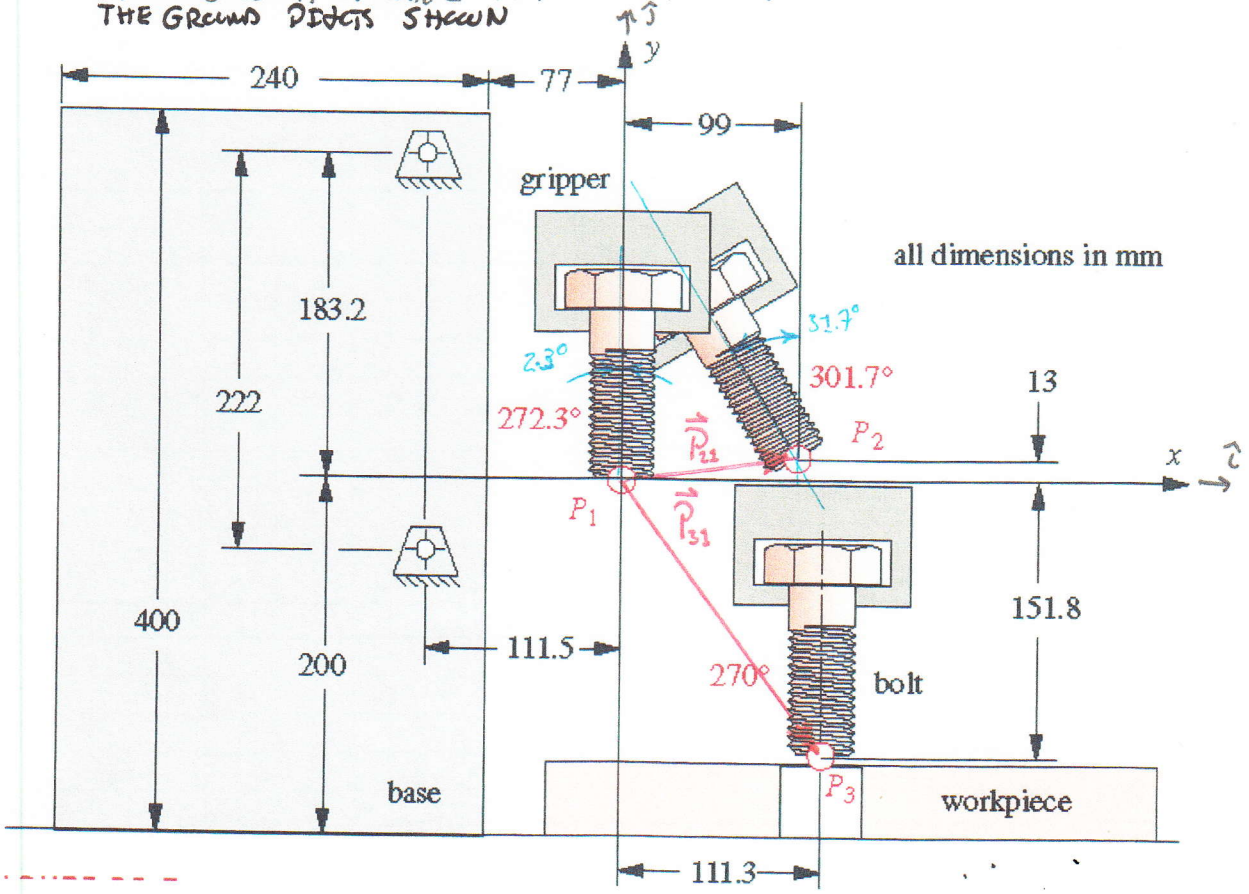
PROBLEM 5.34 | DESIGN A FOURBAR LINKAGE TO CARRY THE BOLT SHOWN BELOW IN THE FIGURE FROM POSITION 1 TO 2 TO 3 WITHOUT REGARD TO THE FIXED PIVOTS SHOWN. THE BOLT IS FED INTO THE GRIPPER IN THE Z-DIRECTION. THE GRIPPER GRABS THE BOLT, AND YOUR LINKAGE MOVES IT TO ~~POSITI~~ POSITION 3 TO BE INSERTED INTO THE HOLE. A SECOND DEGREE OF FREEDOM WITHIN THE GRIPPER ASSEMBLY (NOT SHOWN) PUSHES THE BOLT INTO THE HOLE. EXTEND THE GRIPPER ASSEMBLY AS NECESSARY TO INCLUDE THE MOVING PIVOTS. THE FIXED PIVOTS SHOULD BE ON THE BASE. HINT: TRY GUESS VALUES OF $\beta_2 = 70°$; $\beta_3 = 140°$, $\gamma_2 = -5°$, $\gamma_3 = -49°$

GIVEN:
1. THE CONFIGURATION SHOWN IN THE FIGURE
2. THE FIXED PIVOTS NEED TO BE

ASSUMPTIONS:
1. ALL COMPONENTS ARE RIGID
2. ALL JOINTS ARE FRICTIONLESS
3. ALL MOTION IS PLANAR
4. GRAVITY ACTS VERTICALLY DOWNWARD

FIND:
1) SYNTHESISE A LINKAGE THAT WILL MOVE THE BOLT AS SPECIFIED. AND HAVE THE GROUND PIVOTS SHOWN



SOLUTION:

THIS SOLUTION IS FOR 3 POSITIONS WITH FIXED PIVOTS. THIS IS A DEVIATION FROM THE PROBLEM STATED IN THE BOOK.

THE SOLUTION STARTS ~~AS~~ ~~DID~~ WITH A GRAPHICAL SOLUTION TO THE MECHANISM USING THE 3 POSITION WITH FIXED PIVOTS METHODOLOGY SEEN ON THE NEXT PAGE.

THE GRAPHICAL SOLUTION ON THE NEXT PAGE WILL PROVIDE INSIGHT INTO THE SELECTION OF THE FREE CHOICES FOR THE ANALYTICAL SOLUTION.

THE ANALYTICAL SOLUTION STARTS BY LOCATING POINTS P_1, P_2 & P_3 IN THE PLANE OF THE MECHANISM THAT HAS COORDINATES CENTERED AT P_1. FROM THE FIGURE ON THE PREVIOUS PAGE

$$(P_{1x}, P_{1y}) = (0mm, 0mm)$$

$$(P_{2x}, P_{2y}) = (99mm, 13mm)$$

$$(P_{3x}, P_{3y}) = (111.3mm, -151.8)$$

THE INPUTS THAT ARE CLASSIFIED AS GIVEN CAN NOW BE COMPUTED.

$$\rho_{21} = \sqrt{(P_{2x}-P_{1x})^2+(P_{2y}-P_{1y})^2} = \sqrt{(99mm-0mm)^2+(13mm-0mm)^2} = 99.85mm$$

$$\rho_{31} = \sqrt{(P_{3x}-P_{1x})^2+(P_{3y}-P_{1y})^2} = \sqrt{(111.3mm-0mm)^2+(-151.8mm-0mm)^2} = 188.23mm$$

$$\delta_2 = \tan^{-1}\frac{P_{2y}-P_{1y}}{P_{2x}-P_{1x}} = \tan^{-1}\frac{13mm-0mm}{99mm-0mm} = 7.48^\circ$$

$$\delta_3 = \tan^{-1}\frac{P_{3y}-P_{1y}}{P_{3x}-P_{1x}} = \tan^{-1}\frac{-151.8mm-0mm}{111.3mm-0mm} = 306.25^\circ$$

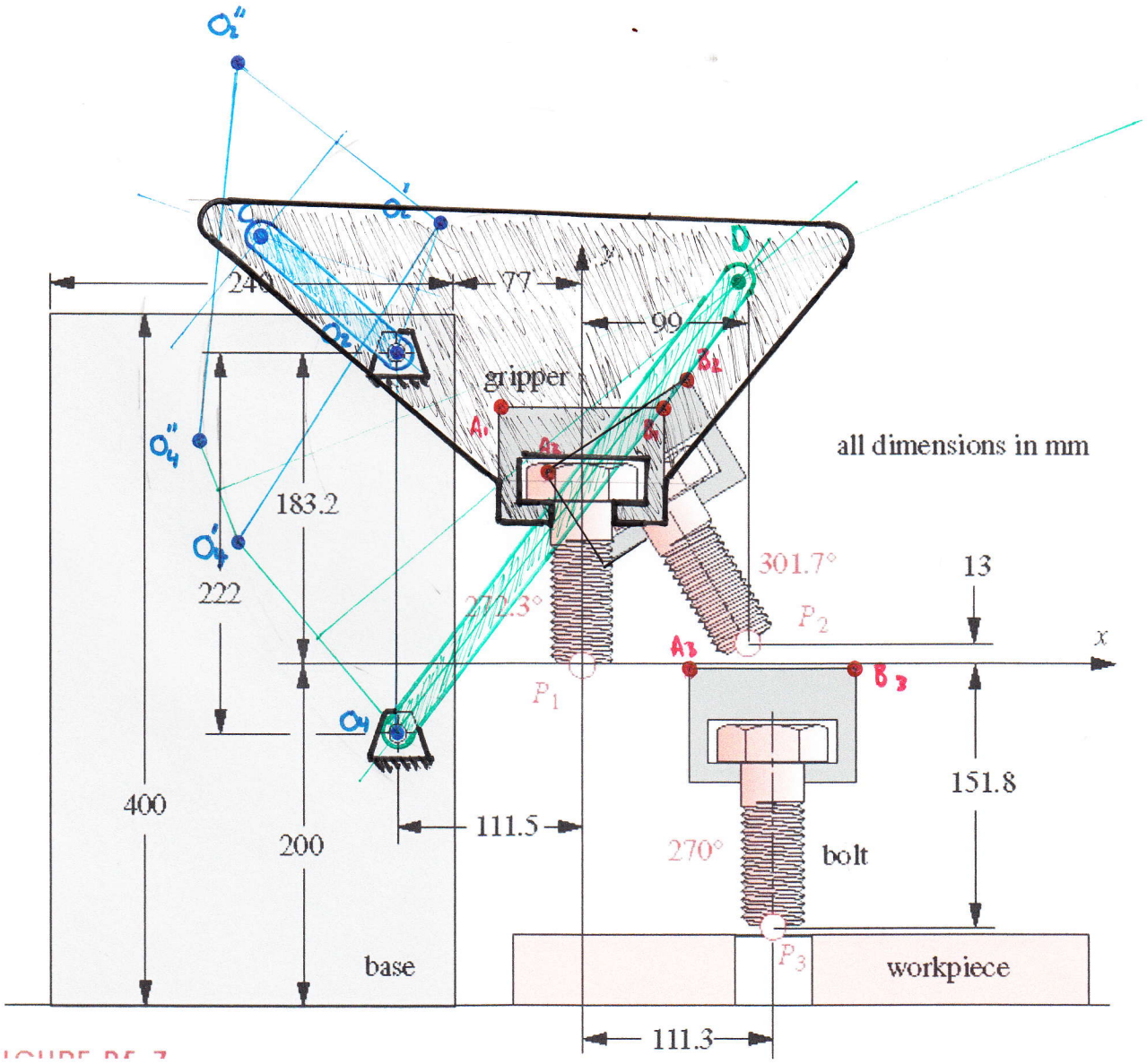
$$\alpha_2 = 31.7^\circ - 2.3^\circ = 29.4^\circ$$

$$\alpha_3 = 360^\circ - 2.3^\circ = 357.9^\circ$$

THE FIGURE ON PAGE 4 ILLUSTRATES HOW THE FREE CHOICES ARE DETERMINED

$$\beta_2 = 70^\circ \qquad \gamma_2 = 3.5^\circ$$

$$\beta_3 = 139^\circ \qquad \gamma_3 = -37.6^\circ$$


gripper
base
bolt
workpiece
all dimensions in mm
240
77
99
183.2
222
400
200
111.5
111.3
151.8
13
301.7°
272.3°
270°
x

HOMEWORK SOLUTION
MER 372: ADVANCED DYNAMICS & KINEMATICS

PROB 5.34 PG 4
NORTON 5TH

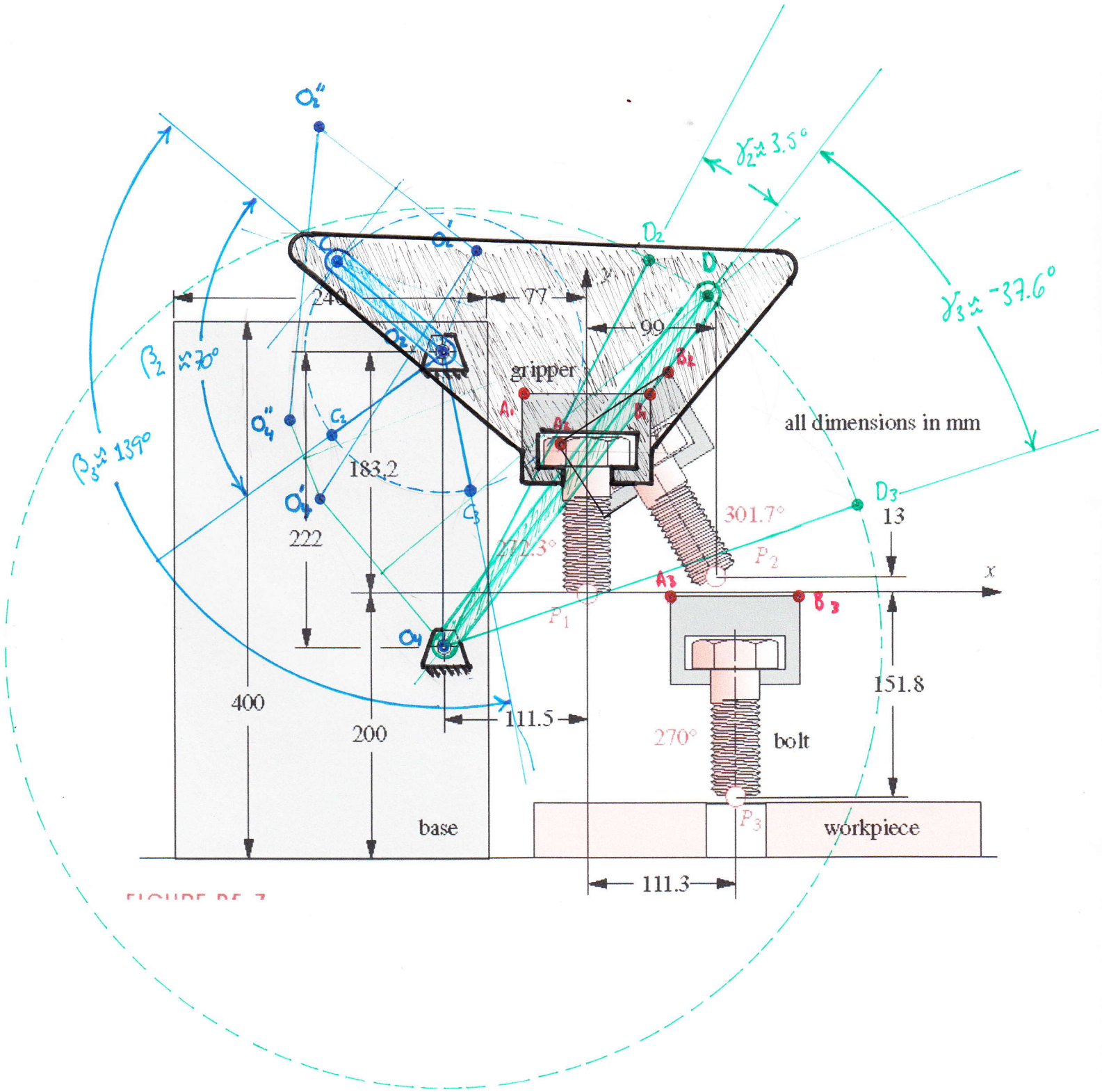


FIGURE P5-7

FIRST DYAD

GIVEN:		CHOSEN:		FIND:	
P12	99.85	β2	70.00	w	100.315
P13	188.23	β3	139.00	θ	150.483
δ2	7.48			z	305.335
δ3	306.25			ϕ	-49.304
α2	29.40			W1x	-87.295
α3	357.70			W1y	49.423
				Z1x	199.091
				Z1y	-231.500

	x-coord	y-coord.
O2	-111.795	182.077
A1	-199.091	231.500
A2	-188.095	116.951
A3	-78.337	87.507
P1	0.000	0.000
P2	99.000	12.998
P3	111.302	-151.797

$$\begin{bmatrix} -0.6580 & -0.9397 & -0.1288 & -0.4909 \\ 0.9397 & -0.6580 & 0.4909 & -0.1288 \\ -1.7547 & -0.6561 & -0.0008 & 0.0401 \\ 0.6561 & -1.7547 & -0.0401 & -0.0008 \end{bmatrix} \begin{Bmatrix} W1x \\ W1y \\ Z1x \\ Z1y \end{Bmatrix} = \begin{Bmatrix} 99.0003 \\ 12.9985 \\ 111.3022 \\ -151.7971 \end{Bmatrix}$$

SECOND DYAD

GIVEN:		CHOSEN:		FIND:	
P12	99.85	γ2	3.50	u	303.038
P13	188.23	γ3	-37.60	σ	56.747
δ2	7.48			s	226.257
δ3	306.25			ψ	-103.040
α2	29.40			U1x	166.167
α3	357.70			U1y	253.418
				S1x	-51.050
				S1y	-220.423

	x-coord	y-coord.
O4	-115.117	-32.995
B1	51.050	220.423
B2	35.269	230.095
B3	171.157	66.400
P1	0.000	0.000
P2	99.000	12.998
P3	111.302	-151.797

$$\begin{bmatrix} -0.0019 & -0.0610 & -0.1288 & -0.4909 \\ 0.0610 & -0.0019 & 0.4909 & -0.1288 \\ -0.2077 & 0.6101 & -0.0008 & 0.0401 \\ -0.6101 & -0.2077 & -0.0401 & -0.0008 \end{bmatrix} \begin{Bmatrix} U1x \\ U1y \\ S1x \\ S1y \end{Bmatrix} = \begin{Bmatrix} 99.0003 \\ 12.9985 \\ 111.3022 \\ -151.7971 \end{Bmatrix}$$