

- <sup>\*†</sup>11-5 Table P11-3 shows kinematic and geometric data for several pin-jointed fourbar linkages of the type and orientation shown in Figure P11-2. All have  $\theta_1 = 0$ . The point locations are defined as described in the text. For the row(s) in the table assigned, use the matrix method of Section 11.4 (p. 579) and program MATRIX or a matrix solving calculator to solve for forces and torques at the position shown. You may check your solution by opening the solution files from the DVD named P11-05x (where x is the row letter) into program FOURBAR.
- <sup>\*†</sup>11-6 Repeat Problem 11-5 using the method of virtual work to solve for the input torque on link 2. Additional data for corresponding rows are given in Table P11-4.
- <sup>\*‡</sup>11-7 For the row(s) assigned in Table P11-3 (a-f), input the associated disk file to program FOURBAR, calculate the linkage parameters for crank angles from zero to  $360^\circ$  by  $5^\circ$  increments with  $\alpha_2 = 0$ , and design a steel disk flywheel to smooth the input torque using a coefficient of fluctuation of 0.05. Minimize the flywheel weight.

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\* Answers in Appendix F.

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† These problems are suited to solution using *Mathcad*, *Matlab*, or *TKSolver* equation solver programs.

**Figure P11-2 and Table P11-3 are on the next pages.**

**TABLE P11-4 Data for Problem 11-6**

Row	$Vg_2$ mag	$Vg_2$ ang	$Vg_3$ mag	$Vg_3$ ang	$Vg_4$ mag	$Vg_4$ ang	$Vp_3$ mag	$Vp_3$ ang	$Vp_4$ mag	$Vp_4$ ang
a.	40.00	135.00	54.44	145.19	14.23	219.30	54.44	145.19	41.39	-160.80
b.	10.00	140.00	21.46	14.74	45.94	56.60	122.10	40.04	130.51	29.68
c.	60.00	-50.00	191.94	299.70	98.91	241.03	191.94	-60.30	296.73	-118.97
d.	60.00	135.00	94.36	353.80	19.03	4.44	152.51	-3.13	67.86	26.38
e.	10.00	255.00	42.89	223.13	11.22	172.71	37.01	-140.37	48.41	-155.86
f.	120.00	255.00	618.05	211.39	213.98	134.01	618.03	-148.61	692.08	116.52
g.	80.00	145.00	118.29	205.52	66.10	196.90	154.85	-152.36	217.15	164.33

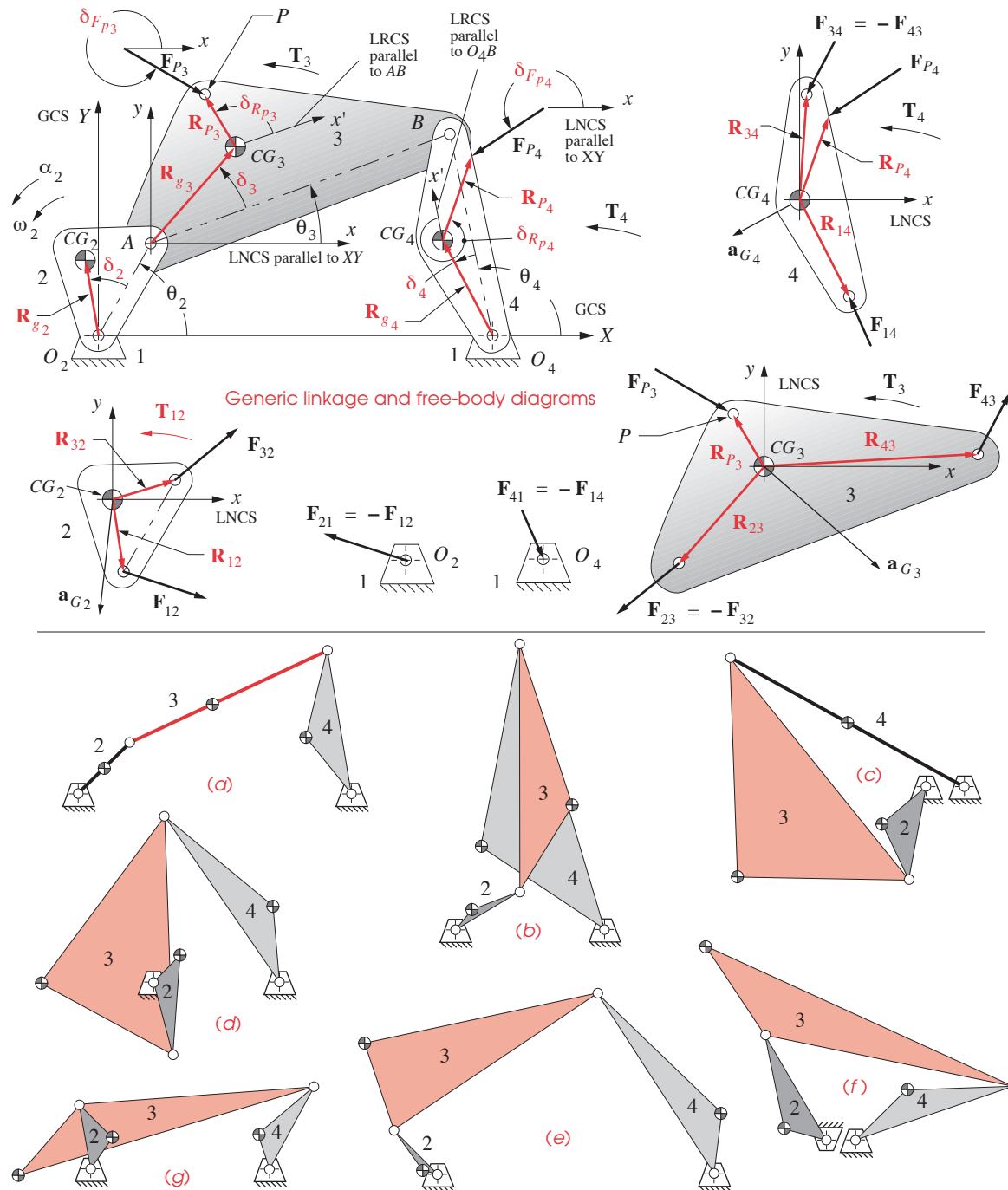


FIGURE P11-2

Sketches of the linkages in Table P11-3

Linkage geometry, notation, and free-body diagrams for Problems 11-5 to 11-7

**TABLE P11-3 Data for Problems 11-5 and 11-7 (See Figure P11-2 for Nomenclature)**Part 1 Lengths in inches, angles in degrees, angular acceleration in rad/sec<sup>2</sup>

Row	link 2	link 3	link 4	link 1	$\theta_2$	$\theta_3$	$\theta_4$	$\alpha_2$	$\alpha_3$	$\alpha_4$
a.	4	12	8	15	45	24.97	99.30	20	75.29	244.43
b.	3	10	12	6	30	90.15	106.60	-5	140.96	161.75
c.	5	15	14	2	260	128.70	151.03	15	78.78	53.37
d.	6	19	16	10	-75	91.82	124.44	-10	-214.84	-251.82
e.	2	8	7	9	135	34.02	122.71	25	71.54	-14.19
f.	17	35	23	4	120	348.08	19.01	-20	-101.63	-150.86
g.	7	25	10	19	100	4.42	61.90	-15	-17.38	-168.99

Part 2 Angular velocity in rad/sec, mass in bobs, moment of Inertia in blob-in<sup>2</sup>, torque in lb-in

Row	$\omega_2$	$\omega_3$	$\omega_4$	$m_2$	$m_3$	$m_4$	$I_2$	$I_3$	$I_4$	$T_3$	$T_4$
a.	20	-5.62	3.56	0.002	0.02	0.10	0.10	0.20	0.50	-15	25
b.	10	-10.31	-7.66	0.050	0.10	0.20	0.20	0.40	0.40	12	0
c.	20	16.60	14.13	0.010	0.02	0.05	0.05	0.10	0.13	-10	20
d.	20	3.90	-3.17	0.006	0.15	0.07	0.12	0.30	0.15	0	30
e.	20	1.06	5.61	0.001	0.04	0.09	0.30	0.80	0.30	25	40
f.	20	18.55	21.40	0.150	0.30	0.25	0.24	0.60	0.92	0	-25
g.	20	4.10	16.53	0.080	0.20	0.12	0.45	0.90	0.54	0	0

Part 3 Lengths in inches, angles in degrees, linear accelerations in inches/sec<sup>2</sup>

Row	$R_{g_2}$ mag	$R_{g_2}$ ang	$R_{g_3}$ mag	$R_{g_3}$ ang	$R_{g_4}$ mag	$R_{g_4}$ ang	$a_{g_2}$ mag	$a_{g_2}$ ang	$a_{g_3}$ mag	$a_{g_3}$ ang
a.	2	0	5	0	4	30	801.00	222.14	1 691.49	208.24
b.	1	20	4	-30	6	40	100.12	232.86	985.27	194.75
c.	3	-40	9	50	7	0	1 200.84	37.85	3 120.71	22.45
d.	3	120	12	60	6	-30	1 200.87	226.43	4 543.06	81.15
e.	0.5	30	3	75	2	-40	200.39	341.42	749.97	295.98
f.	6	45	15	135	10	25	2 403.00	347.86	12 064.20	310.22
g.	4	-45	10	225	4	45	1 601.12	237.15	2 562.10	-77.22

Part 4 Linear accelerations in inches/sec<sup>2</sup>, forces in lb, lengths in inches, angles in degrees

Row	$a_{g_4}$ mag	$a_{g_4}$ ang	$F_{p_3}$ mag	$\delta F_{p_3}$ ang	$R_{p_3}$ mag	$\delta R_{p_3}$ ang	$F_{p_4}$ mag	$\delta F_{p_4}$ ang	$R_{p_4}$ mag	$\delta R_{p_4}$ ang
a.	979.02	222.27	0	0	0	0	40	-30	8	0
b.	1 032.32	256.52	4	30	10	45	15	-55	12	0
c.	1 446.58	316.06	0	0	0	0	75	45	14	0
d.	1 510.34	2.15	2	45	15	180	20	270	16	0
e.	69.07	286.97	9	0	6	-60	16	60	7	0
f.	4 820.72	242.25	0	0	0	0	23	0	23	0
g.	1 284.55	-41.35	12	-60	9	120	32	20	10	0