National Exams December 2009

98-Nav-A1, Fundamental of Naval Architecture

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a CLOSED BOOK EXAM.
   A Casio or Sharp calculator model is permitted.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

1. a) Explain briefly the difference between transverse and longitudinal framing of ships. Draw a sketch whenever necessary.

   b) The displacement and vertical center of gravity of a ship upon arrival to a port are 6,000 tonnef and 6.0 m, respectively. She then discharges and loads the following quantities:

Type	Weight, tonnef	KG, m	Case
Cargo	1250	4.5	Discharge
Cargo	675	3.5	Discharge
Cargo	420	9.0	Discharge
Cargo	980	4.25	Load
Cargo	550	6.0	Load
Bunker	700	1.0	Load
Fresh water	70	12.0	Load

   During the stay in port 30 tonnef of oil (KG = 1.0 m) are consumed. The KM at the final draft as read from the hydrostatic curves was 6.8 m. If the ship has a partially filled ballast tank having a length of 8.0 m and a breadth of 10.0 m, find the GM on departure.

2. a) Where can a weight be added on the deck of a ship such that no trim occurs. Explain the rationale behind your answer.

   b) A ship arrives at port with forward and aft drafts of 6.8 m and 7.2 m, respectively. She then discharges and loads the following quantities:

Type	Weight, tonnef	LCG, m	Case
Cargo	500	40.0 F	Discharge
Cargo	500	25.0 F	Discharge
Cargo	500	20.0 A	Discharge
Cargo	500	50.0 A	Discharge
Cargo	50	15.0 A	Load
Cargo	135	40.0 F	Load

The longitudinal centers of gravity are measured from the midship section. The ship has the following particulars:

Lbp	= 108.0 m
MCT 1 cm	= 400.0 tonnef-m
TPC	= 15.0 tonnef
LCF	= 5.0 m aft of midship section

Determine the final drafts.

c) The ordinates of the statical stability, for a ship of displacement 4000 tonnef, are as follows:

Angle of Heel, deg.	10	20	30	40	50	60
GZ, m	0.12	0.30	0.79	1.04	1.07	0.84

Determine the angle of list when a weight of 50 tonnef already on board is moved a distance of 6.0 m in the transverse direction.

3. a) How does the existence of free surface affect ship's stability. Illustrate your answer with a sketch.

b) A ship having a length of 140.0 m and a displacement of 12640 tonnef. The even keel draft corresponding to this displacement is 7.5 m and the ship has the following hydrostatic characteristics at that draft:

MCT 1 cm	=	147.0 tonnef-m
LCB from FP	=	68.3 m
LCF from FP	=	67.84 m
TPC	=	20.0 tonnef

(i) If the longitudinal center of gravity of the ship is found to lie at a distance 68.6 m from the forward perpendicular, determine the trim, and the drafts forward and aft.

(ii) Determine the drafts forward and aft after a double bottom tank is filled with 450.0 tonnef of fuel. The double bottom tank center is 60.0 m from the forward perpendicular. Assume that the hydrostatic characteristics of the sip will remain the same.

4. a) The model of a ship is found on completion to be unstable. The particulars of the model are given as

Length between perpendiculars	= 1.83 m
Area of the waterplane	= 0.445 m^2
The moment of inertia of the waterplane about its longitudinal axis	= 0.0057 m^4
The volume of displacement in fresh water	= 0.068 m^3
Draft	= 0.14 m
KB	= 0.076 m
KG	= 0.18 m

Assuming that the model is wall sided at this draft, where should a ballast weight of 10.0 Kg be placed to just restore stability? What will be the value of the GM if the ballast weight was increased by an additional 10.0 Kg placed at the same position? Assume KM will remain constant.

b) Explain briefly what is a GZ curve. Sketch the shape of typical GZ curves for the model mentioned above before adding the ballast, after adding a10.0 Kg ballast, and after adding 20.0 Kg ballast.

5. A vessel of constant rectangular section has a length of 120.0 m, and a beam of 24.0 m. The vessel floats in sea water at an even keel draft of 5.0 m. The vessel is subdivided into six equal compartments using 5 water tight transverse bulkheads. If the forward compartment is flooded, find the new fore and aft drafts. The center of gravity is 4.0 m above the keel, the permeability of the flooded compartment is 0.9 and the surface permeability is 0.95.

6. A ship has a displacement of 6150 tonnef floats at a waterline whose half-ordinates at equal intervals of 11.0 meters starting from the forward perpendicular are:

0.0, 2.22, 4.48, 6.21, 6.98, 7.0, 6.95, 6.19, 4.2, 1.95, 0.0. meters

The center of gravity of the ship is 1.5 m above the center of buoyancy. A cargo of 120.0 ton force is loaded at a point 45.0 meters aft of amidships and 60.0 tonnef of material already on board is moved 12.0 meters forward of its original position. What is the combined effect of these two changes in the loading condition on the draft aft.

7. A ship whose water plane's ordinates are given as

Station	FP	1	2	3	4	5	6	7	8	9	10
b/2, m	0	2.16	4.48	6.64	7.5	7.52	7.52	6.95	5.03	2.53	0

started to list as a result of instability. The displacement at this waterline is 7600 tonnef, the waterline length is 110 meters, and the center of buoyancy is 3.29 meters above the keel. Determine the amount of ballast that needs to be added in the double bottom at a center of gravity of 0.91 meters above the keel in order to produce a positive metacentric height 0.15 meters in the upright condition. It may be assumed that the metacentric height above the keel (KM) will not change as a result of the change in draft caused by the addition of the ballast.

Mar-A2, Fundamentals of Naval Architecture
Data Sheet

Water Properties

Type	Property	SI	Metric	British
Sea Water	Density	1025.00 Kg/m^3	1.025 tonne mass/m^3	1.99 slug/ft^3
	Specific weight	10.055 KN/m^3	1.025 tonnef /m^3	64.00 lb/ft^3
Fresh Water	Density	1000.00 Kg/m^3	1.0 tonne mass/m^3	1.94 slug/ft^3
	Specific weight	10.00 KN/m^3	1.0 tonnef/m^3	62.4 lb/ft^3

$TPI = \frac{A_w}{420}$ for salt water

$TPC = \rho\ A_w \times 10^{-5}$ tonnef /m , area in m^2 and density in Kg/m^3

$MCT\ 1\ inch = \frac{I_L}{420\ L}\ ton.ft$ for salt water

$$MCT\ 1m = \frac{0.01005\ I_L}{L}\ MN.m\ for\ sea\ water$$

Rules for numerical Integration
Trapeziodal Rule

$$A = \frac{h}{2}\left[y_o + 2y_1 + 2y_2 + 2y_3 + \ldots + y_n\right]$$

Simpson's First Rule

$$A = \frac{h}{3}\left[y_o + 4y_1 + 2y_2 + 4y_3 + \ldots + 4y_{n-1} + y_n\right]$$