PHY 291- Computational Physics
Homework 1
Trenton Cathcart
1/31/2022

Part 1

Figure 1: Bridge Diagram Problem

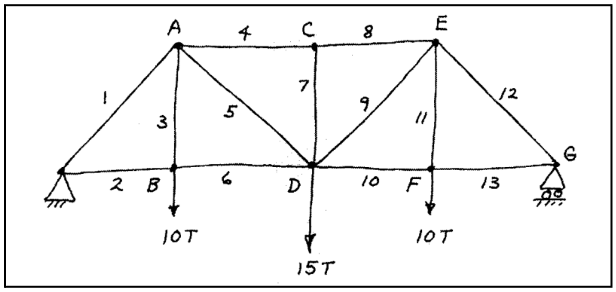

Figure 1 was used to solve for the 13 forces, acting on the 13 trusses. The junctions were used to create a componential linear system of equations. This is all under the assumption that the trusses do not have weight. It may also be known that junction G is on rollers, therefore there is no x component needed. The 13 equations were derived using Newton's 2nd law, for the bridge to be in static equilibrium the net forces must be equal to zero. It was chosen that the beams would be under tension forces to balance out the nodes. Therefore Newton's 2nd law can be used to calculate the forces. Those 13 equations were entered into a 13x13 matrix shown in Matrix A(**Figure 2**).

Figure 2: Matrix A

```
A= [-cosd(45), 0, 0, 1, cosd(45), 0, 0, 0, 0, 0, 0, 0, 0;
    -sind(45), 0, -1, 0, -sind(45), 0, 0, 0, 0, 0, 0, 0, 0;
    0, -1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0;
    0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0;
    0, 0, 0, -1, 0, 0, 0, 1, 0, 0, 0, 0, 0;
    0, 0, 0, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0;
    0, 0, 0, 0, -cosd(45), -1, 0, 0, cosd(45), 1, 0, 0, 0;
    0, 0, 0, 0, sind(45), 0, 1, 0, sind(45), 0, 0, 0, 0;
    0, 0, 0, 0, 0, 0, 0, -1, -cosd(45), 0, 0, cosd(45), 0;
    0, 0, 0, 0, 0, 0, 0, 0, -sind(45), 0, -1, -sind(45), 0;
    0, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 1;
    0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0;
    0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, -cosd(45), -1];
```

Figure 3

```
BridgeForces =

  -24.7487
   17.5000
   10.0000
  -25.0000
   10.6066
   17.5000
         0
  -25.0000
   10.6066
   17.5000
   10.0000
  -24.7487
   17.5000
```

Figure 4

```
B=[0;
   0;
   0;
   10;
   0;
   0;
   0;
   15;
   0;
   0;
   0;
   10;
   0];
```

The solutions to the system of linear equations were entered into a 1x13 matrix shown above in matrix B(**Figure 4**). The inverse of Matrix A(**Figure 2**) was then multiplied by matrix B(**Figure 4**), this returned the Forces shown above in **Figure 3** Respectively. The answers were as expected with negative signs in the correct spaces. This created a balanced bridge.

PHY 291- Computational Physics
Homework 1
Trenton Cathcart
1/31/2022

Part 2

Figure 5: Pressure Problem Diagram

Pipeline	k (m^4/bar·s)	L (m)
1	4.00	20.0
2	0.500	10.0
3	0.980	14.0
4	0.500	10.0
5	0.500	10.0
6	0.128	8.00
7	0.128	8.00
8	0.128	8.00
9	0.500	10.0
10	0.128	8.00

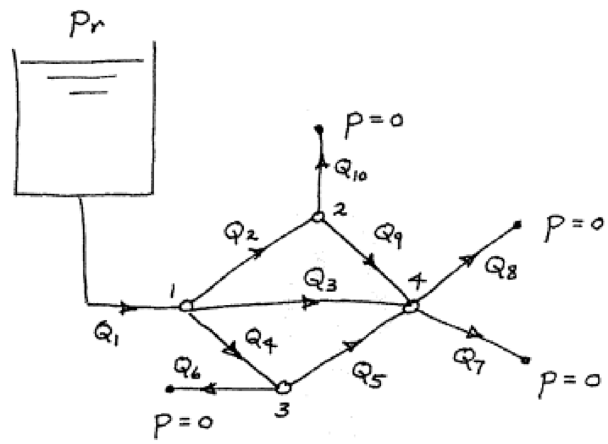

Figure 5 was used to solve for the 4 pressures at the 4 nodes. The junctions were used to create a linear system of equations. The 4 equations were derived using water flow (Q) related to pressure differences(deltaP) multiplied by conductance (G). For any given water flow there must be a pressure difference within the junctions. From **Figure 5** it is given that Pr is 10 bars and the end nodes are zero bars. Therefore there is a pressure difference within the system. Therefore the water flow equation Q=(deltaP)*(G) was used to derive the system of equations. Those 4 equations were entered into a 4x4 matrix shown in Matrix A(**Figure 6**).

Figure 6: Matrix A

```
A=[G(1)+G(2)+G(3)+G(4), -G(2), -G(4), -G(3);
    G(2), -G(2)-G(9)-G(10), 0, G(9);
    G(4), 0, -G(4)-G(5)-G(6), G(5);
    G(3), G(9), G(5), -G(3)-G(5)-G(7)-G(8)-G(9)];
```

Figure 7

```
E=[G(1)*10, 0, 0, 0];
```

Figure 8

```
PipePressures =

    8.1172    5.9893    5.9893    5.7779
```

The inverse of Matrix A(**Figure 2**) was then multiplied by matrix E(**Figure 7**), this returned the pressures shown above in **Figure 8** Respectively. The answers were as expected, I assumed no pressure could be greater than 10 bars and no negative values should be present.