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Answer in the question paper. Write your name, E.No. and group on both sheets in the designated area. One A4 size sheet in your own handwriting is allowed in the examination hall

Q1. Design a crank rocker with optimized transmission angle and a rocking angle of 30° with forward stroke of 210° . Enter the details in the table below after you have done the design. (8 points)

l_4/l_1	l_2/l_1	μ_{min}
	$\simeq 0.2588$	35°

given $\theta_2^{12} = 210^\circ$, $\theta_4^{12} = 30^\circ$

$\frac{\theta_2^{12}}{2} = 105^\circ$, $\frac{\theta_4^{12}}{2} = 15^\circ$

$\beta = 90 - \frac{\theta_4^{12}}{2} = 75^\circ$

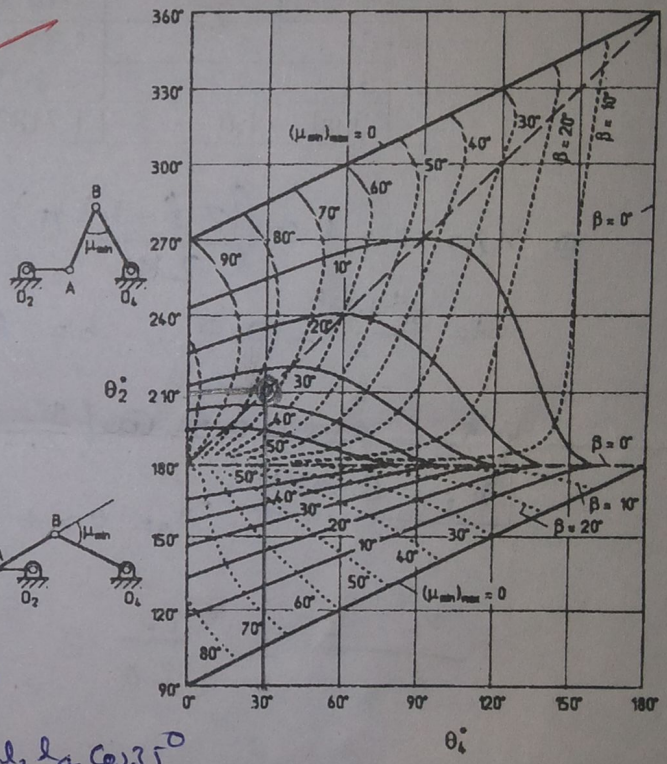
$\frac{l_2}{l_1} = \sin\left(\frac{\theta_4^{12}}{2}\right) = 0.2588$

$(l_1 - l_2)^2 = l_3^2 + l_4^2 - 2 l_3 l_4 \cos(\mu_{min})_{max}$

$l_4^2 = l_1^2 + l_3^2 - l_2^2$

$(3.85)^2 = l_3^2 + l_4^2 - 2 l_3 l_4 \cos(35^\circ)$

$(3.85)^2 = l_3^2 + l_1^2 + l_3^2 - l_2^2 - 2 l_3 l_4 \cos 35^\circ$



* In this case A_1 & R_{12} are at same position.

β between 70 – 80

$\Rightarrow \beta = 75$ (by calculation)

$(\mu_{min})_{max} = \frac{30+40}{2} = 35^\circ$

R_{12} / A_1

l_2

$75^\circ + \beta$

O_2

$-\theta_2^{12}/2$

$l_1 = 5.3\text{cm}$

O_4

$-\theta_4^{12}/2$

$l_2 = 1.45\text{cm}$

R_{12} will on this arc

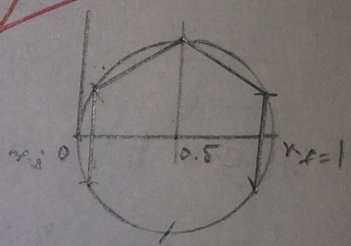
R_{12} will on this line

Q2. Design a 4R linkage to generate the the function $y = e^x - x$ for values of x between 0.0 and 1.0 given that the input angle ranges from 65° to 125° and the output angle ranges from 40° to 80°.

a) Fill up the table below to determine Chebyshev precision points. (4)
b) Calculate the link lengths using Freudenstein's method. (4)
c) Sketch the mechanism to scale in one of the precision positions. (2)

	x	y	θ_2	θ_4
initial	0.0	1.0	65°	40°
1	0.5	1.1052	74°	45.8464
2	0.5	1.35915	95°	59.9974
3	0.9	1.64701	119°	76.025
final	1.0	1.7183	125°	80°

2



0.15

same for y

① $x_i = a + h\cos\left(\frac{(2i-1)\pi}{2K}\right)$ $(i = 1, 2, 3, \ldots K)$

$a = \frac{x^i + x^f}{2} = 0.5$, $h = 0.5 = \frac{x^f - x^i}{2}$

$x_1 = 0.5 + 0.5\cos\left(\frac{\pi}{2.3}\right)$, $x_2 = 0.5 + 0.5\cos\left(\frac{3\pi}{2.3}\right) = 0.5$

$x_i = 0.9999$ $x_3 = 0.5 + 0.5\cos\left(\frac{5\pi}{2.3}\right)$

$\frac{\theta_2^f - \theta_2^i}{x^f - x^i} = \frac{60}{1.0} = \frac{(\theta_2)_2 - \theta_2^i}{x - x_i} \Rightarrow \frac{\theta_2 - 65}{0.15}$ $\Rightarrow (\theta_2)_1 = 74°$

$\frac{\theta_4^f - \theta_4^i}{y^f - y^i} = \frac{40}{0.7183} = \frac{(\theta_4)_1 - (\theta_4)^i}{y - y_i} = 5568$

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Q3. The mass of link 3 is 1 kg and moment of inertia about the CG is 0.005 kg m^2. Block 2 is sliding upwards at the rate of 1 m/s at the instant shown and its mass can be neglected along with that of block 4. You may ignore gravity in all the calculations below.

a) Find the acceleration of block 4 if block 2 has zero acceleration.
b) Find equation for rate of change of kinetic energy of the mechanism as a function of the acceleration of link 2.
c) Find the external power input without friction for force of 15 N applied to link 2 upwards.
d) Find the power loss due to a friction between link 4 and the frame with $\mu = 0.3$.

(2 + 4 + 2 + 4)