1) (https://math.libretexts.org/Courses/Angelo_State_University/Finite_Mathematics)
Niki holds two part-time jobs, Job I and Job II. She never wants to work more than a total of 12 hours a week. She has determined that for every hour she works at Job I, she needs 2 hours of preparation time, and for every hour she works at Job II, she needs one hour of preparation time, and she cannot spend more than 16 hours for preparation.
If Nikki makes $40 an hour at Job I, and $30 an hour at Job II, how many hours should she work per week at each job to maximize her income?

2) (https://math.libretexts.org/Courses/Angelo_State_University/Finite_Mathematics)
A factory manufactures two types of gadgets, regular and premium. Each gadget requires the use of two operations, assembly and finishing, and there are at most 12 hours available for each operation. A regular gadget requires 1 hour of assembly and 2 hours of finishing, while a premium gadget needs 2 hours of assembly and 1 hour of finishing. Due to other restrictions, the company can make at most 7 gadgets a day. If a profit of $20 is realized for each regular gadget and $30 for a premium gadget, how many of each should be manufactured to maximize profit?

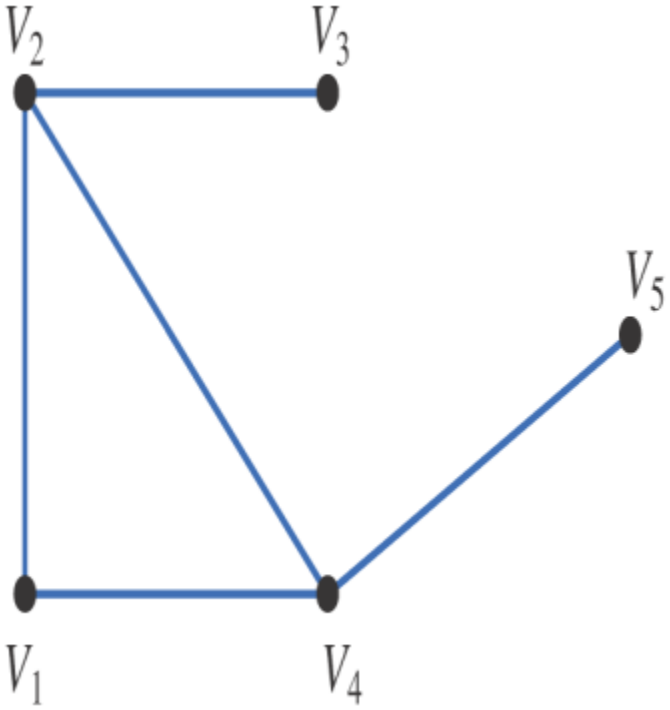
3) (https://math.libretexts.org/Courses/Angelo_State_University/Finite_Mathematics)
The Silly Nut Company makes two mixtures of nuts: Mixture A and Mixture B. A pound of Mixture A contains 12 oz of peanuts, 3 oz of almonds and 1 oz of cashews and sells for $4. A pound of Mixture B contains 12 oz of peanuts, 2 oz of almonds and 2 oz of cashews and sells for $5. The company has 1080 lb. of peanuts, 240 lb. of almonds, 160 lb. of cashews. How many pounds of each of mixtures A and B should the company make to maximize profit?

4) (https://math.libretexts.org/Courses/Angelo_State_University/Finite_Mathematics)
At a university, Professor Symons wishes to employ two people, John and Mary, to grade papers for his classes. John is a graduate student and can grade 20 papers per hour; John earns $15 per hour for grading papers. Mary is an post-doctoral associate and can grade 30 papers per hour; Mary earns $25 per hour for grading papers. Each must be employed at least one hour a week to justify their employment.
If Prof. Symons has at least 110 papers to be graded each week, how many hours per week should he employ each person to minimize the cost?

5) (Linear-algebra-with-applications Page 75)
Nitric acid is prepared commercially by a series of three chemical reactions. In the first reaction, nitrogen (N_2) is combined with hydrogen (H_2) to form ammonia (NH_3). Next, the ammonia is combined with oxygen (O_2) to form nitrogen dioxide (NO_2) and water. Finally, the NO reacts with some of the water to form nitric acid (HNO_3) and nitric oxide (NO). The amounts of each of the components of these reactions are measured in moles (a standard unit of measurement for chemical reactions). How many moles of nitrogen, hydrogen, and oxygen are necessary to produce eight moles of nitric acid?

6) (Linear-algebra-with-applications Page 118)
In a certain town, 30 percent of the married women get divorced each year and 20 percent of the single women get married each year. There are 8000 married women and 2000 single women. Assuming that the total population of women remains constant, how many married women and how many single women will there be after one year? After two years?

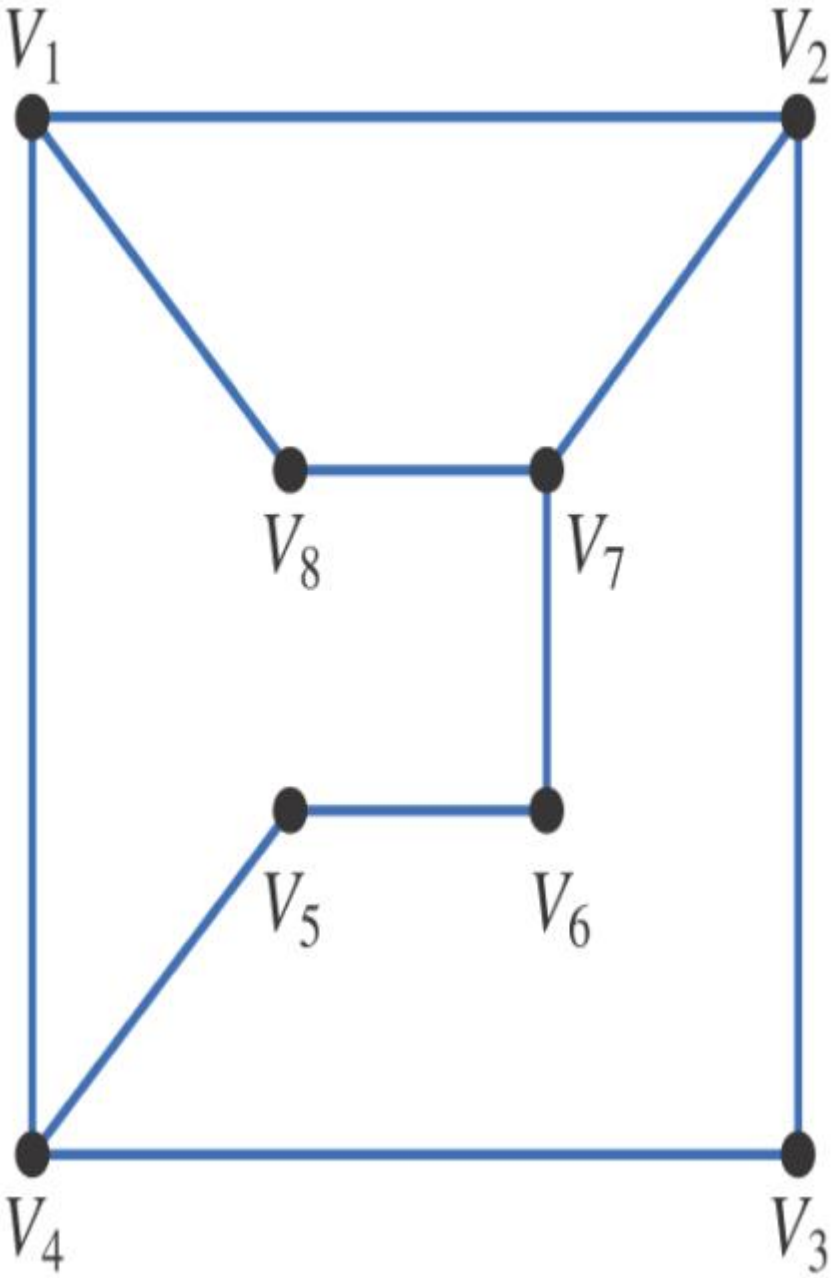
7) (Linear-algebra-with-applications Page 139)
1. Determine the adjacency matrix *A* of the graph.
2. Compute A2. What do the entries in the first row of A2 tell you about walks of length 2 that start from V1?
3. Compute A3. How many walks of length 3 are there from V2 to V4? How many walks of length less than or equal to 3 are there from V2 to V4?
Consider the graph:



8) (Linear-algebra-with-applications Page 182)
1. Determine the adjacency matrix A for the graph and enter it in MATLAB.
2. Compute A2 and determine the number of walks of length 2 from (i) V1 to V7,(ii) V4 to V8, (iii) V5 to V6, and (iv) V8 to V3.
3. Compute A4, A6, and A8 and answer the questions in part (b) for walks of lengths 4, 6, and 8. Make a conjecture as to when there will be no walks of even length from vertex Vi to vertex Vj.

4. Compute A3, A5, and A7 and answer the questions from part (b) for walks of lengths 3, 5, and 7. Does your conjecture from part (c) hold for walks of odd length? Explain. Make a conjecture as to whether there are any walks of length k from Vi to Vj based on whether i + j + k is odd or even.

5. If we add the edges {V3, V6}, {V5, V8} to the graph, the adjacency matrix B for the new graph can be generated by setting B = A and then setting



9) (Linear-algebra-with-applications Page 326)

Suppose that the total population of a large metropolitan area remains relatively fixed; however, each year 6 percent of the people living in the city move to the suburbs and 2 percent of the people living in the suburbs move to the city. If, initially, 30 percent of the population lives in the city and 70 percent lives in the suburbs, what will these percentages be in 10 years? 30 years? 50 years? What are the long-term implications?

10) (https://www.math.purdue.edu/~brown00/LA-app1.pdf)
Three people denoted by P_1, P_2, P_3 intend to buy some rolls, buns, cakes and bread. Each of them needs these commodities in differing amounts and can buy them in two shops S_1, S_2. Which shop is the best for every person P_1, P_2, P_3 to pay as little as possible? The individual prices and desired quantities of the commodities are given in the following tables:
Demanded quantity of foodstuff:

	Roll	Bun	Cake	Bread
P_1	6	5	3	2
P_2	3	6	2	2
P_3	3	4	3	1

Prices in shops S1 and S2:

	S_1	S_2
Roll	1.5	1
Bun	2	2.5
Cake	5	4.5
Bread	16	17

11) (https://www.math.purdue.edu/~brown00/LA-app1.pdf)
To encode a short message a number can be assigned to each letter of the alphabet according to a given table. The text as a sequence of numbers will be organized into a square matrix A; in the case that the number of letters is lower than the number of elements of the matrix A, the rest of the matrix can be filled with zero elements. Let a nonsingular square matrix C be given. To encode the text the matrix A can be multiplied by the matrix C for example on the left. Let the following table and the matrix C be given:
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
8 7 5 13 9 16 18 22 4 23 11 3 21 1 6 15 12 19 2 14 17 20 25 24 10 26

$$C = \begin{pmatrix} 2 & 0 & 1 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

12) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/GraphTheory/GraphTheory_9_17/node14.html)
Three people (denoted by P1, P2, P3) organized in a simple closed society produce three commodities z1, z2, z3. Each person sells and buys from each other. All their products are

consumed by them, no other commodities enter the system (the ”closed model”). The proportions of the products consumed by each of P1, P2, P3 are given in the following table:

	Z1	Z2	Z3
P1	0.2	0.2	0.3
P2	0.1	0.7	0.2
P3	0.3	0.1	0.5

For example, the first column lists that 60% of the produced commodity z1 are consumed by P1, 10% by P2 and 30% by P3. Thus, it is obvious that the sum of elements in each column is equal to 1.

13) (https://topicsoneconom-bizmanagemt.com/images/WSEBM/WSEBM015.pdf)
To ensure sufficient cash for payment, a financial company set up 54 million in A and B companies. The total amount of funds should be the same settlement since it can be used at ordinary time. After a long period of time, we found that majority of the company’s payment funds still kept within each separated company [3]. A company paid 12% funds to B company, and B company paid 10% funds to A company. The initial funds of the two companies are 28 million yuan and 26 million yuan, respectively. How about the amount of the fund? If a financial experts believe that each company's payment fund cannot be less than 24 million, do you need to mobilize other funds if necessary?

14) (https://topicsoneconom-bizmanagemt.com/images/WSEBM/WSEBM015.pdf)
There are three important enterprises in one area, namely coal mine, power plant and local railway. The coal that is mined for 1 yuan of coal the company needs to pay 0.25 yuan of electricity and 0.25 yuan of transportation fee. Power plant that produces 1 yuan of electricity needs to pay 0.65 yuan for coal, 0.05 yuan for electricity and 0.05 transportation costs. For 1 yuan profits the railway company shall pay 0.55-yuan coal and 0.1 yuan electricity In a certain week, the coal mine received an order of 50000 yuan, and the power plant received an order of 25,000 yuan. There was no demand for local railway. What are the total output value of the three enterprises to meet their own and external needs? How much will the three companies pay to each other? How much value will each of the three companies create?

15) (https://topicsoneconom-bizmanagemt.com/images/WSEBM/WSEBM015.pdf)
The total cost of A, B, C, and D products of the A company is listed in the table 2. What is the unit cost of each product?

Table 2: Four test assemblies of four products

batch	Product (kg) *A*	*B*	*C*	*D*	Total cost (yuan)
First batch production	2000	1000	1000	500	29000
Second batch production	5000	2500	2000	1000	70500
Third batch production	1000	400	400	200	13600

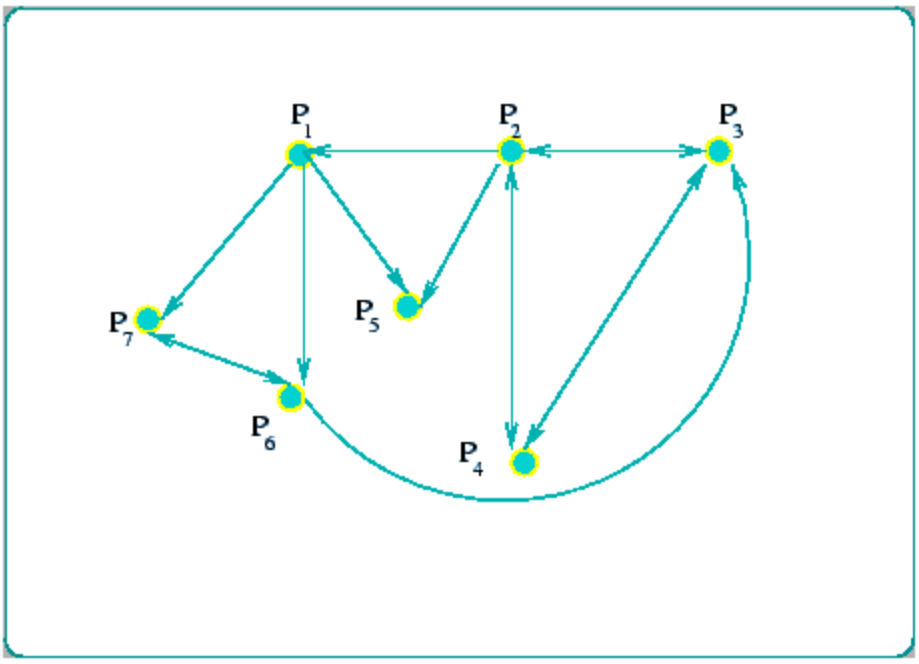
16) (https://topicsoneconom-bizmanagemt.com/images/WSEBM/WSEBM015.pdf)
The profits of four merchandise within four months is listed in table 3. What is the profit for each merchandise?

In time	Sales (1000 yuan)				Profit (1000 yuan)
	rice	alcohol	oil	flour	
1	500	400	600	1200	160
2	400	200	1000	1600	170
3	320	600	800	1500	180
4	600	500	1000	1000	190

17) (https://topicsoneconom-bizmanagemt.com/images/WSEBM/WSEBM015.pdf)
The sales status of a stationery store sells stationery is listed in table 4. What is income of this store every day and the total amount in one week?

stationery	week Monday	Tuesday	Wednesday	Thursday	friday	Saturday	Sunday	Unit price (yuan)
Pencil (branch)	20	25	15	18	22	40	36	0.5
Exercise books (books)	30	18	24	23	26	55	40	0.4
Eraser(block)	15	8	6	10	5	22	30	0.3
Math kit (set)	4	3	6	5	2	10	9	4.5

18) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/GraphTheory/GraphTheory_9_17/node13.html)



consider the following directed graph.

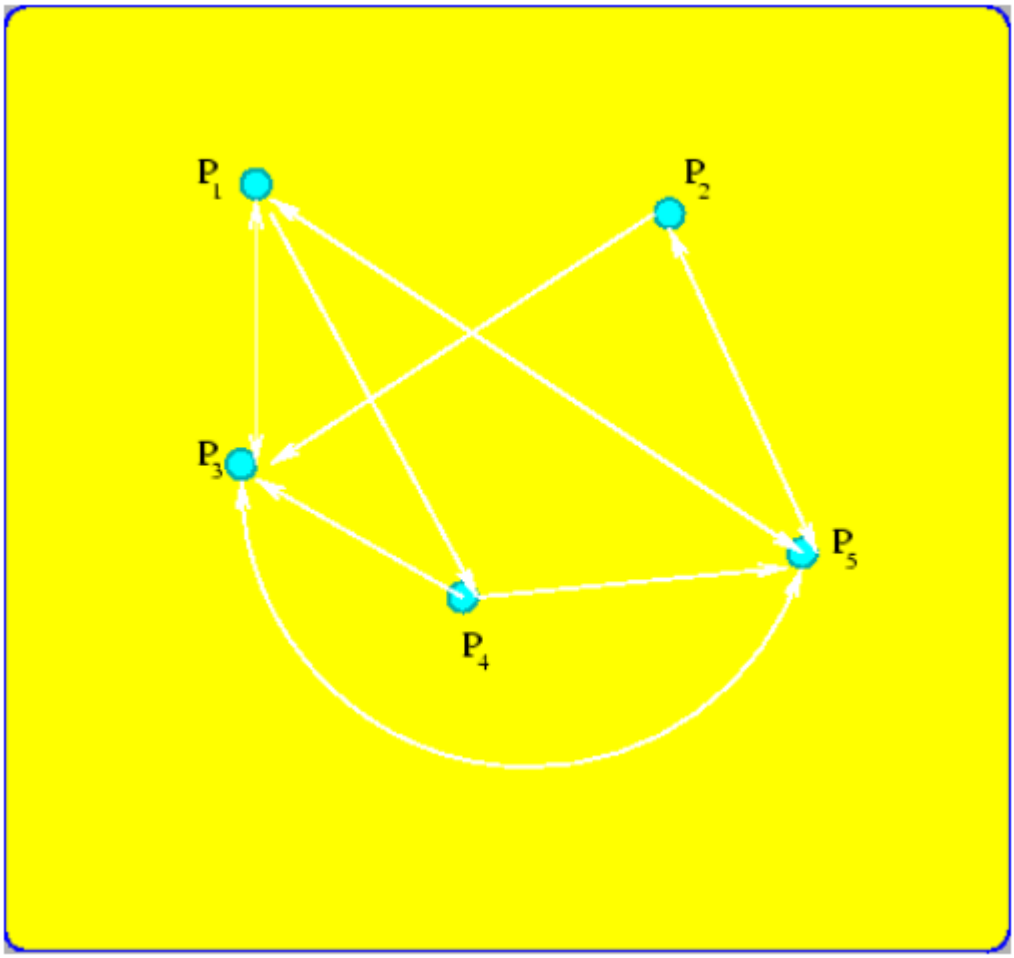
a) Find the vertex matrix of g.
b) Find the number of all paths of length 3.
c) Is the graph connected?
d) Find all paths of length 6 from $P_7 \rightarrow P_6$.

e) Find the number of all 4 step connections from P_1 to P_3.

f) Find all cliques of the graph g.
g) Is g a tournament graph?

19) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/GraphTheory/GraphTheory_9_17/node14.html)

consider the following directed graph.



a) Draw a diagram corresponding to the following vertex matrix.

$$\begin{bmatrix} 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 \end{bmatrix}$$

b) Find all paths of length 3 from P_4 to P_2.

c) Is the graph connected?

d) Find all the loops of link 4 from P_4 to P_4.

e) Find the number of all 4 step connections from P_1 to P_2.

f) Find all cliques of the graph g.

g) Is g a tournament graph?

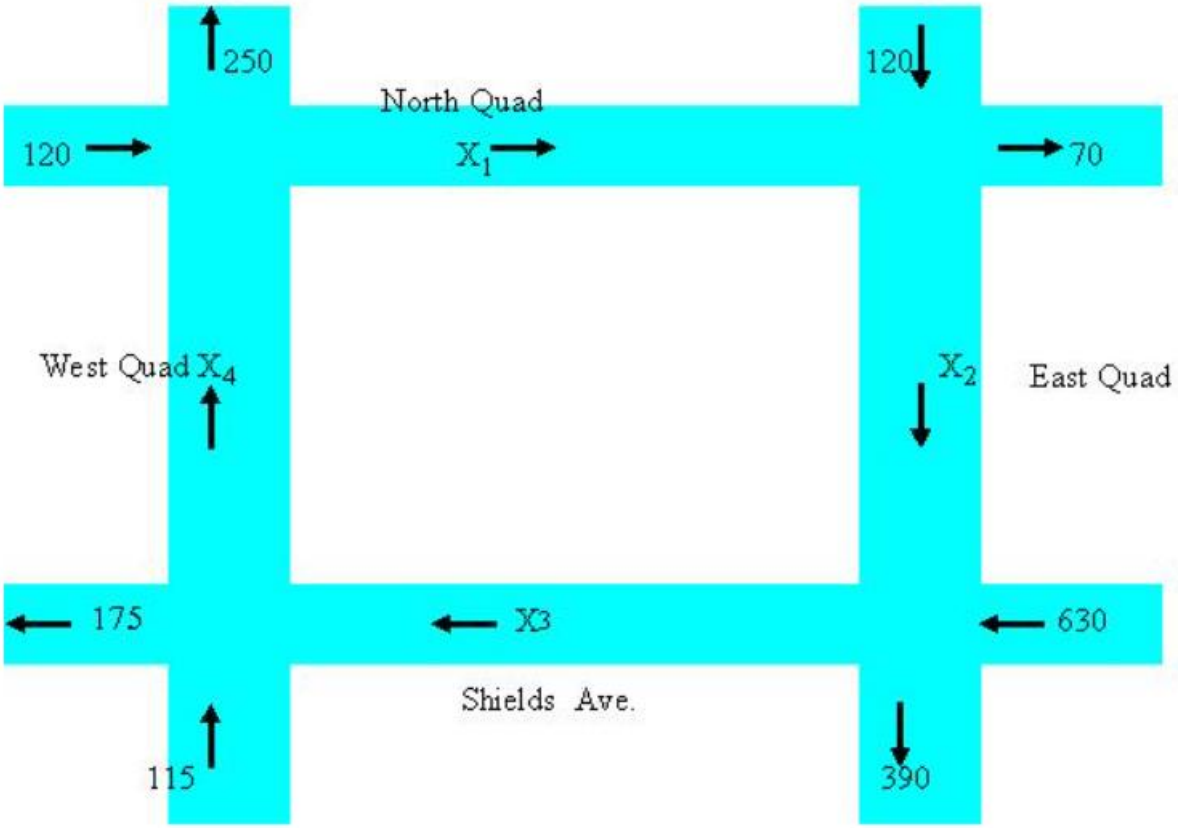
20) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/Genetics/genetics/node6.html)
In a freshman class of a college, there are 200 mathematics major students and 350 biology majors. Every year some math students think that genetics is fun, therefore, they are changing their majors to biology. Meanwhile, some biology students fall in love with math, therefore, they change their major to mathematics. The probability of a student staying in math is 0.92, and the probability of changing from biology to math is 0.04. Assuming that the change of major happens only between these two majors, answer the following questions:
a) What is the transition matrix?
b) How many of the students of this class are math majors in sophomore year?
c) How many of the students of this class will a biology senior ?

21) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/Genetics/genetics/node8.html)
In the previous problem, our product A3X0 is not a whole number, it may due to the multiplication of A3 therefore, we apply different method, in solving the following problems. Assume that in a group of 550 people, 200 are interested in mathematics and 350 are interested in biology. Every year 8 % of Mathematics fan change their heart to biology and only 4 % of Biology lovers change their heart to mathematics.
a) How many of these people are interested in mathematics 15 years later?
b)How many of these people are interested in biology after 20 years ?

22) (https://math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/cryptography/cryptograph_9_17/node10.html)
Decode the message KNOXAOJX given that it is a Hill cipher (based on matrix transformation) with enciphering matrix $\begin{pmatrix} 4 & 1 \\ 3 & 2 \end{pmatrix}$

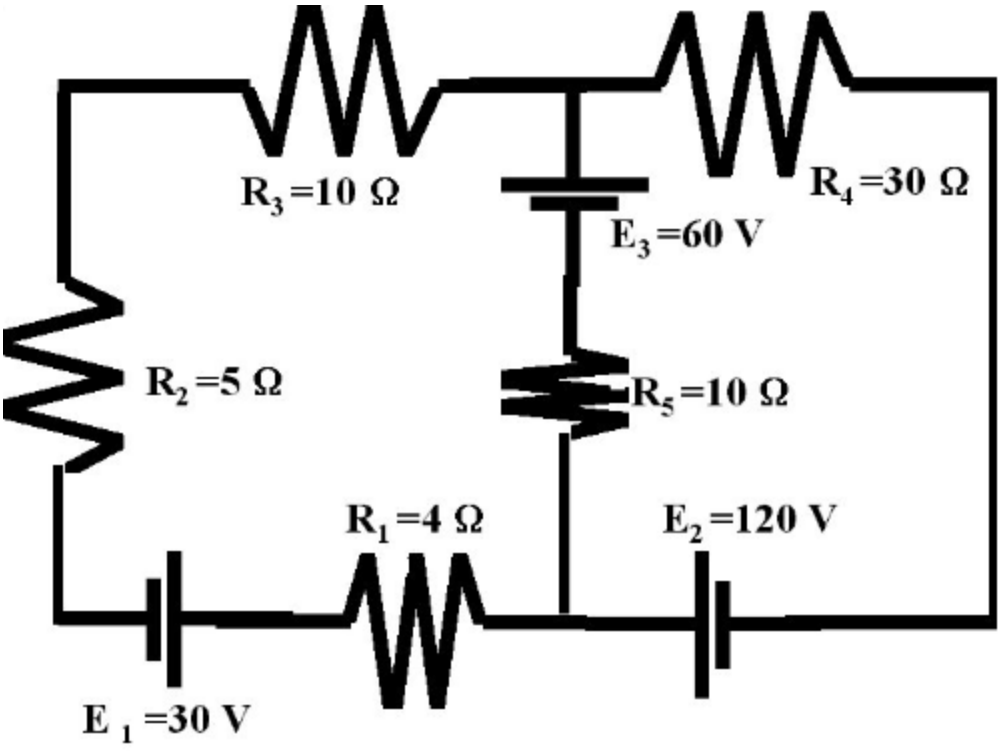
23) (https://math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/cryptography/cryptograph_9_17/node14.html)
Decode the following massage using the standard conversion table and the matrix B = $\begin{pmatrix} 2 & 3 & 2 \\ 1 & 4 & 2 \\ 5 & 2 & 3 \end{pmatrix}$

24) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/trafic_flow/trafic_flow.html)
The following diagram shows part of the central section of UC Davis campus. Assume that the streets are one way, and that the average number of bikes entering and leaving this section during the 10 minutes breaks between classes is given in the chart. Find the amount of the trafficking between each of four intersection .



25) (https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/Electrical_Circuits/Electrical_Circuits.html)

Find the currents in the circuit for the following network.

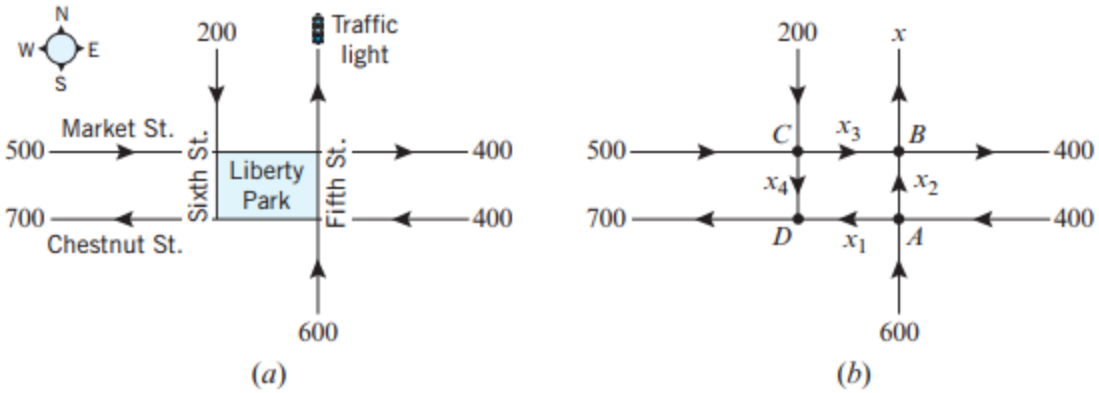


26) (Elementary-Linear-Algebra-Applications Page 99)

The network in Figure 1.9.3 shows a proposed plan for the traffic flow around a new park that will house the Liberty Bell in Philadelphia, Pennsylvania. The plan calls for a computerized traffic light at the north exit on Fifth Street, and the diagram indicates the average number of vehicles per hour that are expected to flow in and out of the streets that border the complex. All streets are one-way.

(a) How many vehicles per hour should the traffic light let through to ensure that the average number of vehicles per hour flowing into the complex is the same as the average number of vehicles flowing out?

(b) Assuming that the traffic light has been set to balance the total flow in and out of the complex, what can you say about the average number of vehicles per hour that will flow along the streets that border the complex?



27) (Elementary-Linear-Algebra-Applications Page 104)

Balance the chemical equation

$$HCl + Na_3PO_4 \longrightarrow H_3PO_4 + NaCl$$

[hydrochloric acid] + [sodium phosphate] ⟶ [phosphoric acid] + [sodium chloride]

28) (Elementary-Linear-Algebra-Applications Page 106)

Find a cubic polynomial whose graph passes through the points

*(*1, 3*), (*2, -2*), (*3, -5*), (*4, 0*)*

29) (Elementary-Linear-Algebra-Applications Page 107)

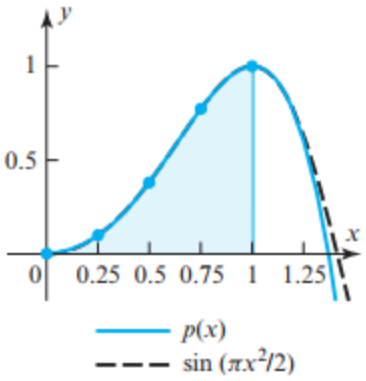
There is no way to evaluate the integral

$$f(x) = \int_0^1 \sin\frac{\pi x^2}{2}\mathrm{dx}$$

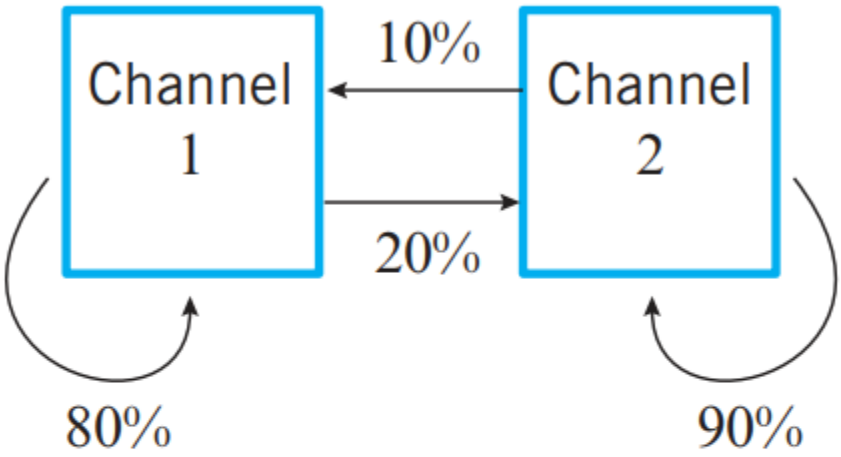
directly since there is no way to express an antiderivative of the integrand in terms of elementary functions. This integral could be approximated by Simpson's rule or some comparable method, but an alternative approach is to approximate the integrand by an interpolating polynomial and integrate the approximating polynomial. For example, let us consider the five points

$x_0 = 0$, $x_1 = 0.25$, $x_2 = 0.5$, $x_3 = 0.75$, $x_4 = 1$

that divide the interval [0, 1] into four equally spaced subintervals (Figure).



30) (Elementary-Linear-Algebra-Applications Page 346)
Suppose that two competing television channels, channel 1 and channel 2, each have 50% of the viewer market at some initial point in time. Assume that over each one-year period channel 1 captures 10% of channel 2's share, and channel 2 captures 20% of channel 1's share (see Figure). What is each channel's market share after one year?



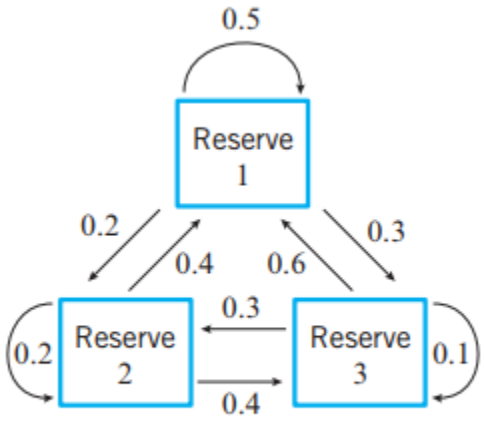
Channel 1 loses 20% and holds 80%.
Channel 2 loses 10% and holds 90%.

31) (Elementary-Linear-Algebra-Applications Page 347)
Track the market shares of channels 1 and 2 in problem 29 over a five-year period.

32) (Elementary-Linear-Algebra-Applications Page 350)

Suppose that a tagged lion can migrate over three adjacent game reserves in search of food, reserve 1, reserve 2, and reserve 3. Based on data about the food resources, researchers conclude that the monthly migration pattern of the lion can be modeled by a Markov chain with transition matrix

$$P = \begin{array}{c} \text{Reserve at time } t = k \\ \begin{matrix} 1 & 2 & 3 \end{matrix} \\ \begin{bmatrix} 0.5 & 0.4 & 0.6 \\ 0.2 & 0.2 & 0.3 \\ 0.3 & 0.4 & 0.1 \end{bmatrix} \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} \end{array} \quad \text{Reserve at time } t = k + 1$$



▲ Figure 5.5.3

(see Figure 5.5.3). That is,
p_{11} = 0.5 = probability that the lion will stay in reserve 1 when it is in reserve 1
p_{12} = 0.4 = probability that the lion will move from reserve 2 to reserve 1
p_{13} = 0.6 = probability that the lion will move from reserve 3 to reserve 1
p_{21} = 0.2 = probability that the lion will move from reserve 1 to reserve 2
p_{22} = 0.2 = probability that the lion will stay in reserve 2 when it is in reserve 2
p_{23} = 0.3 = probability that the lion will move from reserve 3 to reserve 2
p_{31} = 0.3 = probability that the lion will move from reserve 1 to reserve 3
p_{32} = 0.4 = probability that the lion will move from reserve 2 to reserve 3
p_{33} = 0.1 = probability that the lion will stay in reserve 3 when it is in reserve 3
Assuming that t is in months and the lion is released in reserve 2 at time t = 0, track its probable locations over a six-month period.

33) (Elementary-Linear-Algebra-Applications Page 545)
An astronomer who wants to determine the orbit of an asteroid about the Sun sets up a Cartesian coordinate system in the plane of the orbit with the Sun at the origin. Astronomical units of measurement are used along the axes (1 astronomical unit = mean distance of Earth to Sun = 93 million miles). By Kepler's first law, the orbit must be an ellipse, so the astronomer makes five observations of the asteroid at five different times

and finds five points along the orbit to be
*(*8.025*,* 8.310*), (*10.170*,* 6.355*), (*11.202*,* 3.212*), (*10.736*,* 0.375*), (*9.092*,* -2.267*)*
Find the equation of the orbit.

34) (Elementary-Linear-Algebra-Applications Page 562)
The density of water is well known to reach a maximum at a temperature slightly above freezing. Table 2, from the *Handbook of Chemistry and Physics* (CRC Press, 2009), gives the density of water in grams per cubic centimeter for five equally spaced temperatures from -10◦C to 30◦C. We will interpolate these five temperature–density measurements with a parabolic runout spline and attempt to find the maximum density of water in this range by finding the maximum value on this cubic spline. In the exercises we ask you to perform similar calculations using a natural spline and a cubic runout spline to interpolate the data points.

Table 2

Temperature (°C)	Density (g/cm^3)
−10	.99815
0	.99987
10	.99973
20	.99823
30	.99567

35) (Elementary-Linear-Algebra-Applications Page 591)
The federal government desires to inoculate its citizens against a certain flu virus. The virus has two strains, and the proportions in which the two strains occur in the virus population is not known. Two vaccines have been developed and each citizen is given only one of them. Vaccine 1 is 85% effective against strain 1 and 70% effective against strain 2. Vaccine 2 is 60% effective against strain 1 and 90% effective against strain 2. What inoculation policy should the government adopt?

36) (Elementary-Linear-Algebra-Applications Page 598)
A town has three main industries: a coal-mining operation, an electric power-generating plant, and a local railroad. To mine $1 of coal, the mining operation must purchase $.25 of electricity to run its equipment and $.25 of transportation for its shipping needs. To produce $1 of electricity, the generating plant requires $.65 of coal for fuel, $.05 of its own electricity to run auxiliary equipment, and $.05 of transportation. To provide $1 of transportation, the railroad requires $.55 of coal for fuel and $.10 of electricity for its auxiliary equipment. In a certain week the coal-mining operation receives orders for $50,000 of coal from outside the town, and the generating plant receives orders for $25,000 of electricity from outside. There is no outside demand for the local railroad. How much must each of the three industries produce in that week to exactly satisfy their own demand and the outside demand?

37) (https://math.libretexts.org/Bookshelves/Applied_Mathematics/Applied_Finite_Mathematics_(Sekhon_and_Bloom)/02%3A_Matrices/2.06%3A_Applications__Leontief_Models)
We assume that in a village there is a farmer, carpenter, and a tailor, who provide the three essential goods: food, shelter, and clothing. Suppose the farmer himself consumes 40% of the food he produces, and gives 40% to the carpenter, and 20% to the tailor. Thirty percent of the carpenter's production is consumed by himself, 40% by the farmer, and 30% by the carpenter. Fifty percent of the tailor's production is used by himself, 30% by the farmer, and 20% by the tailor. Write the matrix that describes this closed model.