Lesson 4: DOI and Stability

Name: Solution

Homework (Due Wednesday. Presentation does not count. Simply hand these pages in)
Problems 1 to 10: Report the degree of indeterminacy (DOI). If the structure is definitely unstable, write “unstable” in the box.

1. Determine the degree of indeterminacy (DOI) of the structure below:

   ![Diagram 1]

   $\text{DOI} = 2$

2. Determine the degree of indeterminacy (DOI) of the structure below. Is it stable?

   ![Diagram 2]

   $1 \text{ loop} \Rightarrow \text{ DOI} = 3$

   $-4 \text{ PINS}$

   $= -1 \quad \therefore \text{UNSTABLE}$

   $\text{DOI} = -1$

   Stable (yes or no)?

   (no)

3. Determine the degree of indeterminacy (DOI) of the structure below:

   ![Diagram 3]

   $10 \text{ unknowns}$

   $-6 \text{ EQNS}$

   $\Rightarrow 4$

   $\text{DOI} = 4$

4. Show that the structure below is unstable, using Statics. First, recognize that all members are two-force members. Then, examine the support points. Given: all horizontal and vertical members are 10-ft long.

   ![Diagram 4]

   \[ \Sigma F_y = -3 \]

   \[ \Sigma F_y \neq 0 \quad \therefore \text{Not Static} \]

   (Dynamic, i.e., F=m$g$)
5. A and D are pinned supports. B and C are roller supports.

\[ \text{DOI} = \frac{6 \text{ unknowns}}{3 \text{ eqns}} = 2 \]

6. Supports are both pins. Three members are rigidly-connected ("moment connections" or fixed connections).

\[ \text{DOI} = \frac{4 \text{ unknowns}}{3 \text{ eqns}} = 1 \]

7. All foundations are rigid except the rightmost foundation, which is a pinned support. All member-to-member connections are fixed (moment connections).

\[ \text{DOI} = \frac{(3 \text{ loops})(3) + 1 \text{ pin}}{3 \text{ eqns}} = \frac{9}{3} = 3 \]

8. Arch with a pinned support on the left and a roller support on the right.

\[ \text{DOI} = \frac{3 \text{ unknowns}}{3 \text{ eqns}} = 0 \]

9. Arch with a pinned supports on the left and right.

\[ \text{DOI} = \frac{(1 \text{ loop})(3) - 2 \text{ pins}}{1 \text{ eqn}} = 1 \]
10. Determine the degree of indeterminacy (DOI) of the structure below.

\[ \text{T A K E \ P R O B L E M \ 8,} \]
\[ \text{A D D 1 U N K N O W N} \]
\[ \text{F O R C E I N T I E} \]
\[ \Rightarrow \text{DOI} = 1 \] \text{(S A M E A S P R O B . 9)}

11. The truss is composed of pin-ended members, supported by a pinned support on the left and a roller support on the right.

\[ \text{DOI} = -1 \]
\[ \text{(U N S T A B L E)} \]
\[ \text{DOI} = \frac{12 + 3 - 2(8)}{8} = -1 \]

12. Arch with a fixed support on the left and right. All connections are rigid (moment-resisting).

13. Beam with pinned support at A, roller supports at B, E, and F. Study the connections at C and D carefully, recalling what you learned in lab last week.

\[ \text{DOI} = 0 \]

\[ 9 \ \text{UNKNOWNS} \]
\[ - 9 \ \text{EQNS} \]
\[ \Rightarrow \text{DOI} = 0 \]
Problems 14 through 17 refer to the building frame shown below. All supports are pinned. The diagonal brace is pin-ended. The beam to column connections: see the detail and recall what you learned from lab last week about connections.

14. DOI of the frame, as shown.

\[ \text{DOI} = 0 \]

15. Determine the DOI if the brace is deleted.

\[ \text{DOI} = -1 \]

16. Determine the DOI if the brace is still present, but all of the beam-column connections are changed to:

\[ \text{DOI} = 6 \]

Prob 14: DOI = 0

\[ + 6 \text{ Unknowns} \]

\[ = 0 \]

17. For the frame as shown, determine the reaction components at support B.

\[ B_y = 120 \text{ kips} \]
\[ B_x = 0 \text{ kips} \]