490m at a speed of 17.2 knots. (20)

Note: assume 1 nautical mile = 1852m, and g = 9.81 m/sec^2

(b) Calculate the new maximum draught during the turn in Q3(a), assuming the midships cross-section can be considered rectangular. (10)

4. (a) A vessel's side compartment is flooded as a result of a collision. Sketch the vessel's statical stability diagram, showing the effects of the resulting reduction in freeboard and angle of list. (20)

(b) Describe the countermeasures that may be taken in the event of the flooding in Q4(a). (15)

5. A ship is loading in a port in a Tropical zone for a port in a Winter seasonal zone during winter months.
Describe the various precautions and considerations which must be borne in mind at the loading port in order that the voyage is accomplished safely, in accordance with the requirements of the Load Line Rules. (30)

6. (a) Discuss the use and relative accuracy of EACH of the following means of assessing the weight of cargo loaded:

(i) TPC using initial and final midship draughts; (5)

(ii) change in displacement using arithmetic mean of forward and aft draughts (AMD); (5)

(iii) change in displacement using true mean of forward and aft draughts (TMD); (5)

(iv) Draught Survey. (5)

(b) Explain the use of EACH of the following items of information found in the *Stability Information Booklet:*

(i) *Cargo Capacities* table; (4)

(ii) the FSM in the *Tank Capacities* table for fuel oil of a relative density less than FW. (6)

APRIL 2009

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel's present particulars are:

   Forward draught 8.180m, Aft draught 9.420m at an upriver berth in fresh water.

   The vessel is to proceed downriver to cross a sand bar at the river entrance where the relative density of the water is 1.020.

   During the river passage the following items of deadweight will be consumed:

60t	of Heavy Fuel Oil from	No. 3 D.B. Centre tank
21t	of Diesel Oil from	No. 4 D.B. Port tank
21t	of Diesel Oil from	No. 4 D.B. Starboard tank
18t	of Fresh Water from	After Fresh Water tank

   (a) Using the *Stability Data Booklet,* calculate the clearance of the vessel over the bar if the depth of water over the sand bar is 9.500m. (35)

   (b) State the maximum clearance over the sand bar if the vessel is brought to an even keel condition by internal transfer of ballast. (5)

2. A vessel is floating upright in salt water and is about to drydock.

   The vessel's particulars are:

   Length 137.5m KG 8.34m

   Present draughts: Forward 5.420m Aft 6.560m

   (a) Using the *Hydrostatic Particulars* included in the *Stability Data Booklet*, calculate the vessel's effective GM at the critical instant. (25)

   (b) Describe methods of improving the initial stability if the GM at the critical instant is found to be inadequate. (10)

APRIL 2009.

3. A vessel is floating in dock water of R.D. 1.013.

Present draughts:
Forward 7.940m; Midship (Port) 8.610m; Midship (Starboard) 8.550m; Aft 9.120m

The draught marks are displaced as follows:
Forward: 1.66m aft of the FP.
Aft: 2.14m forward of the AP.
The midship draught marks are not displaced.

The *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.

By completion of the Worksheet Q3 and showing any additional calculations in the answer book, determine the vessel's displacement. (30)

4. (a) Distinguish between the causes of an angle of loll and an angle of list. (8)

(b) Describe the dangers to a vessel at an angle of loll in a seaway. (12)

(c) Distinguish between the method of correction of an angle of list and the method of correction of an angle of loll. (10)

5. With reference to the International Grain Code (IMO):

(a) describe how the heeling arm curve is derived; (12)

(b) state the minimum intact stability criteria required; (10)

(c) describe the measures that may be taken to minimise grain heeling moments. (13)

6. Explain, for a 'Type A' ship, the corrections to be applied to the *Tabular Freeboard* in order to obtain the *Assigned Freeboard*, clearly indicating the reason why the freeboard has been increased or decreased in each case. (30)

(This Worksheet must be returned with your answer book)

DRAUGHT SURVEY REPORT

			metres
Draught Forward			
FP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed Trim}$		
Draught at FP			
Draught Aft			
AP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed. Trim}$		
Draught at AP			
True Trim			
Draught (M) Port			
Draught (M) Star.			
Draught Midships Mean			
Amidship line correction	$\frac{\text{Dist. marks displaced}}{LBP} \times \text{True Trim}$		
Draught at Amidships			
Corrected Midship Draught	$\frac{d_{FP} + (6 \times d_M) + d_{AP}}{8}$		

TPC		LCF foap	

			tonne
Displacement			
1st Trim Corrn. (Layer)	$\frac{\text{Dist. of CF from Midships} \times \text{Trim} \times \text{TPC}}{LBP}$		
2nd Trim Corrn. (Form)	$\frac{50 \times \text{True Trim}^2 \times (MCTC_2 - MCTC_1)}{LBP}$		
Corrected Displacement			
Dock Water Displacement	$\Delta \times \frac{\text{R.D. Dock Water}}{1.025}$		

JULY 2009

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box-shaped vessel floating on an even keel in salt water has the following particulars:

   Length 140.00m Breadth 30.00m Draught 6.500m KG 9.80m

   The vessel has a centreline watertight bulkhead with an empty amidships side compartment of length 22.00 m on each side of the vessel.

   Calculate the angle of heel if ONE of these side compartments is bilged. (35)

2. A vessel in salt water is trimmed 0.32m by the stern and heeled 8° to starboard and has the following particulars:

   Displacement 10600 tonne KG 8.52m

   Tunnel side tanks, port and starboard, are full of fuel oil and have centroids 4.30m each side of the centreline. No 3 D.B. tanks, port and starboard, are empty and have centroids 4.80m each side of the centreline.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the total weight of fuel oil to transfer from the Tunnel side tanks to No.3 D.B. tanks in order to bring the vessel to even keel; (10)

   (b) the final weight of fuel oil transferred into EACH of No. 3 D.B. tanks in order to bring the vessel upright, assuming equal quantities are taken from the Tunnel side port and starboard tanks. (25)

3. A vessel is to enter drydock in dock water of relative density 1.013.

   Draughts: Forward 3.100m Aft 4.700m KG 9.55m

   (a) Using the *Stability Data Booklet*, calculate the maximum trim at which the vessel can enter drydock so as to maintain a GM of at least 0.15m at the critical instant. Assume KM remains constant. (30)

   (b) Describe the measure to be taken to ensure that the stability of the vessel is adequate when the dock is flooded prior to the ship leaving the dock. (5)

JULY 2009

4. With reference to the *International Grain Code (IMO)*:

(a) describe how the heeling arm curve is derived; (12)

(b) state the minimum intact stability criteria required; (10)

(c) describe the measures which may be taken to minimise grain heeling moments. (13)

5. For EACH of the following conditions, sketch the vessel's curve of statical stability showing the effect of the condition on EACH curve:

(a) a strong beam wind on a vessel with a high freeboard and a large number of containers on deck; (10)

(b) a change in the KG of the vessel due to the consumption of fuel and water from double bottom tanks during the voyage; (10)

(c) an increase in beam. (10)

6. With reference to the current Passenger Ship Construction Regulations:

(a) state the extent of assumed hull flooding and damage when calculating the ship's ability to survive hull damage; (10)

(b) describe the minimum damaged stability requirements for a passenger ship having sustained the assumed damage. (20)

NOV 2009

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box shaped vessel floating on an even keel in salt water has the following particulars:

   Length 120.00m Breadth 22.00m Draught 5.00m

   There is a midship compartment of length 16.00m, extending the full breadth of the vessel and from the watertight tank top to the freeboard deck.
   Permeability of compartment 0.65. Height of watertight tank top 1.80m

   If this compartment is bilged, calculate EACH of the following:

   (a) the final draught; (15)

   (b) the change in GM. (20)

2. A box shaped vessel, length 96.00m, breadth 11.00m, is floating at a draught of 4.20m in salt water. Initial KG 4.18m.

   (a) Calculate the angle of loll if 620 tonne of cargo, Kg 7.78m, is loaded on deck. (25)

   (b) Calculate the GM at the angle of loll in Q2(a). (10)

3. Worksheet Q3 - *'Trim and Stability'* provides data relevant to a particular condition of loading in a vessel in salt water.

   The *Hydrostatic Particulars* included in the *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.

   By completion of the Worksheet Q3 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (15)

   (b) the draughts forward and aft. (20)

NOV 2009

4. (a) Explain the virtual loss of metacentric height during drydocking. (12)

(b) Explain why the KM in the freely floating condition, prior to drydocking, should not be used in the calculation of the GM at the critical instant. (5)

(c) Explain why it usual for a vessel to enter drydock with a stern trim. (8)

(d) Describe the practical measures that can be taken to improve stability prior to drydocking if it is found to be inadequate. (10)

5. (a) Explain how wind heeling moments are calculated. (8)

(b) Sketch a vessel's curve of statical stability, showing the effects of a strong beam wind. (10)

(c) Sketch a supply vessel's statical stability diagram showing how the GZ curve for the vessel calculated on a *Free Trim* basis may differ from that calculated on a *Fixed Trim* basis. (12)

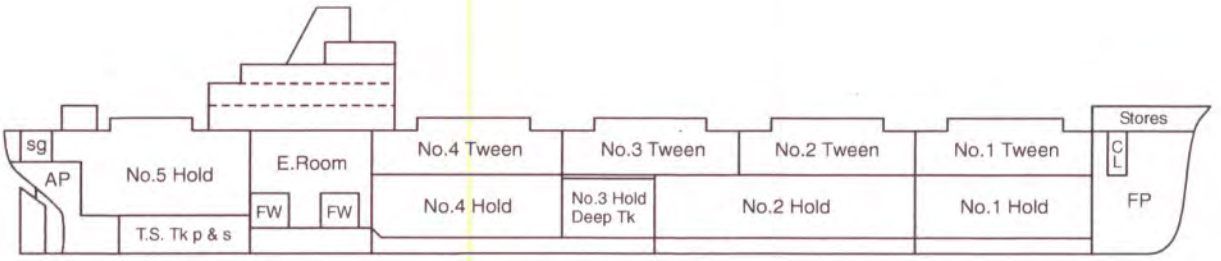
6. (a) Define *dynamical stability*. (6)

(b) List the information that can be extracted from a statical stability curve. (6)

(c) State the intact stability requirements for vessels assigned with timber loadlines. (18)

WORKSHEET Q3

TRIM & STABILITY



CONDITION: LOADED – GENERAL CARGO Length of vessel: 137.50m

Compartment	Grain Capacity m^3	Stowage Factor m^3/t	Weight t	KG m	Vertical Moment tm	Free Surface Moment tm	LCG foap m	Longitudinal Moment tm
All Holds	14606	1.88		5.86			68.6	
1 TD	1365	2.22		10.98			114.0	
2 TD	1332	2.36		10.50			95.6	
3TD	1435	2.14		10.37			74.0	
4 TD	1230	2.28		10.28			53.0	
Oil Fuel			856		1786	568		30074
Fresh Water			83		610	81		4590
Lightship			3831	8.21			69.68	
DISPLACEMENT								

HYDROSTATICS	True Mean Draught	LCB foap	LCF foap
	MCTC		
TRIM			KM_T
			KG
DRAUGHTS: F.	A.		GM

Candidate's Name ..... Examination Centre .....

MARCH 2010

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel, initially upright and on an even keel, has the following particulars:

   Draught (in salt water) 7.000m Breadth 20.42m KG 7.82m

   Further particulars of the vessel can be found in the *Stability Data Booklet*.

   The vessel's heavy lift derrick is to be used to discharge a 58 tonne boiler from a centreline position, Kg 5.30m. The derrick head is 30.00m above the keel and 16.00m from the ship's centreline when plumbing overside.

   (a) Calculate the maximum list angle when the boiler is suspended by the derrick at its maximum outreach during discharge. (15)

   (b) Calculate the increase in draught when the vessel is at the maximum list angle calculated in Q1(a), assuming a rectangular cross section midships. (8)

   (c) Calculate the maximum allowable KG prior to discharging the boiler in order to limit the list angle to 5 degrees. (12)

2. (a) A vessel, initially upright, is to carry out an inclining test.

   Present displacement 5300t. KM 10.96m

   Total weights on board during the experiment:

Ballast	390t,	Kg 3.45m.	Tank full.
Bunkers	175t,	Kg 4.01m.	Free surface moment 996 tm
Water	102t,	Kg 4.45m.	Free surface moment 890 tm
Boiler water	20t,	Kg 4.19m.	Free surface moment 101tm
Inclining weights	48t,	Kg 8.42m	

   A weather deck hatch cover, weight 20t, ashore for repair will be fitted on the vessel at a Kg of 9.46m prior to sailing.

   The plumblines have an effective vertical length of 8.00m. The inclining weights are shifted transversely 7.60m on each occasion and the mean horizontal deflection of the plumbline is 0.68m.

   Calculate the vessel's Lightship KG. (25)

   (b) List FIVE possible causes for a change to the vessel's Lightship KG over a period of time. (10)

MARCH 2010

3. A box shaped vessel floating on even keel in dock water of R.D. 1.015 has the following particulars:

Length 130.00m Breadth 21.00m
Draught 8.000m MCTC (salt water) 300

There is an empty watertight forward end compartment, length 10.00m, height 6.70m, extending the full width of the vessel.

Calculate the draughts forward and aft, if this compartment is bilged. (35)

4. (a) Explain why a vessel laden to the same draught on different voyages may have different natural rolling periods. (12)

(b) Explain the term *synchronous rolling*, describing the dangers associated with it. (10)

(c) State the actions to be taken by the ship's officer when it becomes apparent that the vessel is experiencing *synchronous rolling*. (8)

5. With reference to the current Load Line Regulations:

(a) define a *Type B* ship; (5)

(b) explain, for a *Type A* ship, the corrections to be applied to the Tabular freeboard in order to obtain the Assigned freeboard, clearly indicating the reason why the freeboard has been increased or decreased in EACH case. (30)

6. (a) A vessel is to fill a rectangular double bottom extending the full breadth of the vessel with water ballast.

Sketch the vessel's curve of statical stability on the same axis for EACH of the following conditions:

- Tank empty;
- Tank 5% full;
- Tank 100% full. (20)

(b) A vessel has the following particulars:

Initial Displacement 9250t KG 9.120m

A double bottom tank Kg 0.50m, is to be partially filled with 250t of fresh water resulting in a FSM of 1019tm.

Using the *Maximum KG* table contained in the *Stability Data Booklet*, determine whether the vessel complies with the minimum intact stability criteria specified in the current Load Line Regulations. (10)

JULY 2010

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is upright, starboard side alongside, at a draught of 6.00m in salt water. KG 8.30m.

   There is a 27t boiler on deck, Kg 7.78m, which is to be discharged using the vessel's crane the head of which is 26.0m above the keel. The boiler is to be lifted from a position on the vessel's centreline and landed on a railway truck ashore. The distance of railway truck from vessel's centreline is 23.30m.

   Using the *Hydrostatic Particulars* included in the *Stability Data Booklet*, calculate EACH of the following:

   (23)

   (a) the maximum angle of heel during discharge;

   (b) the maximum angle of heel during discharge if the vessel was first listed 5° to port prior to the discharge of the boiler. (12)

2. A vessel, initially upright, is to carry out an inclining test.

   Present displacement 4800t. KM 10.58m

   Total weights on board during the experiment:

Ballast	400t,	Kg 3.52m.	Tank full.
Bunkers	175t,	Kg 3.86m.	Free surface moment 997 tm
Fresh Water	85t,	Kg 4.46m.	Free surface moment 810 tm
Inclining weights	52t,	Kg 8.42m	

   At the time of the experiment the boilers are empty. They would usually contain a total of 24t of water, Kg 4.18m, with a free surface moment of 124tm.
   A deck crane, weight 18t and still ashore will be fitted on the vessel at a Kg of 9.85m before the next cargo operation.

   The plumbline has an effective vertical length of 7.88m. The inclining weights are shifted transversely 7.20m on each occasion and the mean horizontal deflection of the plumbline is 0.66m.

   (30)

   (a) Calculate the vessel's Lightship KG.

   (b) Identify FIVE possible causes of a change in the vessel's Lightship KG over a period of time. (5)

JULY 2010

3. A vessel is to load a cargo of grain (stowage factor $1.62m^3/t$).

Initial displacement 5900 tonne Initial KG 6.65m

All five holds are to be loaded full of grain.

The tween decks are to be loaded as follows:

No. 1 TD	Part full – ullage 1.75m
No. 2 TD	Full
No. 3 TD	Part full – ullage 2.50m
No. 4 TD	Full

The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

(a) Using the *Maximum Permissible Grain Heeling Moment Table* included in the *Stability Data Booklet,* determine whether the vessel complies with the minimum criteria specified in the *International Grain Code (IMO).* (30)

(b) Calculate the ship's approximate angle of heel in the event of the grain shifting as assumed by the *International Grain Code (IMO).* (5)

4. (a) A vessel loads a packaged timber cargo on deck such that there is an increase in the vessel's KG and an effective increase in freeboard.

Using a sketch, show the effect of loading this cargo on the vessel's GZ curve. (14)

(b) Sketch how the GZ curve for a vessel with a zero GM is affected by EACH of the following:

(i) a rise in the vessel's KG; (8)

(ii) a reduction in the vessel's KG. (8)

JULY 2010

5. (a) Discuss the factors affecting the virtual loss of GM due to a free surface within an undivided rectangular tank. (8)

(b) Explain the effect on the virtual loss of GM due to the free surface when the slack tank is equally divided in EACH of the following situations:

(i) by a longitudinal bulkhead; (5)

(ii) by a transverse bulkhead. (5)

(c) Explain why stability information relating to free surface for a particular tank is usually expressed as a *Free Surface Moment (FSM).* (5)

(d) A double bottom tank, initially empty, is to be ballasted full of salt water.

Sketch a graph to show the way in which the effective KG of the ship will change from the instant of starting to fill the tank until it is full. (12)

6. (a) State the surveys required in order that an International Load Line Certificate remains valid. (5)

(b) List the items to be inspected during the surveys stated in Q6(a), stating the nature of the examination required for EACH. (25)

DECEMBER 2010

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is floating in salt water at draughts 7.640m forward, 8.180m aft.

   The vessel is to load cargo so as to finish on an even keel at a draught of 8.500m. Two spaces available: No. 1 hold and No.5 hold.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the total weight of cargo to load; (15)

   (b) the weight of cargo to load in each compartment. (20)

2. A vessel's loaded particulars in salt water are as follows:

   Displacement 18000 tonne Fluid KG 8.20m

   Using the *Stability Data Booklet*, compare the vessel's stability with ALL the minimum stability criteria required by the current Load Line Regulations, commenting on the result. (35)

3. A vessel is floating at an even keel draught of 7.80m in salt water. KG 7.14m.

   A midship rectangular deck 29.00m long and extending the full breadth of the vessel is flooded with salt water to a depth of 0.60m.

   Height of deck above keel 9.50m.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the fluid GM; (20)

   (b) the angle of loll. (15)

4. (a) State the minimum GM required by the International Grain Code (IMO). (5)

   (b) State the minimum GM required by a vessel assigned reduced freeboard when carrying a timber deck cargo. (5)

   (c) Describe the danger of icing to the stability of a vessel. (10)

   (d) Describe the stability problem associated with vessels engaged in towing. (10)

[OVER

DECEMBER 2010

5. With the aid of labelled sketches, show the effects of EACH of the following on a vessel's curve of statical stability:

   (a) reducing the total free surface moment; (12)

   (b) a tranverse shift of cargo (e.g. Ro/ro units); (12)

   (c) an increase in freeboard. (12)

6. (a) State the surveys required in order that an International Load Line Certificate remains valid. (4)

   (b) List the items to be inspected during the surveys stated in Q6(a), stating the nature of the examination required for EACH. (25)

MARCH 2011

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel's present particulars are:

   Forward draught 7.982m, Aft draught 9.218m at an upriver berth in fresh water.

   The vessel is to proceed downriver to cross a sand bar at the river entrance where the relative density of the water is 1.018.

   During the river passage the following items of deadweight will be consumed:

56t	of Heavy Fuel Oil	from No. 3 D.B. Centre tank
24t	of Diesel Oil	from No. 4 D.B. Port tank
24t	of Diesel Oil	from No. 4 D.B. Starboard tank
15t	of Fresh Water	from Forward Fresh Water tank

   (a) Using the *Stability Data Booklet,* calculate the clearance of the vessel if the depth of water over the sand bar is 9.440m. (30)

   (b) State the maximum clearance over the sand bar if the vessel is brought to an even keel condition by internal transfer of ballast. (5)

2. A box shaped vessel floating at an even keel in salt water has the following particulars:

   Length 100.00m Breadth 15.00m Depth 9.00m Draught 5.000m KG 5.400m

   A midship watertight compartment 20.00m long and extending the full breadth and depth of the vessel is bilged. Permeability of the compartment is 0.85.

   Calculate EACH of the following:

   (a) the new draught; (8)

   (b) the change in GM; (12)

   (c) the righting moment in the flooded condition for an angle of heel of 20 degrees. (15)

MARCH 2011

3. A vessel completes underdeck loading in salt water with the following particulars:

Displacement 15,040 tonne KG 8.00m

The *Stability Data Booklet* provides the necessary data for the vessel.

During the passage 200 tonne of Heavy Fuel Oil (R.D. 0.80) is consumed from No. 3 D.B. tank centre which was full on departure (use VCG of tank for consumption purposes).

Calculate the maximum weight of timber to load on deck Kg 12.60m assuming 15% water absorption during the passage in order to arrive at the destination with the minimum GM (0.05m) allowed under the Load Line Regulations. (35)

Note: Assume KM constant

4. A vessel operating in severe winter conditions may suffer from non-symmetrical ice accretion on decks and superstructure.

Describe, with the aid of a sketch of the vessel's curve of statical stability, the effects on the overall stability of the vessel. (35)

5. List TEN items of the stability and stress data required to be supplied to ships under the current Load Line Regulations, stating for EACH how such information might be used. (30)

6. (a) Explain why the values of trim and metacentric height in the free floating condition are important when considering the suitability of a vessel for drydocking. (10)

(b) Describe TWO methods of determining the upthrust (P force) during the critical period. (10)

(c) Describe how the metacentric height and trim can be adjusted prior to drydocking so as to improve the vessel's stability at the critical instant. (10)

NOVEMBER 2011

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. As a result of a collision a vessel is listed 8° to port in salt water. A deep tank is partially full of an oily water mixture, R.D. 0.95, which is to be fully discharged into a salvage barge alongside. The deep tank is rectangular and is 14.0 m long and 18.0 m wide.

   Present displacement 16000 t KG 8.20 m
   Weight of oily water mixture 846 t Kg 3.20 m

   Using the *Hydrostatic Particulars* contained in the *Stability Data Booklet*, calculate EACH of the following:

   (a) the final list of the vessel; (30)

   (b) the weight of ballast to transfer from a port tank to a starboard tank in order to bring the vessel upright. The centroid of EACH tank is 5.00 m from the centreline. (5)

2. A box-shaped vessel floating on an even keel in salt water has the following particulars:

   Length 120.00 m Breadth 30.00 m Draught 6.600 m KG 11.50 m

   The vessel has a centreline watertight bulkhead with an empty amidships side compartment of length 20.00 m on each side of the vessel.

   (a) Calculate the angle of heel if ONE of these side compartments is bilged as a result of a collision. (30)

   (b) Calculate the clearance over a sand bar in the bilged condition at the entrance of a port of refuge where the depth of water is 11.00 m. (10)

3. A vessel is floating upright in dock water of R.D. 1.012 and is about to drydock.

   The vessel's particulars are:
   Present draughts: Forward 5.340 m Aft 6.660 m KG 8.30 m

   Using the *Stability Data Booklet*, calculate the vessel's effective GM at the critical instant. (25)

NOVEMBER 2011

4. A vessel with a high deck cargo of containers will experience adverse effects due to strong beam winds on lateral windage areas.

   Explain, with the aid of a sketch of the statical stability curve, how the effects of steady and gusting winds are determined, stating the minimum stability requirements with respect to wind heeling under the current regulations. (35)

5. (a) Describe the effects of being in a seaway on a vessel's GZ curve. (8)

   (b) Explain why a vessel laden to the same draught on different voyages may have different natural rolling periods. (12)

   (c) Describe the different rolling characteristics of a vessel for EACH of the following:

      (i) in a stiff condition; (3)

      (ii) in a tender condition; (3)

      (iii) with a small negative GM. (4)

6. (a) The Load Line Regulations require the master to be provided with stability particulars in the stability book for various conditions. Detail the information to be provided for a given service condition, describing how this information may be presented. (20)

   (b) State the purpose of the inclining experiment. (5)

   (c) Describe TEN precautions to be taken by the ship's officer, before and during the inclining experiment. (10)

JULY 2011

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is to transit a canal with a minimum clearance of 0.40 m under a bridge, the underside of which is 21.26 m above the waterline.

   Present draughts in fresh water (R.D. 1.000): Forward 5.380 m Aft 6.560 m

   The fore mast is 110 m foap and extends 26.00 m above the keel.
   The aft mast is 36 m foap and extends 27.20 m above the keel.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the final draughts forward and aft in order to pass under the bridge with minimum clearance; (17)

   (b) the maximum weight of cargo that can be discharged in order to pass under the bridge with minimum clearance. (18)

   Note: Assume masts are perpendicular to the waterline throughout

2. A vessel entered drydock for emergency repairs while carrying cargo.

   Particulars on entry (salt water):
   Displacement 15,716 t Trim 0.64 m by stern KG 8.10 m

   While in drydock 360 tonne of cargo, Kg 3.80 m, Lcg 82.40 m was discharged and is no longer on board. The vessel is now planning to leave drydock.

   (a) Using the *Stability Data Booklet*, calculate the vessel's effective GM at the critical instant on departure. (35)

   (b) State the stability measures that should be considered prior to flooding the dock in order to ensure the safe undocking of this vessel. (5)

JULY 2011

3. (a) Explain why a vessel will heel when turning. (7)

(b) A vessel has the following particulars:

Even keel draught 8.720 m Maximum breadth 22.60 m
KG 7.96 m KM 8.38 m KB 4.18 m

(i) Calculate the angle and direction of heel when turning to port in a circle of diameter 500 m at a speed of 18.2 knots. (20)

(ii) Calculate the new maximum draught during the turn in Q3(b)(i), assuming the midships cross-section can be considered rectangular. (8)

Note: assume 1 nautical mile = 1852 m, and g = 9.81 m/sec^2

4. Sketch a vessel's curve of statical stability, showing the effects of EACH of the following:

(a) a transverse shift of cargo (e.g. Ro/ro unit); (10)

(b) an increase in beam; (10)

(c) a reduction in GM. (10)

5. Explain the corrections to be applied to the *Tabular Freeboard* for a 'Type A' ship in order to obtain the *Assigned Freeboard*, and the reason why the freeboard could be increased or decreased in EACH case. (30)

6. (a) State the minimum stability requirements for a vessel under the current Load Line Regulations. (6)

(b) At ballast draught a vessel complies in every respect with the stability requirements of the Load Line Regulations. At load draught, with the same GM, the vessel does not comply.

Explain, with the aid of a diagram, why the vessel no longer complies. (14)

(c) A vessel has the following particulars:

Initial Displacement 10250 t KG 8.620 m

A double bottom tank is full of fuel oil. During the passage 250 t of oil, Kg 0.500 m, will be consumed from the tank resulting in a free surface moment (FSM) of 1040 tm.

Using the *Maximum KG* table contained in the *Stability Data Booklet,* determine whether the vessel will still comply with the minimum intact stability criteria specified in the Load Line Regulations. (10)

[OVER

MARCH 2012

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. Worksheet Q1 - *Trim and Stability* provides data relevant to a particular condition of loading in a vessel in salt water.

   All holds and tween decks are to be filled with grain (S.F. 1.65 m^3/t).

   The *Stability Data Booklet* provides the necessary data for the vessel.

   By completion of the Worksheet Q1 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (15)

   (b) the draughts forward and aft. (20)

2. A vessel is floating at draughts 7.800 m forward, 8.560 m aft in dock water of relative density 1.015.

   The vessel is to load cargo so as to finish on an even keel at a load draught of 8.560 m in dock water.

   Two spaces available: No.1 hold and No.5 hold.

   Using the Stability Data Booklet, calculate EACH of the following:

   (a) the total weight of cargo to load; (15)

   (b) the weight of cargo to load in each hold. (20)

3. A box shaped vessel of length 110.00 m, breadth 16.40 m, depth 9.10 m is floating in salt water to an even keel draught of 5.90 m.

   (a) Calculate the righting moment when the vessel is heeled to the angle of deck edge immersion if the KG is 6.60 m. (25)

   (b) Calculate the angle of loll if the KG is 6.80 m. (10)

MARCH 2012

4. (a) A vessel's side compartment is flooded as a result of a collision.

Sketch the vessel's statical stability diagram, showing the effects of the resulting reduction in freeboard and angle of list. (18)

(b) Describe the countermeasures that may be taken in the event of such flooding. (12)

5. (a) Distinguish between the causes of an angle of loll and an angle of list. (8)

(b) Describe the dangers to a vessel at an angle of loll in a seaway. (12)

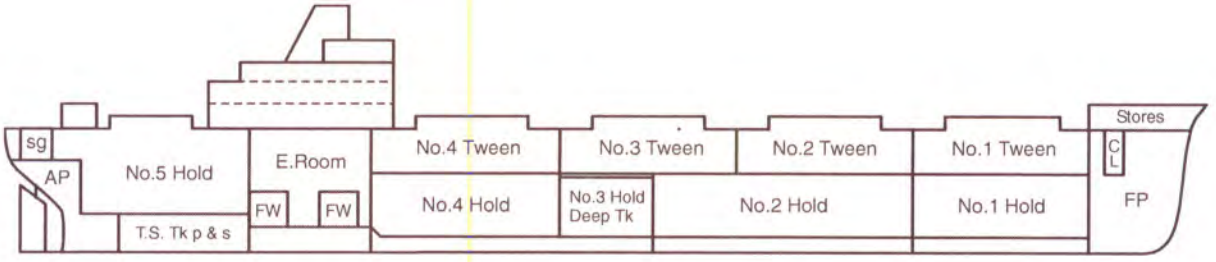
(c) An unstable vessel lying to an angle of loll to port has an empty double bottom tank subdivided into three watertight compartments (port, centre, starboard) of equal width. The tank must be ballasted to return the vessel to a safe condition.

Describe the sequence of actions that should be taken and the possible effects throughout each stage. (15)

6. Describe a Type 'A' vessel under the current Load Line Regulations, including the flooding, stability and assumed damage requirements for a newly built vessel. (30)

WORKSHEET Q1

TRIM & STABILITY



CONDITION: LOADED –

Compartment	Grain Capacity m^3	Stowage Factor m^3/t	Weight t	KG m	Vertical Moment tm	Free Surface Moment tm	LCG foap m	Longitudinal Moment tm
All Holds		1.65		5.64			69.10	
1 TD		1.65		11.26			115.50	
2 TD		1.65		10.78			95.60	
3TD		1.65		10.59			74.10	
4 TD		1.65		10.57			51.70	
Oil Fuel			934		1956	2218		31106
Fresh Water			83		629	73		2538
Lightship			3831	8.21			61.70	
DISPLACEMENT								

HYDROSTATICS	True Mean Draught	LCB foap	LCF foap
	MCTC		
TRIM			KM_T
			KG
DRAUGHTS:			GM

Candidate's Name ..... Examination Centre .....

JULY 2012

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel carrying timber on deck departs from port with a GM of 0.05 m. The stability of the vessel deteriorates on passage and as a result the vessel settles to an angle of loll of 12° to port. Even keel draught 5.700 m in salt water.

   Investigate the effect of ballasting No.2 D.B. tanks, filling the tanks one at a time, in the following order: (1) centre, (2) port, (3) starboard.

   Using the *Stability Data Booklet* calculate EACH of the following:

   (a) the initial negative GM prior to ballasting; (10)

   (b) the angle of loll on commencing to ballast the centre tank (assume weight negligible); (10)

   (c) the GM when the centre tank is full; (5)

   (d) the angle of heel when the port tank, Tcg 5.00 m, is full. (10)

2. A vessel's present particulars are as follows:

   Forward draught 8.240 m, Aft draught 9.240 m at an upriver berth in fresh water.

   The vessel is to proceed downriver to cross a sand bar at the river entrance where the relative density of the water is 1.018.

   During the river passage the following items of deadweight will be consumed:

   58 t of Heavy Fuel Oil from No. 3 D.B. Centre tank
   19 t of Diesel Oil from No. 4 D.B. Port tank
   19 t of Diesel Oil from No. 4 D.B. Starboard tank
   17 t of Fresh Water from After Fresh Water tank

   Using the *Stability Data Booklet,* calculate the clearance of the vessel over the bar if the depth of water over the sand bar is 9.520 m. (35)

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3. A vessel is floating in dock water of R.D. 1.017.
Present draughts:
Forward 8.060 m; Midship (Port) 8.620 m; Midship (Starboard) 8.580 m; Aft 9.260 m

The draught marks are displaced as follows:
Forward: 1.32 m aft of the FP.
Aft: 2.08 m forward of the AP.
Midship: 0.66 m aft of the amidship line.

The *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.

By completion of the Worksheet Q3 and showing any additional calculations in the answer book, determine the vessel's displacement. (30)

4. (a) Describe how the effect of icing on a vessel's stability may be determined when a vessel is operating in severe winter conditions. (10)

(b) Sketch a vessel's curve of statical stability showing the effect of non-symmetrical ice accretion on decks and superstructure. (25)

5. (a) State the purpose of the inclining experiment. (5)

(b) Describe the precautions to be taken, by the ship's officer, before and during the inclining experiment. (16)

(c) List the circumstances when the inclining experiment is required to take place on passenger vessels. (9)

6. (a) A vessel loads a timber deck cargo such that there is an increase in the vessel's KG and an effective increase in freeboard.
Sketch the vessel's GZ curve showing the effect of loading this cargo. (15)

(b) Describe the intact stability requirements for vessels assigned with timber loadlines. (20)

(This Worksheet must be returned with your answer book)

DRAUGHT SURVEY REPORT

			metres
Draught Forward			
FP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed Trim}$		
Draught at FP			
Draught Aft			
AP Correction	$\frac{\text{Dist. marks displaced}}{\text{Dist. between marks}} \times \text{Observed. Trim}$		
Draught at AP			
True Trim			
Draught (M) Port			
Draught (M) Star.			
Draught Midships Mean			
Amidship line correction	$\frac{\text{Dist. marks displaced}}{LBP} \times \text{True Trim}$		
Draught at Amidships			
Corrected Midship Draught	$\frac{d_{FP} + (6 \times d_M) + d_{AP}}{8}$		

TPC		LCF foap	

			tonne
Displacement			
1st Trim Corrn. (Layer)	$\frac{\text{Dist. of CF from Midships} \times \text{Trim} \times \text{TPC}}{LBP}$		
2nd Trim Corrn. (Form)	$\frac{50 \times \text{True Trim}^2 \times (MCTC_2 - MCTC_1)}{LBP}$		
Corrected Displacement			
Dock Water Displacement	$\Delta \times \frac{\text{R.D. Dock Water}}{1.025}$		

DECEMBER 2012

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel, length 137.5 m, arrives off an upriver berth in fresh water with the following particulars:

   Forward draught 3.826 m, Aft draught 4.248 m, GM 0.15 m.

   During berthing operations, a starboard side tank is damaged resulting in the loss of 120 tonnes of water ballast, Kg 9.12 m, Lcg 57.87 m, Tcg 5.10 m and the creation of a (corrected) FSM of 298 m^4.

   Using the *Hydrostatic Particulars* contained in the *Stability Data Booklet,* calculate EACH of the following:

   (a) the resultant draughts, forward and aft; (20)

   (b) the resultant angle and direction of heel. (15)

2. A vessel is to enter drydock in dock water of relative density 1.007.

   Draughts: Forward 3.220 m Aft 4.920 m KG 9.52 m

   (a) Using the *Stability Data Booklet*, calculate the maximum trim at which the vessel can enter drydock so as to maintain a GM of at least 0.10 m at the critical instant. Assume KM remains constant. (25)

   (b) Calculate the weight of ballast to transfer from the After Peak to the Fore Peak in order to bring the vessel to the maximum trim calculated in Q2(a). (10)

3. A box shaped vessel floating upright on even keel in salt water has the following particulars:

   Length 162.00 m Breadth 30.00 m Draught 8.800 m KG 10.850 m

   The vessel has two longitudinal bulkheads each 6.00 m from the side of the vessel.

   Calculate the angle of heel if a midships side compartment 27.00 m long is bilged. (35)

DECEMBER 2012

4. (a) Explain the difference between the *Angle of Deck Edge Immersion* and the *Angle of Flooding*, stating typical values from the *Stability Data Booklet.* (5)

(b) A vessel in the upright condition has a small negative GM. Explain how, when a vessel heels to an angle of loll, it now has a small positive GM. (10)

(c) Explain why a vessel carrying timber on deck may be allowed a smaller GM than is usual for a cargo vessel. (10)

(d) Explain how an increase in the beam of a vessel can improve a vessel's stability and why such improvement is more pronounced at smaller angles of heel. (10)

5. (a) Explain how wind heeling moments are calculated. (10)

(b) Sketch a vessel's curve of statical stability, showing the effects of a strong beam wind. (10)

(c) Sketch a supply vessel's statical stability diagram showing how the GZ curve for the vessel calculated on a *Free Trim* basis may differ from that calculated on a *Fixed Trim* basis. (10)

6. Describe the general provisions of the current Load Line Regulations governing the ability of Type B vessels with reduced freeboard to withstand flooding due to damage, and the stability in the final condition after such damage. (30)

MARCH 2013

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box shaped vessel floating on even keel in dock water of R.D. 1.011 has the following particulars:

   Length 120.00 m Breadth 22.00 m
   Draught 7.800 m MCTC (salt water) 290

   There is an empty watertight forward end compartment, length 12.00 m, height 6.50 m, extending the full width of the vessel.

   Calculate the draughts forward and aft, if this compartment is bilged. (35)

2. A vessel completes underdeck loading in salt water with the following particulars:

   Displacement 14,115 tonne KG 8.00 m

   The *Stability Data Booklet* provides the necessary data for the vessel.

   During the passage 190 tonne of Heavy Fuel Oil (R.D. 0.81) is consumed from No. 3 D.B. tank centre which was full on departure (use Kg of tank for consumption purposes).

   Calculate the maximum weight of timber to load on deck Kg 13.20 m assuming 15% water absorption during the passage in order to arrive at the destination with the minimum GM (0.05 m) allowed under the Load Line Regulations. (35)

   Note: Assume KM constant.

MARCH 2013

3. A vessel is to load a cargo of grain (stowage factor 1.65 m^3/t).
Initial displacement 6020 tonne Initial KG 6.68 m

All five holds are to be loaded full of grain.

The tween decks are to be loaded as follows:

No. 1 TD	Full
No. 2 TD	Part full – ullage 2.50m
No. 3 TD	Part full – ullage 1.25m
No. 4 TD	Full

The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

(a) Using the *Maximum Permissible Grain Heeling Moment Table* included in the *Stability Data Booklet,* determine whether the vessel complies with the minimum criteria specified in the *International Grain Code (IMO).* (30)

(b) Calculate the ship's approximate angle of heel in the event of the grain shifting as assumed by the *International Grain Code (IMO).* (5)

4. With reference to the Passenger Ship Construction Regulations:

(a) explain the function of the *Factor of Subdivision*; (9)

(b) describe the use of sub-division loadlines; (9)

(c) state the extent of assumed hull flooding and damage when calculating the vessel's ability to survive hull damage; (9)

(d) describe the purpose of the *Stockholm Agreement,* stating the type of vessel to which it applies. (8)

5. (a) State the main factors which affect the shape and size of the curve of statical stability of a vessel in an initially upright condition. (6)

(b) Sketch curves of statical stability showing the effects of an increase in EACH of the main factors stated in Q5(a). (24)

6. (a) Explain why a vessel laden to the same draught on different voyages may have different natural rolling periods. (13)

(b) Explain the term *synchronous rolling*, describing the dangers associated with it. (10)

(c) State the actions to be taken by the ship's officer when it becomes apparent that the vessel is experiencing *synchronous rolling.* (7)

JULY 2013

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is listed 8° to starboard in salt water. A centreline deep tank is partially full of an oily water mixture, R.D. 0.92, which is to be fully discharged into a salvage barge alongside. The deep tank is rectangular and is 14.0 m long and 16.0 m wide.

   Present displacement 17400 t KG 8.20 m
   Weight of oily water mixture 886 t Kg 3.30 m

   Using the *Hydrostatic Particulars* contained in the *Stability Data Booklet*, calculate EACH of the following:

   (30)

   (a) the final list of the vessel;

   (b) the weight of ballast to transfer from a starboard tank to a port tank in order to bring the vessel upright. The centroid of EACH tank is 4.90 m from the centreline. (5)

2. A vessel's loaded particulars in salt water are as follows:

   Displacement 16000 tonne Fluid KG 8.10 m

   Using the *Stability Data Booklet*, compare the vessel's stability with ALL the minimum stability criteria required by the current Load Line Regulations, commenting on the result. (35)

3. A vessel has the following particulars:
   Displacement 12300 t Even keel draught 7.69 m Maximum breadth 20.66 m
   KG 7.95 m KM 8.21 m KB 4.13 m

   (a) Explain why this vessel will heel when turning. (6)

   (b) Calculate the angle and direction of heel when turning to starboard in a circle of diameter 580 m at a speed of 15.5 knots. (18)

   Note: assume 1 nautical mile = 1852 m, and g = 9.81 m/s^2

   (c) Calculate the new maximum draught during the turn in Q3(b), assuming the midships cross-section can be considered rectangular. (6)

JULY 2013

4. (a) Explain why a vessel experiences a virtual loss of metacentric height during drydocking. (12)

(b) Explain why the KM in the freely floating condition, prior to drydocking, should not normally be used in the calculation of the GM at the critical instant. (5)

(c) Explain why it usual for a vessel to enter drydock with a stern trim. (8)

(d) Describe the practical measures that can be taken to improve stability prior to drydocking if it is found to be inadequate. (10)

5. Discuss the use, limitations and relative accuracy of EACH the following means of stability assessment:

(a) Simplified stability tables (eg Max KG); (7)

(b) Curves of statical stability based on KN tables; (10)

(c) Initial metacentric height (GM); (4)

(d) Righting levers based on Wallsided Formula; (7)

(e) Rolling period. (7)

6. (a) The current Load Line Regulations require the master to be provided with stability particulars for various pre-worked conditions.

Detail the information to be provided for a given service condition, describing how this information may be presented. (24)

(b) A vessel has the following particulars:

Displacement 17400 t KG 8.070 m

Using the *Maximum KG* table contained in the *Stability Data Booklet*, determine whether the vessel complies with the minimum intact stability criteria specified in the current Load Line Regulations. (6)

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box-shaped vessel floating at an even keel in salt water has the following particulars:
Length 112.00m Breadth 24.00m Depth 10.120m
Draught 6.200m KG 9.64m
A midship watertight compartment 19.00m long, permeability 0.80, and extending full breadth of vessel, is bilged.

   Calculate EACH of the following:

   (a) the final draught; (8)

   (b) the metacentric height in the flooded condition; (12)

   (c) the righting moment at the angle of deck edge immersion in the bilged condition. (15)

2. A vessel, initially upright, has the following particulars:
Displacement 13 000 tonne KG 7.50m

   The vessel is to load a 76 tonne locomotive using the vessel's heavy lift derrick, the head of which is 26.75m above the keel. The locomotive is to be lifted from a position 29.30m to port of the centreline of the vessel.

   (a) Using the *Hydrostatic Particulars* contained in the *Stability Data Booklet*, calculate the maximum angle of heel. (13)

   (b) Show, with the aid of a labelled sketch, the effect on the vessel's dynamical stability when first taking the weight on the derrick. (10)

   (c) Calculate the weight of ballast water to transfer between a divided double bottom over a transverse distance of 10.00m so as to limit the maximum list to 5 degrees. (12)

3. A vessel is floating upright in salt water and is about to drydock.
The vessel's particulars are: KG 8.47m
Present draughts: Forward 5.010m Aft 6.690m

   (a) Using the *Hydrostatic Particulars* contained in the *Stability Data Booklet*, calculate the vessel's effective GM at the critical instant. (27)

   (b) Describe methods of improving the initial stability if the GM at the critical instant is found to be inadequate. (8)

4. (a) Discuss the use and relative accuracy of EACH of the following means of assessing the weight of cargo loaded:

(i) TPC using initial and final midship draughts; (5)

(ii) change in displacement using arithmetic mean of forward and aft draughts (AMD); (5)

(iii) change in displacement using true mean of forward and aft draughts (TMD); (5)

(iv) Draught Survey. (5)

(b) Outline the use of EACH of the following items of information found in the *Stability Information Booklet:*

(i) *Cargo Capacities* table; (4)

(ii) the FSM in the *Tank Capacities* table for fuel oil of a relative density less than FW. (6)

5. A vessel in a seaway is lying at an angle of loll. It is proposed to rectify the situation by ballasting double bottom tanks.

(a) Sketch the vessel's GZ curve in the initial condition. (5)

(b) Sketch the initial effect on the vessel's GZ curve of first introducing water ballast into a centre tank thereby creating free surface effect. (10)

(c) Show the effect on the vessel's GZ curve of filling an offcentre tank on the low side, assuming EACH of the following:

(i) the resulting GM is negative; (8)

(ii) the resulting GM is now positive. (7)

6. With reference to the *International Grain Code (IMO)*:

(a) describe how the heeling arm curve is derived; (12)

(b) state the minimum intact stability criteria required; (10)

(c) describe the measures which may be taken to minimise grain heeling moments. (13)

Question 1

(a) Effective length of bilged compartment = 19.00 x 0.80 = 15.2m

Sinkage = $\frac{\text{Volume of lost buoyancy}}{\text{Area of intact waterplane}} = \frac{15.2 \times 24 \times 6.2}{(112 - 15.2) \times 24}$ = 0.974m

New draught = 6.200 + 0.974 **= 7.174m**

(b) KB = $\frac{\text{Draught}}{2} = \frac{7.174}{2}$ = 3.587m

BM = $\frac{LB^3}{12V} = \frac{96.8 \times 24 \times 24 \times 24}{12 \times 112 \times 24 \times 6.2}$ = 6.691m

KM	10.278m
KG	9.640m
GM	**0.638m**

(c) Tan θ_{de} = $\frac{\text{New Freeboard}}{\text{Half Beam}} = \frac{(10.120 - 7.174)}{12} = \frac{2.946}{12}$

Angle of deck edge immersion = 13.8°

GZ = Sin θ (GM + ½BM.Tan$^2\theta$)

GZ = Sin 13.8° (0.638 + ½ x 6.691 x Tan^2 13.8°) = 0.200m

W = L x B x draught x R.D. = 112 x 24 x 6.2 x 1.025 = 17,082t

Righting Moment at θ_{de} = W x GZ = 17,082 x 0.200 = **3416 t.m.**

Question 2

(a)

Weight	KG	Vertical Moment	Distance offcentre	Listing Moment
13,000	7.50	97500	0	0
+76	26.75	+ 2033	29.30	2227
13,076	7.61	99533		2227
From tables KM	8.42			
GM	0.81			

$$\text{Tan } \theta = \frac{\text{Listing Moment}}{\text{W x GM}} = \frac{2227}{13076 \text{ x } 0.81}$$

Maximum Angle of Heel = 11.9º

(c) $$\text{Tan } \theta = \frac{\text{Listing Moment}}{\text{W x GM}}$$

Listing Moment = W x GM x Tan θ = 13,076 x 0.81 x Tan 5º

= 927t.m.

Present Listing Moment = 2,227t.m

Change in Listing Moment = 1,300t.m. = w x s

$$w = \frac{1300}{s} = \frac{1300}{10.00} = 130t$$

Ballast Water to Transfer = 130t

Question 3

(a) Mean draught = $\frac{5.010 + 6.690}{2}$ = 5.850m

From Tables: LCF = 68.50m

T.M.D = Draught aft – $\frac{LCF}{L}$ x Trim = $6.690 - \frac{68.50}{137.5} \times (6.690 - 5.010) = 5.853$m

From tables at 5.853m draught:-

LCF = 68.50m MCTC = 167.9 W = 11,967t

$P = \frac{t \times MCTC}{LCF} = \frac{168 \times 167.9}{68.50} =$ 412t

Displacement at Critical instant = W – P = 11,967 – 412 = 11,555t

From tables at W = 11,555t in SW:-

Draught = 5.669m KM = 8.64m

Loss of GM = $\frac{P \times KM}{W} = \frac{412 \times 8.64}{11967}$ = 0.30m

KM	8.64m
KG	8.47m
GM	0.17m
Loss of GM	0.30m

GM at Critical Instant –0.13m

STABILITY AND STRUCTURE Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel in salt water is trimmed 0.92 m by the stern and heeled 9° to port and has the following particulars in salt water:

   Displacement 13 200 tonne KG 8.23 m

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the total weight of fuel oil to transfer from the Tunnel side tanks to No. 3 D.B. tanks, port and starboard, in order to bring the vessel to a trim of 0.40 m by the stern; (10)

   (b) the final weight of fuel oil to transfer into EACH No.3 D.B. tank, port and starboard, in order to bring the vessel upright, assuming equal quantities are taken from EACH of the Tunnel side tanks. (25)

2. A container vessel's particulars in salt water are as follows:

   Displacement 16000 tonne KG 8.10 m Draught 7.40 m
   Lateral windage area 5160 m^2 Centroid of the windage area 10.30 m above the waterline

   (a) Construct a righting moment curve using the *KN Tables* in the *Stability Data Booklet*. (10)

   (b) Using the righting moment curve in Q2(a), determine EACH of the following:
   (i) the angle of heel due to a steady lateral wind pressure of 48.5 kgs/m^2; (15)

   (ii) the angle of heel if the wind pressure increases by 50% due to gusting. (5)

3. Worksheet Q3 *Trim and Stability* provides data relevant to a particular condition of loading of a vessel in salt water.

   The *Hydrostatic Particulars* included in the *Stability Data Booklet* provide the necessary hydrostatic data for the vessel.

   By completion of the Worksheet Q3 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (15)

   (b) the draughts forward and aft. (20)

[OVER

4. Sketch a vessel's curve of statical stability showing the effect of EACH of the following conditions on EACH curve:

   (a) a reduction in draught; (10)

   (b) an increase in KG; (10)

   (c) an increase in beam. (10)

5. (a) Discuss the factors affecting the virtual loss of GM due to a free surface within an undivided rectangular tank. (8)

   (b) Explain the effect on the virtual loss of GM due to the free surface when the slack tank is equally divided in EACH of the following situations:

      (i) by a longitudinal bulkhead; (5)

      (ii) by a transverse bulkhead. (5)

   (c) Explain why stability information relating to free surface for a particular tank is usually expressed as a *Free Surface Moment (FSM).* (5)

   (d) A double bottom tank, initially empty, is to be ballasted full of salt water.

      Sketch a labelled diagram to show the way in which the effective KG of the ship will change from the instant of starting to fill the tank until it is full. (12)

6. With reference to the current Load Line Regulations:

   (a) explain why the *tabulated freeboard* for a Type 'A' vessel is significantly less than the *tabulated freeboard* for a Type 'B' vessel of the same length; (20)

   (b) list the additional corrections required when converting *basic freeboard* to *assigned freeboard,* explaining the reason for EACH correction. (15)

MARCH 2014

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box-shaped vessel floating at an even keel in salt water has the following particulars:

   Length 110.00m Breadth 24.00m

   Draught 6.200m KG 9.58m

   An amidship watertight compartment 19.00m long, height 7.00m, and extending full breadth of vessel, is bilged. The compartment is fully loaded with cargo of relative density 0.82 and stowing at 1.64m^3/tonne.

   Calculate EACH of the following:

   (a) the final draught; (15)

   (b) the change in GM. (20)

2. (a) Describe the means by which water can flood the vehicle deck of a conventional Ro/ro vehicle ferry. (20)

   (b) A Ro/ro vessel is floating at an even keel draught of 8.600m in salt water. KG 6.40m. A rectangular vehicle deck 100m long, 19m wide and 11.75m above the keel is flooded with salt water to a depth of 0.50m.

   Using the *Stability Data Booklet* calculate the final fluid GM. (20)

3. A vessel is to load a cargo of grain (stowage factor 1.70m^3/t).
   Initial displacement 5950 tonne Initial KG 6.71m
   All five holds are to be loaded full of grain.
   The tween decks are to be loaded as follows:-

No. 1 TD	Full
No. 2 TD	Part full – ullage 2.00m
No. 3 TD	Full
No. 4 TD	Part full – ullage 2.50m

   The *Stability Data Booklet* provides the necessary cargo compartment data for the vessel.

   Using the *Maximum Permissible Grain Heeling Moment Table* included in the *Stability Data Booklet*, determine whether the vessel complies with the minimum criteria specified in the *IMO International Grain Code*. (30)

4. (a) Distinguish between the causes of an angle of loll and an angle of list. (10)

(b) Distinguish between the method of correction of an angle of list and the method of correction of an angle of loll. (10)

(c) A box-shaped vessel floating at an even keel in fresh water has the following particulars:

Length 100.00m Breadth 16.50m Displacement 9900t KG 7.00m

Calculate the angle of loll. (20)

5. Sketch a vessel's curve of statical stability showing the effects of EACH of the following:-

(a) a reduction in draught; (10)

(b) an increase in beam; (10)

(c) a reduction in free surface. (10)

6. List the items to be inspected during the surveys required in order that an International Load Line Certificate remains valid, stating the nature of the examination required for each. (25)

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is to transit a canal with a minimum clearance of 0.30 m under a bridge, the underside of which is 20.50 m above the waterline.

   Present draughts in fresh water: Forward 5.700 m Aft 7.000 m

   The aft mast is 40 m foap and extends 26.50 m above the keel.

   The fore mast is 108 m foap and extends 25.50 m above the keel.

   (Assume masts are perpendicular to the waterline throughout.)

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the final draughts forward and aft in order to pass under the bridge with minimum clearance; (17)

   (b) the maximum weight of cargo to discharge in order to pass under the bridge with minimum clearance. (18)

2. A vessel, initially upright, is to carry out an inclining test.

   Present displacement 4700 t. KM 10.63 m

   Total weights on board during the experiment:

   Ballast 368 t, Kg 3.48 m. Tank full.
   Bunkers 182 t, Kg 3.91 m. Free surface moment 974 tm.
   Fresh Water 86 t, Kg 4.54 m. Slack tank. Free surface moment 799 tm
   Inclining weights 50 t, Kg 8.88 m.

   At the time of the experiment the boilers are empty. They would usually contain a total of 26 t of water, Kg 4.22 m, with a free surface moment of 129 tm.

   A deck crane, weight 21t and still ashore will be fitted on the vessel at a Kg of 9.86 m at a later date.

   The plumbline has an effective vertical length of 7.90 m. The inclining weights are shifted transversely 7.50 m on each occasion and the mean horizontal deflection of the plumbline is 0.69 m.

   Calculate the vessel's Lightship KG. (30)

3. A vessel is floating upright in dock water R.D. 1.019 on an even keel draught of 5.000 m. KG 8.70 m.

   The After Peak is empty and is to be filled with dock water ballast before entering drydock.

   Using the *Stability Data Booklet*, calculate:

   (a) the trim on entering the drydock; (20)

   (b) the vessel's effective GM at the critical instant. (20)

4. (a) State the minimum intact stability criteria required by the *IMO International Grain Code.* (10)

   (b) Describe, with the aid of a sketch, of a curve of statical stability, the effect of increasing the GM on a vessel with a list due to a transverse shift of cargo. (25)

5. With reference to the current Load Line Regulations:

   (a) distinguish between a Type A vessel and a Type B vessel, explaining why they have different *tabular freeboards*. (15)

   (b) Identify the additional corrections required when converting *basic freeboard* to *assigned freeboard*, explaining the reason for each correction. (15)

6. (a) Explain how wind heeling moments are calculated. (8)

   (b) Sketch a vessel's curve of statical stability, showing the effects of a strong beam wind. (10)

   (c) Sketch a supply vessel's statical stability diagram showing how the GZ curve for the vessel calculated on a *Free Trim* basis may differ from that calculated on a *Fixed Trim* basis. (12)

NOVEMBER 2014

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A vessel is floating at draughts 7.640 m forward, 8.180 m aft in dock water of R.D. 1.019.

   The vessel is to load cargo so as to finish on an even keel at a draught of 8.500 m on departure in salt water.

   Two spaces available: No. 1 hold and No.5 hold.

   Using the *Stability Data Booklet*, calculate EACH of the following:

   (a) the total weight of cargo to load; (15)

   (b) the weight of cargo to load in each compartment. (20)

2. A vessel is floating upright and has to load TWO weights using the ship's own derrick.

   The inboard weight is to be loaded first. The maximum allowable list at any time is 6 degrees.

   Using the following particulars, calculate the minimum initial metacentric height required.

   Initial draughts: 5.000 m, forward and aft, in salt water
   Derrick head 23.00 m above the keel

   Two weights, each 42 tonne, on the quay 20.80 m from the centreline of the vessel.

   Stowage position on deck Kg 12.00 m, 8.20 m each side of the centreline. (30)

3. A vessel is floating in dock water of R.D. 1.014.

Present draughts:
Forward 7.480 m; Midship (Port) 8.000 m; Midship (Starboard) 8.060 m;
Aft 8.620 m

The draught marks are displaced as follows:
Forward: 1.68 m aft of the FP.
Aft: 2.44 m aft of the AP.
(The midship draught marks are not displaced)

The *Stability Data Booklet* provides the necessary hydrostatic data for the vessel.

By completion of the Worksheet Q3 and showing any additional calculations in the answer book, determine EACH of the following:

(a) the vessel's displacement; (30)

(b) the maximum cargo to load for a Summer Load Line Zone. (5)

Note: assume no hog or sag in the Summer Load condition.

4. (a) State the effect of reducing the KG on:

(i) a vessel at an angle of heel due to an offcentre weight; (4)

(ii) a vessel at an angle of loll. (6)

(b) State the effect of winging out weights on a vessel on:

(i) the critical period when drydocking; (4)

(ii) the rolling period of the vessel. (4)

(c) State the effect of increasing a vessel's trim by the stern on:

(i) the GM at the critical instant when drydocking; (4)

(ii) the maximum cargo to load with limited underkeel clearance; (3)

(iii) the vessel's True Mean Draught. (2)

(d) State the effect of an increase in a vessel's displacement on:

(i) the virtual loss of metacentric height due to free surface; (4)

(ii) an angle of heel due to an offcentre weight (4)

JULY 2015

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each part question are shown in brackets

1. A box shaped vessel floating on even keel in dock water of R.D. 1.014 has the following particulars:

   Length 124.00 m Breadth 20.00 m
   Draught 7.800 m MCTC (salt water) 300.1

   There is an empty watertight forward end bottom compartment, length 10.00 m, height 6.50 m, extending the full width of the vessel.

   Calculate the draughts forward and aft, if this compartment is bilged. (35)

2. A vessel is upright, starboard side alongside, at a draught of 5.000 m in salt water.

   KG 8.50 m

   A 38 t generator is to be loaded from a railway truck ashore. The distance of the railway truck from the vessel's centreline is 19.30 m. The generator is to be loaded using the vessel's crane, the head of which is 25.10 m above the keel.

   Using the *Hydrostatic Particulars* included in the *Stability Data Booklet*, calculate EACH of the following:

   (a) the maximum angle of heel during the loading operation; (15)

   (b) the maximum angle of heel if the vessel was listed 4° to port prior to loading; (12)

   (c) the weight of ballast to transfer from No.2 DB starboard to No. 2 DB port in order to achieve the list of 4° to port prior to loading (assume both tanks partially full). (8)

3. A vessel's loaded particulars in salt water are as follows:

   Displacement 16000 tonne Fluid KG 8.15 m

   Using the *Stability Data Booklet*, compare the vessel's stability with ALL the minimum stability criteria required by the current Load Line Regulations, commenting on the result. (35)

[OVER

4. (a) A vessel loads a packaged timber cargo on deck such that there is an increase in the vessel's KG and an effective increase in freeboard.

Using a single sketch, show the effect of loading this cargo on the vessel's GZ curve. (15)

(b) Using a single sketch, show how the GZ curve for a vessel with a zero GM is affected by EACH of the following:

(i) a rise in the vessel's KG; (8)

(ii) a reduction in the vessel's KG. (8)

5. With reference to the *International Grain Code (IMO)*:

(a) describe how the heeling arm curve is derived; (12)

(b) state the minimum intact stability criteria required; (10)

(c) describe the measures which may be taken to minimise grain heeling moments. (12)

6. (a) A ship is shipping heavy seas over one side of the vessel:

(i) explain why this is likely to have detrimental effects on the vessel's transverse stability; (6)

(ii) show the effect on a sketch of the vessel's statical stability diagram. (10)

(b) During a sea passage a vessel develops an angle of loll:

(i) show the effect of an alteration of course involving a significant rate of turn on the vessel's statical stability diagram; (8)

(ii) describe how this effect could be minimised (other than improving the GM). (6)