DIRECTORATE OF MERCHANT SHIPPING
GOVERNMENT OF SRI LANKA
CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : CHIEF MATE ON SHIPS OF 500 GT OR MORE (UNLIMITED)
SUBJECT : SHIP BOARD OPERATIONS
DATE : 03rd February 2016

Time allowed THREE hours	Total marks : 180
ANSWER ALL QUESTIONS	Pass marks : 60%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

1) Write short notes on following specifying objectives and requirements
   a) Polar code
   b) Enhanced survey program
   c) Ballast water convention and Regulations
   d) Planned maintenance system
   e) Shipboard energy Efficiency Management Plan
   f) Cargo Securing Manual

(05 marks each)

2) Answer the following questions with regard to carriage of bulk cargoes:
   a) With reference to solid bulk cargoes, explain in detail on board test procedure for cargoes which may liquefy to determine the possibility of liquefaction.

(10 marks)

   b) With reference to ISM code describe how you implement ISM on a brand new bulk carrier, if this bulk carrier is the first bulk vessel in a company with container fleet.

(10 marks)

   c) With reference to International grain code, describe how you derive heeling arm curve.

(10 marks)

3) Answer the following questions with regard to seaworthiness of a vessel:
   a) International Load line convention has specified the requirements during assignment of freeboard to a vessel. What are the criterions taken into consideration for the application of the deductions? (Explain at least five of the deductions)

(20 marks)

b) For the purpose of seaworthiness and cargo worthiness of a vessel, Flag states and classification societies are maintaining special relationship with each other. Explain above statement.

(10 marks)

4) A vessel is to load a heavy cargo unit require lashing according to vessels CSM (Cargo Securing Manual). Find the minimum required number of lashing if below mentioned lashing materials being used for the purpose and show lashing arrangement that you will adapt with a suitable diagram. **Use the formulas and tables in Annex – I**.

Details of the vessel

Length = 180 m	Breadth = 25 m	GM = 3.2 m
Speed = 18Kts	load density 25MT/m²	TPC = 56MT/cm
MCTC = 578		

Cargo unit is to load at 126m from AP on twin deck.

Specification of cargo unit

Weight = 48MT Dimensions = 8 x 8 x 8 in meters.

Details of securing material

Wire rope (single Use): breaking strength = 125 kN ,
Shackles, turnbuckles, deck rings: breaking strength = 180 kN
Stowage on dunnage boards, μ=0.3 (Steel – timber)

(30 marks)

5) Answer following in relation to managerial stability of vessels:
   a) A vessel with 5 cargo holds has loaded with bulk Alumina powder in cargo holds and general cargoes on deck experienced a bad weather and inclined to a particular angel. Stowage factor and angle of repose of the bulk alumina is 1.26M³/MT and 14° respectively. Explain in detail how you will asses above situation and effective remedial actions to be taken for all identified situations.

(15 marks)

   b) With reference to above it is identified that listing of the vessel has caused due to shifting of bulk Alumina powder. Explain in detail with suitable diagrams and GZ curves the effect of above cargo shift on vessels transverse stability.

(15 Marks)

6) Answer following questions with regard to reefer cargo:
   a) Cargo related information supplied by the shipper is very essential in refer trade for proper stowage, carriage and discharging of refer cargo. Enumerate and describe information required to be supplied by the shipper in relation to cargo carried by an ordinary refer vessel.

(15 marks)

   b) New generation refer vessels are fitted with controlled atmosphere (CA) type refrigeration plans. Explain how does the extended cargo preservation achieved by CA system compared to ordinary refrigeration system.

(10 marks)

   c) During the carriage of cargo, preservation of cargo is achieved by various means. Temperature control is one of the main methods used to preserve certain cargoes. Explain with suitable examples main reasons for temperature control.

(05 Marks)

Annex - I

Formulas and Tables to be used for Lashing Calculations

External forces calculating formula

$$F_{(x,y,z)} = ma_{(x,y,z)} + F_{w(x,y)} + F_{s(x,y)}$$

Balance forces calculation formulas

Transverse sliding : $\mathbf{Fy \leq \mu \cdot m \cdot g + fy_1 \cdot CS_1 + ... + fy_n \cdot CS_n}$

Longitudinal sliding : $\mathbf{Fx \leq \mu(m \cdot g - Fz) + fx_1 \cdot CS_1 + ... + fx_n \cdot CS_n}$

Transverse tipping : $\mathbf{Fy \cdot a \leq b \cdot m \cdot g + 0.9(CS_1 \cdot c_1 + CS_2 \cdot c_2 + ... + CS_n \cdot c_n)}$

MSLs for different securing devices (Table 1)

Material	MSL
Shackles, deckeyes, twistlocks, lashing rods, D-rings, stackers, bridge fittings, turnbuckles of mild steel	50% of breaking strength
Fibre rope	33% of breaking strength
Wire rope (single use)	80% of breaking strength
Wire rope (re-useable)	30% of breaking strength
Steel band (single use)	70% of breaking strength
Chains	50% of breaking strength
Web lashings	50% of breaking strength

The basic acceleration data (Table 2)

Transverse acceleration a_y in m/s²										Longitudinal acceleration a_x in m/s²
on deck, high	7.1	6.9	6.8	6.7	6.7	6.8	6.9	7.1	7.4	3.8
on deck, low	6.5	6.3	6.1	6.1	6.1	6.1	6.3	6.5	6.7	2.9
'tween-deck	5.9	5.6	5.5	5.4	5.4	5.5	5.6	5.9	6.2	2.0
lower hold	5.5	5.3	5.1	5.0	5.0	5.1	5.3	5.5	5.9	1.5
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9 L
Vertical acceleration a_z in m/s²										
	7.6	6.2	5.0	4.3	4.3	5.0	6.2	7.6	9.2	

Correction factors for length and speed (Table 3)

Length [m] / Speed [kN]	30	40	50	60	70	80	90	100	120	140	160	180	200	250	300
9	1,37	1,31	1,20	1,09	1,00	0,92	0,85	0,79	0,70	0,63	0,57	0,53	0,49	0,41	0,36
12	1,56	1,47	1,34	1,22	1,12	1,03	0,96	0,90	0,79	0,72	0,65	0,60	0,56	0,48	0,42
15	1,75	1,64	1,49	1,36	1,24	1,15	1,07	1,00	0,89	0,80	0,73	0,68	0,63	0,55	0,48
18	1,94	1,80	1,64	1,49	1,37	1,27	1,18	1,10	0,98	0,89	0,82	0,76	0,71	0,61	0,54
21	2,13	1,96	1,78	1,62	1,49	1,38	1,29	1,21	1,08	0,98	0,90	0,83	0,78	0,68	0,60
24	2,32	2,13	1,93	1,76	1,62	1,50	1,40	1,31	1,17	1,07	0,98	0,91	0,85	0,74	0,66

Table 3 – Correction factors for length and speed

Correction factor for B/GM<13 (Table 4)

B / GM	4	5	6	7	8	9	10	11	12	13 →
on deck, high	2,30	1,96	1,72	1,56	1,40	1,27	1,19	1,11	1,05	1,00
on deck, low	1,92	1,70	1,53	1,42	1,30	1,21	1,14	1,09	1,04	1,00
Tween-deck	1,54	1,42	1,33	1,26	1,19	1,14	1,09	1,06	1,03	1,00
lower hold	1,31	1,24	1,19	1,15	1,12	1,09	1,06	1,04	1,02	1,00

Table 4 - Correction factors for B/GM < 13

Friction coefficients (μ) (Table 5)

Materials in contact	**Friction coefficient, (μ)**
timber-timber, wet or dry	0,4
steel-timber or steel-rubber	0,3
steel-steel, dry	0,1
steel-steel, wet	0,0

Table 5 – Friction coefficients

Table 7 – fx-values and fy-values as a function of α, β and μ

Table 7.1 for μ = 0.4

β for fy	α														β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.67	0.80	0.92	1.00	1.05	1.08	1.07	1.02	0.99	0.95	0.85	0.72	0.57	0.40	**90**
10	0.65	0.79	0.90	0.98	1.04	1.06	1.05	1.01	0.98	0.94	0.84	0.71	0.56	0.40	**80**
20	0.61	0.75	0.86	0.94	0.99	1.02	1.01	0.98	0.95	0.91	0.82	0.70	0.56	0.40	**70**
30	0.55	0.68	0.78	0.87	0.92	0.95	0.95	0.92	0.90	0.86	0.78	0.67	0.54	0.40	**60**
40	0.46	0.58	0.68	0.77	0.82	0.86	0.86	0.84	0.82	0.80	0.73	0.64	0.53	0.40	**50**
50	0.36	0.47	0.56	0.64	0.70	0.74	0.76	0.75	0.74	0.72	0.67	0.60	0.51	0.40	**40**
60	0.23	0.33	0.42	0.50	0.56	0.61	0.63	0.64	0.64	0.63	0.60	0.55	0.48	0.40	**30**
70	0.10	0.18	0.27	0.34	0.41	0.46	0.50	0.52	0.52	0.53	0.52	0.49	0.45	0.40	**20**
80	-0.05	0.03	0.10	0.17	0.24	0.30	0.35	0.39	0.41	0.42	0.43	0.44	0.42	0.40	**10**
90	-0.20	-0.14	-0.07	0.00	0.07	0.14	0.20	0.26	0.28	0.31	0.35	0.38	0.39	0.40	**0**

Table 7.2 for μ = 0.3

β for fy	α														β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.72	0.84	0.93	1.00	1.04	1.04	1.02	0.96	0.92	0.87	0.76	0.62	0.47	0.30	**90**
10	0.70	0.82	0.92	0.98	1.02	1.03	1.00	0.95	0.91	0.86	0.75	0.62	0.47	0.30	**80**
20	0.66	0.78	0.87	0.94	0.98	0.99	0.96	0.91	0.88	0.83	0.73	0.60	0.46	0.30	**70**
30	0.60	0.71	0.80	0.87	0.90	0.92	0.90	0.86	0.82	0.79	0.69	0.58	0.45	0.30	**60**
40	0.51	0.62	0.70	0.77	0.81	0.82	0.81	0.78	0.75	0.72	0.64	0.54	0.43	0.30	**50**
50	0.41	0.50	0.58	0.64	0.69	0.71	0.71	0.69	0.67	0.64	0.58	0.50	0.41	0.30	**40**
60	0.28	0.37	0.44	0.50	0.54	0.57	0.58	0.58	0.57	0.55	0.51	0.45	0.38	0.30	**30**
70	0.15	0.22	0.28	0.34	0.39	0.42	0.45	0.45	0.45	0.45	0.43	0.40	0.35	0.30	**20**
80	0.00	0.06	0.12	0.17	0.22	0.27	0.30	0.33	0.33	0.34	0.35	0.34	0.33	0.30	**10**
90	-0.15	-0.10	-0.05	0.00	0.05	0.10	0.15	0.19	0.21	0.23	0.26	0.28	0.30	0.30	**0**

Table 7.3 for μ = 0.2

β for fy	α														β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.77	0.87	0.95	1.00	1.02	1.01	0.97	0.89	0.85	0.80	0.67	0.53	0.37	0.20	**90**
10	0.75	0.86	0.94	0.98	1.00	0.99	0.95	0.88	0.84	0.79	0.67	0.52	0.37	0.20	**80**
20	0.71	0.81	0.89	0.94	0.96	0.95	0.91	0.85	0.81	0.76	0.64	0.51	0.36	0.20	**70**
30	0.65	0.75	0.82	0.87	0.89	0.88	0.85	0.79	0.75	0.71	0.61	0.48	0.35	0.20	**60**
40	0.56	0.65	0.72	0.77	0.79	0.79	0.76	0.72	0.68	0.65	0.56	0.45	0.33	0.20	**50**
50	0.46	0.54	0.60	0.64	0.67	0.67	0.66	0.62	0.60	0.57	0.49	0.41	0.31	0.20	**40**
60	0.33	0.40	0.46	0.50	0.53	0.54	0.53	0.51	0.49	0.47	0.42	0.36	0.28	0.20	**30**
70	0.20	0.25	0.30	0.34	0.37	0.39	0.40	0.39	0.38	0.37	0.34	0.30	0.26	0.20	**20**
80	0.05	0.09	0.14	0.17	0.21	0.23	0.25	0.26	0.26	0.26	0.26	0.25	0.23	0.20	**10**
90	-0.10	-0.07	-0.03	0.00	0.03	0.07	0.10	0.13	0.14	0.15	0.17	0.19	0.20	0.20	**0**

Table 7.4 for μ = 0.1

β for fy	α														β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.82	0.91	0.97	1.00	1.00	0.97	0.92	0.83	0.78	0.72	0.59	0.44	0.27	0.10	**90**
10	0.80	0.89	0.95	0.98	0.99	0.96	0.90	0.82	0.77	0.71	0.58	0.43	0.27	0.10	**80**
20	0.76	0.85	0.91	0.94	0.94	0.92	0.86	0.78	0.74	0.68	0.56	0.42	0.26	0.10	**70**
30	0.70	0.78	0.84	0.87	0.87	0.85	0.80	0.73	0.68	0.63	0.52	0.39	0.25	0.10	**60**
40	0.61	0.69	0.74	0.77	0.77	0.75	0.71	0.65	0.61	0.57	0.47	0.36	0.23	0.10	**50**
50	0.51	0.57	0.62	0.64	0.65	0.64	0.61	0.56	0.53	0.49	0.41	0.31	0.21	0.10	**40**
60	0.38	0.44	0.48	0.50	0.51	0.50	0.48	0.45	0.42	0.40	0.34	0.26	0.19	0.10	**30**
70	0.25	0.29	0.32	0.34	0.35	0.36	0.35	0.33	0.31	0.30	0.26	0.21	0.16	0.10	**20**
80	0.10	0.13	0.15	0.17	0.19	0.20	0.20	0.20	0.19	0.19	0.17	0.15	0.13	0.10	**10**
90	-0.05	-0.03	-0.02	0.00	0.02	0.03	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	**0**

Table 7.5 for μ = 0.0

β for fy	α														β for fx
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**45**	**50**	**60**	**70**	**80**	**90**	
0	0.87	0.94	0.98	1.00	0.98	0.94	0.87	0.77	0.71	0.64	0.50	0.34	0.17	0.00	**90**
10	0.85	0.93	0.97	0.98	0.97	0.93	0.85	0.75	0.70	0.63	0.49	0.34	0.17	0.00	**80**
20	0.81	0.88	0.93	0.94	0.93	0.88	0.81	0.72	0.66	0.60	0.47	0.32	0.16	0.00	**70**
30	0.75	0.81	0.85	0.87	0.85	0.81	0.75	0.66	0.61	0.56	0.43	0.30	0.15	0.00	**60**
40	0.66	0.72	0.75	0.77	0.75	0.72	0.66	0.59	0.54	0.49	0.38	0.26	0.13	0.00	**50**
50	0.56	0.60	0.63	0.64	0.63	0.60	0.56	0.49	0.45	0.41	0.32	0.22	0.11	0.00	**40**
60	0.43	0.47	0.49	0.50	0.49	0.47	0.43	0.38	0.35	0.32	0.25	0.17	0.09	0.00	**30**
70	0.30	0.32	0.34	0.34	0.34	0.32	0.30	0.26	0.24	0.22	0.17	0.12	0.06	0.00	**20**
80	0.15	0.16	0.17	0.17	0.17	0.16	0.15	0.13	0.12	0.11	0.09	0.06	0.03	0.00	**10**
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**

Remark: $fx = \cos\alpha \cdot \sin\beta + \mu \cdot \sin\alpha$ $fy = \cos\alpha \cdot \cos\beta + \mu \cdot \sin\alpha$

Answers

Answer 4

Fx=73Kn , Fy=258Kn , Fz=227Kn (rounded values)
Fwd/Aft Lashing : 1 Lashing each side or to be compensate with transverse lashings
Transverse Lashings: 2 Lashings each side
Vertical Lashings: Not required