Lab 7

Exercise 1: Down-plunge views **Read *each* problem before you start to do it.**

1A) Graphical solution **(18 points total)**

a Draw in a top view a line OF that represents a fold axis that trends N70°W and plunges 30°. The length of the projection of the line *as seen in the top view* should have a length of 10.00 cm. Show a north arrow on your top view. Draw an adjacent view "A" that shows the plunge of the line; you need to visualize how to look at the line so that you see its plunge. Adjacent to view "A" draw another view "B" that allows you to see line OF as viewed down-plunge (**not** up-plunge). In each view label points O and F, where O is the high point (and is at the coordinate origin) and F is the low point. **(2 points for the top view, 2 points for the second view, 1 point for the third view, 1 point for the north arrow, 3 points total for the labels; 9 points total)**

b Assuming that point O is at the coordinate origin and that **x= north, y = east, and z = down**, find the coordinates of point O and point F. Let 1 coordinate unit = 1 cm.

Point	x-coordinate	y-coordinate	z-coordinate
O	(1 pt)	(1 pt)	(1 pt)
F	(1 pt)	(1 pt)	(1 pt)

In the top view, ***draw and label*** two right-handed horizontal axes x and y; the z– axis points down, so you cannot draw it. Draw the axes such that:

c The x axis points **north.** **(1 point)**

d The y-axis points east. **(1 point)**

In the top view, draw and label two ***right-handed*** horizontal axes x' and y'; the z'– axis points into the page, so you cannot draw it. Draw the axes such that:

e The y'-axis points **parallel to the trend of** OF. **(1 point)**

f The x'-axis points perpendicular to OF. **(1 point)**

In the down-plunge view (i.e., view B), draw and label two right-handed axes z" and x"; the y" – axis points into the page, so you cannot draw it. Draw the axes such that:

g The z"-axis points from "line" OF away from the fold line separating views A and B. **(1 point)**

h The x"-axis points away from "line" OF and parallel to the fold line separating views A and B, and is consistent with the y" axis pointing in the down-plunge direction. **(1 point)**

1B) Spherical projection (equal-angle) solution **(36 points)**

Here you will revisit the same line as in 1a, but you will obtain the down-plunge view of the line by successive rotations about the z, x', and y" axes using an equal-angle (stereonet) projection. Earlier we discussed how the rotations could be done about the x, y', and z", but they also could be done about the z, x', and y" axes. Use **one** spherical projection for this problem.

a Plot a fold axis that plunges 30° in the direction N70°W. Label the line with an F.
Consider this line as being fixed in space.
(2 points for plotting the line, 1 point for the label; 3 points total)
Plot three right-handed axes:

b The x-axis trends due north and plunges 0°. Label it "x".
(2 points for plotting the line, 1 point for the label; 3 points total)

c The y-axis trends due east and plunges 0°. Label it "y".
(2 points for plotting the line, 1 point for the label; 3 points total)

d The z-axis trends north and plunges 90°. Label it "z".
(2 points for plotting the line, 1 point for the label; 3 points total)

Now rotate the axes about the **positive** z-axis to yield a new set of axes (x', y', z') such that the **trend** of the y' axis matches trend of the **fixed** fold axis F.

e The angle of rotation about z is: ______ **Pay attention to the sign of the angle!**
(1 point for the magnitude, 1 point for the sign; 2 point total)

On the same plot, plot the new right-handed axes x', y', z':

f Label the x'-axis.
(2 points for plotting the line, 1 point for the label; 3 points total)

g Label the y'-axis.
(2 points for plotting the line, 1 point for the label; 3 points total)

h Label the z'-axis.
(2 points for plotting the line, 1 point for the label; 3 points total)

i Draw a curved arrow that shows the angle of rotation connecting y to y' and label the curved arrow with the angle of rotation. **(1 point)**

Now rotate the axes about the **positive** x'-axis to yield a new set of axes (x", y", z") such that the trend and plunge of the y'' axis matches trend of the **fixed** fold axis F.

j The angle of rotation about x' is: ______ **Pay attention to the sign of the angle!**

(1 point for the magnitude, 1 point for the sign; 2 points total)

Plot the new right-handed axes x'', y'', z'':

k Label the x''-axis.

(2 points for plotting the line, 1 point for the label; 3 points total)

l Label the y''-axis.

(2 points for plotting the line, 1 point for the label; 3 points total)

m Label the z''-axis.

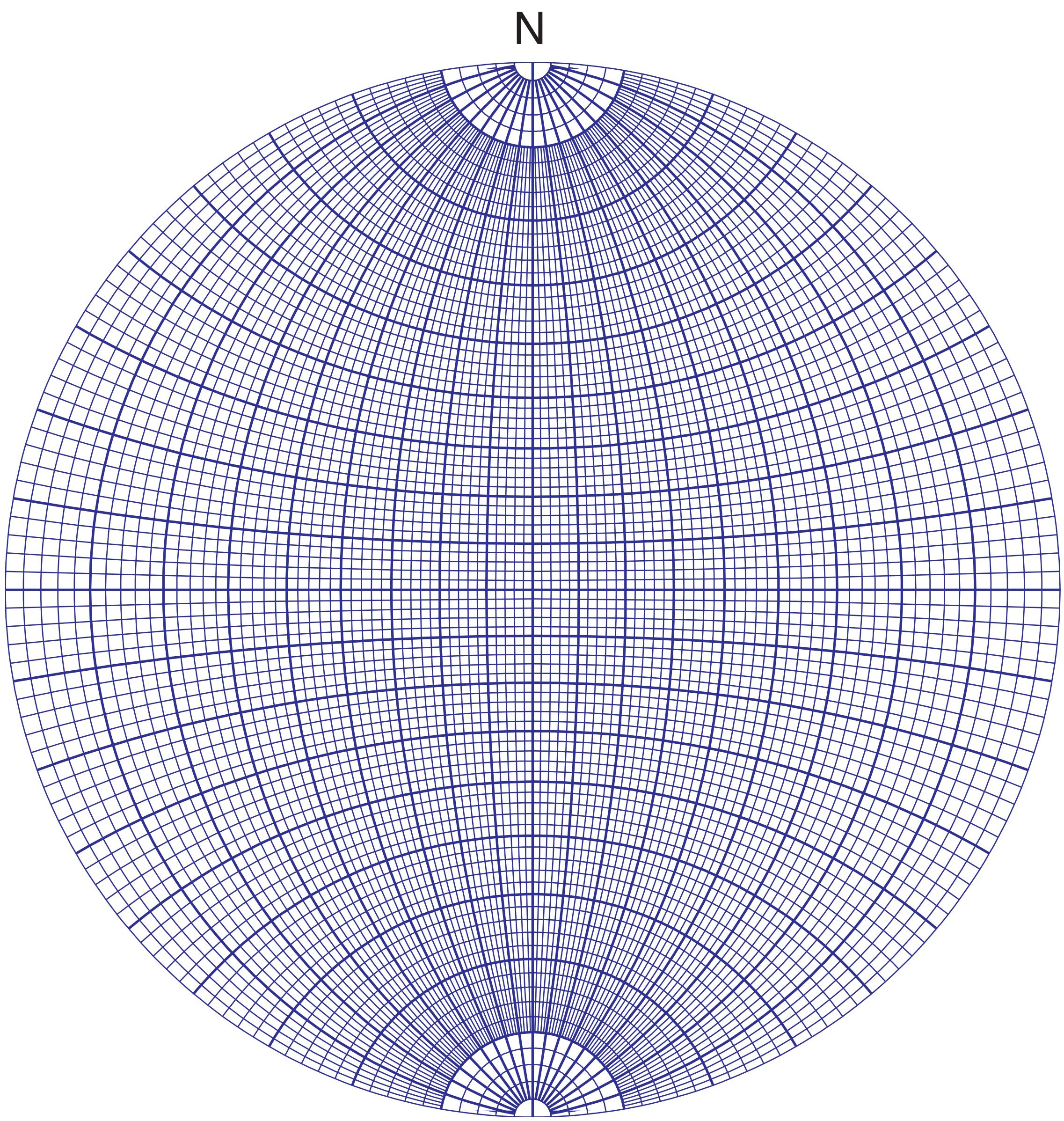
(2 points for plotting the line, 1 point for the label; 3 points total)

n Draw an arrow that shows the angle of rotation connecting y' to y", and label it with the angle of rotation. **(1 point)**

No third rotation is needed in this case to obtain the down plunge view of fold axis F, but a rotation about the y'' axis (if needed) could bring the x''' and z''' axes into the desired orientations.

This exercise should show you how three successive rotations about right-handed axes can rotate one reference frame to another.

Equal-Angle Net
(Wulff Net)



Exercise 1C: Rotations using matrices and Matlab (40 points total)

Start up Matlab after reading what the exercise asks for. Turn in your Matlab printout.

a Using the expressions for a rotation about the z-axis as described in Lab 6 and your answers from exercise 1B of this lab, find matrix R1 that describes the rotation about the z-axis in exercise 1B. Enter the matrix elements in Matlab and include a copy of the printout. Provide the element values to 4 decimal points. For example:

$$R_1 = \begin{bmatrix} a_{x'x} & a_{x'y} & a_{x'z} \\ a_{y'x} & a_{y'y} & a_{y'z} \\ a_{z'x} & a_{z'y} & a_{z'z} \end{bmatrix}$$

R1 = [axx', ax'y, ax'z; ay'x, ay'x, ay'z; az'x, az'y, az'z] (9 points)

b Using the expressions for a rotation about the x-axis as described on page 2 of Lab 6 and your answers from exercise 1B, find matrix R2 that describes the rotation about the x'-axis in exercise 1B. Enter the matrix elements in Matlab and include a copy of the printout. For example:

$$R_2 = \begin{bmatrix} a_{x''x'} & a_{x''y'} & a_{x''z'} \\ a_{y''x'} & a_{y''y'} & a_{y''z'} \\ a_{z''x'} & a_{z''y'} & a_{z''z'} \end{bmatrix}$$

R2 = [b11, b12, b13; b21, b22, b23; b31, b32, b33] (9 points)

c Using your answers for Ox, Oy, Oz, Fx, Fy, and Fz in exercise 1a, assign values to Ox, Oy, Oz, Fx, Fy, and Fz in Matlab and then type

O = [Ox; Oy; Oz] (4 points)

F = [Fx; Fy; Fz] (4 points)

d Type

OF1 = R2*R1*[0,F] (1 point)

e Based on your answers for exercise 1A and 1C, describe what OF1 is:

____ (2 point)

f Type

R = R2*R1 (1 point)

g Type

OF2 = R*F (1 point)

h Describe what R is: R is ____

____ (2 points)

i Based on your answers for exercise 1A and 1C, describe what OF2 is:

____ (2 point) j Describe whether or not you answers here are consistent with the last three answers of exercise 1A: ____

____

____ (2 points)

k Type

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% Plotting commands
plot(OF1(1,1),OF1(3,1),'ro','MarkerSize',10)
hold on
plot(OF1(1,2),OF1(3,2),'bs','MarkerSize',20)

% Add axes and labels
quiver([0,0],[0,0],[-1,0],[0,-1])
text(-0.8, 0.1,'x"')
text(0.1,-0.8, 'z"')
axis([-1 1 -1 1])
axis equal
hold off
```

(1 point)

l Describe the meaning of this plot (and turn in a copy of it) _____________________

____ (2 points)

Exercise 2: Preparing a map from a cross section **(46 points total)**

2) A geologic map shows the intersection of one of more surfaces of geologic structures with the topographic surface. Although not usually thought of this way, this is an **essential** aspect of what a geologic map is. **Points** along the intersection of a geologic surface with a topographic surface are located where geologic structure contours at a given contour level intersect topographic contours **of that same level** (e.g., at the intersection of the 100-meter structure contour with the 100-meter topographic contour). By finding the intersection points of other structure contours with the corresponding topographic contours, one can find other points along the intersection of the geologic surface with the topographic surface. By connecting these points, as shown in Fig. 5.2 of Lecture 5, one can construct a geologic map.

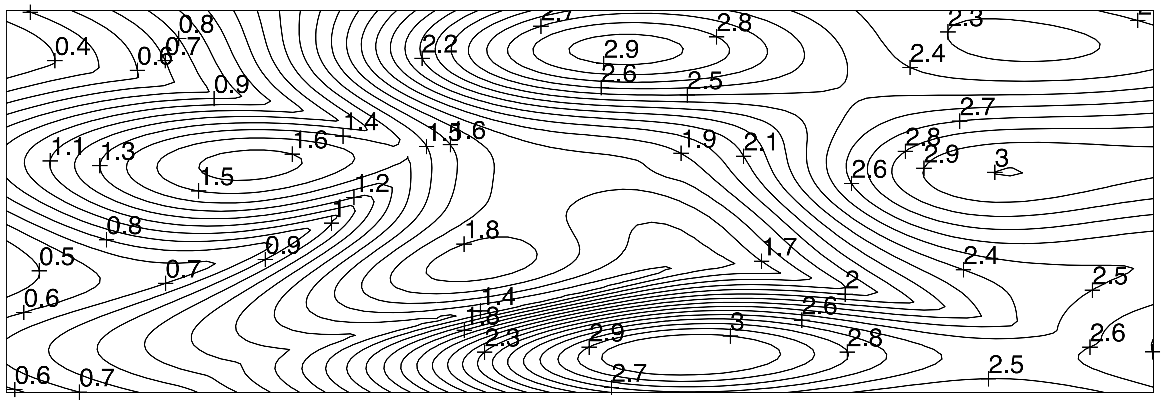
To get the base map either use the attached map or get an electronic copy. To get and electronic copy, check your e-mail and open the attachment labeled Lab07_Ex2.m. Copy the contents of this entire file. Then start up Matlab and open a new window. Paste the contents of Lab07_Ex2.m into the opened window, and save the file as Lab07_Ex2.m. Then go to Matlab and type

```
Lab07_Ex2
```

This should give you a copy of the figure.

Draw (with light lines on the map) the structure contours for the dipping plane shown in the cross section; draw the structure contours at the same contour levels as the topographic contours. In other words if the topographic contours were at elevations of 0m, 100m, 200m, and 300m, then draw structure contours at 0m, 100m, 200m, and 300m. Find the intersection points of structure contours and the corresponding topographic contours, as shown in Fig. 5.2 of Lecture 5. Then construct a geologic map showing the surface trace of the plane by connecting the intersection points with one or more smooth curves, whichever is appropriate. **(1 point deducted for each incorrect intersection [43 points total for no deductions]; 1 point for each of 3 curves)**

Map of the GG303 Quadrangle (North to Top)



West-East Structure Strike-View Cross Section of the GG303 Quadrangle