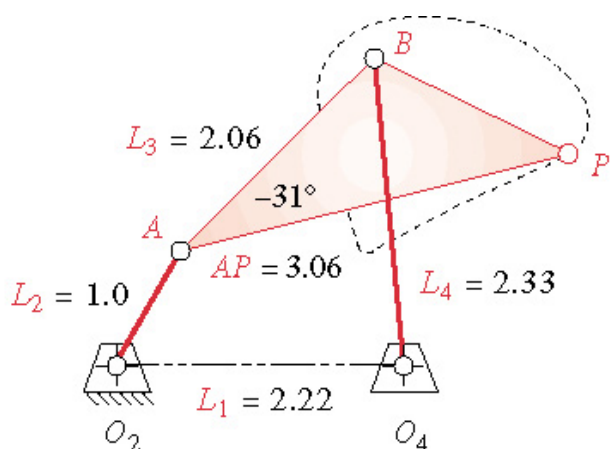**NAME: EXAM SOLUTION**

PROBLEM 1 (25 pts): The figure below shows a four bar mechanism. The lengths of all the link dimensions are given in meters. Link 2 is rotating at $\omega_2 = -10\frac{1}{s}$, $\alpha_2 = 100\frac{1}{s^2}$.
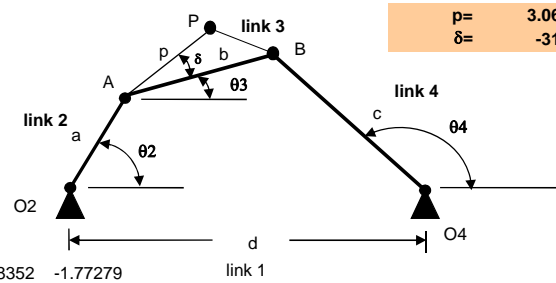

1a. Use the tool that you developed in class to calculate all the important parameters. Print out your solution. Print the solution such that it all fits on a single page and staple it directly behind this page. Make sure that I can read your output.

4-Bar Linkage-Exam I, Fall 2013

a=	1	Link 2
b=	2.06	Link 3
c=	2.33	Link 4
d=	2.22	Link 1

$\theta_2 =$ 45   0.785398163

$\dot{\theta}_2 =$ -10 $1/s$

$\ddot{\theta}_2 =$ 100 $1/s^2$

By=	2.32	-1.31
Bx=	1.99	0.29

$\theta_3 =$ 51.5   -101.6   0.898352 -1.77279

$\theta_4 =$ 95.7   -145.8   1.669549 -2.54399

$\dot{\theta}_3 =$ 5.3864E+00   -1.3002E+00

$\dot{\theta}_4 =$ 6.9405E-01   3.3921E+00

$\ddot{\theta}_3 =$ 1.9356E+01   9.8358E+01

$\ddot{\theta}_4 =$ 9.0550E+01   2.7164E+01

K1= 9.0657E-01
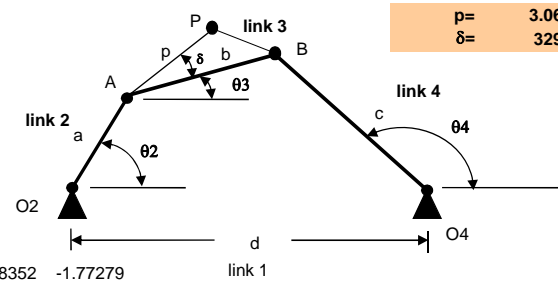K2= 4.6739E-01
K3= 1.0076E+00
K4= -3.0398E+00

p=	3.06
δ=	-31

	x comp	y comp	mag	angle	i	j
r04=	2.22	0.00	2.220	0.0	1.000	0.000
rA=	0.71	0.71	1.000	45.0	0.707	0.707
rBA=	1.28	1.61	2.060	51.5	0.623	0.782
rBO4=	-0.23	2.32	2.330	95.7	-0.099	0.995
rB=	1.99	2.32	3.056	49.4	0.651	0.759
rPA=	2.87	1.07	3.060	20.5	0.937	0.350
rP=	3.57	1.78	3.991	26.4	0.895	0.445
vA=	7.07	-7.07	10.000	-45.0	0.707	-0.707
vBA=	-8.68	6.91	11.096	141.5	-0.782	0.623
vB=	-1.61	-0.16	1.617	-174.3	-0.995	-0.099
vPA=	-5.76	15.44	16.482	110.5	-0.350	0.937
vP=	1.31	8.37	8.472	81.1	0.154	0.988
aA=	-141.42	0.00	141.421	180.0	-1.000	0.000
aBA	-68.42	-21.92	71.847	-162.2	-0.952	-0.305
aB	-209.84	-21.92	210.985	-174.0	-0.995	-0.104
aPA=	-103.89	24.44	106.724	166.8	-0.973	0.229
aP=	-245.31	24.44	246.524	174.3	-0.995	0.099
ALT	x comp	y comp	mag	angle	i	j
rO4=	2.22	0.00	2.220	0.0	1.000	0.000
rA=	0.71	0.71	1.000	45.0	0.707	0.707
rBA=	-0.41	-2.02	2.060	-101.6	-0.201	-0.980
rBO4=	-1.93	-1.31	2.330	-145.8	-0.827	-0.563
rB=	0.29	-1.31	1.344	-77.4	0.219	-0.976
rPA=	-2.07	-2.25	3.060	-132.6	-0.677	-0.736
rP=	-1.36	-1.55	2.061	-131.4	-0.661	-0.750
vA=	7.07	-7.07	10.000	-45.0	0.707	-0.707
vBA=	-2.62	0.54	2.678	168.4	-0.980	0.201
vB=	4.45	-6.53	7.903	-55.8	0.563	-0.827
vPA=	-2.93	2.69	3.979	137.4	-0.736	0.677
vP=	4.14	-4.38	6.027	-46.6	0.687	-0.727
aA=	-141.42	0.00	141.421	180.0	-1.000	0.000
aBA	199.20	-37.24	202.647	-10.6	0.983	-0.184
aB	57.77	-37.24	68.735	-32.8	0.841	-0.542
aPA=	225.14	-199.81	301.019	-41.6	0.748	-0.664
aP=	83.72	-199.81	216.640	-67.3	0.386	-0.922

4-Bar Linkage-Exam I, Fall 2013

a=	1	Link 2
b=	2.06	Link 3
c=	2.33	Link 4
d=	2.22	Link 1

$\theta_2 =$ 45   0.785398163

$\dot{\theta}_2 =$ -10 $1/s$

$\ddot{\theta}_2 =$ 100 $1/s^2$

By=	2.32	-1.31
Bx=	1.99	0.29

$\theta_3 =$ 51.5   -101.6   0.898352   -1.77279

$\theta_4 =$ 95.7   -145.8   1.669549   -2.54399

$\dot{\theta}_3 =$ 5.3864E+00   -1.3002E+00

$\dot{\theta}_4 =$ 6.9405E-01   3.3921E+00

$\ddot{\theta}_3 =$ 1.9356E+01   9.8358E+01

$\ddot{\theta}_4 =$ 9.0550E+01   2.7164E+01

K1=	9.0657E-01
K2=	4.6739E-01
K3=	1.0076E+00
K4=	-3.0398E+00

p=	3.06
δ=	329

	x comp	y comp	mag	angle	i	j
r04=	2.22	0.00	2.220	0.0	1.000	0.000
rA=	0.71	0.71	1.000	45.0	0.707	0.707
rBA=	1.28	1.61	2.060	51.5	0.623	0.782
rBO4=	-0.23	2.32	2.330	95.7	-0.099	0.995
rB=	1.99	2.32	3.056	49.4	0.651	0.759
rPA=	2.87	1.07	3.060	20.5	0.937	0.350
rP=	3.57	1.78	3.991	26.4	0.895	0.445
vA=	7.07	-7.07	10.000	-45.0	0.707	-0.707
vBA=	-8.68	6.91	11.096	141.5	-0.782	0.623
vB=	-1.61	-0.16	1.617	-174.3	-0.995	-0.099
vPA=	-5.76	15.44	16.482	110.5	-0.350	0.937
vP=	1.31	8.37	8.472	81.1	0.154	0.988
aA=	-141.42	0.00	141.421	180.0	-1.000	0.000
aBA	-68.42	-21.92	71.847	-162.2	-0.952	-0.305
aB	-209.84	-21.92	210.985	-174.0	-0.995	-0.104
aPA=	-103.89	24.44	106.724	166.8	-0.973	0.229
aP=	-245.31	24.44	246.524	174.3	-0.995	0.099
ALT	x comp	y comp	mag	angle	i	j
rO4=	2.22	0.00	2.220	0.0	1.000	0.000
rA=	0.71	0.71	1.000	45.0	0.707	0.707
rBA=	-0.41	-2.02	2.060	-101.6	-0.201	-0.980
rBO4=	-1.93	-1.31	2.330	-145.8	-0.827	-0.563
rB=	0.29	-1.31	1.344	-77.4	0.219	-0.976
rPA=	-2.07	-2.25	3.060	-132.6	-0.677	-0.736
rP=	-1.36	-1.55	2.061	-131.4	-0.661	-0.750
vA=	7.07	-7.07	10.000	-45.0	0.707	-0.707
vBA=	-2.62	0.54	2.678	168.4	-0.980	0.201
vB=	4.45	-6.53	7.903	-55.8	0.563	-0.827
vPA=	-2.93	2.69	3.979	137.4	-0.736	0.677
vP=	4.14	-4.38	6.027	-46.6	0.687	-0.727
aA=	-141.42	0.00	141.421	180.0	-1.000	0.000
aBA	199.20	-37.24	202.647	-10.6	0.983	-0.184
aB	57.77	-37.24	68.735	-32.8	0.841	-0.542
aPA=	225.14	-199.81	301.019	-41.6	0.748	-0.664
aP=	83.72	-199.81	216.640	-67.3	0.386	-0.922

**PROBLEM 2 (25 pts):** A slider crank linkage has the following dimensions.

Link 2	Link 3	Offset	θ_2	ω_2	α_2
2m	6m	-3m	60	$-12\ \frac{1}{s}$	$5\ \frac{1}{s^2}$

2a. 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.

Slider Crank--Exam I, Fall 2013

a=	2	Link 2
b=	6	Link 3
c=	-3	Link 1

$\theta_2 =$ 60   1.047197551
$\dot{\theta}_2 =$ -12 $1/s$
$\ddot{\theta}_2 =$ 5 $1/s^2$

By=	-3.00	-3.00
Bx=	4.69	-2.69
$\theta_3 =$	-52.1	-127.9
$\dot{\theta}_3 =$	3.25	-3.25
$\ddot{\theta}_3 =$	52.68	-52.68
vB=	36.18	5.39
aB=	57.60	-362.92
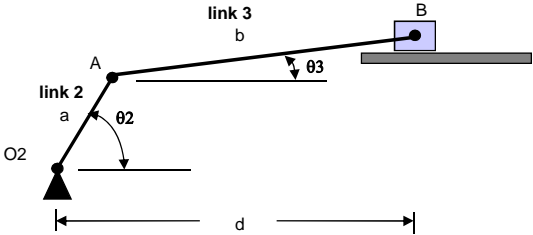
	x comp	y comp	mag	angle	i	j
rB=	4.69	-3.00	5.57	-32.6	0.842	-0.539
rA=	1.00	1.73	2.00	60.0	0.500	0.866
rBA=	3.69	-4.73	6.00	-52.1	0.615	-0.789
vB	36.18	0.00	36.18	0.0	1.000	0.000
vA	20.78	-12.00	24.00	-30.0	0.866	-0.500
vBA	15.39	12.00	19.52	37.9	0.789	0.615
aB	57.60	0.00	57.60	0.0	1.000	0.000
aA	-152.66	-244.42	288.17	-122.0	-0.530	-0.848
aBA	210.26	244.42	322.41	49.3	0.652	0.758

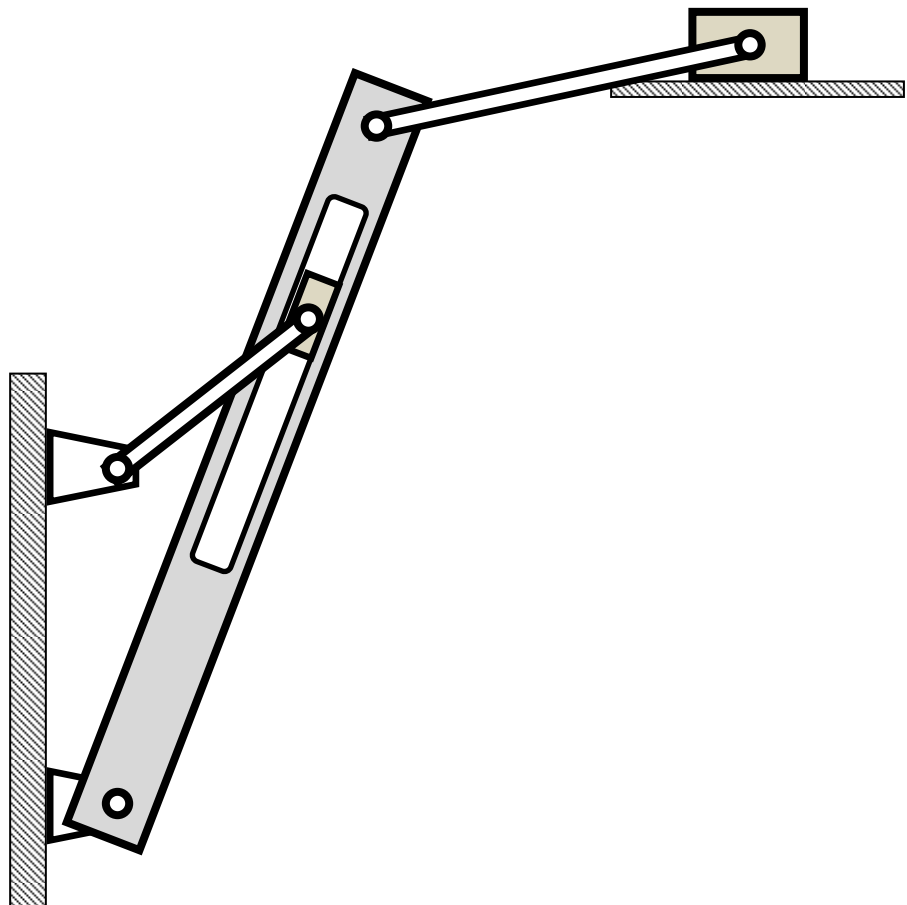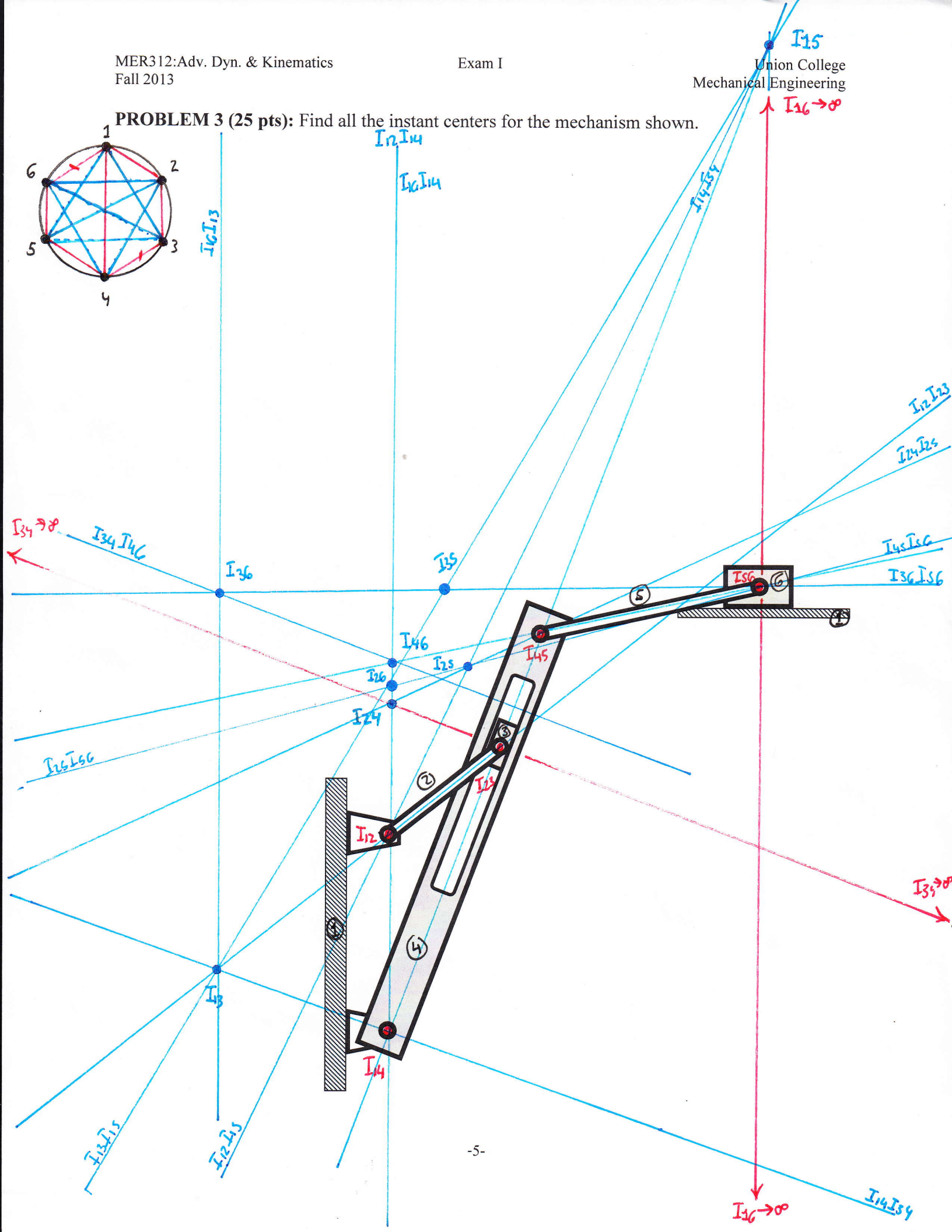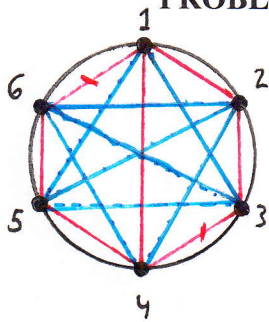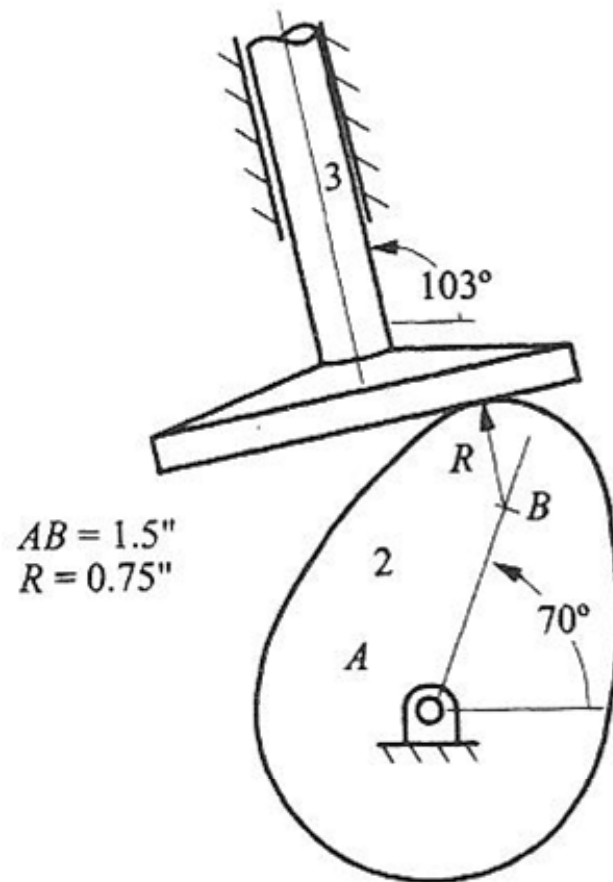| alt	x comp	y comp	mag	angle	i	j
rB=	-2.69	-3.00	4.03	-131.9	-0.667	-0.745
rA=	1.00	1.73	2.00	60.0	0.500	0.866
rBA=	-3.69	-4.73	6.00	-127.9	-0.615	-0.789
vB	5.39	0.00	5.39	0.0	1.000	0.000
vA	20.78	-12.00	24.00	-30.0	0.866	-0.500
vBA	-15.39	12.00	19.52	142.1	-0.789	0.615
aB	-362.92	0.00	362.92	180.0	-1.000	0.000
aA	-152.66	-244.42	288.17	-122.0	-0.530	-0.848
aBA	-210.26	244.42	322.41	130.7	-0.652	0.758
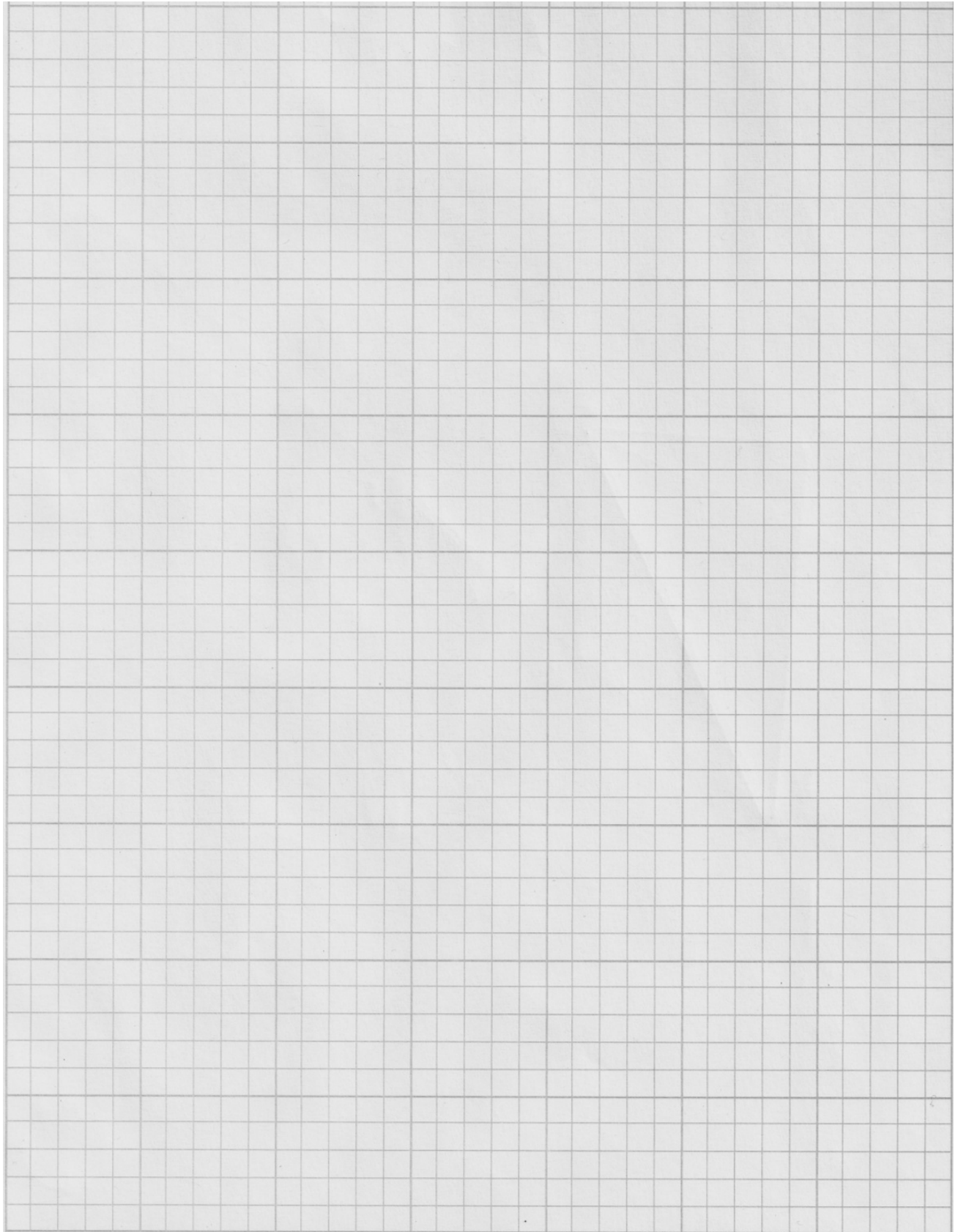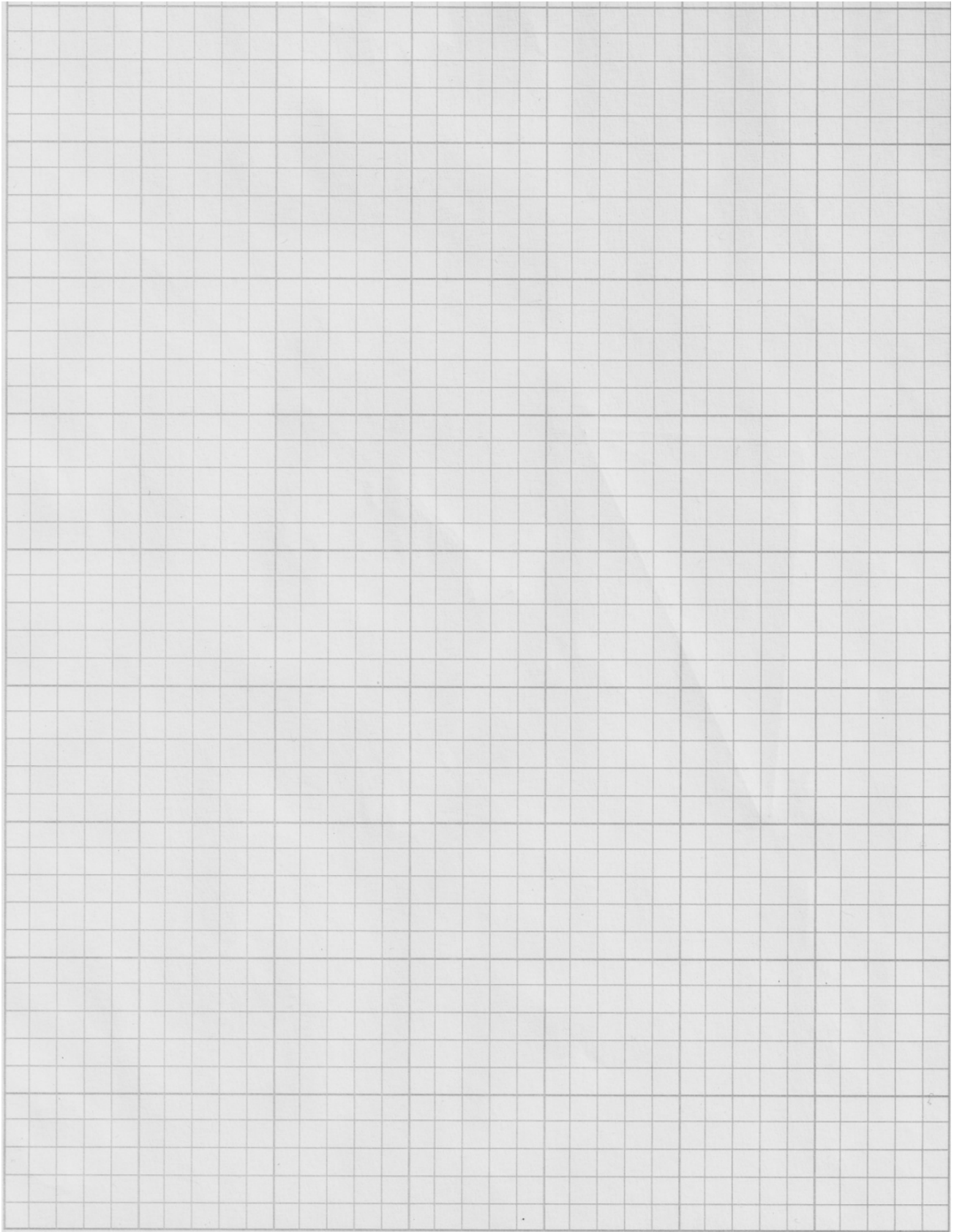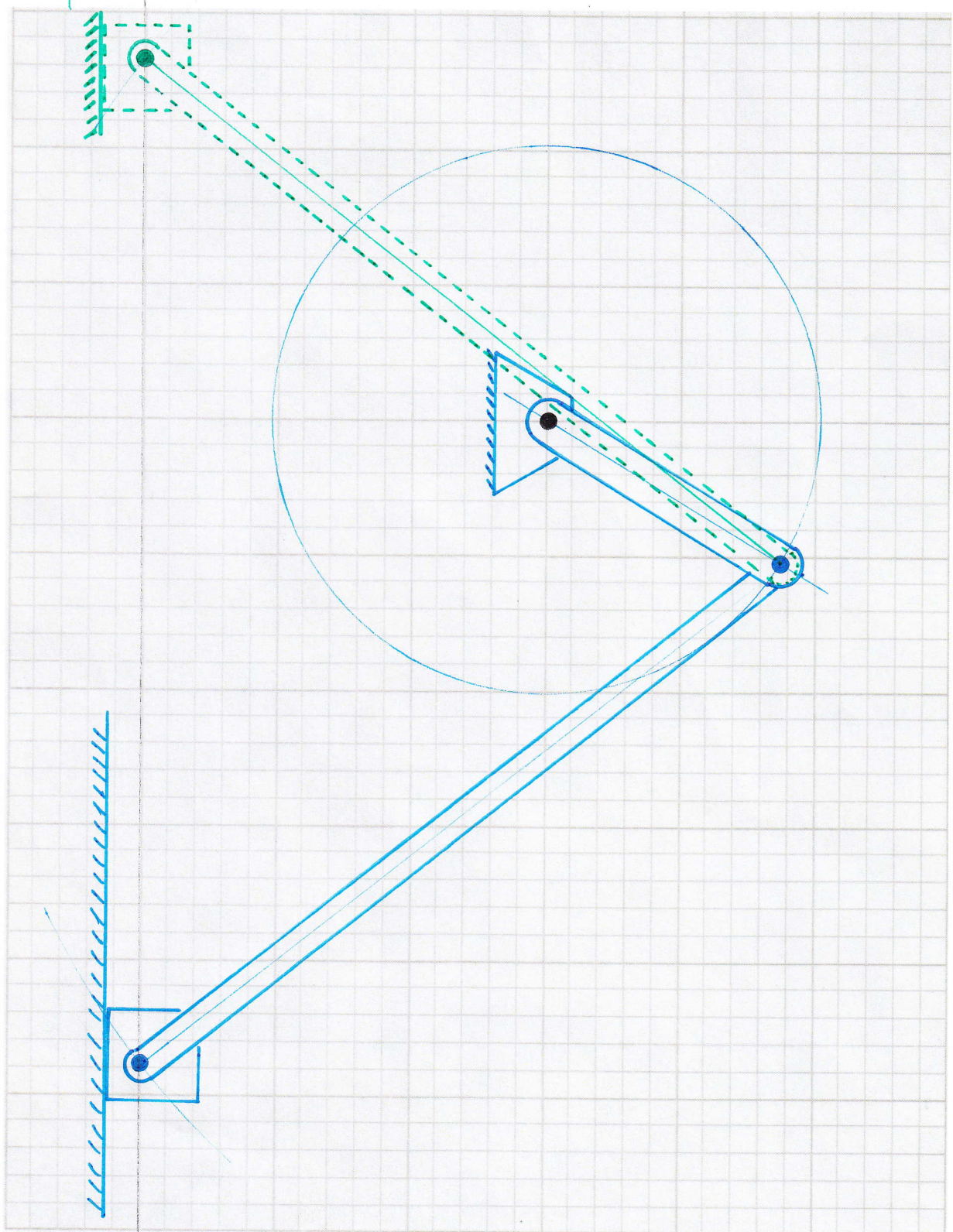
PROBLEM 3 (25 pts): Find all the instant centers for the mechanism shown.

PROBLEM 3 (25 pts): Find all the instant centers for the mechanism shown.

I_{15}

$I_{16} \to \infty$

$I_{12} I_{14}$

$I_{16} I_{14}$

$I_{16} I_{13}$

$I_{14} I_{34}$

$I_{12} I_{23}$

$I_{24} I_{25}$

$I_{34} \to \infty$

$I_{34} I_{46}$

I_{36}

I_{35}

$I_{45} I_{56}$

$I_{36} I_{56}$

I_{46}

I_{26}

I_{25}

I_{56}

I_{45}

I_{24}

$I_{25} I_{56}$

I_{23}

I_{12}

$I_{35} \to \infty$

I_{13}

I_{14}

$I_{16} \to \infty$

$I_{14} I_{34}$

$I_{45} I_{15}$

$I_{12} I_{13}$

PROBLEM 4 (25 pts): Find all the instant centers for the mechanism shown.

103°

R

B

AB = 1.5"
R = 0.75"

2

70°

A

PROBLEM 4 (25 pts): Find all the instant centers for the mechanism shown.

PERPENDICULAR TO THE
TANGENT OF THE CLAM

$I_{13} \to \infty$

$I_{13} \to \infty$

103°

R

B

$AB = 1.5"$
$R = 0.75"$

2

70°

A

I_{12}

I_{13}

$I_{12} I_{13}$