# Writing in Discrete Unit 6

by Errol Brown
South Mecklenburg High School

This curriculum unit is recommended for teachers of Discrete Math or teachers who intend to teach Discrete.

**Keywords:** Routing Problems • Traveling Salesman Problems • Critical Paths • Earliest/Latest • Minimization • Nearest Neighbor Algorithm•Brute Force Algorithm• Repetitive Nearest Neighbor Algorithm• Cheapest Link Algorithm• Weighted graph•

**Teaching Standards:** See Appendix 1 for teaching standards addressed in this unit.

**Synopsis:** This unit is about teaching a new and interesting unit in Discrete Math where my students will be able to apply their current life experiences to real math problems. In this unit, we will look at the old ways of doing things and apply it to the new and technology rich lives of the students we teach. Meaning, we will be examining the 'Travelling Salesman' and how these salesmen of the past regularly travelled from state to state or from house to house to make sales. They also had to use logical reasoning to decide which locations to travel to, the shorter routes to take, and the cost effectiveness of their decisions. At the end of this unit, students will complete a final project by applying all that they have learned. I am confident that they will enjoy this project because students will be given the opportunity to choose an institution of their liking, and calculate not only the distance between the institutions but also the overall cost.

*I plan to teach this unit during the month of November 2019 to 28 students.*

## Introduction

### Rationale

Even though the topics in Discrete Math are related to everyday life, some topics are a turn off for students because of their archaic sounding names such as “The Mathematics of Sharing”, “The Mathematics of Apportionment”, “The Circuit Comes to Town”, “The Traveling Salesman Problem”, “The Mathematics of Networks”, “The Mathematics of Scheduling”, “Spiral Growth in Nature”. I created this unit to address the needs of my students to know more about Discrete Math, and how it relates to their every-day life. I had originally planned to work on the entire Discrete curriculum but based on valuable information garnered from my seminars, the time it would take to complete that would be great. I then decided on a unit that I believed the students would greatly benefit from. Therefore, based on the conditions outlined, I chose to narrow it down to one specific unit: “The Travelling Salesman: Hamilton Circuit and Path”.

### School Demographics

At South Mecklenburg High School, we have over 3,000 students, which is three times larger than the district’s average and four times larger than the state’s average. The population is very diverse comprising of 36 percent Caucasians, 31 percent Hispanics, 26 African-Americans, 3 percent Asian, 3 percent two or more races and 0.3 percent American Indian or Alaskan Native. I appreciate the diversity as it brings different cultures together working under one roof.

### Goal

In our Modern society, we have become obsessed with the internet and using it for just about everything. The purpose of this unit is to help the students to see how a past generation had to travel distances and the decisions they had to make in terms of places to visit and the cost associated with travel in the previous decades. The students find it hard to believe that people had to travel very far distances to make a living and incredulously ask if they had no internet to sell or advertise. In writing in math, I want my students to write about what they are learning in math and explain how the past is different from the present.

In teaching Honors Discrete Math, the topic of the Traveling Salesman has always intrigued and fascinated the students. They struggle as they try to understand and make connections as to how people had to travel those distances, and had to make difficult choices as to where to go and how to get there, while trying to save money as well as to make a profit. This is just one of the topics I would have loved to write about in writing in Math. Topics like Euler and Hamilton Circuits are relevant to their everyday life, but they struggle with learning it because they cannot make a connection with it. These circuits were the GPSs of the past.

**Content Research**

Discrete Math is a course where students are exposed to a lot of real-world applications and relevance to their lives. Some of my students need this course to get into universities, like North Carolina State University. Others are cognizant of the fact that they will have to do it in college, so it forms a strong preparation background for them. The cohort is comprised of seniors and juniors, which means that they have completed, Math1, Math 2, Math 3, Pre-Calculus and Calculus AB and some Calculus BC. This means that they have completed all of their Math courses and this is their last high school math course. The students are mature and willing to try different things to learn. Therefore, this course and especially this unit will be different for them and the evaluation will be a compilation of quite a few things in this unit where they have to write and be creative.

Students learn mathematics more effectively and more deeply when reading and writing is part of learning mathematics. Although reading and writing in mathematics may necessitate more skills and practice to master, the mathematical learning derived from reading and writing mathematics far outweighs the burden it places on teachers and students (Bosse, 2009, p. 1). In reading the article by Bosse, I agree that reading and writing in Math go hand in hand. Bosse also says that the teacher would have to change the culture of his or her classroom when implementing this and the teacher would have to do more work upfront. However; in the end, the focus on writing benefits the student in all subject areas.

So, what is writing in Math? "The literature on writing in mathematics class reveals a mixture of writing that attends to the mathematics discipline and writing associated with language arts (Colonnese, 2017)". In this unit, we see that mathematical writing is integrated with other courses, emphasizing the need to teach the language of the unit or course you are teaching to the students.

Why do we write in Math? One reason could be to fulfill school or district writing requirements. Many mathematics teachers report that they annually assign writing biographical reports to their students (Bosse, 2009), and I am guilty of that as I would normally ask my students to write about their math experience. However, with attending this seminar I have learned more and more that this is not what writing in Math is. "Writing one's feelings about Mathematics in a journal (e.g Jurdak & Zein, 1998) or a biography of a famous mathematician (e.g Tayeh and Pokay, 2012) contrasts with writing that involves reasoning, such as the relationship between addition and Subtraction" (Cohen, Casa, Miller, & Firmender, 2015). In this unit, my students will be asked to differentiate between the Euler and Hamilton theories. The theories are similar but once the students know the language of both theories they can differentiate between both of them. Hence, my students will be experiencing writing in math and getting a better understanding of the concepts being taught, which will prepare them for the project at the end of the unit.

I have learned that there are different types of writing in Math. These are "Exploratory to make sense of a problem, or situation, Informal/Explanatory to describe, to explain, Argumentative to construct, to critique and Mathematically Creative to document original ideas, problems, and /or solutions, convey fluency and flexibility in thinking, and elaborate on ideas." (Casa et al., 2016). All of these types of writing will be highlighted in the project as students will be allowed the flexibility to choose which one to best meet their needs.

The students will use Exploratory writing, "Writing mathematically to personally make sense of a problem, situation, or one's own ideas" (Casa et al., 2016) in this unit. Although the

project reflects real-world situations, the students have to make sense of the problem first, and then start answering the questions asked.

Then, the next step is to write an Informative/ Explanatory piece. Students will collect the information using the correct mathematical language to start putting the information together and interpreting the different Algorithms. Using the different Algorithms, the students will be comparing the different Algorithms and constructing arguments as to which of these would be the best Algorithm to use and why. Here we are using the four components of writing. Then finally, the Mathematical Creativity will now come into play as the final portion of the writing process comes into play. Here the students will be asked to be creative and not limit themselves to what they were accustomed to but to use their ingenuity to convey their ideas on solving a problem.

In teaching students how to write in math, there are a few basic things that would have to be taught to the students before-hand. The first is teaching my students that my classroom is a safe place to think outside the box and to even make mistakes. When this is done, my students will be willing to try different ways to express themselves and not being worried about being wrong. I have achieved this because my students in Discrete math are willing to share their opinions during a lesson.

Writing in Mathematics often requires a solid understanding of numeric, symbolic, graphical and verbal representations, their uses, and their interconnection (Bosse, 2009). Once those skills are taught to the students we would be able to get the type of writing we are expecting. The teacher here has to prepare for this and the work before the teacher gets to the students is the key. Keeping in mind numerous studies report that students demonstrate greater mathematical understanding and learning through writing to learn mathematics (Gopen & Smith, 1990); (Pugalee, 1997); (Porter & Masingila, 2000). Teaching my students vocabulary, in relation to the Travelling Salesman, will help them complete the course and use the correct math language when completing the project.

**Assessment**

This unit will be assessed using a project. Many assessments measure only recently taught knowledge and never ask for authentic performance (conditional knowledge and skill in context).

**Instructional Implementation**

*Teaching Strategies*

I have plans to use worksheets. We have a project to do that I know is relevant to my students' future plans, I have worksheets plus discussions that will take place around this course. I will try and do more research on other things that I can use to make this lesson more relevant to their present day lives.

In teaching this unit, I give the students background information by introducing them to the Hamilton Circuits vocabulary, such as what is a Hamilton Circuit. A Hamilton Circuit is a circuit that visits each vertex of the graph once and only once (at the end, of course, the circuit must return to the starting vertex) and a Hamilton Path is a path that visits each vertex of the graph once and only once. We will compare it to that of Euler where we look at similarities and differences. In doing this, I will ask my students to write what they discover base on the definition of the Two and use illustrations to show the differences or write about the differences.

We will look at ways to identify a Hamilton Path or Circuit from a graph by using Dirac's theorem. This will give the students time and another opportunity to compare what

happens with Euler and Hamilton. In this difference, they will write. They will also know what a complete graph is and how to find the number of edges in a graph. They will also learn that once you have a Hamilton Path on a graph it can become a Hamilton Circuit

The number of Hamilton Circuits present in a graph will also be explored. My students have already been exposed to factorial and we will use this previous knowledge to calculate the number of Hamilton Circuits. The number gets large very quickly because we are using factorial. In this I can ask my students to tell me what they think will happen in a graph of N vertices.

| Honors Discrete Math | | | SMHS WEEKLY LESSON PLAN 11/12-11/15 | | MR.Brown |
|---|---|---|---|---|---|
| 4th block | | | Hamilton Circuits | | |
| DAY | DATE | STANDARD | OBJECTIVE | AGENDA | C.F.U |
| MO | 11/11 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Students will understand Brute Force & Nearest Neighbor | 1Warm-up 2.Lesson on Brute Force & Nearest Neighbor | Completion of Worksheet |
| TU | 11/12 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Students will understand Repetitive Nearest Neighbor | 1Warm-up 2.Leson on Repetitive Nearest Neighbor | Completion of Study Guide |
| WE | 11/13 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Student will understand the Cheapest Link | Warm-up Lesson on the Cheapest Link | Quiz, worksheet and Quizlet live |
| TH | 11/14 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Work study Guide | 1Warm-up 2.Lesson on Hamilton | Completion of worksheet and quizzes |

The “Traveling Salesman” is a convenient metaphor for many different important real-life applications, all involving Hamilton circuits in complete graphs but only occasionally

involving salespeople. Here my students will be introduced to what is a weighted graph and a completely weighted graph. Then we will have a discussion to find an optimal Hamilton circuit (a Hamilton circuit with least total weight) for the given weighted graph. I will talk with them about what we use today like GPS and ask them to do a search using Map Quest to a chosen destination. I know sometimes the shortest distance might take the longest time and vice versa. Tell them Companies like UPS and Fedex use this every day and that this is being used in our electronics as well.

Using the vocabulary to draw a model as well. Here my students will be introduced to two different strategies the "Exhaustive search" and the "Go Cheap Method". They will be given a graph and asked to create tables based on the methods above. We will compare both and then have a discussion on what they think is the best method and why. The use of tables is important for us here.

They will be introduced to the three final Algorithms: The Repetitive Nearest-Neighbor Algorithm, Brute-force algorithm and Nearest-neighbor algorithm. We will explore all 3 and then do a comparison. We will make specific notes on similarities and differences as well as how do we use it in our everyday lives. Either at work or home. Once we have an understanding as to what we are doing then I will tell them about their project.

Their project would be to Identify your top 4 college choices (or 4 different locations, i.e. favorite colleges, favorite sports teams, historic sites, etc.). The locations must be within the continental United States and at least one must be outside of North Carolina (identify addresses of locations). Then, I will ask them to do different things in relation to these colleges keeping in mind what we have just studied. There is a rubric that will be attached so they will know exactly what to do and I will also provide guidance to ensure that we have common knowledge around what we are doing. In this, my students are exploring all the different ways of writing in Math as well as using different means of representing and expressing themselves. Their creativity will be called upon because the different ways they can present this project. I know this will have a lot more writing than the others units covered in Discrete Mathematics.

**Assessments** – The students will be assessed for this unit by completing a culminating project. This project is a real-life project where the student gets to plan to go to different destinations they would like to visit or have visited. In this the will calculate the different distances as well as calculate the shortest possible distance and time to the destinations.

Teacher Resources
Discrete Math
Name_____
Honors Project
Due: Monday. Dec.2

Tasks

- Identify your top 4 college choices (or 4 different locations, i.e. favorite colleges, favorite sports teams, historic sites, etc.). The locations must be within the continental United States and at least one must be outside of North Carolina (identify addresses of locations).
- Use the internet or a mapping software to find the distances between each pair of locations (include South Mecklenburg High School— 8900 Park Rd, Charlotte, NC 28210) as your fifth location.
- Create a mileage chart between each pair of locations.
- Create and label a weighted graph for the information.
- Determine the best route using the Repetitive Nearest Neighbor Algorithm (write the circuit beginning and ending with SMHS). Give the Hamilton Circuit and its weight.
- Determine the best route using Cheapest Link Algorithm (write the circuit beginning and ending with SMHS). Give the Hamilton Circuit and its weight.

Product-Submit a project paper with the following in this order (no poster board or triptychs).

___1. Cover sheet. Use this sheet as the cover sheet. (10 points)
___2. Page 1 (a-10 points, b-15 points, c-15 points)
___a. List your locations by name, city, and state (e.g. NC State University, Raleigh, NC)
___b. A mileage chart with the city and state of SMHS and your locations.
___c. A weighted graph with all locations and weights.
___3. Page 2 (a-20 points, b-5 points, c-10 points, d-5 points)
___a. A display of all routes and distances using repetitive nearest neighbor.
___b. Identify the best route from repetitive nearest neighbor (written to and from SMHS).
___c. Route and distance given by cheapest link (written to and from SMHS).
___d. Identify which algorithm gave you the best solution.
___4. Optional 5-point bonus (Page 3)—Create a chart displaying ALL possible routes and distances using Brute Force Algorithm. Identify the optimal route and distance.

Additional Bonus

___5 points—Submit your project in class Dec.2
___4 points—Submit your project in class Dec.3

___3 points—Submit your project in class Dec.4
___2 points—Submit your project in class Dec.5
___1 point—Submit your project in class Dec.6

Notes

-The project is one test grade.
-There are 110 total possible points (out of 100)—90 as outlined in the above and 10 discretionary points based on presentation and neatness, and 10 bonus points.
-Bonus points will only be given to fully completed projects.
-Late submissions will result in an automatic 10-point deduction per day

**Appendix 1**

https://files.nc.gov/dpi/documents/curriculum/mathematics/scos/current/discrete.pdf Discrete Math Standards

https://www.wsfcs.k12.nc.us/Page/5708?_sm_au_=iVVzTP13ftPM2D5F

https://www.wsfcs.k12.nc.us/Page/68605 project website

# Worksheets

## Honors Discrete 6.1 – 6.3 Short Quiz Review Guide

### Hamilton Circuit or Path:

- Provide a **definition** and **Find** them in a graph (Hint: degree 1 and 2)

### Weighted Graph:

- Provide a definition
- Create weighted graph
- Use the weighted graph table
- Find weight of a circuit or path

### Complete Graph:

- Provide a **definition**
- **Properties to calculate**

1) **Vertices = N**
2) **Degree = N – 1**
3) **Edges = N(N – 1)/2**
4) **Distinct Hamilton Circuits = (N – 1)!**

## 6.1 – 6.5 Practice Problems

### Section 6.2: COMPLETE GRAPH Calculations

1) **Find the number of edges, degree of each vertex, and number of Hamilton Circuits in $K_{12}$.**
2) **How many edges does a complete graph of 23 vertices have?**
3) **What is the degree of each vertex in $K_{64}$?**
4) **If degree of each vertex in $K_N$ is 34, how many vertices does the graph have?**

5) **How many vertices does $K_N$ have if it is known to have 703 edges?**
6) **How many vertices does a $K_N$ have if it is known to have 479,001,600 distinct Hamilton Circuits?**

**<u>Section 6.3:</u> Draw a weighted graph for each description.**

**Graph #1**

It takes Joey 10 minutes to bike to the grocery store and bike shop from his home. It takes him 15 minutes to bike to school and only 7 minutes to get to Mark's house from home. Joey doesn't ever go to the bike shop from the grocery store because of traffic. From school it takes him 9 minutes to the grocery store and 13 minutes to the bike shop. He also goes to Mark's house which is only 3 minutes away from school.

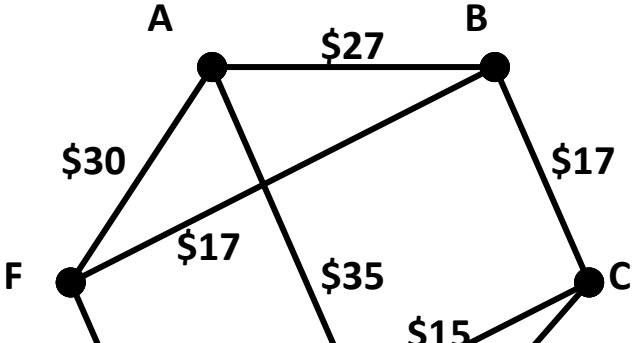
**Graph #2**

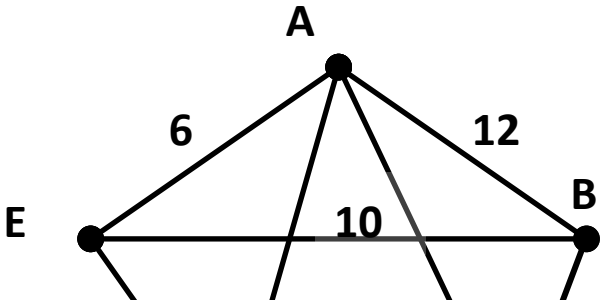
| | A | B | C | D | E |
|---|---|---|---|---|---|
| A | | $9 | $13 | | $4 |
| B | $9 | | | $15 | $8 |
| C | $13 | | | | $11 |
| D | | $15 | | | $3 |
| E | $4 | $8 | $11 | $3 | |

**<u>Section 6.1:</u> Hamilton Circuits and Paths**

**<u>Find the Hamilton circuit for starting at A and its weight.</u>**

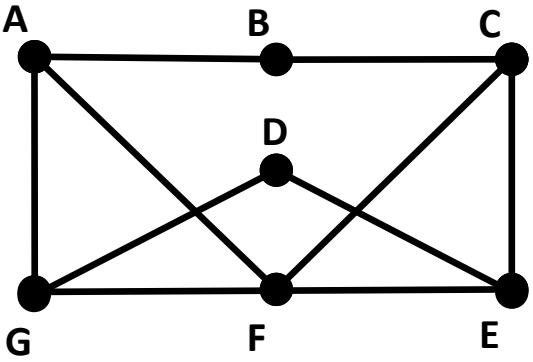
**<u>Find the optimal Hamilton Circuit starting at A.</u>**

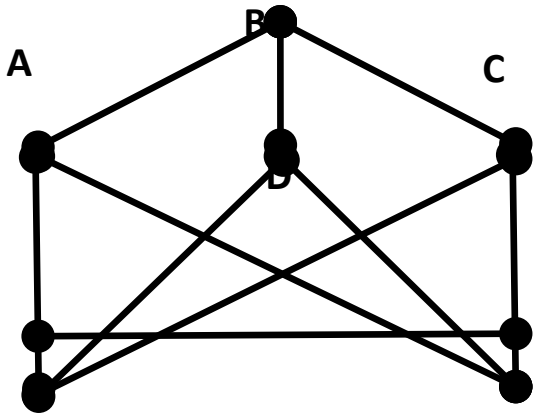


**Find a Hamilton Circuit starting at A, if not possible explain**

**Find at least 2 Hamilton Paths Starting at B and Ending at C.**




## Discrete Chapter 6.1 – 6.3 Short Quiz Review SOLUTIONS

E F

## Section 6.2:

1) **Find the number of edges, degree of each vertex, and number of Hamilton Circuits in $K_{12}$.**
   - **a.** Vertices = 12
   - **b.** Edges = 12*11/2 = 66
   - **c.** Degree of each vertex = 12 – 1 = 11
   - **d.** Number of Hamilton Circuits = (12-1)! = 39,916,800 circuits
     (half are the reverse order of each other)
2) **How many edges does a complete graph of 23 vertices have?**
   - **a.** Vertices = 23
   - **b.** Edges = 23*22/2 = 253
3) **What is the degree of each vertex in $K_{64}$?**
   - **a.** Vertices = 64
   - **b.** Degree of each vertex = 63
4) **If degree of each vertex in $K_N$ is 34, how many vertices does the graph have?**
   - a. Degree = 34
   - b. Vertices = 34 + 1 = 35
5) **How many vertices does $K_N$ have if it is known to have 703 edges?**
   N(N-1)/ 2 = 703 → N(N-1) = 1406
   Square Root Trick: √(1406) = 37.50; Round Up and Down

   **N = 38** and N –1 = 37

**6) How many vertices does a $K_N$ have if it is known to have 479,001,600 distinct Hamilton Circuits?**

Division Method: 479,001,600/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/ 10/ 11 = 12

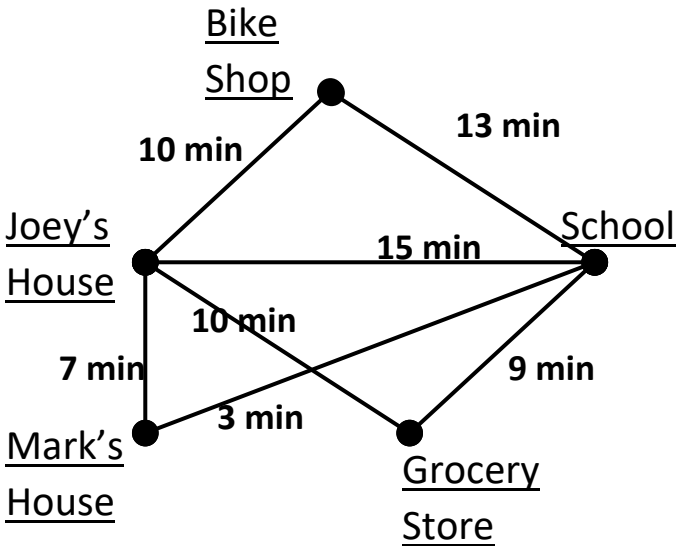
Multiplication Method: 1*2*3*4*5*6*7*8*9*10*11*12= 479,001,600

N – 1 = 12; **N = 13 vertices**

## Section 6.3: Use the following information to create weighted graphs.

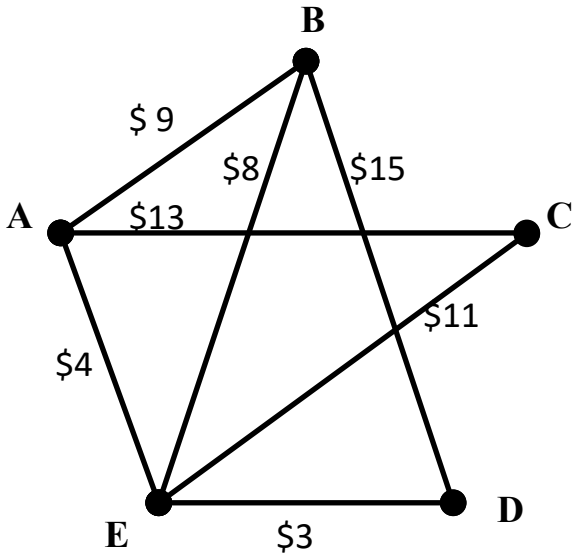
**Graph #1**

It takes Joey 10 minutes to bike to the grocery store and bike shop from his home. It takes him 15 minutes to bike to school and only 7 minutes to get to Mark's house from home. Joey doesn't ever go to the bike shop from the grocery store because of traffic. He from school it takes him 9 minutes to the grocery store and 13 minutes to the bike shop. He often goes to Mark's house after school which is only 3 minutes away.



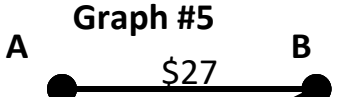

**Graph #2**

| | A | B | C | D | E |
|---|---|---|---|---|---|
| A | | $9 | $13 | | $4 |
| B | $9 | | | $15 | $8 |
| C | $13 | | | | $11 |
| D | | $15 | | | $3 |
| E | $4 | $8 | $11 | $3 | |

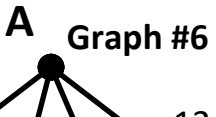



**Find the Hamilton circuit for Brute-Force for starting at A.**

**Graph #5**



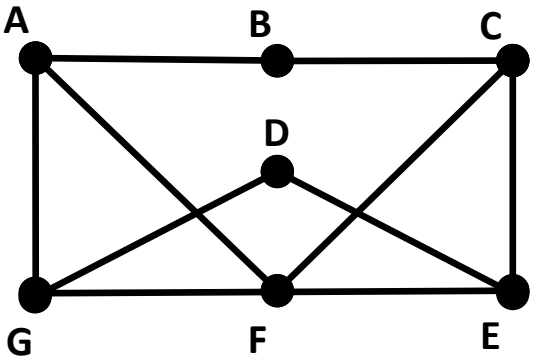

**Graph #6**

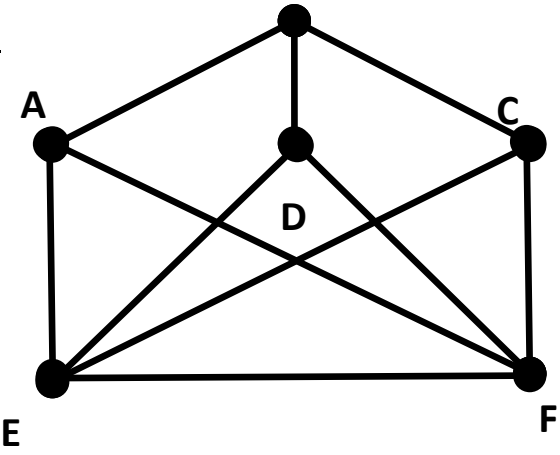


| All Hamilton circuits starting at A | All Hamilton circuits starting at A |
|---|---|
| A – B – C – D – E – F – A | A – B – C – D – E – A |
| A – B – F – E – C – D – A | A – B – E – D – C – A |
| A – F – B – C – E – D – A | A – E – B – C – D – A |
| A – F – E – D – C – B – A (reverse of #1) | A – C – B – E – D –A |
| A – D – C – E – F- B – A (reverse of #2) | A – E – D – C – B – A (reverse of #1) |
| A – D – E – C – B – F – A (reverse of #3) | A – C – D – E – B – A (reverse of #2) |
| | A – D – C – B – E – A (reverse of #3) |
| | A – D – E – B – C – A (reverse of #4) |
| Optimal = smallest total weight | |

**Find 3 Hamilton Circuit starting at A, if not possible explain**

**Find 2 Hamilton Paths Starting at B and Ending at C.**




A, G, D, E, F, C, B, A

A, F, G, D, E, C, B, A

A, B, C, F, E, D, G, A

A, B, C, E, D, G, F, A

B, A, G, D, E, F, C

B, A, F, G, D, E, C

A, B, C, F, D, E, A and A, E, D, F, C, B, A

A, B, C, E, D, F, A and A, F, D, E, C, B, A

A, B, D, F, C, E, A and A, E, C, F, D, B, A

A, B, D, E, C, F, A and A, F, C, E, D, B, A

B, A, E, D, F, C

B, A, F, D, E, C

B, D, E, A, F, C

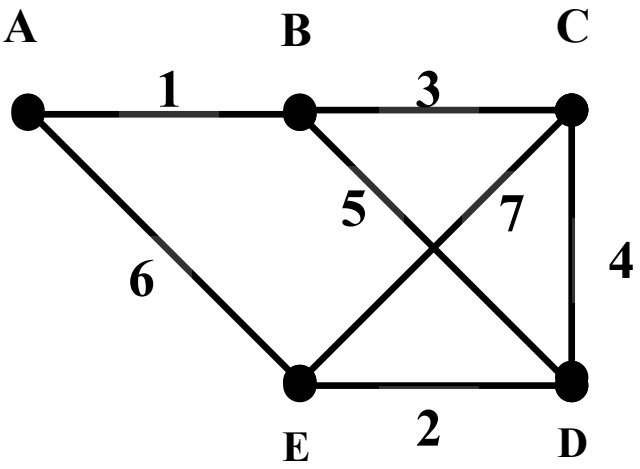
B, D, F, A, E, C

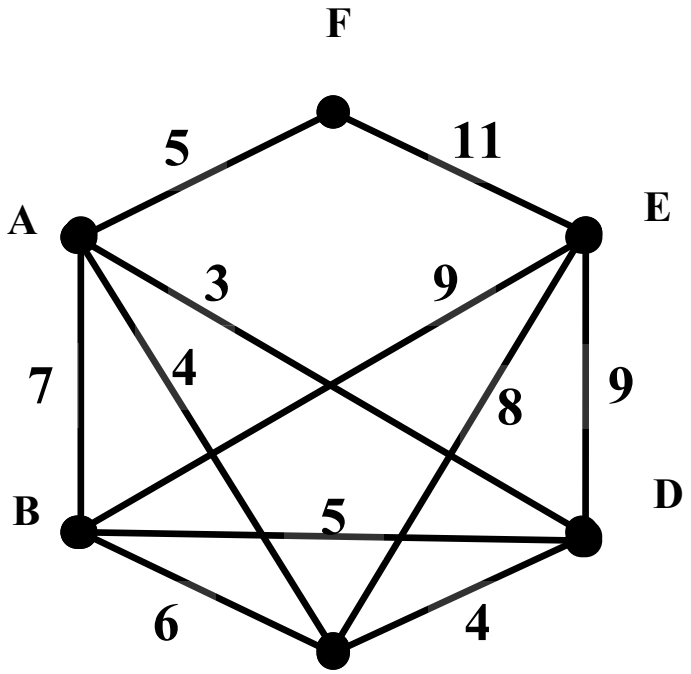
# 6.4 + 6.5 Brute Force/ Nearest Neighbor Algorithm Practice

**For each of the following graphs perform both algorithms:**

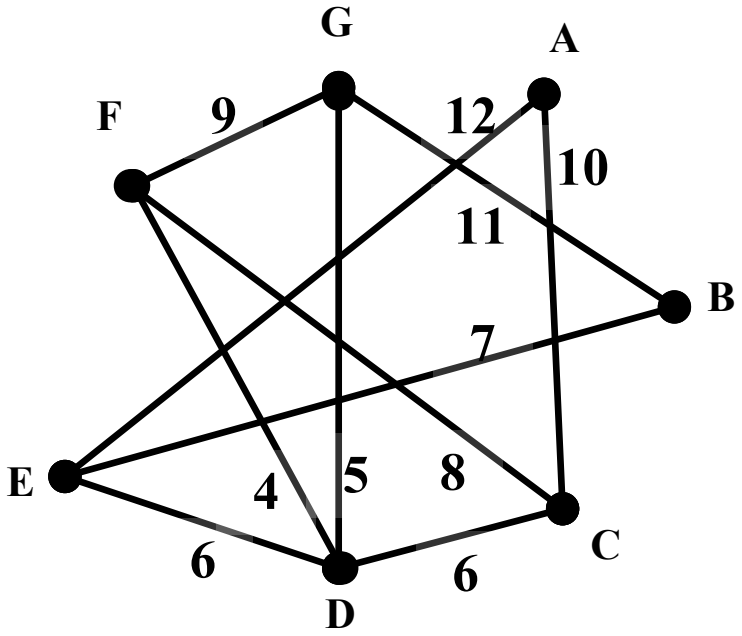
**BRUTE FORCE:** Find ALL Possible Hamilton Circuits Starting at A and Find the SHORTEST TOTAL WEIGHT

**NEAREST-NEIGHBOR:** Find the Hamilton Circuit Starting at A by taking the Shortest Weight to the next vertex (neighbor).



NAME: _____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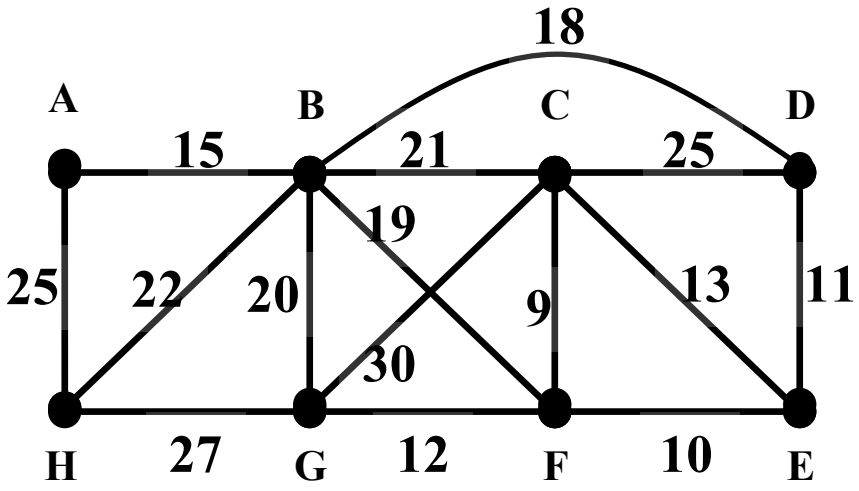
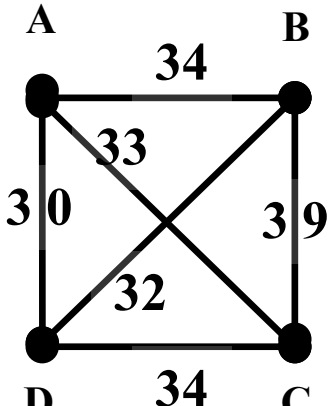
D


18
A
B
C
D
15
21
25
19
25
22
20
9
13
11
30
H
27
G
12
F
10
E

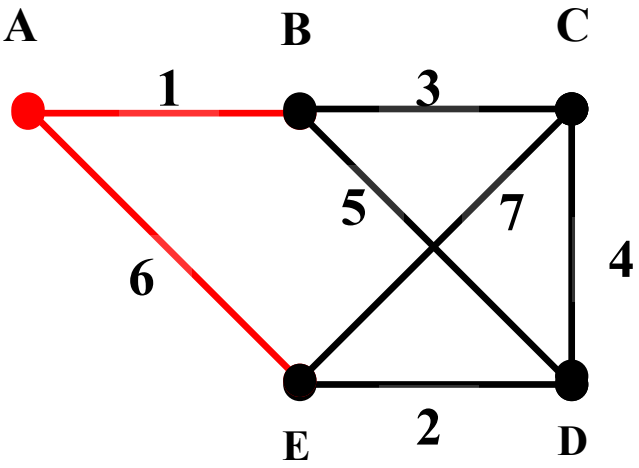

A
B
34
33
30
39
32
34

# 6.4 + 6.5 Brute Force/ Nearest Neighbor Algorithm SOLUTIONS

**For each of the following graphs perform both algorithms:**

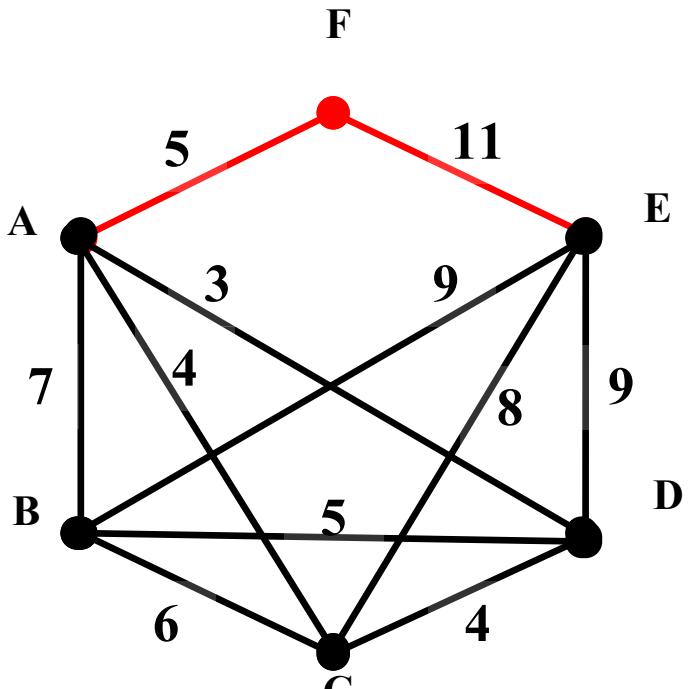
**BRUTE FORCE:** Find ALL Possible Hamilton Circuits Starting at A and Find the SHORTEST TOTAL WEIGHT

**NEAREST-NEIGHBOR:** Find the Hamilton Circuit Starting at A by taking the Shortest Weight to the next vertex (neighbor).




Brute Force:
A, B, C, D, E, A or A, E, D, C, B, A = 16
A, B, D, C, E, A or A, E, C, D, B, A = 23

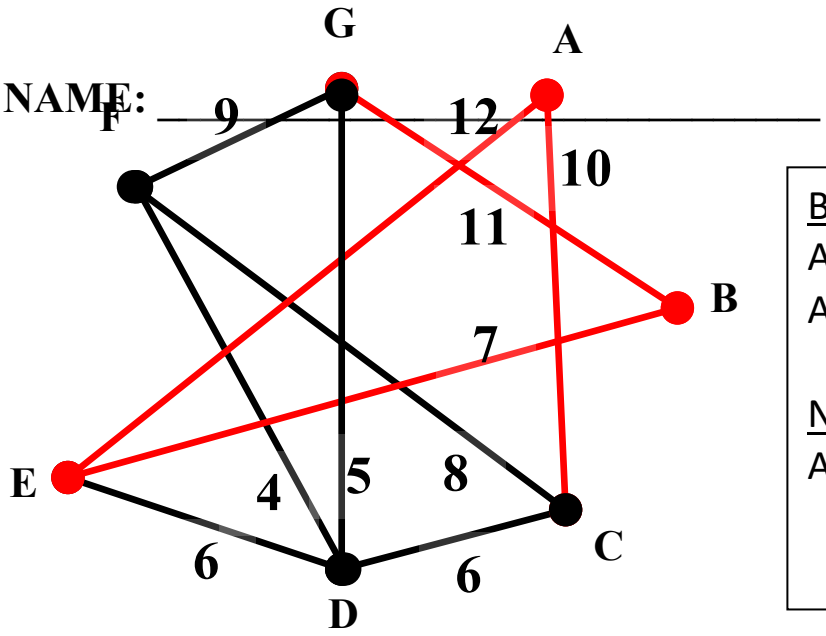
Nearest – Neighbor:
A, B, C, D, E, A = 16




Brute Force:
A, B, C, D, E, F, A = 42
A, B, D, C, E, F, A = 40
A, C, B, D, E, F, A = 40
A, C, D, B, E, F, A = 38
A, D, C, B, E, F, A = 38
A, D, B, C, E, F, A = 38

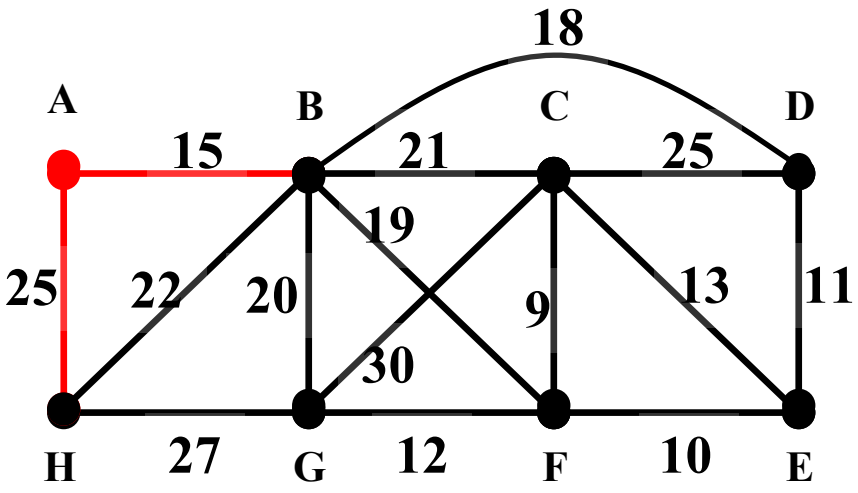
Nearest – Neighbor:
A, D, C, B, E, F, A = 38

NAME: _____



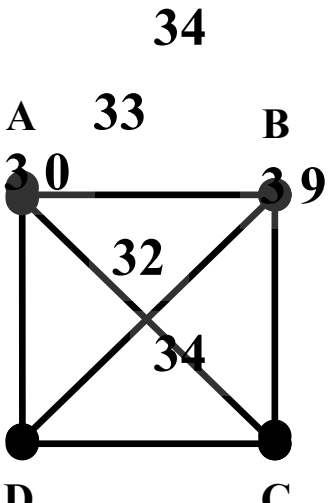

Brute Force:
A, C, D, F, G, B, E, A = 59
A, C, F, D, G, B, E, A = 57

Nearest – Neighbor:
A, C, D, F, G, B, E, A = 59




Brute Force:
A, B, D, E, F, C, G, H, A = 145
A, B, D, C, E, F, G, H, A = 145
A, B, D, E, C, F, G, H, A = 130
A, B, C, D, E, F, G, H, A =146
A, B, F, E, D, C, G, H, A = 162

Nearest – Neighbor:
A, B, D, E, F, C, G, H, A = 145




Brute Force:
A, B, C, D, A = 137
A, B, D, C, A = 133
A, C, B, D, A = 134

Nearest – Neighbor:
A, D, B, C, A = 134

# Lesson Plan

| Honors Discrete Math | | | SMHS WEEKLY LESSON PLAN 11/12-11/15 | | MR.Brown |
|---|---|---|---|---|---|
| 4th block | | | Hamilton Circuits | | |
| **DAY** | **DATE** | **STANDARD** | **OBJECTIVE** | **AGENDA** | **C.F.U** |
| **MO** | 11/11 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Students will understand Brute Force & Nearest Neighbor | 1Warm-up<br>2.Lesson on Brute Force & Nearest Neighbor | Completion of Worksheet |
| **TU** | 11/12 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Students will understand Repetitive Nearest Neighbor | 1Warm-up<br>2.Leson on Repetitive Nearest Neighbor | Completion of Study Guide |
| **WE** | 11/13 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Student will understand the Cheapest Link | 1. Warm-up<br>2. Lesson on the Cheapest Link | Quiz, worksheet and Quizlet live |
| **TH** | 11/14 | The learner will analyze data and apply probability concepts to solve problems: Hamilton Circuit | Work study Guide | 1Warm-up<br>2.Lesson on Hamilton | Completion of worksheet and quizzes |

**Student Resources**

https://www.wsfcs.k12.nc.us/Page/5708?_sm_au_=iVVzTP13ftPM2D5F

The website above have practice problems for students to work. I used this with my students to get practice and they get can check to see how they answered the questions.

https://sites.google.com/a/chccs.k12.nc.us/ms-neill-s-page/home/discrete/chapter-4-apportionment

This is another website I recommend to my students as it has the outline of all the Discrete topics, with examples an practice question an solutions.

**Teacher Resources**

Learning and Assessing Mathematics through Reading and Writing Michael J. Bosse & Johna Faulconer 2009

This book gives information about Reading and Writing in Math, along with the strategies we can use to implement this. It is information packed for us teachers and the benefits of the implementation.

Developing Instructional Guidelines for Elementary Mathematical Writing ( Colonnese M.W. 2017

This article is easy to read although it says for Elementary it can be applied to high schools. This was written by my Seminar leader and I highly recommend it.

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