UNIVERSIDAD TECNOLOGICA DE PANAMA
Facultad de Ingeniería Mecánica
Centro Regional deVeraguas

PARCIAL N.2 DE MECANISMOS

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1. En la figura abajo se muestra la configuración y terminología de un mecanismo de cuatro barras manivela-corredera descentrada, para lo cual se pide encontrar las aceleraciones de las juntas de pasador A y B y la aceleración de deslizamiento en la junta deslizante con un método analítico. Justifique sus respuestas. (30 puntos)

   Represente en una tabla:

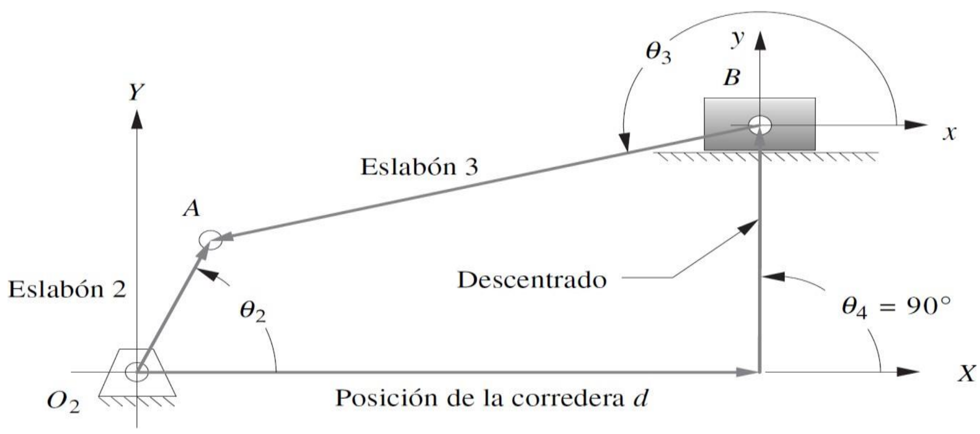
   a) Las longitudes de los eslabones y longitud descentrada.

   b) Posiciones, velocidades y aceleraciones angulares

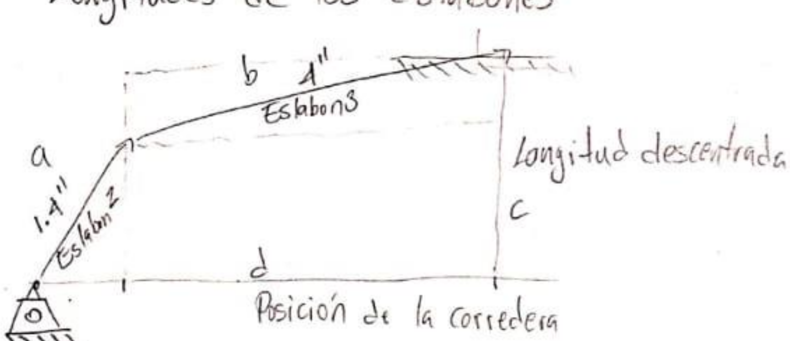
   c) Posiciones y velocidades y aceleraciones lineales

Eslabón 2, a = 1.4 ″ **Eslabón 3, b = 4 ″** **α2= 0 rad.seg^{-2}**

Descentrado, c= 1 ″ **θ_2 = 45 grados** **ω2= 10 rad.seg^{-1}**



Longitudes de los eslabones



Eslabón 2 = 1.4" = a   descentrado = c = 1"

Eslabón 3 = 4" = b

$$\vec{R}_2 - \vec{R}_3 - \vec{R}_4 - \vec{R}_1 = 0$$

$$a\cos\theta_2 - b\cos\theta_3 - c\cos\theta_4 - d\,\overset{1}{\cancel{\cos\theta_1}} = 0$$

$$a\cos\theta_2 - b\cos\theta_3 - c\cos\theta_4 - d = 0$$

Parte imaginaria componente y

$ja\ sen\,\theta_2 - jb\ Sen\,\theta_3 - jc\ Sen\,\theta_4 - jd\ Sen\,\theta_1 = 0$

$a\ Sen\theta_2 - b Sen\theta_3 - c\ Sen\,\theta_4 = 0$

Reemplazando

$1.4\cos 45 - 4\cos\theta_3 - 1\cancel{\cos 90} - d = 0$

$1.4\cos 45 - 4\cos\theta_3 - d = 0$ ①

$1.4\ Sen(45) - 4\ Sen\theta_3 - c\ \cancel{Sen 90} = 0$

$1.4\ Sen\,45 - 4\ Sen\,\theta_3 - 1 = 0$ ②

$\theta_{3_1} = Sen^{-1}\left(\frac{1.4\ Sen 45 - 1}{4}\right)$

$\theta_{3_1} = -0.1440°$

$\theta_{32} = -\theta_{3_1} + 180° = 180.144°$

Resolviendo ① y ②

$d = 1.4\cos 45 - 4\cos(180.1440)$

$d = 4.9899''$

Analisis de Velocidad

$\omega_2 = 10\ \frac{rad}{s}$

$ae^{i\theta_2} + be^{i\theta_3} - ce^{i\theta_4} - de^{i\theta_1} = 0$

$ae^{i\theta_2} + be^{i\theta_3} - ce^{i\theta_4} - (a\cos\theta_2 - b\cos\theta_3)\cancel{e^{i\theta_1}} = 0$

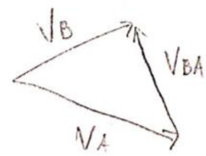
$ae^{i\theta_2} + be^{i\theta_3} - ce^{i\theta_4} - a\cos\theta_2 + b\cos\theta_3 = 0$

$ae^{i\theta_2}(i\dot\theta_2) + be^{i\theta_3}(i\dot\theta_3) - ce^{i\theta_4}(i\dot\theta_4) + a\,Sen(\theta_2)\cdot\dot\theta_2 - b\,Sen(\theta_3)\,\dot\theta_3 = 0$

$i\omega_2 ae^{i\theta_2} + i\omega_3 be^{i\theta_3} - i\cancel{\omega_4} ce^{i\theta_4} + \omega_2\, a Sen\,\theta_2 - \omega_3 b\ Sen\,\theta_3 = 0$

$i\omega_2\, ae^{i\theta_2} + i\omega_3 be^{i\theta_3} - (\omega_3 b\ Sen\theta_3 - \omega_2 a\ Sen\theta_2) = 0$ ①

$V_A + V_{BA} - V_B = 0$



$V_A = i\omega_2\, a\ e^{i\theta_2}$

$V_{BA} = i\omega_3 be^{i\theta_3}$

$V_B = (\omega_3 b\,Sen\theta_3 - \omega_2 a\,Sen\theta_2)$

$W_2 = 10\,rad/s \quad W_3 = ? \quad \theta_2 = 45° \quad \theta_3 = 180.1410°$

Reemplazando en ①

$$i w_2 a e^{i\theta_2} + i w_3 b e^{i\theta_3} - (w_3 b \,Sen\, \theta_3 - w_2 a \,Sen\, \theta_2) = 0$$

$$i a w_2 (\cos\theta_2 + j Sen\theta_2) + i b w_3 (\cos\theta_3 + j Sen\theta_3) - w_3 b \,Sen\,\theta_3 + w_2 a \,Sen\,\theta_2 = 0$$

$$i b w_3 (\cos\theta_3 + j Sen\theta_3) - w_3 \,Sen\,\theta_3 = -i a W_2 (\cos\theta_2 + j Sen\theta_2) - w_2 a Sen\theta_2$$

$$W_3 \left[ib (\cos\theta_3 + j Sen\theta_3) - sen\,\theta_3 \right] = -ia W_2 (\cos\theta_2 + j sen\theta_2) - W_2 a \,Sen\,\theta_2$$

$$W_3 = \frac{-ia W_2 (\cos\theta_2 + j Sen\theta_2) - W_2 a \,sen\,\theta_2}{ib(\cos\theta_3 + j Sen\theta_3) - Sen\theta_3}$$

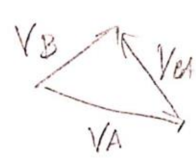
$$W_3 = \frac{-i(1.4)(10)[\cos(45) + i(Sen\,45)] - (10)(1.4)Sen(45)}{i(4)[\cos(180.144) + i(Sen\,180.144)] - Sen(180.144)}$$

$\boxed{W_3 = 2.47\,rad/s}$ Velocidades Angulares

$\boxed{W_1 = W_4 = 0}$ $\boxed{W_2 = 10\,rad/s}$

Velocidades lineales

$V_A + V_{BA} - V_B = 0$



$$V_A = i a w_2 (\cos\theta_2 + j Sen\theta_2)$$

$$V_{BA} = i b W_3 (\cos\theta_3 + j \,sen\,\theta_3)$$

$$V_B = W_3 b \,Sen\theta_3 - W_2 a \,Sen\theta_2$$

Reemplazando $W_3 = 2.47\,rad/s$; $a = 1.4$; $\theta_2 = 45°$; $\theta_3 = 180.144$; $b = 4$

$V_A = i(1.4)(10)[\cos(45) + j Sen(45)] =$

$V_A = -9.8995 + j9.8995$

$|V_A| = \sqrt{9.8995^2 + (9.8995)^2}$

$\boxed{|V_A| = 14\,pul/s}$

$$V_{BA} = i(4)(2.47)\left[\cos(180.144) + j(\operatorname{Sen}(180.144))\right]$$

$$V_{BA} = 0.010053 - 4j$$

$$|V_{BA}| = \sqrt{(0.010053)^2 + (-4j)^2}$$

$$\boxed{|V_{BA}| = 4 \ \text{pulg}/s}$$

$$V_B = (2.47)(4)(\operatorname{Sen}180.144) - (10)(1.4)\operatorname{Sen}(45)$$

$$\boxed{V_B = -9.92 \ \text{pulg}/s}$$

Analisis de Aceleración

$$R_2 + R_3 - R_4 - R_1 = 0$$

$$a e^{j\theta_2} + b e^{j\theta_3} - c e^{j\theta_4} - d e^{j\theta_1} = 0 \quad \boxed{\text{Posición}}$$

$\boxed{\text{Velocidad}}$

$$j\omega_2 a e^{j\theta_2} + j\omega_3 b e^{j\theta_3} - \omega_3 b \operatorname{Sen}\theta_3 + \omega_2 a \operatorname{Sen}\theta_2) = 0$$

derivando

$$\left(j^2 a \omega_2^2 e^{j\theta_2} + ja\alpha_2 e^{j\theta_2}\right) + \left(j^2 b\omega_3^2 e^{j\theta_3} + jb\alpha_3 e^{j\theta_3}\right) + \omega_3^2 b\cos\theta_3 - \omega_2^2 a\cos\theta_2 i$$

$$\left(ja\alpha_2 e^{j\theta_2} - a\omega_2^2 e^{j\theta_2}\right) + \left(jb\alpha_3 e^{j\theta_3} - b\omega_3^2 e^{j\theta_3}\right) + \omega_3^2 b\cos\theta_3 - \omega_2^2 a\cos\theta_2 = 0$$

Reemplazando $\alpha_2 = 0$ rad/s^2 ; $\omega_2 = 10$ rad/s ; $\omega_3 = 2.47$ rad/s ; $a = 1.4$; $b = 4$; $\theta_2 = 45°$; $\theta_3 = 180.144°$

$$-a\omega_2^2(\cos\theta_2 + j\operatorname{Sen}\theta_2) + jb\alpha_3(\cos\theta_3 + j\operatorname{Sen}\theta_3) - b\omega_3^2(\cos\theta_3 + j\operatorname{Sen}\theta_3) + \ldots$$

$$\ldots + \omega_3^2 b\cos\theta_3 - \omega_2^2 a\cos\theta_2 = 0$$

$$jb\alpha_3(\cos\theta_3 + j\operatorname{Sen}\theta_3) = a\omega_2^2(\cos\theta_2 + j\operatorname{Sen}\theta_2) + b\omega_3^2(\cos\theta_3 + j\operatorname{Sen}\theta_3) + \omega_2^2 a\cos\theta_2 - \omega_3^2 b\cos\theta_3$$

$$\alpha_3 = \frac{a\omega_2^2(\cos\theta_2 + j\operatorname{Sen}\theta_2) + b\omega_3^2(\cos\theta_3 + j\operatorname{Sen}\theta_3) + \omega_2^2 a\cos\theta_2 - \omega_3^2 b\cos\theta_3}{jb(\cos\theta_3 + j\operatorname{Sen}\theta_3)}$$

$$\alpha_3 = \frac{(1.4)(10)^2(\cos 45 + j\operatorname{Sen}45) + 4(2.47)^2(\cos(180.144) + j\operatorname{Sen}(180.144)) + (10)^2(1.4)\cos(45) - (2.47)^2(4)\cos(180.144)}{j(4)(\cos 180.144 + j\operatorname{Sen}180.144)}$$

$$\alpha_3 = -49.3576 + j49.6217$$

$$|\alpha_3| = \sqrt{(49.3576)^2 + j(49.6217)^2}$$

$\boxed{|\alpha_3| = 70 \ \text{rad}/s^2}$ $\boxed{\alpha_2 = 0 \ \text{rad}/s^2}$ $\boxed{\alpha_1 = 0 \ \text{rad}/s}$ $\boxed{\alpha_4 = 0 \ \text{rad}/s^2}$

Aceleraciones Lineales

$$A_A + A_{BA} - A_B = 0$$

$$A_A = j a \cancel{\alpha_2} e^{j\theta_2} - a\omega_2^2 e^{j\theta_2}$$

$$A_A = -a\omega_2^2 (\cos\theta_2 + j\,Sen\,\theta_2)$$

$$A_A = (-1.4)(10)^2 (\cos(45) + j\,Sen\,(45))$$

$$A_A = -98.99 - j\,98.99$$

$$|A_A| = \sqrt{(98.99)^2 + (-j\,98.99)^2}$$

$$\boxed{A_A = 140 \text{ pulg/s}^2}$$

$$A_{BA} = j b \alpha_3 e^{j\theta_3} - b\,\omega_3^2 e^{j\theta_3}$$

$$A_{BA} = j b \alpha_3 (\cos\theta_3 + j\,Sen\,\theta_3) - b\,\omega_3^2 (\cos\theta_3 + j\,Sen\,\theta_3)$$

$$A_{BA} = j(4)(70)[\cos(180.144) + j\,Sen\,(180.144)] - (4)(2.47)^2[\cos(180.144) + j\,Sen\,(180.144)]$$

$$A_{BA} = 25.1072 - j\,279.938$$

$$|A_{BA}| = \sqrt{(25.1072)^2 + (-j\,279.938)}$$

$$\boxed{|A_{BA}| = 281.06 \text{ pulg/s}^2}$$

$$A_B = -\omega_3^2 b \cos\theta_3 + \omega_2^2 a \cos\theta_2$$

$$A_B = -(2.47)^2(4)\cos(180.144) + (10)^2(1.4)\cos(45)$$

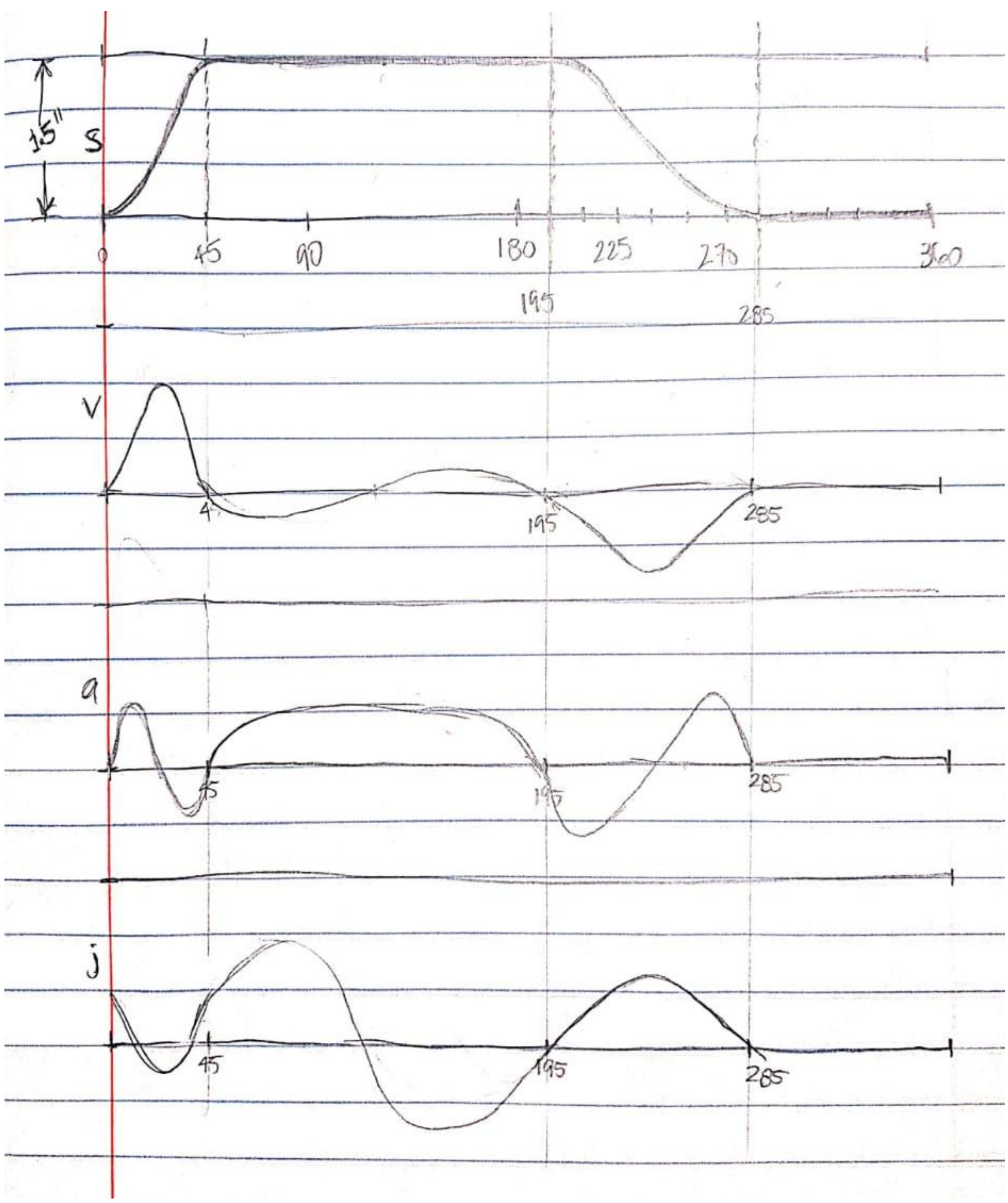
$$\boxed{A_B = 123.40 \text{ pulg/s}^2}$$

2. Diseñe una leva de doble detenimiento para mover un seguidor de 0 a 1.5″ en 45°, detenimiento durante 150°, bajada de 1.5″ en 90° y detenimiento en el resto del movimiento. El ciclo total debe tomar 6 s. Escoja funciones adecuadas de subida y bajada para minimizar las velocidades. Trace los diagramas *s v a j*. (30 puntos)

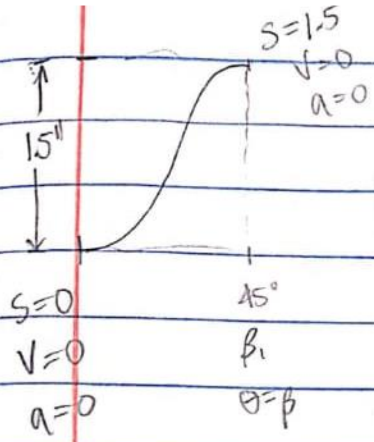
TABLA 8-3 Factores para velocidad y aceleración pico de algunas funciones de leva

Función	Vel. máx.	Acel. máx.	Golpeteo	Comentarios
Aceleración constante	2.000 h/β	4.000 h/β^2	Infinito	Golpeteo ∞; no aceptable
Desplazamiento armónico	1.571 h/β	4.945 h/β^2	Infinito	Golpeteo ∞; no aceptable
Aceleración trapezoidal	2.000 h/β	5.300 h/β^2	44 h/β^3	No es tan buena como la trapezoidal modificada
Aceleración trapezoidal modificada	2.000 h/β	4.888 h/β^2	61 h/β^3	Baja aceleración, pero aceleración brusca
Aceleración seno modificada	1.760 h/β	5.528 h/β^2	69 h/β^3	Baja velocidad, buena aceleración
Desplazamiento polinomial 3-4-5	1.875 h/β	5.777 h/β^2	60 h/β^3	Buena combinación
Desplazamiento cicloidal	2.000 h/β	6.283 h/β^2	40 h/β^3	Aceleración uniforme y golpeteo
Desplazamiento polinomial 4-5-6-7	2.188 h/β	7.526 h/β^2	52 h/β^3	Golpeteo uniforme, alta aceleración

Su uso el desplazamiento polinomial 3-4-5 para una buena combinación.



Función de Subida



$n = K-1$

$n = 6-1 = 5$

$$S = C_0 + C_1\left(\frac{\theta}{\beta}\right) + C_2\left(\frac{\theta}{\beta}\right)^2 + C_3\left(\frac{\theta}{\beta}\right)^3 + C_4\left(\frac{\theta}{\beta}\right)^4 + C_5\left(\frac{\theta}{\beta}\right)^5$$

$$V = \frac{1}{\beta}\left[C_1 + 2C_2\left(\frac{\theta}{\beta}\right) + 3C_3\left(\frac{\theta}{\beta}\right)^2 + 4C_4\left(\frac{\theta}{\beta}\right)^3 + 5C_5\left(\frac{\theta}{\beta}\right)^4\right]$$

$$a = \frac{1}{\beta^2}\left[2C_2 + 6C_3\left(\frac{\theta}{\beta}\right) + 12C_4\left(\frac{\theta}{\beta}\right)^2 + 20C_5\left(\frac{\theta}{\beta}\right)^3\right]$$

Condiciones de frontera

$a=0$; $\theta=0$

$$0 = \frac{1}{\beta^2}\left[2C_2 + 0 + 0 + 0\right] \Rightarrow \boxed{C_2 = 0}$$

$V=0$; $\theta=0$

$$0 = \frac{1}{\beta}\left[C_1 + 0 + 0 + 0 + 0\right] \Rightarrow \boxed{C_1 = 0}$$

$S=0$; $\theta=0$

$$0 = C_0 + 0 + 0 + 0 + 0 + 0 \Rightarrow \boxed{C_0 = 0}$$

$\theta=\beta$; $a=0$

$$0 = \frac{1}{\beta^2}\left[2(0) + 6C_3 + 12C_4 + 20C_5\right]$$

$$0 = 6C_3 + 12C_4 + 20C_5 \quad (1)$$

$\theta=\beta$, $V=0$

$$0 = \frac{1}{\beta}\left[0 + 2(0) + 3C_3 + 4C_4 + 5C_5\right]$$

$$0 = 3C_3 + 4C_4 + 5C_5 \quad (2)$$

$\theta=\beta$, $S=1.5$

$$1.5 = 0 + 0 + 0 + C_3 + C_4 + C_5$$

$$1.5 = C_3 + C_4 + C_5 \quad (3)$$

Resolviendo el sistema ①, ② y ③

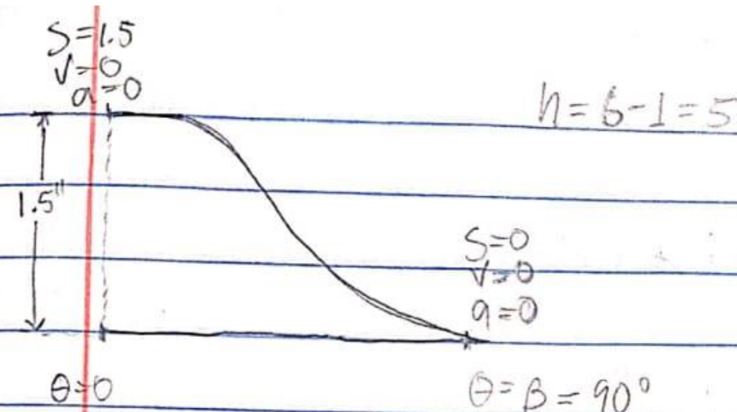
$$0 = 6C_3 + 12C_4 + 20C_5$$
$$0 = 3C_3 + 4C_4 + 5C_5$$
$$1.5 = C_3 + C_4 + C_5$$

$\boxed{C_3 = 15}$

$\boxed{C_4 = -\frac{45}{2}} = -22.5$

$\boxed{C_5 = 9}$

$$S = 15\left(\frac{\theta}{\beta}\right)^3 - \frac{45}{2}\left(\frac{\theta}{\beta}\right)^4 + 9\left(\frac{\theta}{\beta}\right)^5$$ Polinomio 3-4-5



$$S = C_0 + C_1\left(\frac{\theta}{\beta}\right) + C_2\left(\frac{\theta}{\beta}\right)^2 + C_3\left(\frac{\theta}{\beta}\right)^3 + C_4\left(\frac{\theta}{\beta}\right)^4 + C_5\left(\frac{\theta}{\beta}\right)^5$$

$$V = \frac{1}{\beta}\left[C_1 + 2C_2\left(\frac{\theta}{\beta}\right) + 3C_3\left(\frac{\theta}{\beta}\right)^2 + 4C_4\left(\frac{\theta}{\beta}\right)^3 + 5C_5\left(\frac{\theta}{\beta}\right)^4\right]$$

$$a = \frac{1}{\beta^2}\left[2C_2 + 6C_3\left(\frac{\theta}{\beta}\right) + 12C_4\left(\frac{\theta}{\beta}\right)^2 + 20C_5\left(\frac{\theta}{\beta}\right)^3\right]$$

Condiciones de frontera

$a = 0$; $\theta = 0$

$$0 = \frac{1}{\beta^2}\left[2C_2 + 0 + 0 + 0\right] \Rightarrow \boxed{C_2 = 0}$$

$V = 0$; $\theta = 0$

$$0 = \frac{1}{\beta}\left[C_1 + 2(0) + 0 + 0 + 0\right] \Rightarrow \boxed{C_1 = 0}$$

$S = 1.5$; $\theta = 0$

$$1.5 = C_0 + 0 + 0 + 0 + 0 + 0 \Rightarrow \boxed{C_0 = 1.5}$$

$a=0\ ;\ \theta=\beta$

$$0=\frac{1}{\beta^2}\left[0+6C_3+12C_4+20C_5\right]$$

$$0=6C_3+12C_4+20C_5 \quad (1)$$

$V=0\ ;\ \theta=\beta$

$$0=\frac{1}{\beta}\left[0+0+3C_3+4C_4+5C_5\right]$$

$$0=3C_3+4C_4+5C_5 \quad (2)$$

$S=0\ ,\ \theta=\beta$

$$0=1.5+0+0+C_3+C_4+C_5$$

$$0=1.5+C_3+C_4+C_5 \quad (3)$$

Resolviendo el sistema (1), (2) y (3)

$0=6C_3+12C_4+20C_5$ (1) $\qquad C_3=-15$

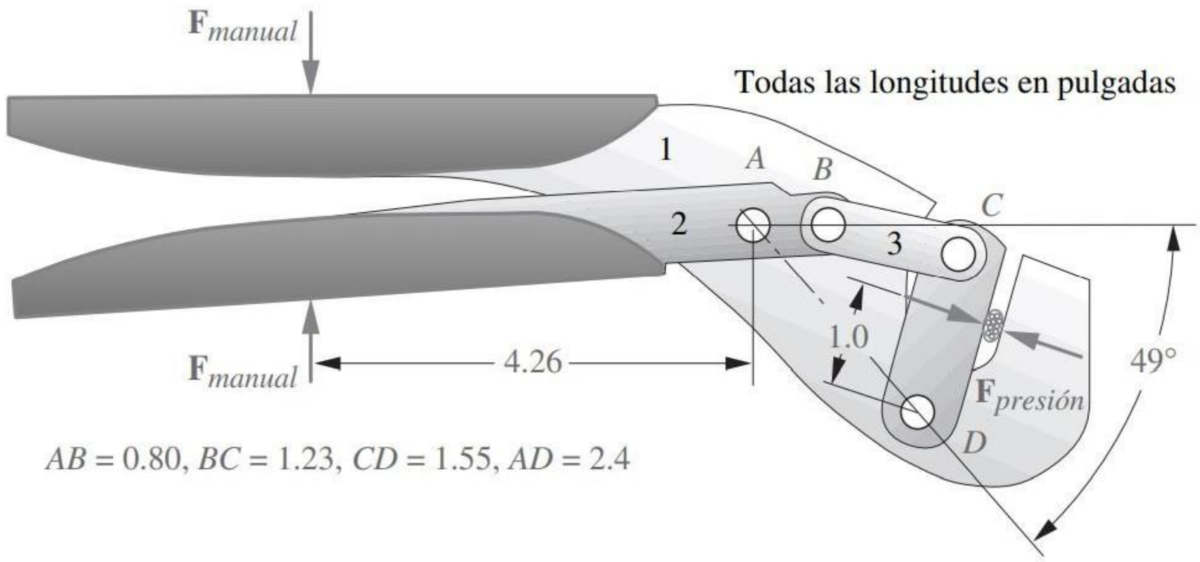
$0=3C_3+4C_4+5C_5$ (2) $\qquad C_4=45/2=22.5$

$0=1.5+C_3+C_4+C_5$ (3) $\qquad C_5=-9$

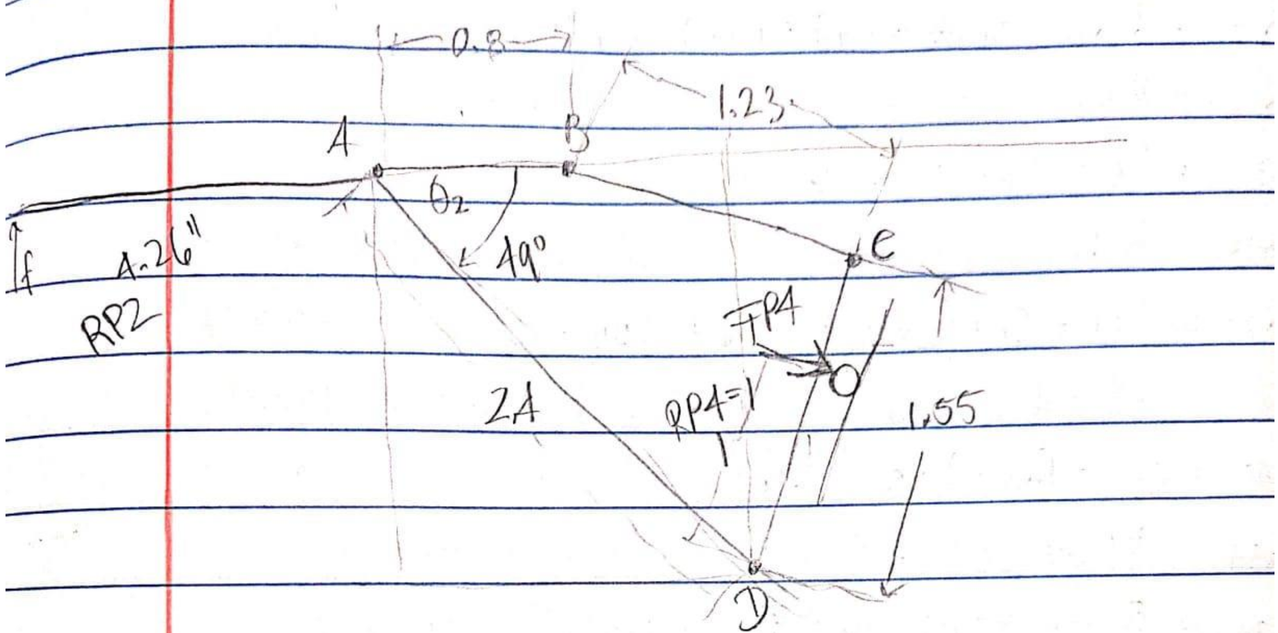
$$S=1.5-15\left(\frac{\theta}{\beta}\right)^3+\frac{45}{2}\left(\frac{\theta}{\beta}\right)^4-9\left(\frac{\theta}{\beta}\right)^5$$

Polinomio 3-4-5

3. La figura abajo muestra una herramienta de presión. Encuentre la fuerza F_{manual} necesaria para generar una fuerza $F_{presión}$ de 2 000 lb. Encuentre las fuerzas en los pasadores A, B, C y D. (40 puntos)



$AB = 0.80$, $BC = 1.23$, $CD = 1.55$, $AD = 2.4$



$FP4 = 2000$ lbf $\qquad \theta_3 = 31.039$

$RP2 = 4.26 \qquad \theta_4 = 123.518$

$RP4 = 1 \qquad \theta FPA = 123.518 + 90 = 213.518°$

$RCG2 = (0.5)(0.80) = 0.4$

$RCG3 = (0.5)(0.23) = 0.615$

$RCG4 = (0.5)(1.55) = 0.775$

$R_{12x} = RCG2 \cos(\theta_2 + 180) = (0.4)(\cos(49+180)) = -0.262$

$R_{12y} = RCG2\ Sen(\theta_2 + 180) = (0.4)Sen(49+180) = -0.302$

$R_{32x} = RCG2 \cos(\theta_2) = (0.4)\cos(49) = 0.262$

$R_{32y} = RCG2\ Sen(\theta_2) = (0.4)Sen(49) = 0.302$

$R_{23x} = RCG3 \cos(\theta_3 + 180) = (0.615)\cos(34.039+180) = -0.510$

$R_{23y} = RCG3\ Sen(\theta_3 + 180) = (0.615)Sen(34.039+180) = -0.344$

$R_{43x} = (BC - RCG3)\cos(\theta_3) = (1.23 - 0.615)\cos(34.039) = 0.510$

$R_{43y} = (BC - RCG3)Sen(\theta_3) = (1.23 - 0.615)Sen(34.039) = 0.344$

$R_{34x} = RCG4 \cos\theta_4 = (0.775)\cos(123.518) = -0.428$

$R_{34y} = RCG4\ Sen\theta_4 = (0.775)sen(123.518) = 0.646$

$R_{14x} = RCG4 \cos(\theta_4 + 180) = (0.775)\cos(123.518+180) = 0.428$

$R_{14x} = RCG4\ Sen(\theta_4 + 180) = (0.775)Sen(123.518+180) = -0.646$

$R_{P2y} = (R_{P2} + RCG2)Sen(\theta_2 + 180) = (4.26+0.4)Sen(49+180) = -3.517$

$R_{P2x} = (R_{P2} + RCG2)\cos(\theta_2 + 180) = (4.26+0.4)\cos(49+180) = -3.057$

$R_{P4x} = (R_{P4} - RCG4)\cos\theta_4 = (1 - 0.775)\cos(123.518) = -0.124$

$R_{P4y} = (R_{P4} - RCG4)Sen\theta_4 = (1 - 0.775)Sen(123.518) = 0.188$

$F_{P4x} = F_{P4}\cos(\theta F_{P4}) = (2000 lb)\cos(213.518) = -1667.5\ lbf$

$F_{P4y} = F_{P4}\ Sen(\theta F_{P4}) = (2000\ lb)Sen(213.518) = -1104.4\ lbf$

$$C := \begin{pmatrix}
1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\
\frac{-R_{12y}}{in} & \frac{R_{12x}}{in} & \frac{-R_{32y}}{in} & \frac{R_{32x}}{in} & 0 & 0 & 0 & 0 & \frac{R_{P2x}}{in} & \frac{-R_{P2y}}{in} \\
0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & \frac{R_{23y}}{in} & \frac{-R_{23x}}{in} & \frac{-R_{43y}}{in} & \frac{R_{43x}}{in} & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & \frac{R_{34y}}{in} & \frac{-R_{34x}}{in} & \frac{-R_{14y}}{in} & \frac{R_{14x}}{in} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \tan\left(\theta_2 + \frac{\pi}{2}\right) & -1
\end{pmatrix}$$

$$F := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -F_{P4x} \cdot lbf^{-1} \\ -F_{P4y} \cdot lbf^{-1} \\ \left(-R_{P4x} \cdot F_{P4y} + R_{P4y} \cdot F_{P4x}\right) \cdot lbf^{-1} \cdot in^{-1} \\ 0 \end{bmatrix}$$

Resolviendo las Matrices tal que

$R = C^{-1} \cdot F$ obtenemos

$F_{12x} = 1029\ lbf$

$F_{12y} = 757\ lbf$

$F_{32x} = -1069\ lbf$

$F_{32y} = -722\ lbf$

$F_{43x} = -1069\ lbf$

$F_{43y} = -722\ lbf$

$F_{14x} = 598\ lbf$

$F_{14y} = 382\ lbf$

$F_{manual_x} = 40.1\ lbf$

$F_{manual_y} = -34.9\ lbf$

Sacando las magnitudes de las fuerzas resultantes

Pasador A $= F_{12} = \sqrt{(1029)^2 + (757)^2} = 1278\ lbf$

Pasador B $= F_{32} = \sqrt{(-1069)^2 + (-722)^2} = 1290\ lbf$

Pasador C $= F_{43} = \sqrt{(-1069)^2 + (-722)^2} = 1290\ lbf$

Pasador D $= F_{14} = \sqrt{(598)^2 + (382)^2} = 710\ lbf$

$F_{manual} = \sqrt{(40.1)^2 + (-34.9)^2} = 53.1\ lbf$

Nota: Además de someter el parcial como asignación este debe ser entregado en su cuenta personal del bloque de notas para que vea sus correcciones.