NUMERICALS

Q 198. A hold of length 8m x breadth 6m x height 4m to be filled with steel pipes (SF 1.06m^3 /t) and paint drums (S.F 1.85 m^3/t). If the load density of the tank top is 3.20 t/m^2, upto what height should the steel be loaded so that the hold is filled without exceeding load density. How many tonnes of steel pipes and paint drums can be loaded.

Solution : Actual Volume of the hold = L x B x H = 8 x 6 x 4
= 192 m^3
Load density = 3.20 t/m^2 (Given)

Total quantity of Cargo which can be loaded = Area x Load density
=8 x 6 x 3.20
=153.6 t

Now, Let us suppose quantity of steel pipe = x tonne
And quantity of paint drum = y tonne
Xt + Yt = 153.6t
X + Y = 153.6 ------- (1)
1.06x + 1.85y = 192 --------- (2)
x + y = 153.60 X 1.06
1.06x + 1.06y = 162.816 -------- (3)

1.06x + 1.06y = 162.816
-1.06x + 1.85y = 192.00
0.79y = 29.184

Y = 29.184/0.79
=36.94t

Paint Drum = 36.94t
Steel = 153.6 – 36.94
=116.66

Height of Steel = Volume of Steel Cargo / Area of Hold
= Quantity x S.F / Area
= 116.66 x 1.06 / 8 x 6
=2.57m
Height of steel pipe = 2.57m

Q 199. A tween deck 9m x 6m x 4m has a permissible load density of3.10 t/m². Steel tubes (S.F 1.05m³ /t) and lub oil drums (S.F 1.85 m³ /t) are to be loaded in the bold to fill all available space. Find maximum quantity of steel tubes and drums that can be loaded without exceeding load density?

Solution :
Actual Volume of hold = L x B x H
=9 x 6 x 4
=216m³
Load Density = 3.10 t/m² (Given)
Total quantity of Cargo which can be loaded = Area x Load density
=(9 x 6) x (3.10)
=167.4t
Let us suppose quantity of steel tubes = x tonne &
Quantity of lub oil drums = y tonne .
Xt + Yt = 167.4t
X + Y = 167.4 ……(1)
1.05x + 1.85y = 216 ----- (2)
x + y = 167.4 X 1.05
1.05x + 1.05y = 175.77 …… (3)

1.05x + 1.05y = 175.77
-1.05 + 1.85y = 216.00
0.8y = 40.23
Y = 40.23 / 0.8
= 50.287 t
Luboil drums = 50.287 t
Steel tubes = 167.4 – 50.287
= 117.1125 t

Q 200. **A hold 12m x 12m x 7m is to be loaded with steel pipes (S.F 1.06 Cubic meter/t) and wire rod coils (S.F 1.85 cubic meter/t). If the load density of the tank top is 5.0 t/square meter.**

Calculate

a. How many tones of each can be loaded?

b. The height of both types of cargo?

Solution :

Actual volume of hold = L x B x H

=12 x 12 x 7

=1008 Cu.m

Load density = 502 t/m^2 (given)

Total quantity of cargo which can be loaded = Area x Load density

= (12x12) x (5.0)

=720t

Let us suppose quantity of steel pipe = x tonne &

Quantity of wire rod coils = y tones

xt + yt = 720t

x + y = 720 .... (1)

1.06x + 1.85y = 1008 .... (2)

x + y = 720 X 1.06

1.06x + 1.06y = 763.2

-1.06x + 1.85y = 1008.00

0.79y = 244.8

Y = 244.8 / 0.79

=309.87t

Wire rod coils = 309.87 t

Steel pipe = 720 – 309.87

= 410.13t

Height of wired rod coils = Volume of wire rod coils / Area of hold

= Quantity of wire rod x S.F / L x B

= 309.87 x 1.85 / 12 x 12

=3.998 meter

Height of steel pipe = Quantity of steel pipe x S.F / L x B

= 410.13 x 1.06 / 12 x 12

= 3.019 meter

Q 201. **A Cargo hold 22m x 15m x 12m of bale capacity 3900 cu.m and load density 5 t/m^2 is to be filled so as to maximize the freight .The Cargo available is ....**

Steel billets S.F : 0.7 cu.m/tonne freight = $30/-per

Cotton bales S.F : 2.8 cu.m /tonne freight = $50/-per

How much of each cargo will you load and what is the freight earned?

Solution :

Actual Volume of hold = L x B x H

= 22 x 15 x 12

= 3960 m^3

Load density = 5 t /m^2 (given)

Total quantity of cargo which can load = Area x Load density
= (22x15) x (5)
=1650 t
Let us suppose quantity of steel billets = x tonne
Quantity of cotton bales = y tonne
xt + yt = 1650 t
x + y = 1650 ..... (1)
0.7x + 2.8y = 3960 ...... (2)
x + y = 1650   X 0.7
0.7x + 0.7y = 1155 ------ (3)
0.7x + 0.7y = 1155
-0.7x + 2.8y = 3960
2.1y = 2805
Y= 2805/2.1
= 1335.71 t
Cotton bales = 1335.71 t
Steel billets = 1650 – 1335.71
= 314.28 t
Steel billets → 314.28 x 30 = $9428.5
Cotton Bales → 1335.71 x 50 = $66785.5

Q 202. **A general cargo vessel with a summer draft of 5.5m has a hold with following dimensions L = 40m, B = 20m, H = 8m. Calculate maximum cargo of S.F 0.5 m/t that the hold can load if :**

a. The cargo is trimmed level

b. Max height of pile when trimmed

Solution :

Summer draft = 5.5m
Untrimmed →
Maximum concentrate that can be load = 0.9 x l x b x 5.5m
= 0.9 x 40 x 20 x 5.5
= 3960 t

Trimmed →
Maximum concentrate that can be load = (0.9 x L x B x 5.5) + 20%
= 3960 + 20% = 4752 t

Maximum height of pile = quantity of Cargo x S.F / Area of hold
=4752 x 0.5
40 x 20
= 2.97 meter

Q 203. **A hold of general cargo ship measures L = 20m, b = 15m, h = 9.05m. Dunnage consist of a layer of dunnage 5cms high and side battens extend 0.2m from ship side. It contains a cargo of 50 machinery cases of 1.5m x 1.3m x 20m showed with a B.S of 20% - 200% of cotton bales S.F= 2.5m/t and B.S = 10%. Find weight of jute bales (B.S. 0%) S.F 1.6m/t can be loaded in remaining space.**

Solution :

Volume of hold = L x B x H

= 20 x 14.6 x 9

= 2628 m^3

Machinery Space →

Total volume occupied by machinery space = (l x b x h)x 50 + B.S

=(1.5x 1.3 x 2.0)x50 + 20%

=195 +39

=234 m^3

Cotton Bales →

Total volume occupied by cotton bales = Weight of Cotton bales x S.F + B.S

=200 x 2.5 + 10%

= 500 + 50

= 550 m^3

Total Volume occupied by machinery space & cotton bales

=234 + 550 = 784 m^3

Total Volume Available = Total Volume – Occupied volume

= 2628 – 784

= 1844 m^3

Jute Bales →

Weight of jute bale that can be loaded = Volume hold / S.F

= 1844 / 1.6

= 1152.5 t

Q 204. **Hold No.1 (L= 14m, B= 9m) and Hold No. (L= 17.5m, B= 10.5m) are available to load coal (S=1.23 m^3/t) and iron are (S.F=0.38m^3/t) on a bulk carrier whose summer draft is 12.8m. Find out how much of each cargo you would be able to load in both holds separately and the maximum height of the cargo if:**

a. The cargos were loaded without trimming

b. The cargos was trimmed

c. The holds had a sharp tunnel passing through them.

d. The cargo was loaded and trimmed in a hold containing a shaft tunnel. State what restrictions given in . The code could prevent you from loading the full amount of iron are as calculated.

Solution :

Hold No.1 → Untrimmed

Maximum Coal that can be load = 0.9 x L x B x Summer draft

= 0.9 x 14 x 9 x 12.8

=1451.52 t

Maximum Iron Ore that can be load = 0.9 x L x B x Summer draft

= 0.9 x 14 x 9 x 12.8

=1451.52 t

Q 205. A gun tackle used to advantage and a luff tackle used to disadvantage are used in combination to lift a load of 4 tons. The load is supported from the gun tackle. Calculate:

a. The effort required to lift the load

b. The efficiency of the system

c. The minimum size of nylon rope to be used on each tackle.

Solution :

Gun Tackle →

W = 4t, n = 2, VR = 2+1=3 (advantage)

%F = 10%, FS = 6

Effort = W + MW x F% / VR

= (4) + (2x 4)x10% / 3

= 4 + 0.8 / 3

= 1.6 t

1.6 t effort of the gun tackle, Now became load for luff tackle

Luff Tackle →

W = 1.6 t , n = 3, VR = 3 (disadvantage)

%F = 10%, FS = 6

Effort = w + nw x F% / VR

(1.6) + (3 x 1.6) x 10% / 3

1.6 + 0.448 /3 = 0.6933 t

Effort required to lift the load = 0.6933 t

i. Efficiency of system

M.A = Load / Effort

= 4 / 0.6933

= 5.7695

V.R canbe taken as the product of the V.R of each

V.R = 3 x 3 = 9

Efficiency = M.A / VR x 100

= 5.7695/9 x 100

= 64.10%

ii. Breaking Stress = SWL x FS

= 0.6933 x 6

= 4.1598

B.S of Nylon Rope = $5D^2 / 300$

D = 15.79 i.e 16mm

Q 206. A simple derrick is filled with a 6 x 24 wire rope of 28mm diameter. The chain register specifies a safety factor of 7. Calculate:

a. The maximum load that can be safely lifted by this derrick.

b. In case two of these derricks used as union purchase, then what will be the safe working load of the system and what are the precautions to be observed?

Solution :

i. Wire rope = 6 x 24 → 28mm

FS = 7

%F = 10

B.S of 6 x 24 wire = $20D^2 / 500$
= $20 \times 28^2 / 500$
= 31.36
B.S = swl x F.S
31.36 = swl x 7
Swl = 31.36 / 7
= 4.48 t

Q 207. A weight of 12 tonnes is to be lifted by a two fold purchase rigged to advantage. The holding part of this purchase is attached to the single sheave block of a luff tackle. Find the size of nylon rope, which has to be used for each purchase and the efficiency of the system (Assume VR of the system to be the product of individuals VRS, Friction 8%, per sheave and factor of safety 6)

Solution :
Two Fold Purchase →
w = 12t, n = 4, VR = 4 + 1 = 5 (advantage)
F = 8%, FS = 6
Effort = w + nw x F% / VR
= (12) + (4 x 12) x 8% / 5
= 12 + 3.84 / 5
= 3.168 t
3.168 t effort of two fold purchase is now become a load for luff tackle.
Luff Tackle →
W = 3.168t, n = 3, VR = 3 (disadvantage)
F = 8%, FS = 6
Effort = w + nw x F% / VR
= (3.168) + (3x3.168) x 8% / 3
= 3.168 + 0.76032 / 3
= 1.30944 t
M.A = Load / Effort
= 12 / 1.30944
= 9.1642
Efficiency = MA / VR x 100
VR can be taken as product of the VR of each
VR = 5 x 3 = 15
Efficiency = 9.1642 / 15 x 100
= 61.09%
Efficiency of System = 61.09%
Luff Tackle →
Breaking Stress = Effort x FS
= 1.30944 x 6
= 7.85664
B.S of Nylon Rope = $5D^2 / 300$
7.85664 = $5D^2 / 300$
D = 21.71
D = 22 mm
Two Fold Purchase →
B.S = Effort x FS

= 3.168 x 6
= 19.008
B.S of Nylon rope = $5D^2 / 300$
19.008 = $5D^2 / 300$
D = 33.7 mm

Q 208. A three fold purchase is used to advantage to lift a weight of 2 t. If 6 x 37 size rope Is used Find the stress on the hauling part and also minimum size of the rope. (Assume friction to be 10% per sheave, Factor of safety as 5).

Solution :
w = 2t, n = 6, VR = 6 + 1 = 7 (advantage)
%F = 10%, F = 5
Effort = w + nw x F% / 7
= 2 + 1.2 / 7
= 0.4571 t
MA = Load / Effort
= 2 / 0.4571
= 4.375
Efficiency = MA / VR x 100
= 4.375 / 7 x 100
= 62.5
B.S = Effort x FS
= 0.4571 x 5
= 2.2855
BS of 6x37 Wire Rope = $21D^2 / 500$
2.2855 = $21D^2 / 500$
D = 7.37 i.e 8mm

Q 209. A simple derrick is used to lift a load of 8 tonnes means of gyn tackle used to disadvantage. If the wire is 6x24. What should be its size?

Solution :
w = 8t, n = 5, VR = 5 (disadvantage)
FS = 6, F% = 10%
Effort = w + nw x F% / VR
= (8) + (5x8) x 10% / 5
= 2.4 t
B.S = Effort x F.s
= 2.4 x 6
= 14.4
B.S of 6x24 Wire = $20D^2 / 500$
14.4 = $20D^2 / 500$
D = 18.97
D = 19mm

Q 210. **A two fold purchase rigged to disadvantage is received with a nylon rope so as to safely lift a weight of 6t using '6' as the factor of safety .How much extra load can it safely lift when used to advantage using 4 as the factor of safety?**

Solution :

w = 6t, n = 4, VR = 4 (disadvantage)
FS = 6, F% =10%
Effort = w + nw x F% / VR
= 6 + (4 x 6) x 10% / 4
= 2.1 t
B.S = Effort x F.S
= 2.1 x 6
= 12.6
B.S Nylon = $5D^2$ / 300
12.6 x 300 / 5
= 28 mm
N = 4 , VR = 4 + 1 = 5 , FS = 4
B.s = 5D2 / 300
= 5 x 756 / 300
= 12.6 t
B.S = Effort x F.S
12.6 = Effort x 4
Effort = 12.6 / 4
= 3.15 t
Effort = w + nw x f / VR
3.15 = w + 4w x 0.1 / 5
15.75 = 1.4w
W = 15.75 / 1.4
= 11.25 t
11.25 – 6 = 5.2.5 t
5.25 tons extra load safely lift.

not Required

Q 211. **A Steel girder weighing 7t is to be lifted by a single derrick using ~~a gum~~ gun tackle to advantage. A block at the derrick head leads the wire down to the winch. Find the minimum size of 6x37 wire to be used as the runner wire?**

Solution :

W = 7t, n = 2, VR = 2 + 1 (advantage)
FS = 6, F% = 10%
Gun Tackle →
Effort = w + nw x F% / VR
= 7 + (2x7) x 10% / 3
= 7 + 1.4 / 3
= 2.8 t
Effort of gun tackle now becomes load for lead block
Lead Block →
W = 2.8 t, n = 1, VR = 1 (disadvantage)
FS = 6, F% = 10%
Effort = w + nw x F% / VR

FS = 6, F% = 10%
Effort = w + nw x F% / VR
= 10 + (4 x 10 x 0.1) / 4
= 3.5 t
This effort is now become a load to gun tackle
W = 3.5t, n = 2, VR = 2 + 1 = 3 (advantage)
FS = 6, F% = 10%
Effort = w + nw x F% / VR
= 3.5 + (2 x 3.5 x 0.1) / 3
= 1.4 t
Effort Required to lift the load = 1.4 t

b. Ma = initial load / total effort
= 10 / 1.4
=7.142
Efficiency of system = MA / VR x 100
= 7.142 / 4 x 3
= 59.52 %
c. B.S = Effort x FS
= 3.5 x 6
= 21 t
BS for Nylon Rope = $5D^2 / 300$
$21 \times 300 = 5D^2$
D = 35.49 mm
D = 36 mm

Q 214. The hauling part of a gun tackle is attached to the moving block of a width tackle. Calculate the percentage efficiency of the system when a 24t weight is being lifted. Both tackles are rigged to advantage and the friction per sheave is estimated of 5% of the load.

gun watch

Solution :
W = 24t, F% = 5%
Gun Tackle →
N = 5, VR = 5 + 1 = 6 (advantage)
F% = 5%, FS = 6, w = 24t
Effort = w + nw x F% / VR
= 24 + (5 x 24 x 0.05) / 6
= 5 t
Effort is now become a load for watch tackle
Luff Tackle or Watch Tackle
W = 5t, n = 3, VR = 3 + 1 = 4 (advantage)
F% = 5%
Effort = w + nw x F% / VR
5 + (3 x 5 x 0.05) / 4
= 1.433
MA = Load / Effort
= 24 / 1.4375
= 16.69
Efficiency = MA / Product of VR
= 16.69 / 4x6 x 100

Q 215. **A derrick 15m long has its heel 2.4m above the deck span 9 m in length is attached to the derrick head and the mast 12m above deck. A weight of 15t is being lifted by a four fold purchase, the holding part of which leads along the derrick hence through a heel block to the winch. Find the thrust on the derrick boom and the tension in the span wire . Friction taken as 10% per sheave.**

Solution :
Wt = 15t, n = 8, VR = 8+1=9 (Advantage) F = 10%
Effort = w + nw x F% / VR
= 15 + (8 x 15 x 10%) / 9
= 3 t
Tension on Span wire = 14.1 t

Q 216. **A 10m long heterogeneous steel beam weighing 6t is to be lifted using two slings of identical wire type, lengths of slings being 6m and 8m. Aweight of 1 ton is placed at a distance of 3m from one end. Find tension in the sling, and minimum size of the wire rope required for each sling. Also find the angle that the beam will make with horizontal. (Construction of wire 6x24, factor of safety = 5)**

out of Portion

Solution :
BE x 1 + BD x 6 = Resultant dist x 7
3 x 1 + 5 x 6 = X x 7
3 + 30 = X x 7
33/7 = x
X = 4.71 m
Tension on T1 = 5.4t
Tension on T2 = 4.6t
For T1,
BS = swl x FS
= 5.4 x 5
= 27t
BS of 6 x 24 = $20D^2 / 500$
D = 25.98
D = 26 mm
For T2,
BS = swl x fS
= 4.6 x 5
= 23t
BS of 6 x 24 = 20D2 / 500
23 = $20D^2 / 500$
D = 23.97
D = 24 mm

Q 217. **A beam 10m in length and weighing 6t is to be lifted by a two legged sling made of 6x37 const. FSWR, one leg of the sling is 6 meter long and the other is 7 meter long. What is the size of wire will be required if the factor of safety is 6?**

Solution :

Tension on T1 = 4.3t
Tension on T3 = 5.1t
BS = swl x FS
= 5.1 x 6
= 30.6
BS of 6x37 wire = $21D^2 / 500$
$30.6 = 21D^2 / 500$
D = 26.99
D = 27 mm