ID : 7829

Section: A

Subject : Stouctuoal Analysis (II)

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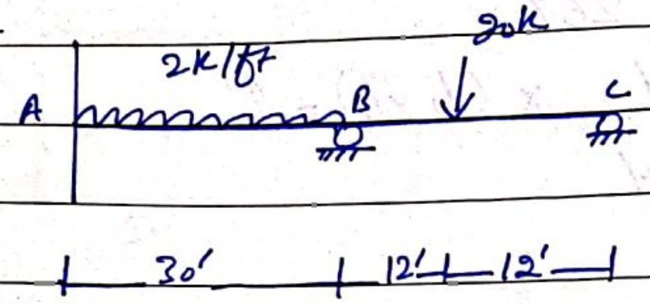
Date : 21-08-2020

Exam : Sumer (Mid Term)

Q. No #01:

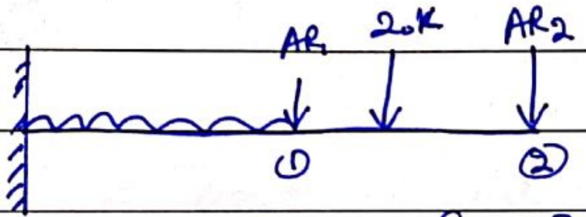
Sol:-



Structural Indeterminacy = 2°

Step # 01:-

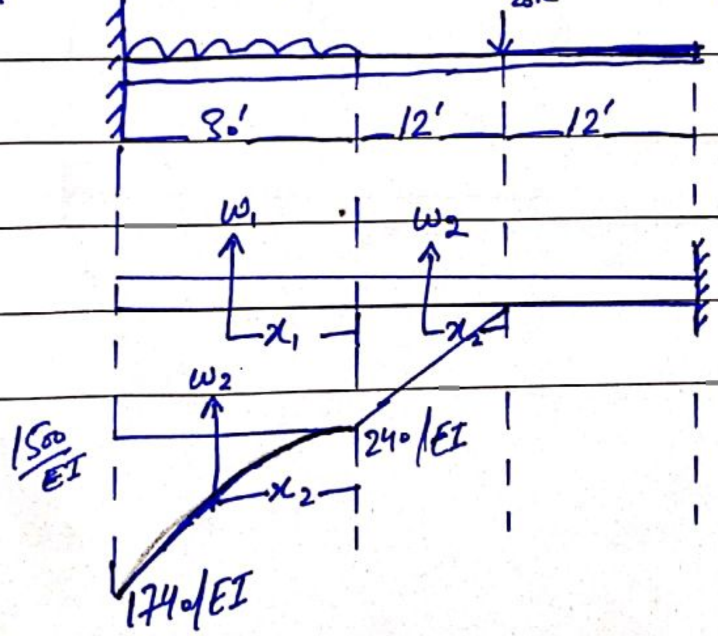
Select Redundant Actions.



$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

$$[DRS] = [DRL] + [F] \times [AR]$$

Step #2:- Compute the values of [DRL]



$w_1 = 1500 \times 30 = 45000$ $\quad 20 \times 12 = 240$

$w_2 = \frac{1}{3} \times 30 \times 240 = 2400$ $\quad 20 \times (12 \times 30) + 2 \times 30 \times 15$

$= 1740$

$w_3 = \frac{1}{2} \times 12 \times 240 = 1440$

$x_1 = b/2 = 30/2 = 15'$

$x_2 = \frac{3}{n+2} \times L = \frac{3}{2+2} \times 30 = 22.5'$

$x_3 = 2/3 \times L = 2/3 \times 12 = 8'$

Now finding DRL:-

$DRL_2 = w_1 \times (x_1 + 24) + w_2 \times (x_2 + 24) + w_3 \times (x_3 + 12)$

$= 45000 (15 + 24) + 2400 (22.5 + 24) + 1440 (8 + 12)$

$= 175000 + 111600 + 28800$

$DRL_2 = 1895400 / EI$

$DRL_1 = w_1 (x_1) + w_2 (x_2)$

$= 45000 (15) + 2400 (22.5)$

$= 675000 + 54000$

$= 729000.$

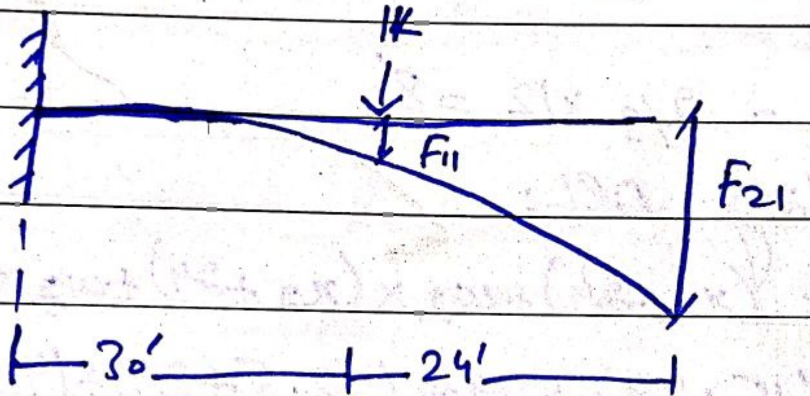
So,

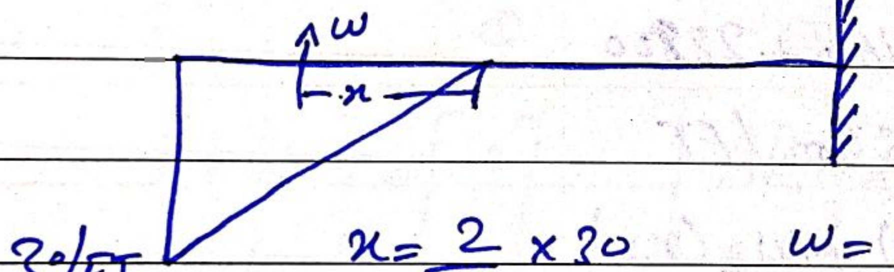
$$DRL = \frac{1}{EI} \begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step #3: Flexibility Matrix

$$[F]_{(2\times2)} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

a) Applying unit load on AR_1





$x = \frac{2}{3} \times 30$

$= 20'$

$w = 1/2\left(\frac{30}{EI} \times 30\right)$

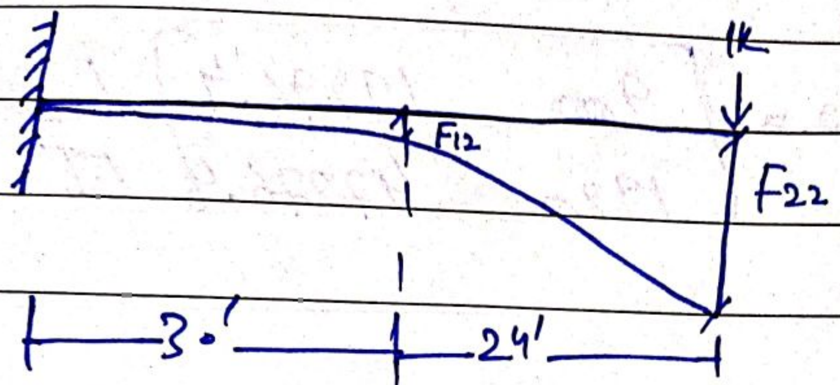
$w = 450/EI$

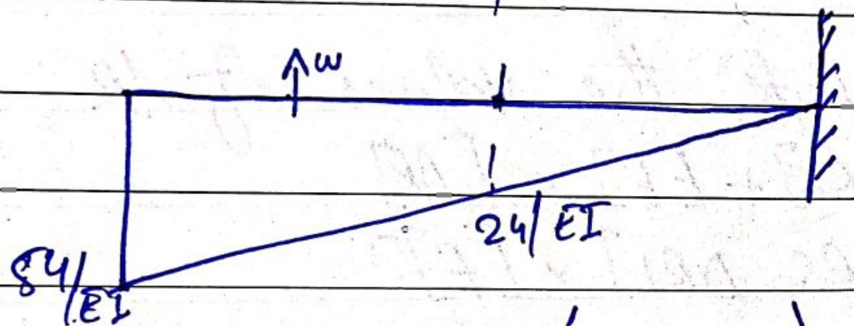
So,

$$F_{11} = \frac{450}{EI}(20) = 9000/EI$$

$$F_{21} = \frac{450}{EI}(20+24) = 19800/EI$$

Now Apply unit load on AR2.





$$w = \left(\frac{54+24}{2EI}\right) \times 30$$

$$= 1170/EI$$

Now the distance,

$$x = \frac{L}{3}\left[\frac{b+2(a)}{a+b}\right]$$

$$= \frac{30}{3}\left[\frac{24+2(54)}{54+24}\right] = 16.92'$$

$$\Rightarrow F_{12} = \frac{1170}{EI} \times 16.92' = \frac{19796.4}{EI}$$

$$\Rightarrow F_{22} = \frac{1170}{EI} \times (16.92+24) = \frac{47876.4}{EI}$$

Hence

$$F_{2\times2} = \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

Step # 04 :-

Compute the values of AR

$[DRS] = [DRL] + [F] \times [AR]$

$[AR] = [DRS - DRL] \times [F]^{-1}$

$$[F]^{-1} = \frac{1}{|F|} \times Adj\, F$$

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

$|F| = (9000 \times 47876.4 - 19796.4 \times 19800)$

$|F| = 38918880$

$$\Rightarrow Adj\, A = \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0-729000 \\ 0-1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{3891880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \begin{bmatrix} \frac{\begin{matrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{matrix}}{38918880} \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$

x x x

Question #02:

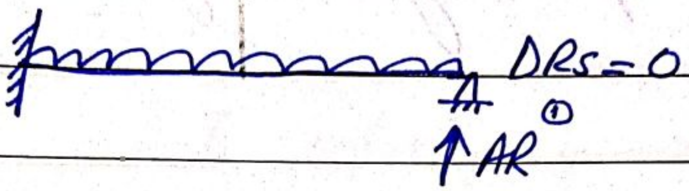
Answer #02:

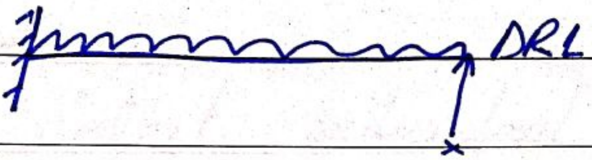
i- Force Method:-

This method is also Known as Flexibility or Compatibility method. In this method the degree of static indeterminacy of the Stru is determined and the redundants are identified. A Co-ordinate is assigned to each redundants.

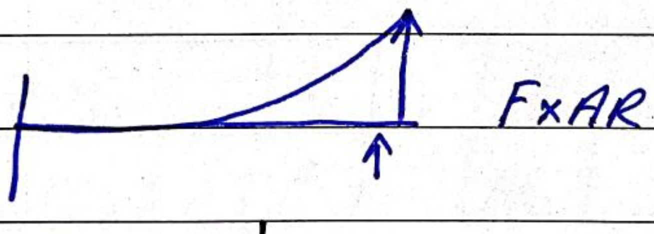
Thus AR_1, AR_2 ..... AR_n are the redundants at Co-ordinates 1, 2, ... n, If all the redundants are removed The resulting structure Known as the released stru: is statically determinate from the principle of Superposition, This net displacement at any point in a statically determinate stru is the sum of the displacements in the basis determinate stru due to applied loads and the redundants

This condition know as compatibility condition may be expressed by the equations for "n" redudant actions.





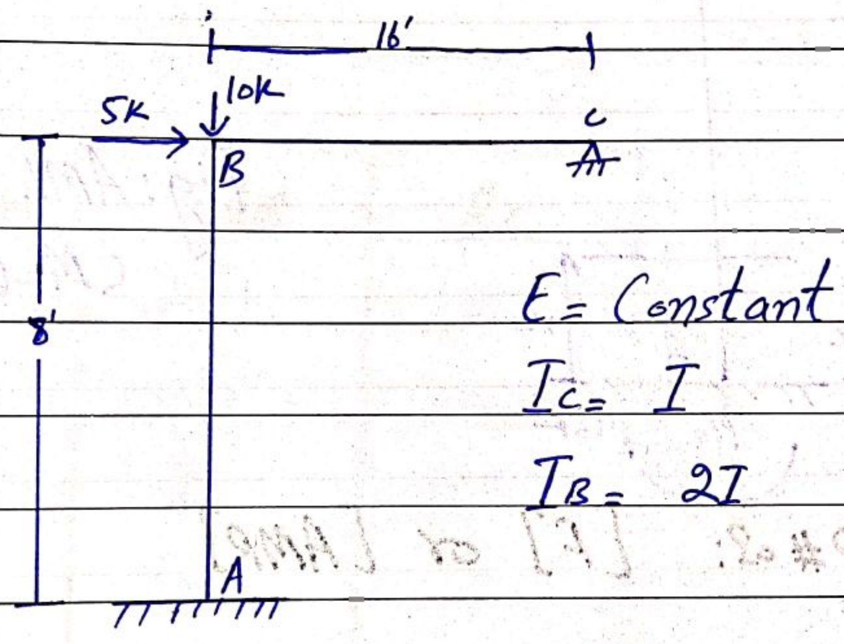
* Force per unit displacement.
* Propped Contilever
* Propped Contilever



Force Method.	Displacement Method.
* $Ds < Dk$	* $Ds > Dk$
* Forces are redudant or unknown	* Displacement are redundant or unknown
* Starts with equilibrium of forces	* Starts with compatible deformation.

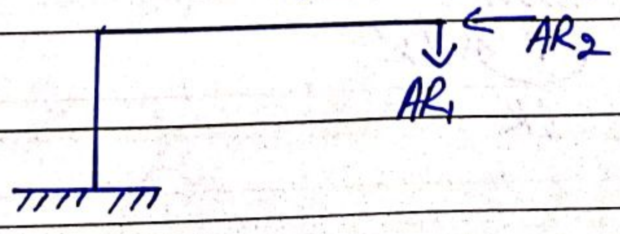
* Number of redundant = Ds	* no. of redundants = Dk
* Not Suitable for Compatibility	* Not Suitable for truses.

Q. No 3:
Analyze the rigid-joint frame shown in FIG-2 by flexibility method. Assume EI is Constant for all members.



Sol:-
Total Statical indeterminacy
$\Rightarrow R = 3$
$\Rightarrow 5-3 = 2^\circ c$

Step #01:- IDentify Redundant Actions



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$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \quad \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Step #2: Compute value of [DRL]

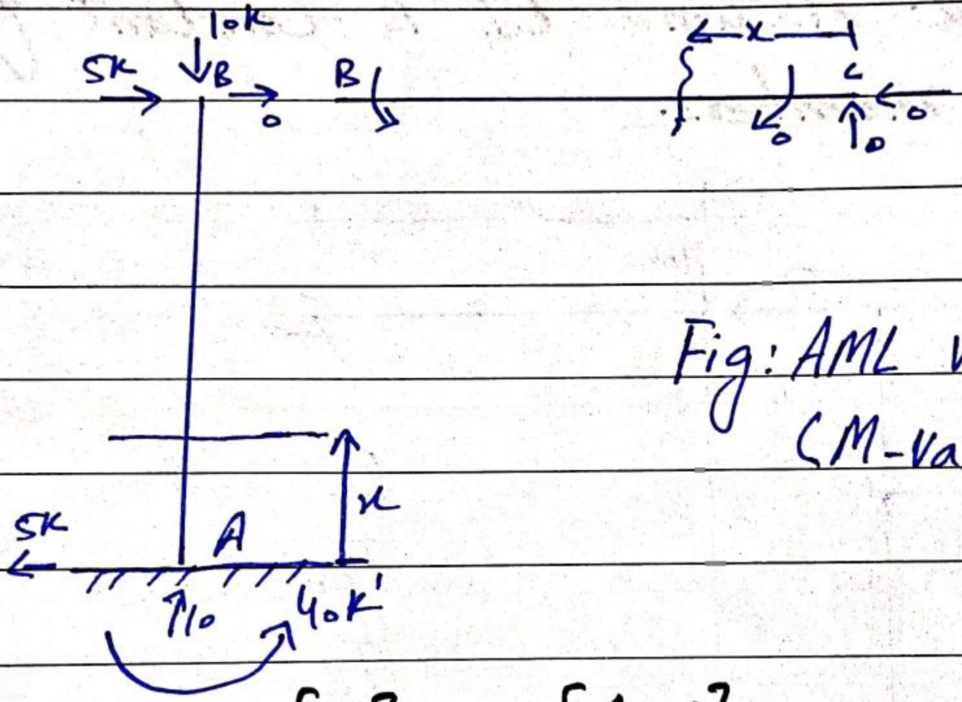

Fig: AML values
(M-values)

Step #03: [F] or [AMR]

a)

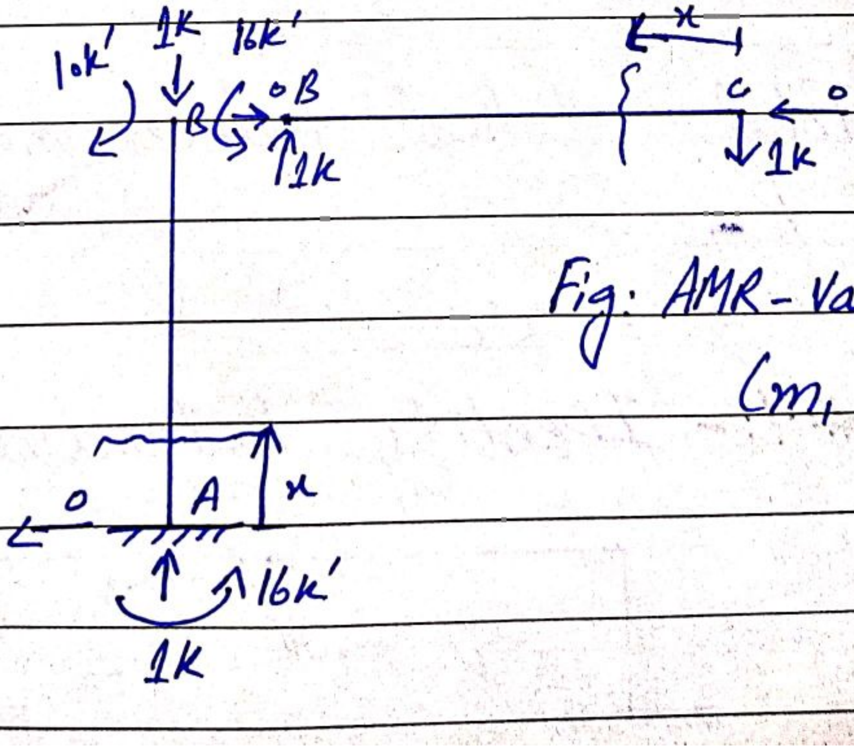

Fig: AMR-values
(m_1 values)

b.

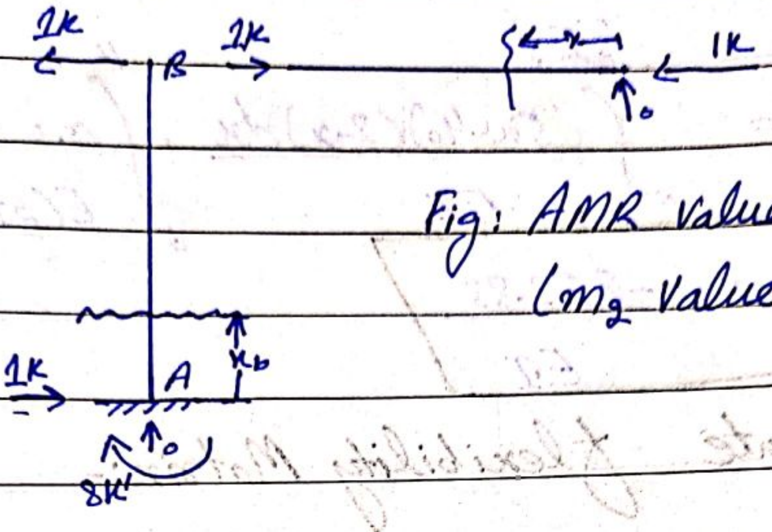

Fig: AMR values
(m_2 values)

Member	AB	BC
Origin	A	C
Limits	0-8	0-16
I	I	2I
M	$5x-40$	0
m_1	-16	x
m_2	$8-x$	0

→ For Finding values of DRL's:-

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot m_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot m_2(BC)}{EI}$$

$$= \int_0^8 \frac{(5x-40)(-16)dx}{EI} + \int_0^{16} \frac{0 \cdot x \, dx}{E(2I)}$$

$$\boxed{DRL_1 = \frac{2560}{EI}}$$

$$DRL_2 = \int_0^8 \frac{(5x-40)(8-x)\,dx}{EI} + \int_0^{16} \frac{0.0\,dx}{E(2I)}$$

$$\boxed{DRL_2 = \frac{-853.33}{EI}}$$

⇒ Compute flexibility Matrix:-

$$F_{2\times2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

$$\Rightarrow F_{11} = \int_0^8 \frac{m_1^2(AB)}{EI} + \int_0^{16} \frac{m_1^2(BC)}{EI} = \int_0^8 \frac{(-16)^2\,dx}{EI} + \int_0^{16} \frac{x^2\,(AC)}{E(2I)}$$

$$\boxed{F_{11} = \frac{2730.67}{EI}}$$

$$F_{12} = F_{21} = \int_0^8 \frac{m_1(AB)\cdot m_2(AB)}{} + \int_0^{16} m_1(BC)\cdot m_2(BC)$$

$$= \int_0^8 \frac{(-16)(8-x)\,dx}{EI} + \int_0^{16} \frac{(x)^0(0)\,dx}{2EI}$$

$$\boxed{F_{12} = F_{21} = \frac{-512}{EI}}$$

$$F_{22} = \int_0^8 (m_2)^2_{AB}\,dx + \int_0^{16} (m_2)^2_{BC}\,dx$$

$$= \int_0^8 \frac{(8-x)^2}{EI}\,dx + \int_0^{16} \frac{0^2}{2EI}\,dx.$$

$$\boxed{F_{22} = 170.67}$$

As we know that.

$[DRS] = [DRL] + [AR] \times [F]$

$\Rightarrow [AR] = \dfrac{[DRS]-[DRL]}{[F]}$

$\Rightarrow [AR] = [F]^{-1} \times [DRS-DRL]$

$$= \begin{bmatrix} 2730.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0-2560 \\ 0+853.33 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.00005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}.$$