National Taiwan University | **Finite Element Method**
Department of Civil Engineering | Instructors: C.-S. CHEN

Lab Assignment 1, 03/07/2019, 1800 -- 2000

Due 2000

Lab Grading Policy: Attendance 20%, Basic 80%, Bonus 20%

You are expected to complete the basic part during the Lab. In case you have difficulty in finishing the basic part on time, you should upload them before 2100 on Saturday and a penalty of 20% discount will be applied on your score. You are encouraged to complete the bonus part (no penalty applied). Basic and/or bonus parts should be submitted by **2100 on Saturday and no late submission is permitted**. We will in general post the reference solutions by **Sunday**.

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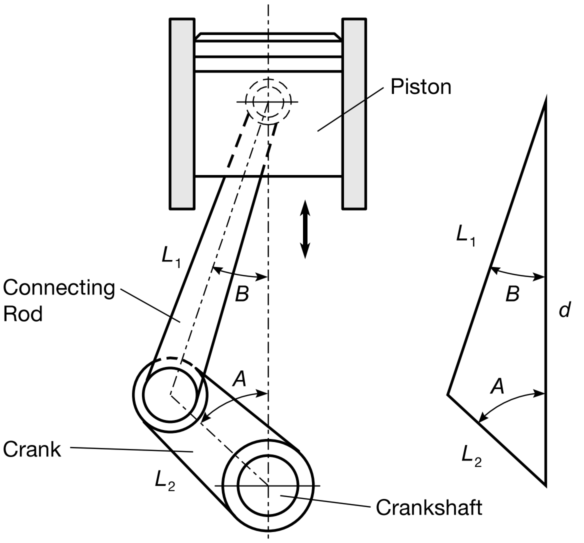
1. **(40%)** Write a MATLAB script ( ) that will pick n cards at random from a deck of 52 cards. The ranks for the cards are and the suits for the cards are . The card number follows the order of suits and ranks. For example: card number for is , card number for is , card number for is . Below are two sample runs (user inputs are shown in boldface):

```
6
```

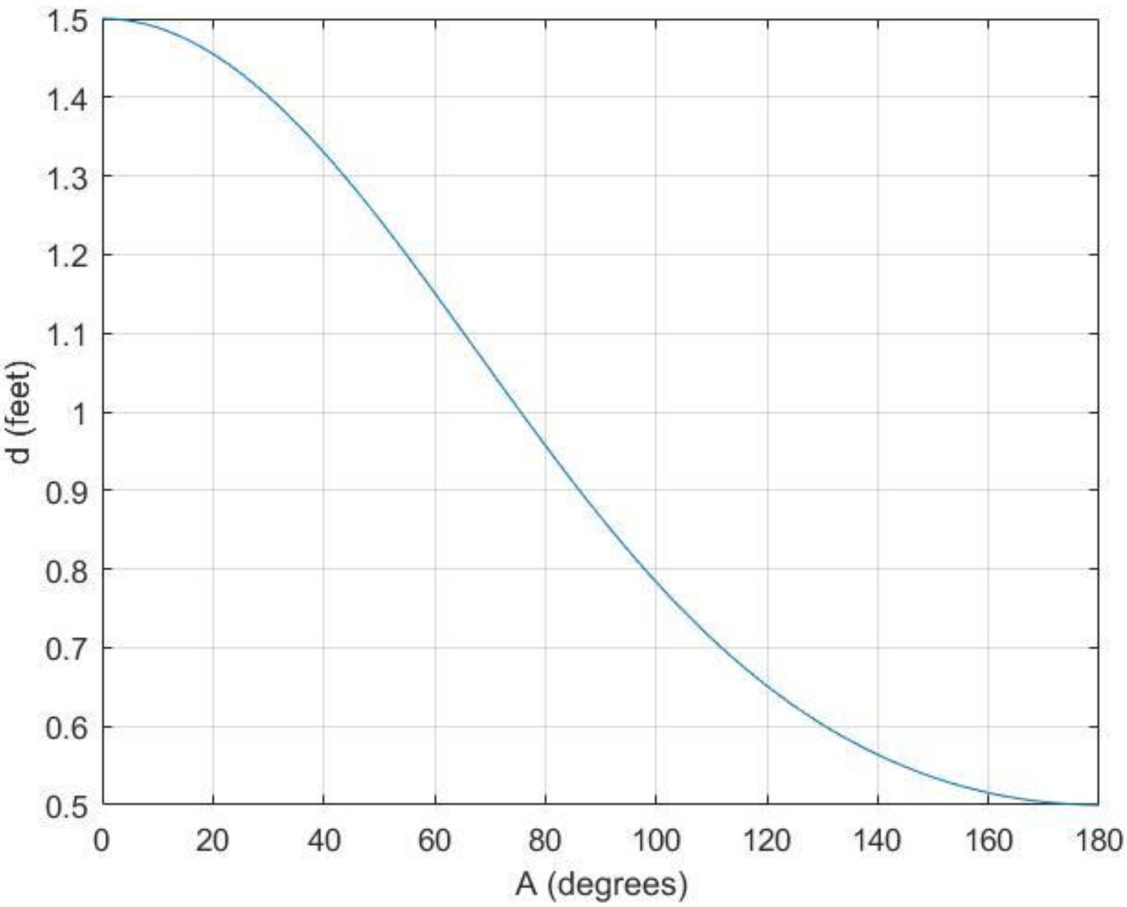
```
8
```

2. **(40%)** Figure below shows a piston, connecting rod, and crank for an internal combustion engine. When combustion occurs, it pushes the piston down. This motion causes the connecting rod to turn the crank, which causes the crankshaft to rotate. Develop a MATLAB program to compute and plot the distance *d* as a function of the angle *A*, for L_1 = 1 ft and L_2 = 0.5 ft.



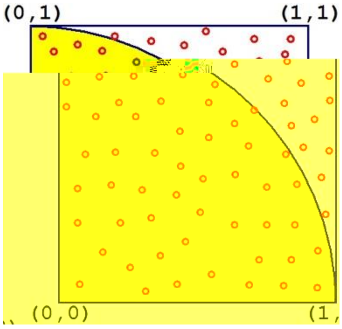
(a) (b)

Below is a sample plot for each degree of *A* vs. the distance *d*. (MATLAB command hint: , ,)



3. **(Bonus 20%)** The Monte Carlo simulation refers to a **computational** technique that uses **random numbers and probability to solve problems**. This method has a wide range of applications. We will use the Monte Carlo simulation for the estimation of .

The square in the following figure has a unit length, and thus unit area. The yellow fan has an area of a quarter of a circle. In other words, the area of the yellow fan has an area of .



If we uniformly hit the square with bullets, the probability of having a bullet hitting the fan, , will be the area of the fan, , divided by the area of the square, . In other words:

We can thus use random numbers and probability to compute π. Write a MATLAB Monte Carlo simulation script ( ) for the estimation of . Below are three sample runs (user inputs are shown in boldface):

```
                 1000

                 2000000

                 10000000
```