MEMORIAL UNIVERSITY OF NEWFOUNDLAND

Faculty of Engineering and Applied Science

Engineering 5003 - Ship Structures

MID-TERM EXAMINATION

Date: Thur., Feb. 17, 2011 **Professor: Dr. C. Daley**
Time: 2:30 - 3:30 pm

Answer all questions. Total 20 marks. Each question is worth marks indicated **[x].**

Name: ______________________________

Student No: ______________________________

Watch your time. 60min
Think through your answers, then write and sketch clearly.

Good luck.

1. Answer the following questions in the space provides (ie on 2 lines each) **[3]**

a) In preliminary design, when can the preliminary structural calculations be made?

Only after the vessel mission and general arrangement and hull form are developed

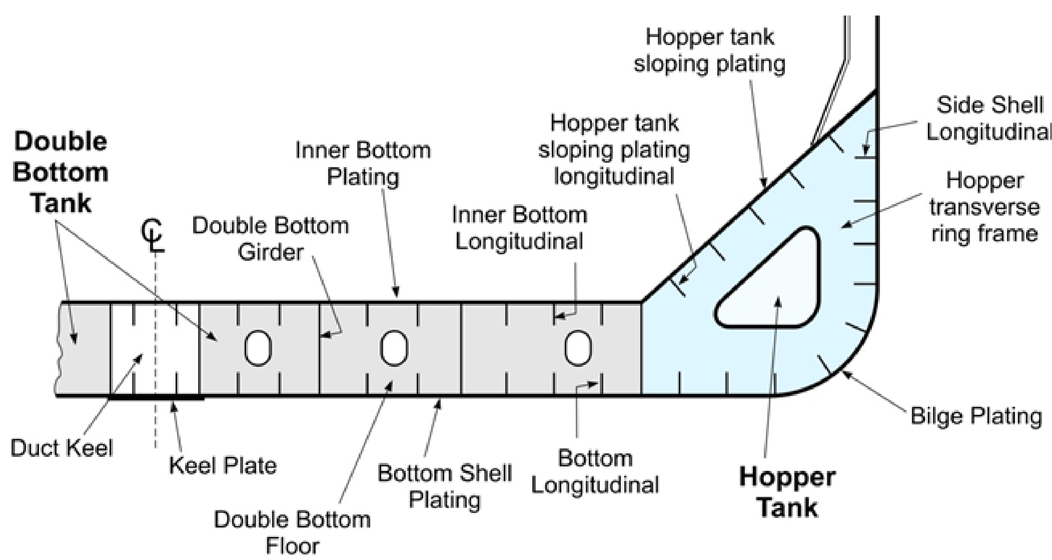
b) List 5 purposes of structure in a ship.

Strength, stiffness, watertight integrity, provide subdivision, support payload

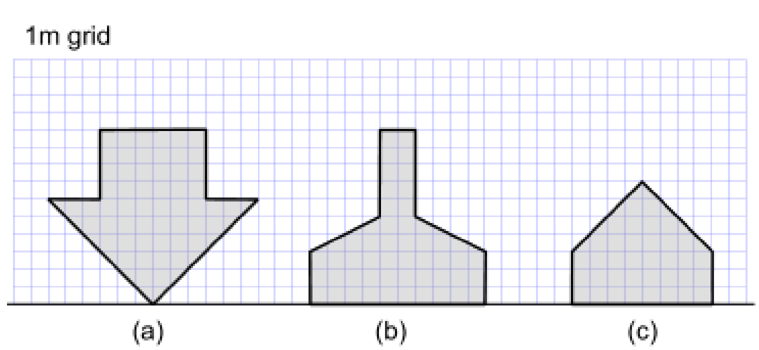
c) When is a load considered to be quasi-static?

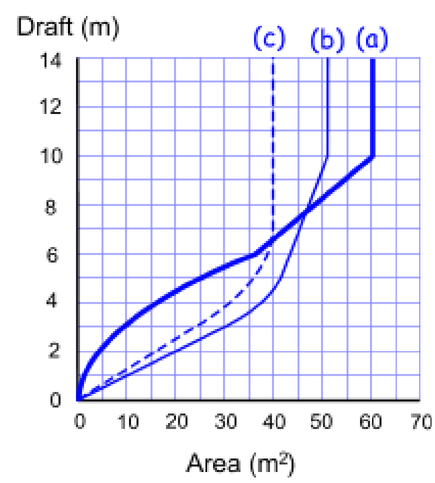
When load vary, but so slowly that inertial effects can be ignored

2. Sketch in the space below, by free hand drawing, the structure in the double bottom of a ship. Keep it neat and label the elements **[3]**

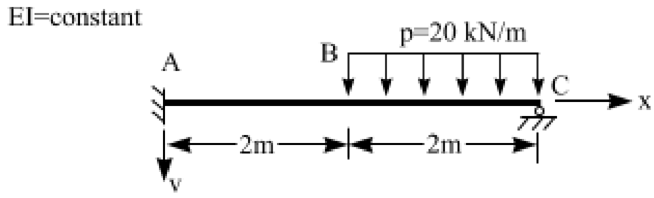


3. For the three station profiles shown below, sketch the corresponding bonjean curves **[4]**

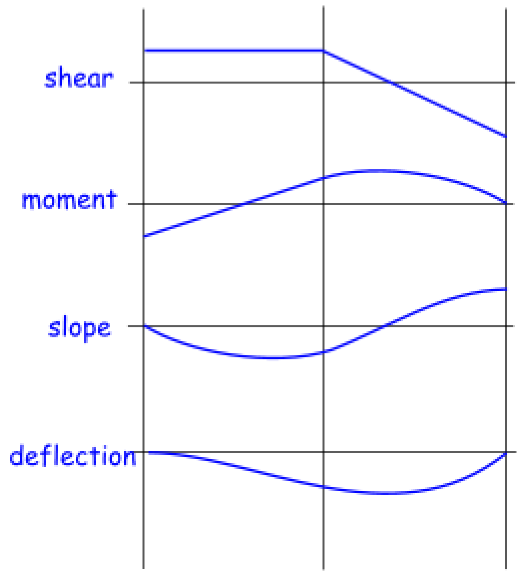




4. Beam Mechanics. For the beam sketch below:

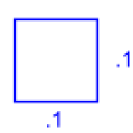


a) sketch by hand the shear, moment, slope and deflection diagrams **[5]**



b) Assuming the beam is a 10cm x 10cm square steel bar, solve the problem to find the bending stress at the fixed support. Use any method you like. **[5]**

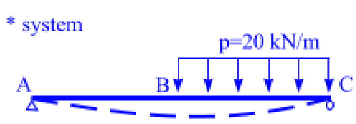
x-section

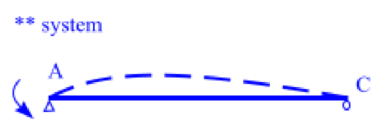


$I = 1/12\ 0.1 \times 0.1^3$
$= 8.33\text{e-}6\ \ m4$

$Z = 1.667\ \text{e-}4\ \ m3$

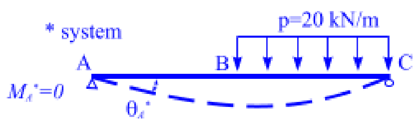
one way to solve the system is to use the force method:



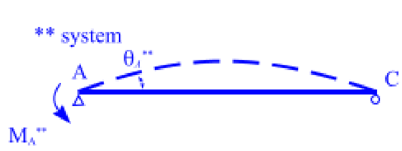


release center support
add force at B to correct central deflection
add * + ** systems

solution:



release LH moment $\theta_A^* = \frac{-7\,pL^3}{384\,EI} = \frac{-7x\,20\,x4^3}{384\,EI} = \frac{23.3}{EI}$



add moment A to correct LH rotation $\theta_A^{**} = \frac{M_A^{**}L}{3EI} = \frac{M_A^{**}4}{3EI} = \frac{4}{3}\frac{M_A^{**}}{EI}$

the deflections in * and ** will cancel, so: $\theta_A^* + \theta_A^{**} = 0$ $\quad MA = MA^* + M_A^{**} = 17.5\ kN\text{-}m$

the moment at A will be .0175 MN-m

Stress = M/Z = .0175/1.667e-4 = 105 MPa <==== ANS

Formulae

Weight of a Vessel:

$$W = \Delta = C_B \cdot L \cdot B \cdot T \cdot \gamma$$

Prohaska for parallel middle body : $\overline{W} = \dfrac{W_{hull}}{L}$ the values of a and b are ;

	$\frac{a}{\overline{W}}$	$\frac{b}{\overline{W}}$
Tankers (C_B = .85)	.75	1.125
Full Cargo Ships (C_B = .8)	.55	1.225
Fine Cargo Ships (C_B=.65)	.45	1.275
Large Passenger Ships (C_B=.55)	.30	1.35

$$\Delta lcg = \frac{x}{\overline{W}} L \frac{7}{54}$$

Murray's Method

$$BM_B = \frac{1}{2}\left(\Delta_a g_a + \Delta_f g_f\right) = \frac{1}{2}\Delta \cdot \bar{x}$$

$$\bar{x} = L(a \cdot C_B + b)$$

Where

T/L	a	b
.03	.209	.03
.04	.199	.041
.05	.189	.052
.06	.179	.063

This table for a and b can be represented adequately by the equation;

$$a = .239 - T / L$$

$$b = .1.1T / L - .003$$

Trochoidal Wave Profile

$$x = R\theta - r \sin \theta$$

$$z = r(1 - \cos \theta)$$

θ = rolling angle

Section Modulus Calculations

Ina = 1/12 a d^2

= 1/12 t b^3 $\cos^2\theta$

Family of Differential Equations Beam Bending

$v =$ deflection [m]

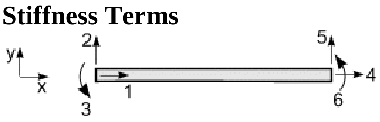
$v' = \theta =$ slope [rad]

$v''EI = M =$ bending moment [N-m]

$v'''EI = Q =$ shear force [N]

$v''''EI = P =$ line load [N/m]

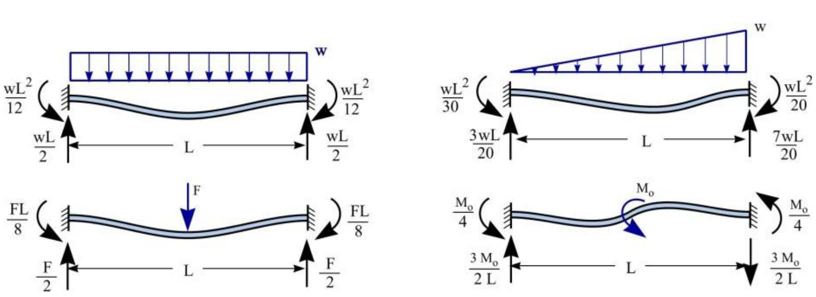
Stiffness Terms



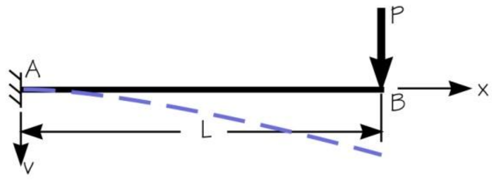
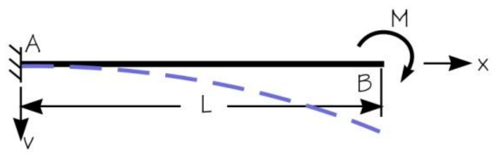
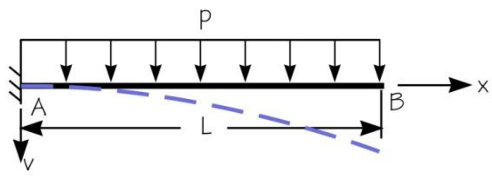
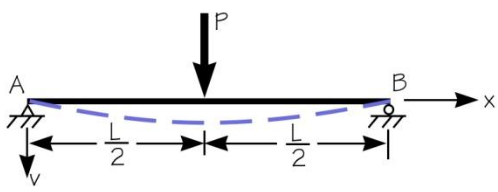
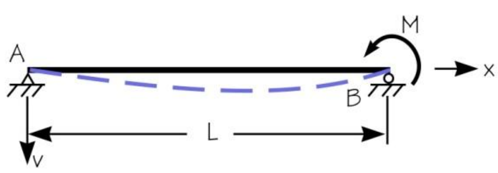
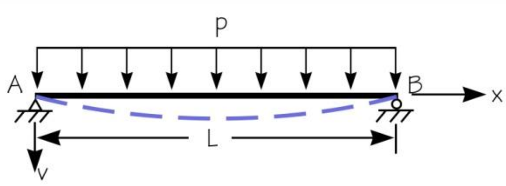
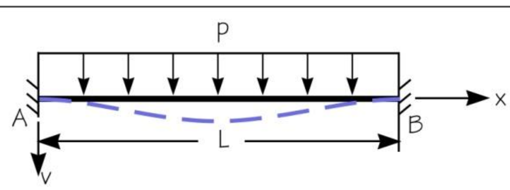
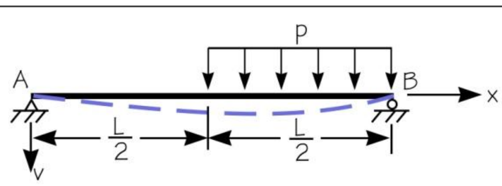
2D beam = 6 degrees of freedom

$$K = \begin{bmatrix} \frac{AE}{L} & 0 & 0 & \frac{-AE}{L} & 0 & 0 \\ 0 & \frac{12EI}{L^3} & \frac{6EI}{L^2} & 0 & \frac{-12EI}{L^3} & \frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{4EI}{L} & 0 & \frac{-6EI}{L^2} & \frac{2EI}{L} \\ \frac{-AE}{L} & 0 & 0 & \frac{AE}{L} & 0 & 0 \\ 0 & \frac{-12EI}{L^3} & \frac{-6EI}{L^2} & 0 & \frac{12EI}{L^3} & \frac{-6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{2EI}{L} & 0 & \frac{-6EI}{L^2} & \frac{4EI}{L} \end{bmatrix}$$

Fixed End Reactions



Deflection and Slopes of Beams

Loading	Deflection	Slope
	$v = \frac{Px^2}{6EI}(3L - x)$ $v_{max} = v_B = \frac{PL^3}{3EI}$	$\theta_B = \frac{PL^2}{2EI}$
	$v = \frac{Mx^2}{2EI}$ $v_{max} = v_B = \frac{ML^2}{2EI}$	$\theta_B = \frac{ML}{EI}$
	$v = \frac{px^2}{24EI}(6L^2 - 4Lx + x^2)$ $v_{max} = v_B = \frac{pL^4}{8EI}$	$\theta_B = \frac{pL^3}{6EI}$
	$v = \frac{Px^2}{48EI}(3L^2 - 4x^2)$ $v_{max} = \frac{PL^3}{48EI}$ @ $x=L/2$	$\theta_A = -\theta_B = \frac{PL^2}{16EI}$
	$v = \frac{Mx}{6EI\,L}(L^2 - x^2)$ $v_{max} = \frac{ML^2}{9\sqrt{3}\,EI}$ @ $x=L/\sqrt{3}$	$\theta_A = \frac{ML}{6EI}$ $\theta_B = -\frac{ML}{3EI}$
	$v = \frac{px}{24EI}(L^3 - 2Lx^2 + x^3)$ $v_{max} = \frac{5\,pL^4}{384\,EI}$ @ $x=L/2$	$\theta_A = -\theta_B = \frac{pL^3}{24EI}$
	$v = \frac{px^2}{24EI}(L - x)^2$ $v_{max} = \frac{pL^4}{384\,EI}$ @ $x=L/2$	$\theta_A = \theta_B = 0$
	$v_{cent} = \frac{3\,pL^4}{256\,EI}$ @ $x=L/2$	$\theta_A = \frac{-7\,pL^3}{384\,EI}$ $\theta_B = \frac{3\,pL^3}{128\,EI}$