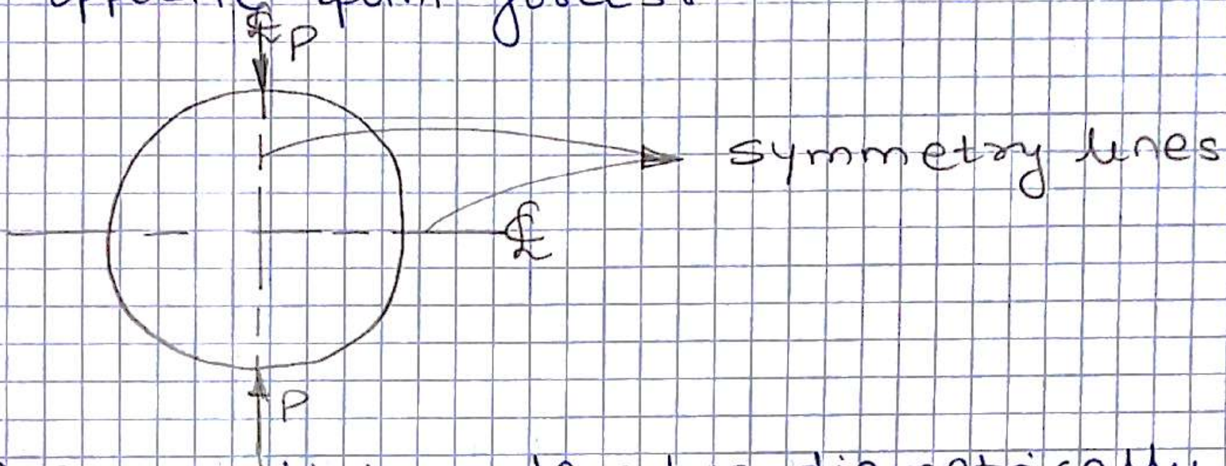
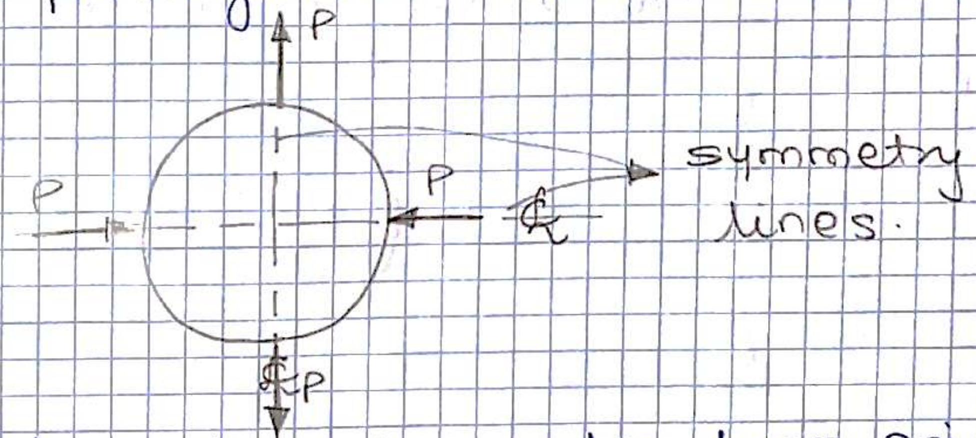
ASSIGNMENT 2. | CSMD

Q.1 Identify symmetry and antisymmetric lines

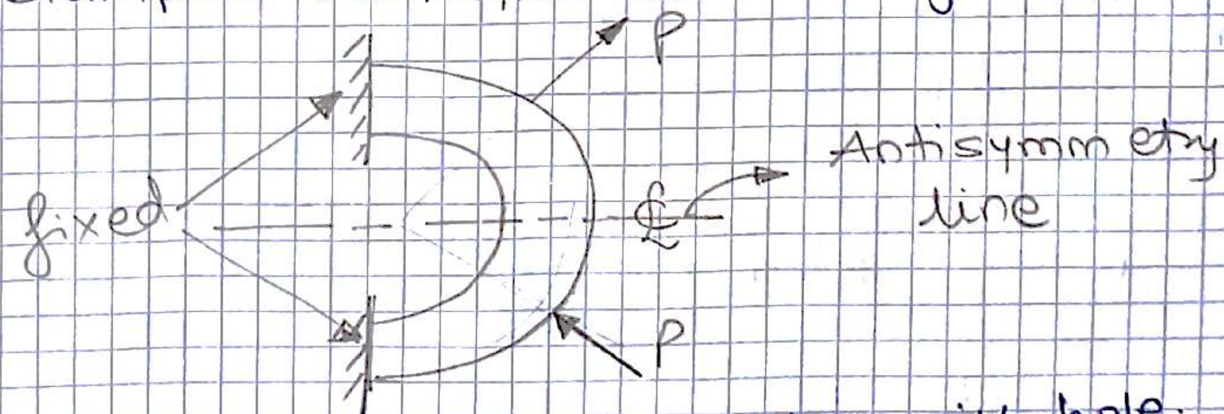
(a) circular disk under two diametrically opposite point forces:



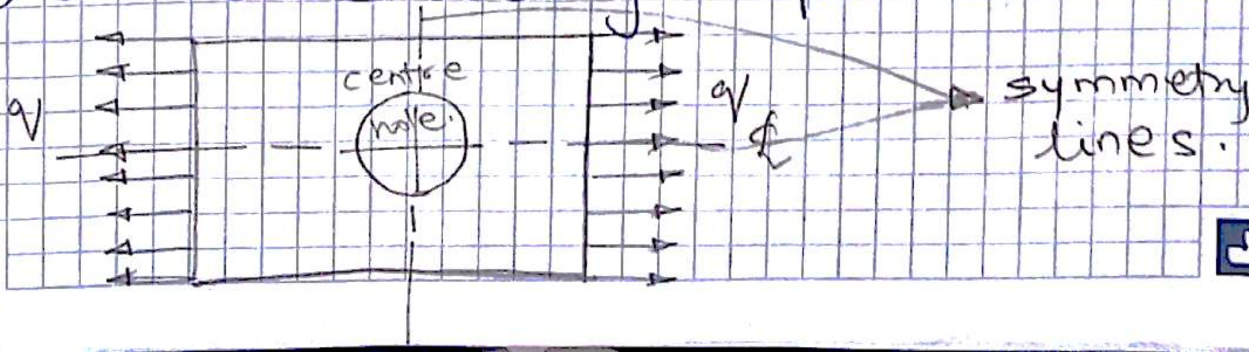
(b) same disk under two diametrically opposite point forces.



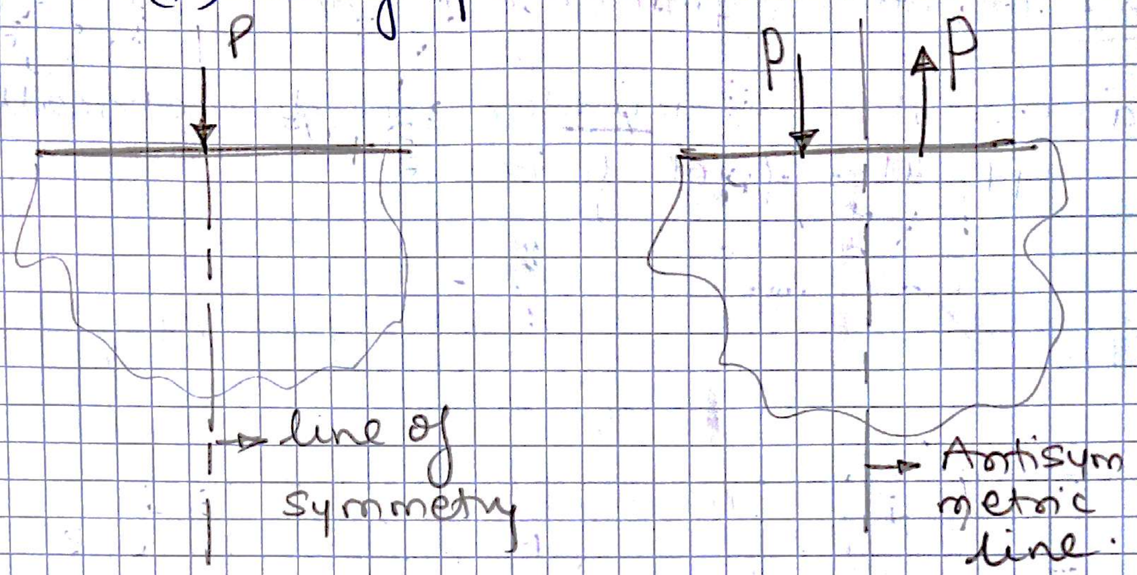
(c) clamped semiannulus under force pair



(d) a stretched rectangular plate with hole.

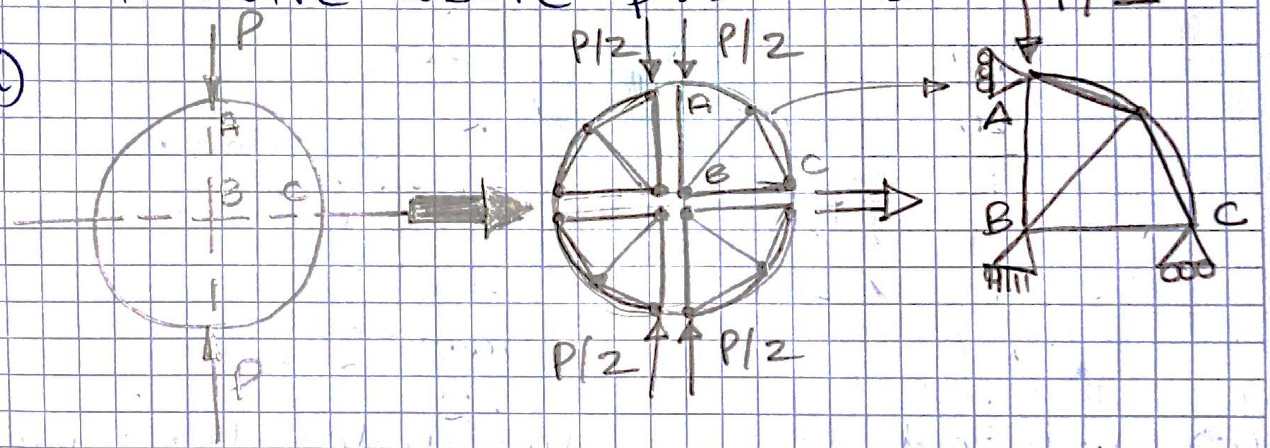


(e) and (f) half planes under load.

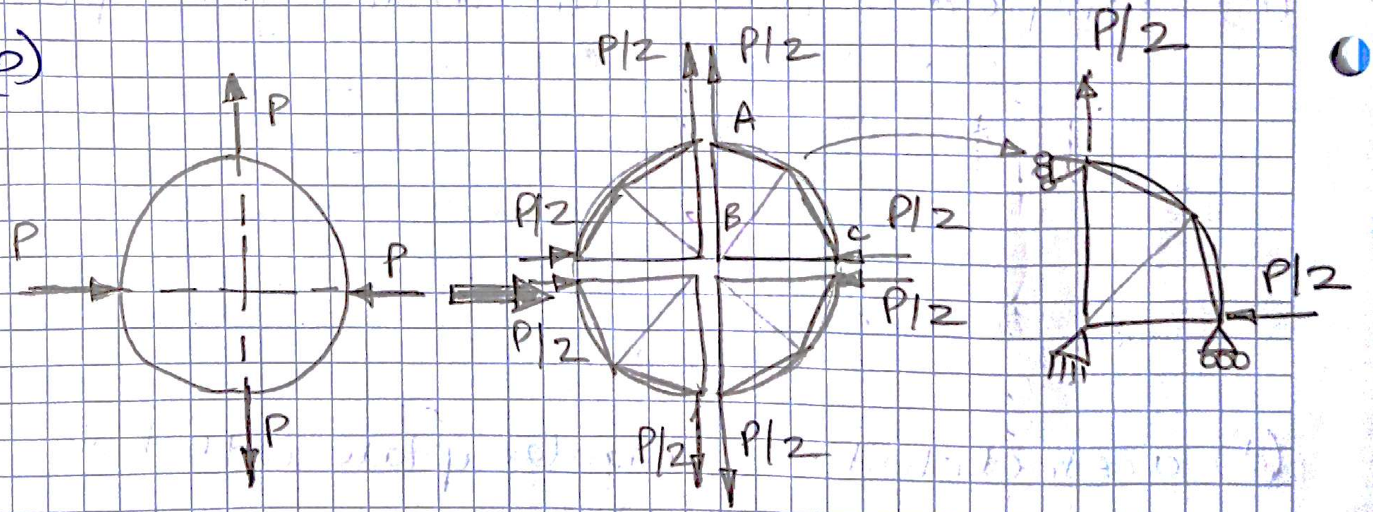


Q.2 Coarse mesh and Boundary condition to solve above problems.

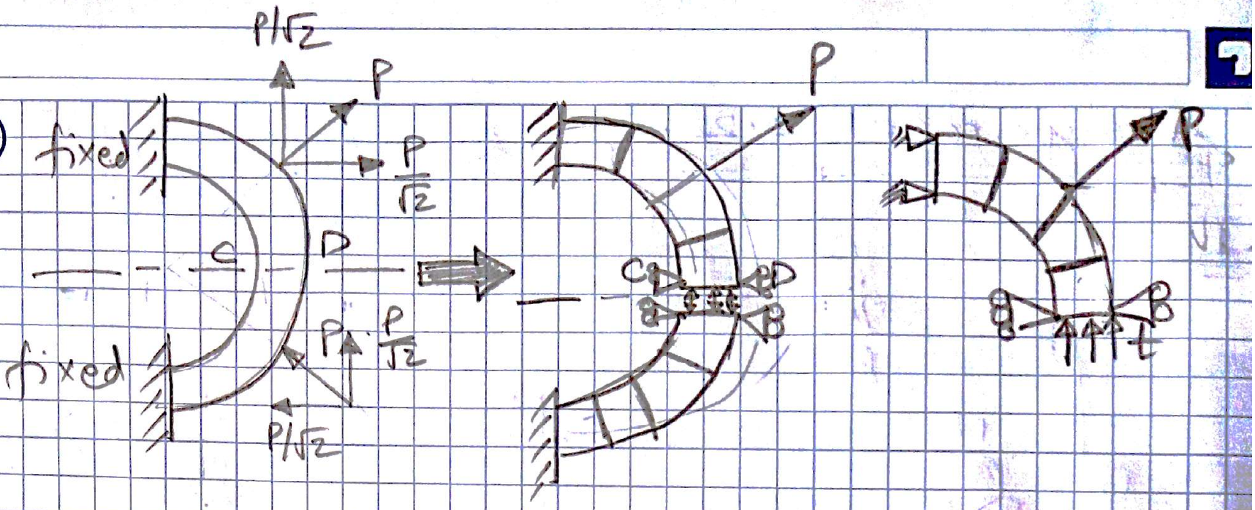
(a)



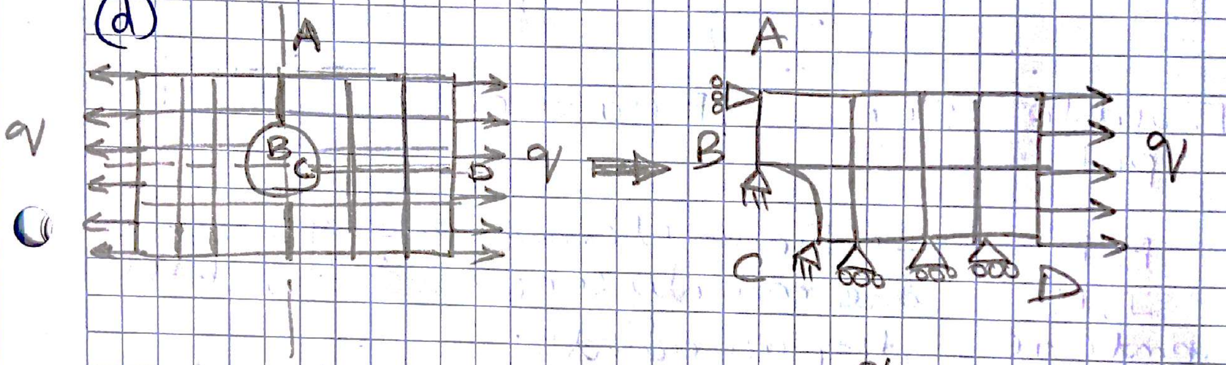
(b)



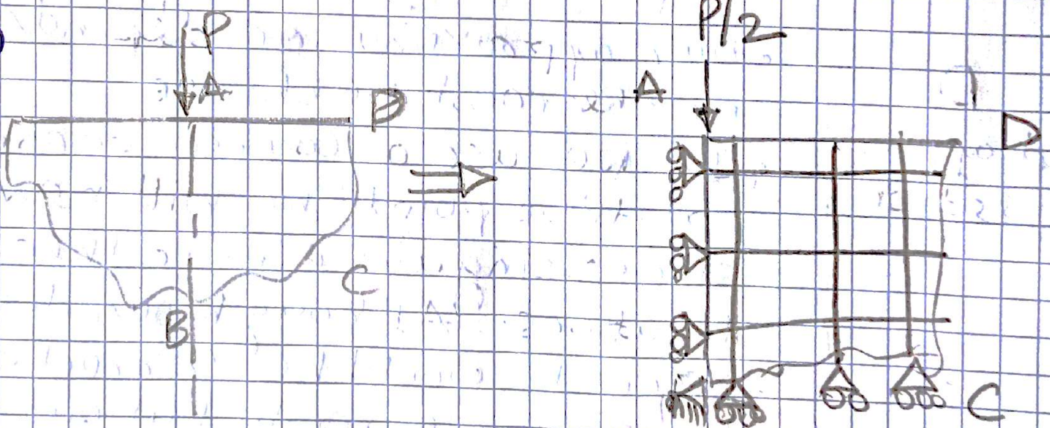
(c)


fixed
fixed
P/√2
P
P/√2
C
D
P
P/√2
P/√2
P
C
D
B
P
B

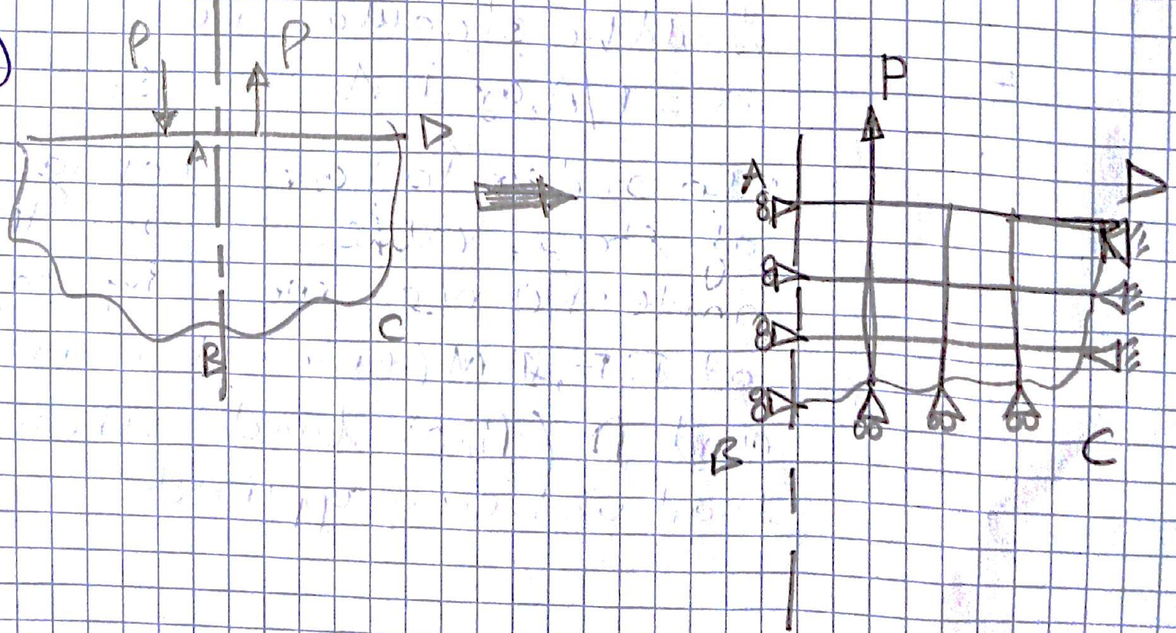
(d)


A
q
B
C
q
A
B
q
C
D

(e)

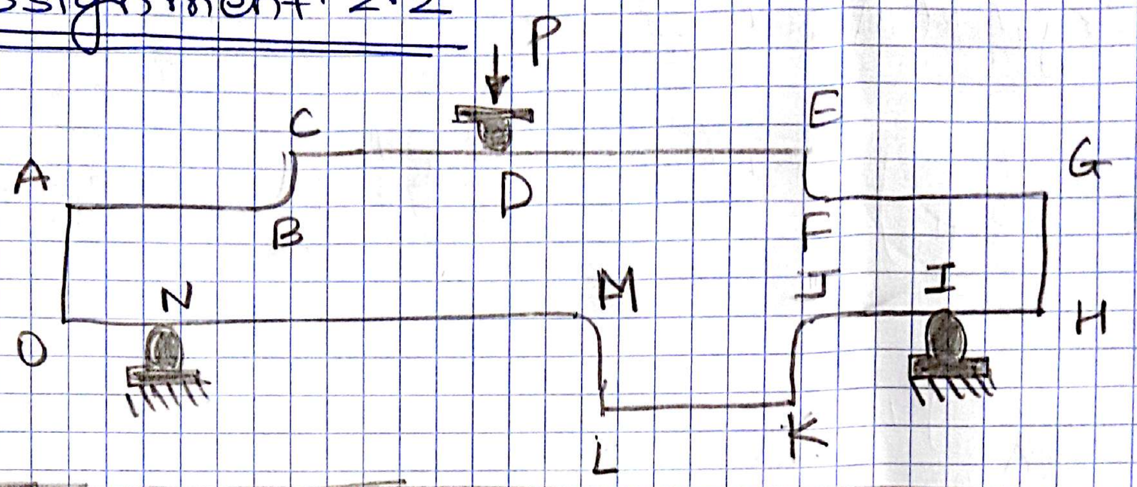

P
A
D
C
B
P/2
A
D
C

(f)


P
P
D
A
C
B
P
A
D
C
B

Assignment 2.2

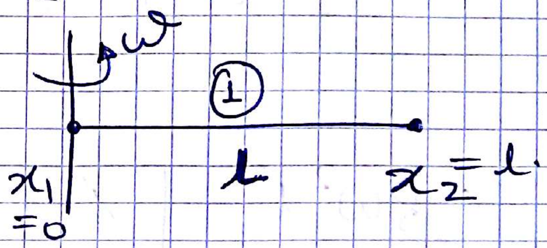
1.



Trouble Spots	Reason
B, F J, M (entrant corner) D (Load application)	• In Finite element analysis we are mainly concerned with the displacements. • Our approximation depends on the mesh we choose. • If we use a coarse mesh at these points we will have stress singularities in these locations. Although our displacements would be correct even for a coarse mesh. But our stress would be singular i.e. $\sigma = P/A$ and $A \to 0$ $\sigma = \infty$ • In order to have convergence of stress values to something finite. we need mesh refinement at B, F, J, M (entrant corner) and D (Point load) where load is being applied.

Assignment 2.3

1. $A = A_i(1-\xi) + A_j\xi$



$$q(x) = \rho A \omega^2 x$$

$$\xi = \frac{x_2 - x_1}{l}$$

$$\therefore \xi = \frac{x}{l} \qquad \therefore x = \xi l$$

$$\boxed{q(\xi) = \rho\omega^2\xi\left[A_i(1-\xi) + A_j(\xi)\right]}$$

$$f_{ext} = \int_0^1 q \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} l\, d\xi$$

$$= \int_0^1 \left[\rho\omega^2 l A_i(\xi - \xi^2) + \xi^2 A_j \rho\omega^2 l\right] \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} l\, d\xi$$

$$= \rho\omega^2 l^2 \int_0^1 \begin{bmatrix} A_i(1-\xi)^2\xi + \xi^2(1-\xi)A_j \\ A_i(\xi^2 - \xi^3) + A_j\xi^3 \end{bmatrix} d\xi$$

$$= \rho\omega^2 l^2 \int_0^1 \begin{bmatrix} A_i(\xi - 2\xi^2 + \xi^3) + A_j(\xi^2 - \xi^3) \\ A_i(\xi^2 - \xi^3) + A_j\xi^3 \end{bmatrix} d\xi$$

$$= \rho \omega^2 l^2 \int_0^1 \begin{bmatrix} A_i\left(\xi^2/2 - 2\xi^3/3 + \xi^4/4\right) + A_j\left(\xi^3/3 - \frac{\xi^4}{4}\right) \\ A_i\left(\frac{\xi^3}{3} - \frac{\xi^4}{4}\right) + A_j\left(\frac{\xi^4}{4}\right) \end{bmatrix}$$

$$= \rho \omega^2 l^2 \begin{bmatrix} A_i\left(\frac{1}{2} - \frac{2}{3} + \frac{1}{4}\right) + A_j\left(\frac{1}{3} - \frac{1}{4}\right) \\ A_i\left(\frac{1}{3} - \frac{1}{4}\right) + A_j\left(\frac{1}{4}\right) \end{bmatrix}$$

$$f_{ext} = \rho \omega^2 l^2 \begin{bmatrix} A_i\left(\frac{1}{12}\right) + A_j\left(\frac{1}{12}\right) \\ A_i\left(\frac{1}{12}\right) + A_j\left(\frac{1}{4}\right) \end{bmatrix}$$

when $A_i = A_j$

$$\boxed{f_{ext} = \rho \omega^2 l^2 A \begin{bmatrix} 1/6 \\ 1/3 \end{bmatrix}}$$

when $A_i = A_j$

b) $$f_{ext} = \int_0^1 \rho \omega^2 l \left(A - \cancel{A\xi} + \cancel{A\xi}\right) \xi \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} l \, d\xi.$$

$$= \int_0^1 \rho \omega^2 l^2 A \begin{bmatrix} 1-\xi \\ \xi \end{bmatrix} d\xi.$$

$$= \rho \omega^2 l^2 \int_0^1 \begin{bmatrix} \xi - \frac{\xi^2}{2} \\ \xi^2 \end{bmatrix} d\xi =$$

$$= \rho \omega^2 l^2 \left[\begin{matrix} \xi^2/2 - \xi^3/3 \\ \xi^3/3 \end{matrix} \right]_0^1$$

$$= \rho \omega^2 l^2 \begin{bmatrix} 1/2 - 1/3 \\ 1/3 \end{bmatrix} = \rho \omega^2 l^2 \begin{bmatrix} 1/6 \\ 1/3 \end{bmatrix}$$

$$\boxed{f_{ext} = \rho \omega^2 l^2 \begin{bmatrix} 1/6 \\ 1/3 \end{bmatrix}}$$