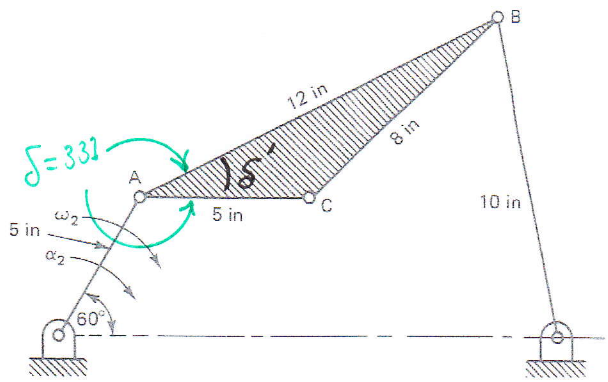
NAME: Solution

PROBLEM 1 (35 pts): The figure below shows a four bar mechanism. The length of the base link O_2O_4 is 15 in, all other dimensions of the link are shown in the figure. Link 2 is rotating at $\omega_2 = -25\frac{1}{s}$, and $\alpha_2 = -180\frac{1}{s^2}$.



1a. Use the program/tool that you developed in class to calculate all the important parameters. Print out your solution. Print the solution such that it **all fits on a single page** and staple it **directly behind this page**. Make sure that I can read your output.

$$(8in)^2 = (12in)^2 + (5in)^2 - 2\cdot(12in)(5in)\cos\delta'$$

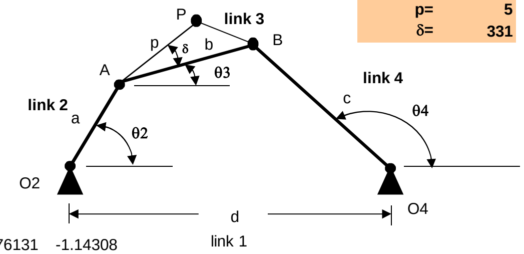
$$\cos\delta' = -\left[\frac{(8in)^2 - (12in)^2 + (5in)^2}{2(12in)(5in)}\right] \Rightarrow \delta' = \cos^{-1}\left[\frac{(12in)^2 + (5in)^2 - (8in)^2}{2(12in)(5in)}\right] = 29^\circ$$

$$\delta = 360 - \delta' = 331^\circ$$

1a. Use the figure on the next page, find all instant centers then use the instant centers to verify your calculated results for V_A, V_B, V_C, ω_3, and ω_4.

4-Bar Linkage

a=	5	Link 2	
b=	12	Link 3	
c=	10	Link 4	
d=	15	Link 1	
$\theta_2 =$	60	1.047197551	
$\dot{\theta}_2 =$	-25	$1/s$	
$\ddot{\theta}_2 =$	-180	$1/s^2$	
By=	9.83	-6.59	
Bx=	13.17	7.48	
$\theta_3 =$	27.3	-65.5	0.476131 -1.14308
$\theta_4 =$	100.6	-138.8	1.755312 -2.42226
$\dot{\theta}_3 =$	7.0737E+00	-3.5022E+00	
$\dot{\theta}_4 =$	-7.0545E+00	1.0626E+01	
$\ddot{\theta}_3 =$	2.2918E+02	3.2675E+02	
$\ddot{\theta}_4 =$	2.7146E+02	2.8447E+02	

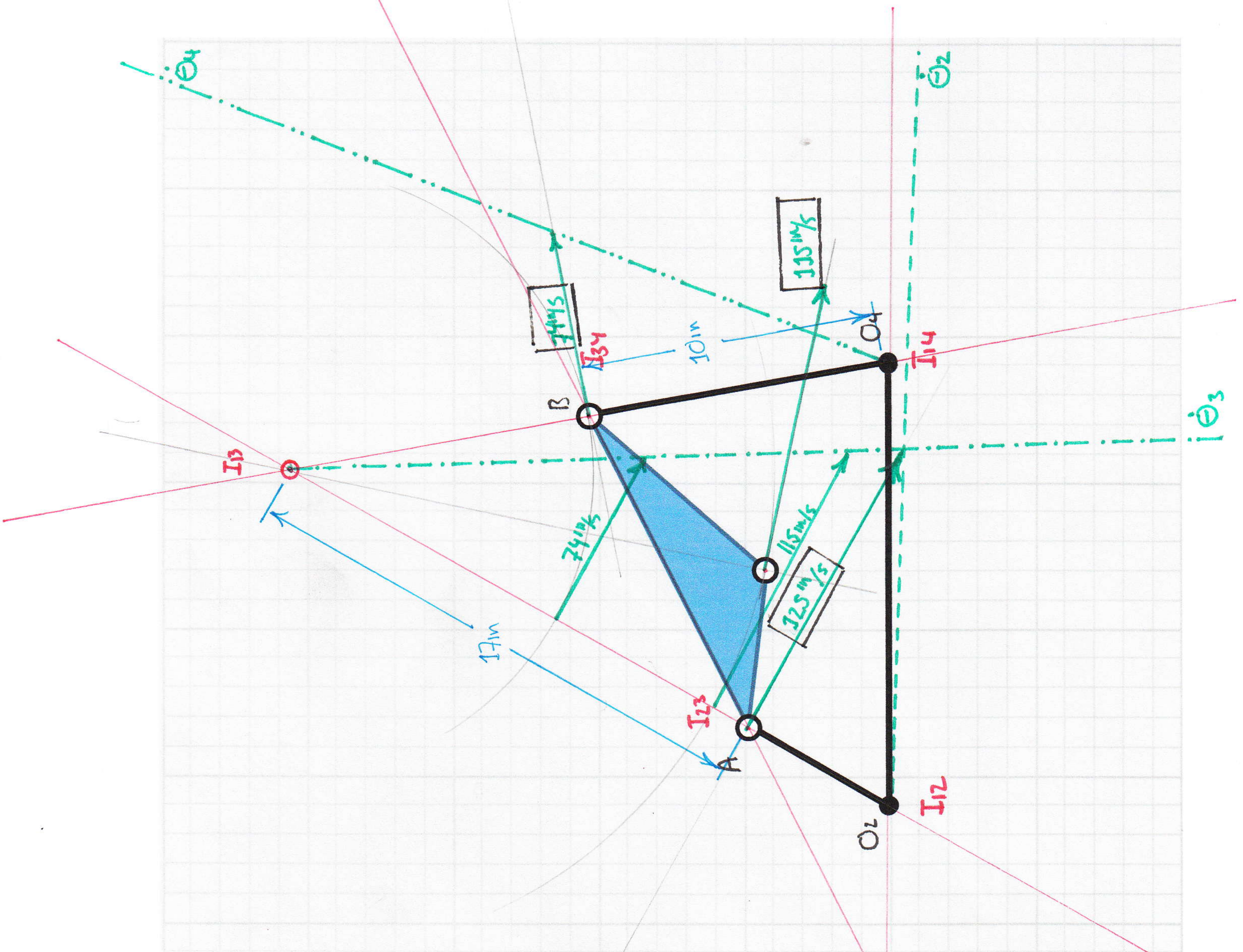


p=	5
δ=	331

K1=	9.7600E+00
K2=	3.4641E-01
K3=	3.2414E+00
K4=	-6.4770E+01

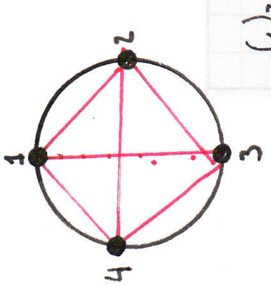
	x comp	y comp	mag	angle	e_r i	e_r j	e_θ i	e_θ j
r04=	15.00	0.00	15.000	0.0	1.000	0.000	0.000	1.000
rA=	2.50	4.33	5.000	60.0	0.500	0.866	-0.866	0.500
rBA=	10.67	5.50	12.000	27.3	0.889	0.458	-0.458	0.889
rBO4=	-1.83	9.83	10.000	100.6	-0.183	0.983	-0.983	-0.183
rB=	13.17	9.83	16.430	36.7	0.801	0.598	-0.598	0.801
rPA=	5.00	-0.15	5.000	-1.7	1.000	-0.030	0.030	1.000
rP=	7.50	4.18	8.584	29.1	0.873	0.487	-0.487	0.873
vA=	108.25	-62.50	125.000	-30.0	0.866	-0.500	0.500	0.866
vBA=	-38.91	75.44	84.884	117.3	-0.458	0.889	-0.889	-0.458
vB=	69.35	12.94	70.545	10.6	0.983	0.183	-0.183	0.983
vPA=	1.06	35.35	35.368	88.3	0.030	1.000	-1.000	0.030
vP=	109.31	-27.15	112.635	-13.9	0.971	-0.241	0.241	0.971
aA=	-783.08	-3156.33	3252.019	-103.9	-0.241	-0.971	0.971	-0.241
aBA	-1794.18	2169.07	2814.948	129.6	-0.637	0.771	-0.771	-0.637
aB	-2577.26	-987.26	2759.879	-159.0	-0.934	-0.358	0.358	-0.934
aPA=	-215.68	1152.89	1172.895	100.6	-0.184	0.983	-0.983	-0.184
aP=	-998.76	-2003.44	2238.588	-116.5	-0.446	-0.895	0.895	-0.446

ALT	x comp	y comp	mag	angle	i	j	i	j
rO4=	15.00	0.00	15.000	0.0	1.000	0.000	0.000	1.000
rA=	2.50	4.33	5.000	60.0	0.500	0.866	-0.866	0.500
rBA=	4.98	-10.92	12.000	-65.5	0.415	-0.910	0.910	0.415
rBO4=	-7.52	-6.59	10.000	-138.8	-0.752	-0.659	0.659	-0.752
rB=	7.48	-6.59	9.966	-41.4	0.750	-0.661	0.661	0.750
rPA=	-0.39	-4.98	5.000	-94.5	-0.078	-0.997	0.997	-0.078
rP=	2.11	-0.65	2.208	-17.2	0.955	-0.296	0.296	0.955
vA=	108.25	-62.50	125.000	-30.0	0.866	-0.500	0.500	0.866
vBA=	-38.24	-17.43	42.027	-155.5	-0.910	-0.415	0.415	-0.910
vB=	70.01	-79.93	106.259	-48.8	0.659	-0.752	0.752	0.659
vPA=	-17.46	1.37	17.511	175.5	-0.997	0.078	-0.078	-0.997
vP=	90.80	-61.13	109.456	-34.0	0.830	-0.558	0.558	0.830
aA=	-783.08	-3156.33	3252.019	-103.9	-0.241	-0.971	0.971	-0.241
aBA	3506.76	1760.36	3923.805	26.7	0.894	0.449	-0.449	0.894
aB	2723.68	-1395.97	3060.583	-27.1	0.890	-0.456	0.456	0.890
aPA=	1633.55	-66.86	1634.919	-2.3	0.999	-0.041	0.041	0.999
aP=	850.47	-3223.19	3333.504	-75.2	0.255	-0.967	0.967	0.255



$$\omega_3 = \frac{125\ \text{in/s}}{17\ \text{in}} = \boxed{7.4\ \text{1/s}}\ \text{CCW}$$

$$\omega_4 = \frac{74\ \text{in/s}}{10\ \text{in}} = \boxed{7.4\ \text{1/s}}\ \text{CW}$$



PROBLEM 2 (35 pts): A slider crank linkage has the following dimensions.

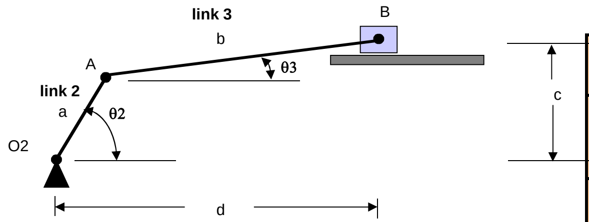
Link 2	Link 3	Offset	θ_2	ω_2	α_2
5.5m	21m	2m	55	-20 $\frac{1}{s}$	5 $\frac{1}{s^2}$

2a. Using the program that you have been developing, calculate all the critical parameters associated with this linkage in both of the possible configurations. Print out the results of your program and staple it **directly behind this page**.

2b. Using the grid paper on the next two pages, draw the mechanism in both the open and crossed configurations. Find the instant centers in the open configuration and verify the velocity of the slider that you calculated in the previous section.

Slider Crank

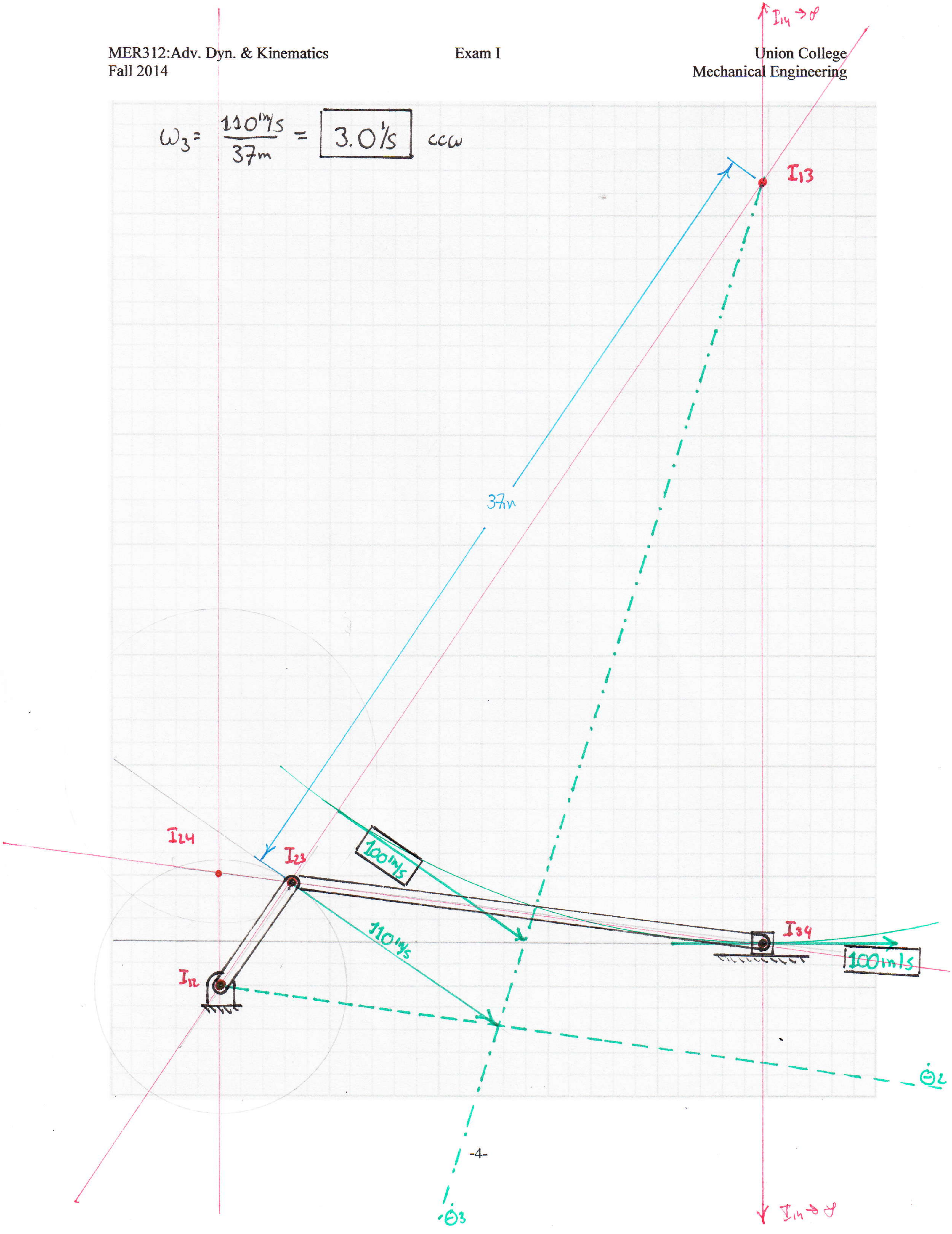
a=	**5.5**	Link 2	
b=	**21**	Link 3	
c=	**2**	Offset	
$\theta_2 =$	**55**		0.959931089
$\dot{\theta}_2 =$	**-20**	$1/s$	
$\ddot{\theta}_2 =$	**5**	$1/s^2$	
By=	**2.00**		**2.00**
Bx=	**24.00**		**-17.70**
$\theta_3 =$	**-6.9**		**-173.1**
$\dot{\theta}_3 =$	**3.03**		**-3.03**
$\ddot{\theta}_3 =$	**84.58**		**-84.58**
vB=	**97.69**		**82.53**
aB=	**-1263.43**		**-1305.36**

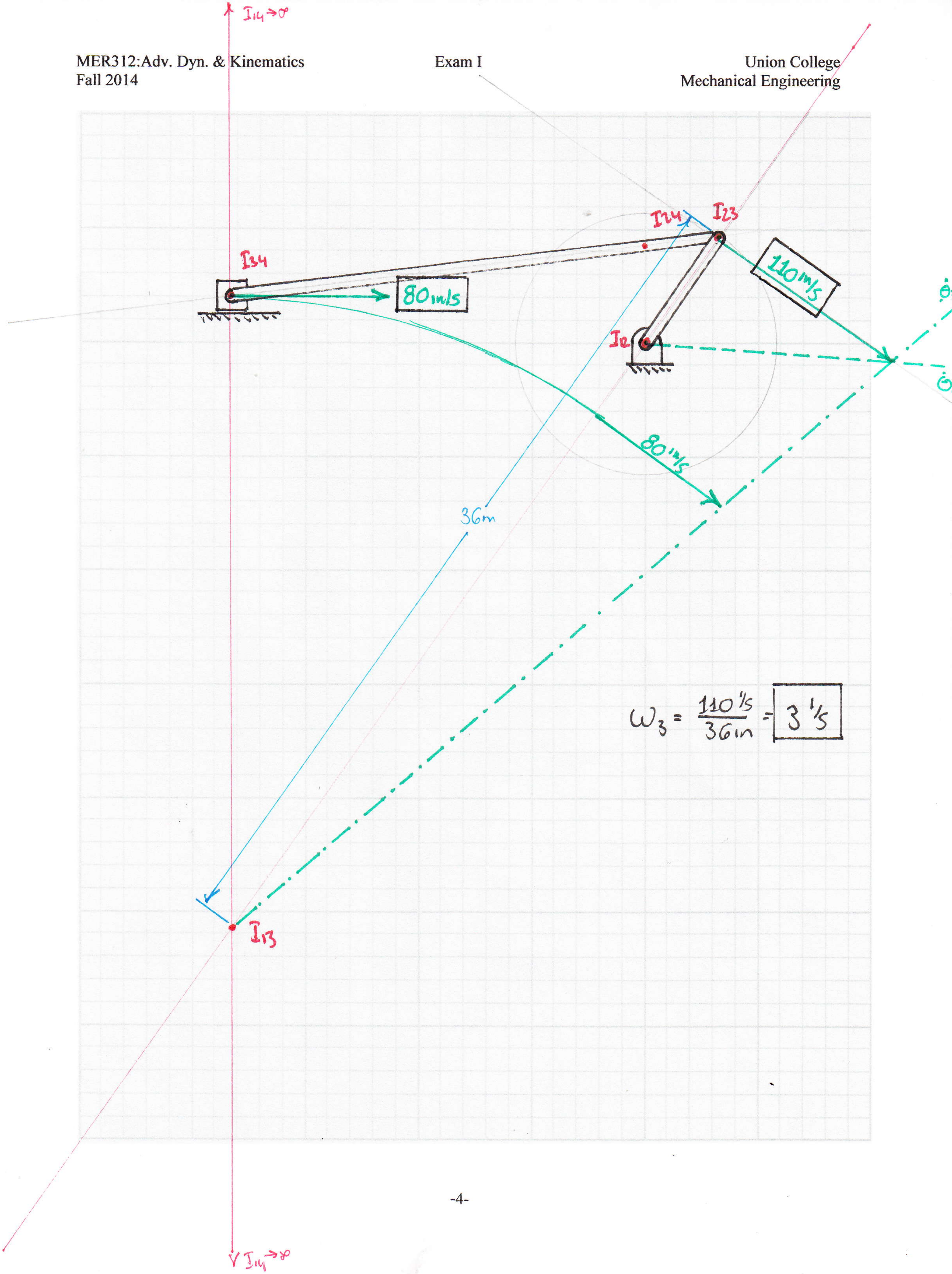


					e_r		e_θ	
	x comp	**y comp**	**mag**	**angle**	**i**	**j**	**i**	**j**
rB=	**24.00**	**2.00**	**24.09**	**4.8**	**0.997**	**0.083**	-0.083	0.997
rA=	**3.15**	**4.51**	**5.50**	**55.0**	**0.574**	**0.819**	-0.819	0.574
rBA=	20.85	-2.51	21.00	-6.9	0.993	-0.119	0.119	0.993
vB	**97.69**	**0.00**	**97.69**	**0.0**	**1.000**	**0.000**	0.000	1.000
vA	**90.11**	**-63.09**	**110.00**	**-35.0**	**0.819**	**-0.574**	0.574	0.819
vBA	7.58	63.09	63.55	83.1	0.119	0.993	-0.993	0.119
aB	**-1263.43**	**0.00**	**1263.43**	**180.0**	**-1.000**	**0.000**	0.000	-1.000
aA	**-1284.39**	**-1786.36**	**2200.17**	**-125.7**	**-0.584**	**-0.812**	0.812	-0.584
aBA	20.97	1786.36	1786.48	89.3	0.012	1.000	-1.000	0.012

alt	**x comp**	**y comp**	**mag**	**angle**	**i**	**j**	**i**	**j**
rB=	**-17.70**	**2.00**	**17.81**	**173.6**	**-0.994**	**0.112**	-0.112	-0.994
rA=	**3.15**	**4.51**	**5.50**	**55.0**	**0.574**	**0.819**	-0.819	0.574
rBA=	-20.85	-2.51	21.00	-173.1	-0.993	-0.119	0.119	-0.993
vB	**82.53**	**0.00**	**82.53**	**0.0**	**1.000**	**0.000**	0.000	1.000
vA	**90.11**	**-63.09**	**110.00**	**-35.0**	**0.819**	**-0.574**	0.574	0.819
vBA	-7.58	63.09	63.55	96.9	-0.119	0.993	-0.993	-0.119
aB	**-1305.36**	**0.00**	**1305.36**	**180.0**	**-1.000**	**0.000**	0.000	-1.000
aA	**-1284.39**	**-1786.36**	**2200.17**	**-125.7**	**-0.584**	**-0.812**	0.812	-0.584
aBA	-20.97	1786.36	1786.48	90.7	-0.012	1.000	-1.000	-0.012

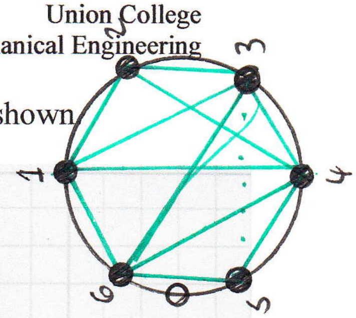
$$\omega_3 = \frac{110\,\text{in/s}}{37\,\text{in}} = \boxed{3.0\,\text{1/s}}\ \text{ccw}$$

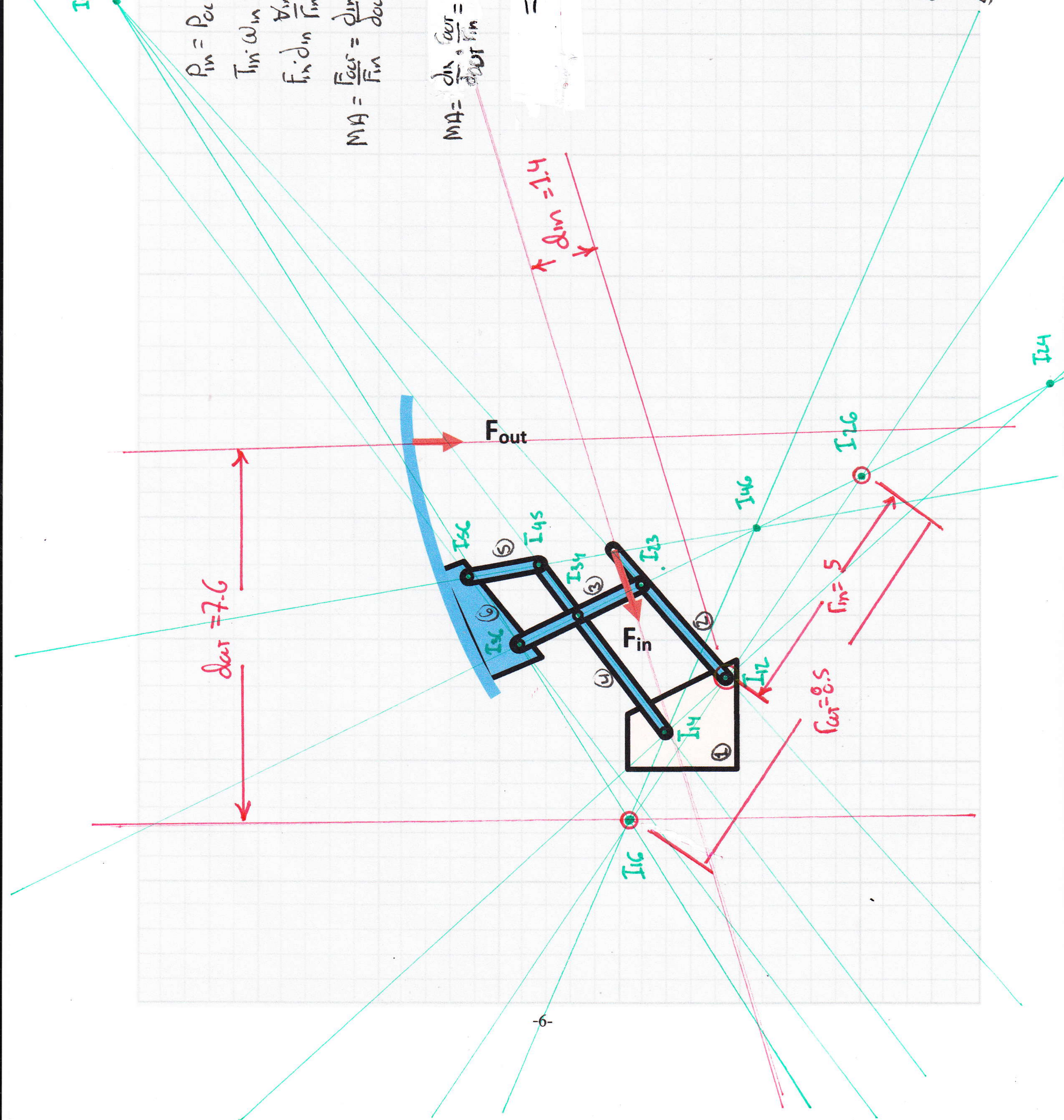




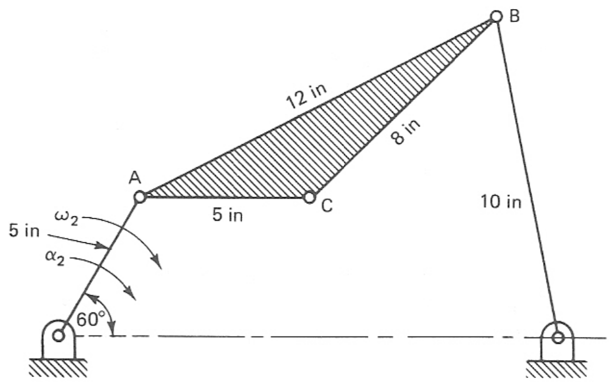
$$\omega_3 = \frac{110\ ^{in}/_{s}}{36\,in} = \boxed{3\ ^{1}/_{s}}$$

PROBLEM 3 (30 pts): Find the mechanical ad antage for the hood mechanism shown.



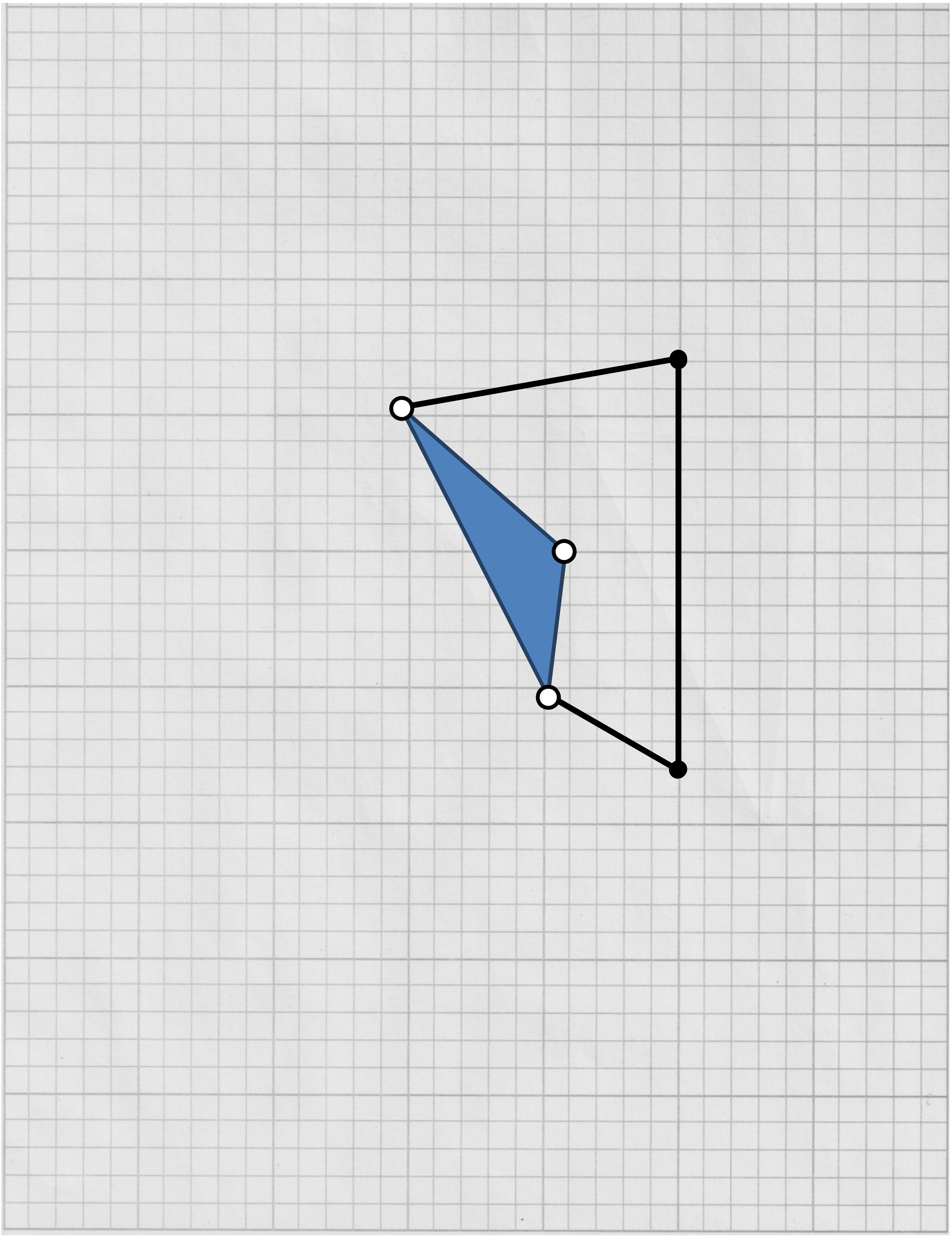


PROBLEM 1 (35 pts): The figure below shows a four bar mechanism. The length of the base link O_2O_4 is 15 in, all other dimensions of the link are shown in the figure. Link 2 is rotating at $\omega_2 = -25\frac{1}{s}$, and $\alpha_2 = -180\frac{1}{s^2}$.



1b. Use the program/tool that you developed in class to calculate all the important parameters. Print out your solution. Print the solution such that it **all fits on a single page** and staple it **directly behind this page**. Make sure that I can read your output.

1a. Use the figure on the next page, find all instant centers then use the instant centers to verify your calculated results for V_A, V_B, V_C, ω_3, and ω_4.



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Link 2	Link 3	Offset	θ_2	ω_2	α_2
5.5m	21m	2m	55	-20 $\frac{1}{s}$	5 $\frac{1}{s^2}$

2a. Using the program that you have been developing, calculate all the critical parameters associated with this linkage in both of the possible configurations. Print out the results of your program and staple it **directly behind this page**.

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PROBLEM 3 (30 pts): Find the mechanical advantage for the hood mechanism shown.