Institute of Information Technology, University of Dhaka
Bachelor of Science in Software Engineering
STAT 1203: Statistics for Engineers II
1st Year 2nd Semester Final Examination 2023

Marks: 60 **Time: 3 Hours**

Professionalism Excellence Respect

Answer any **FIVE(5)** *of the following questions.*

1. (a) What is the p-value of a test? A population distribution is known to have standard deviation 20. We want to test the hypothesis that the population mean is equal to 50 against it is not equal to 50. Determine the p-value of a test if the average of a sample of 68 observations are (i) 52.5 and (ii) 57.5. [6]

   (b) Sample weights (in pounds) of newborn babies born in two adjacent cities in the western USA yielded the following data: [6]

   $$\text{City } 1 : n = 53,\ \bar{x} = 6.8,\ s^2 = 5.2$$
   $$\text{City } 2 : m = 44,\ \bar{y} = 7.2,\ s^2 = 4.9.$$

   Consider a test of the hypothesis that the mean weight of newborns is the same in both cities. Interpret the decision of the test.

2. (a) What is the power of a test? Calculate the power of the test $H_0 : \mu_0 = 8$, for $n = 5$, $H_1 : \mu = 10$, $\alpha = 0.05$, and $\sigma = 2$. [4]

   (b) What role does decision criterion play in a hypothesis test? [3]

   (c) A producer specifies that the mean lifetime of a certain type of battery is at least 240 hours. A sample of 18 such batteries yielded the following data. [5]

   237, 242, 232, 242, 248, 230, 244, 243, 254, 262, 234, 220, 225, 236, 232, 218, 228, 240

   Assuming that the life of the batteries is approximately normally distributed. Define null and alternative hypotheses to test whether specifications are being met. Use a 5 percent level of significance to test the hypothesis.

3. (a) Describe two real-life scenarios using two independent and paired samples t-tests. [2]

   (b) Derive the test statistic for testing the equality of two means of two independent normal populations when population variances are unknown and assumed equal. [5]

   (c) To determine the efficacy of aspirin in preventing heart attacks, 22000 healthy middle-aged men were randomly divided into two equal groups, one of which was given a daily dose of aspirin and the other a placebo. The experiment was halted at a time when 104 men in the aspirin group and 189 in the control group had heart attacks. (i) Define two distributions for the variables of interest for the aspirin and placebo groups. (ii) Define the null and alternative hypotheses to examine whether aspirin has any effect on reducing heart attacks and perform the test. [5]

4. (a) Describe a simple linear regression model with appropriate notations and necessary assumptions. How would you connect a simple linear regression model with the problem of comparing the means of two populations? [5]

   (b) What is the ordinary least square estimation procedure? Obtain the expressions of parameter estimates of simple linear regression model using ordinary least square method of estimation. [5]

   (c) Express a simple linear regression model in matrix notation. [2]

5. (a) Obtain the expression of the standard error of the estimate of the slope of a simple linear regression model. Describe a test procedure to test the significance of the slope parameter. [6]

(b) A recent study attempted to relate job satisfaction to years on the job using a random sample of 9 city corporation workers. The job satisfaction the value given to each worker is his or her assessment of such, with a score of 1 being the lowest and ten being the highest.

years on the job	:	8	4	12	9	16	14	10	15	22
job satisfaction	:	5.6	6.3	6.8	6.7	7.0	7.7	7.0	8.0	7.8

(i) Consider a regression model for job satisfaction on years on the job and estimate the model parameters. (ii) Interpret the estimates of the model parameters. (iii) What is the estimated job satisfaction of an employee who has spent five years on the job?

6. (a) Three standard chemical procedures are used to determine the magnesium content in a certain chemical compound. Each procedure is used four times on a given compound with the following data resulting.

Method		
1	2	3
76.42	80.41	74.2
78.62	82.26	72.68
80.40	81.15	78.84
78.20	79.20	80.32

With appropriate notations, suggest a model for comparing the equality of three methods and state the associated null and alternative hypotheses. Construct the ANOVA table associated with the the null hypothesis of equality of three methods.

(b) What do you understand by expected frequency? How would you estimate expected frequency from a contingency table?

(c) An experiment designed to study the relationship between hypertension and cigarette smoking yielded the following data.

	Nonsmoker	Moderate smoker	Heavy smoker
Hypertension	30	38	28
No hypertension	60	27	18

Test the hypothesis that whether or not an individual has hypertension is independent of how much that person smokes.

7. (a) Explain the differences between parametric and nonparametric methods, especially in the context of estimating cumulative distribution function.

(b) Consider a fitted regression model $\hat{y} = 12 + 0.5x_1 + 1.75x_2$, where y is the midterm mark, x_1 is the time (in hours) spent on study per week, and x_2 is a binary variable ($x_2 = 0$ for male and $x_2 = 1$ for female). Interpret the estimates of model parameters and estimate the midterm mark for a male student who usually studies three hours per week.

(c) Describe the Kolmogorov-Smirnov fit test for continuous data.

Institute of Information Technology
University of Dhaka
Bachelor of Science in Software Engineering (BSSE)
2nd Semester Final Examination, 2023
CSE 1211: Computer Organization
Marks: 60 # Time: 3 Hours

Professionalism Excellence Respect

[Answer any 5 of the following questions.]

1. a. Pictorially explain the structure of Magnetic HDD. 5

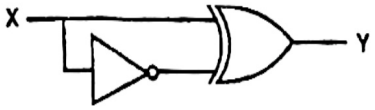
   b. Explain the components of a computer system with relevant figure. 5

   c. What are the main differences between a multi-processor system and a multi-computer system? 2

2. a. Define electronic logic gates. Draw the symbols of basic logic gates and show their truth table (AND, OR, NAND, XOR, XNOR). 5

   b. List the name of the universal logic gates. With the help of Boolean Algebra, justify why they are called universal logic gates. 5

   c. Determine the output of the following logic circuit. 2



3. a. What do you mean by combinational logic circuit? Briefly describe the following with necessary figures. 8
      i. AND-OR and NAND network
      ii. OR-AND and NOR network

   b. Explain half adder circuit with figure. 4

4. a. Define decoder. Explain detail of the decoder circuit for two-bit parallel active high active low, and alternative structure. 5

   b. Explain the implementation of logic functions using decoders. 4

   c. Simplify the following expression: 3

      $(A + B)(A + C)$

5. a. What is computer instruction? Describe the core differences between 32-bit and 64-bit processor architecture. 5

   b. Write short notes on SR-flip-flop and latch. 5

   c. Does pipelining improve the latency of individual instructions? Explain. 2

6. a. Define numbering system. What are the different types of numbering systems? Convert the following numbers $(123)_{10}$ to $(\ )_2$, $(\ )_8$, $(\ )_{16}$ and $(101111.101)_2$ to $(\ )_8$, $(\ )_{10}$, $(\ )_{16}$ 5

   b. Contrast DRAM and SRAM. How many types of BUS are in the computer system? Describe their roles and interactions with each other with proper diagram. 5

   c. Explain the difference between static RAM and dynamic RAM. 2

7. a. Define Flip-flop. Explain details the masters slave SR Flip-Flop. 5

   b. Define IC (Integrated Circuit). Draw the pin configuration of Hex AND, OR, and Inverter. 4

   c. Explain the roles of compiler, interpreter, and assembler. 3

IIT

Institute of Information Technology
University of Dhaka
GE 1212: Bangladesh Studies
1st year 2nd Semester Final Examination, 2023
Marks 60 # Time: 3 hours

Professionalism Excellence Respect

[Answer any **five** out of seven questions. When answering a question, please answer all the subsections of it at once]

1. a. What was the status of education in the British era and what educational institutions (name two universities and at least five colleges from the Bengal) were established during the British era in India? 4

   b. How were the following sectors of East India Company (EIC) developed in British India? 6

   i) Economy, ii) Government, iii) Waterways, iv) Infrastructure and transport.

   c. How did the East India Company (EIC) come to India and when did they start direct ruling of India? 2

2. a. Describe the reasons for the establishment of Pakistan. 2

   b. Briefly discuss the following persons' roles on the occasions where they have contributed to their nation. 2.5 ×4 =10

   i. Nawab Sir Khwaja Salimullah Bahadur
   ii. Sher-e-Bangla A. K. Fazlul Huq
   iii. Huseyn Shaheed Suhrawardy
   iv. Abdul Hamid Khan Bhashani

3. a. What is the six-point program of Bangabandhu Sheikh Mujibur Rahman? Do you think they are the foundation of our independence in 1971? 6

   b. What do you know about the Agartala Conspiracy case? Why Bangabandhu is imprisoned for this case? 6

4. a. Our freedom fighters achieved victory for our country through a 9-month war which is known as the "war of independence". Briefly discuss the major events that happened during this war including Operation Searchlight, declaration of war, dividing sectors, freedom fighters training, refuge seeking in India, Mujibnagar Government, and instrument of surrender. 8

   b. Briefly describe the gallantry awards of the Liberation War 1971 of Bangladesh. 4

5. a. What do you know about the vision 2041? What are the goals Bangladesh would like to achieve by 2041? 4

   b. Define government. Briefly discuss the three branches of government. 4

   c. Briefly discuss the origin of the Bengali Language. 4

6. a. What do you know about the demographics of Bangladesh? 4

   b. What is climate change? How does it affect the environment? 6

   c. *Briefly discuss the causes of flooding in Bangladesh and measures to be taken to limit the destruction.* 3

7. *Briefly discuss the poverty issue in Bangladesh. How Bangladesh is improving the national poverty line? What are the major causes of rural and urban poverty? What are the environmental problems related to poverty? What are the government's actions to reduce poverty? Write the implications of poverty in Bangladesh.* 3 2x6 =12

Institute of Information Technology
University of Dhaka
Bachelor of Science in Software Engineering (BSSE)
1st Year 2nd Semester Final Examination, 2023
SE 1206: Object Oriented Concepts
Marks: 60 Time: 3 Hours

Professionalism *Excellence* *Respect*

[Answer any **5 (five)** of the following questions. When answering a question, please answer all the subsections of it at once]

1. a. When will you choose abstract class over interface? Explain. 5

   b. Find the error in each of the following program segments. Explain how to correct the error. 7

   i)

```
1  void g() {
2     System.out.println("Inside method g");
3
4     void h() {
5        System.out.println("Inside method h");
6     }
7  }
```

   ii)

```
1  int sum(int x, int y) {
2     int result;
3     result = x + y;
4  }
```

2. a. Create a class called **Invoice** that a hardware store might use to represent an invoice for an item sold at the store. An Invoice should include four pieces of information as instance variables—**a part number (type String)**, **a part description (type String)**, **a quantity of the item being purchased (type int)** and **a price per item (double)**. Your class should have a **constructor** that initializes the four instance variables. Provide a **set** and a **get** method for each instance variable. In addition, provide a method named **getInvoiceAmount** that calculates the invoice amount (i.e., multiplies the quantity by the price per item), then returns the amount as a double value. If the quantity is not positive, it should be set to 0. If the price per item is not positive, it should be set to 0.0. Write a test app named **InvoiceTest** that demonstrates class Invoice's capabilities. 8

   b. Should all the instance variables in a class be accessed using getter-setters? Explain with an example. 4

3. a. What are mutators and accessors? Explain with an example. 4

   b. What are the key differences between method overloading and method overriding in Java? 4

   c. Show two examples where using public variables is not recommended. 4

4. In the Mobile communication system of our country, the service can be divided into two broad categories based on the billing methods. First type is known as Prepaid service and it charges a fixed monthly bill at the beginning of each month. The total bill amount is calculated by summing up the fixed bill and the vat on the fixed bill. Another type is known as Postpaid service and the total bill is calculated by multiplying the total minutes of talk times and rate per minute, plus the vat. 12

   i. Design a class `MobilePackage` with its attributes for operator name and phone number; and methods including an abstract method `calculateTotalBill()` which will be used to calculate the bill of various services to be implemented in the subclasses.

   ii. Design two classes `PrepaidPackage` and `PostpaidPackage` that inherit the

MobilePackage class. Sub-classes have to implement the abstract method **`calculateTotalBill()`**.

iii. Add constructor methods where you think necessary. The **`toString()`** method is overridden in the two sub-classes to print the operator name, phone number and total bill amount. 6

5. a. Explain how *default* methods enable you to add new methods to an existing interface without breaking the classes that implemented the original interface. Why is it useful to be able to add private methods to interfaces?

b. Design an interface named **`Colorable`** with a void method named **`howToColor()`**. Every class of a colorable object must implement the **`Colorable`** interface. Design a class named **`Square`** that extends **`GeometricObject`** and implements **`Colorable`**. Implement **`howToColor`** to display the message "Color all four sides". 6

Write a test program that creates an array of five **`GeometricObjects`**. For each object in the array, display its area and invoke its **`howToColor`** method if it is colorable 4

6. a. What will be the output of the following code snippet? Explain.

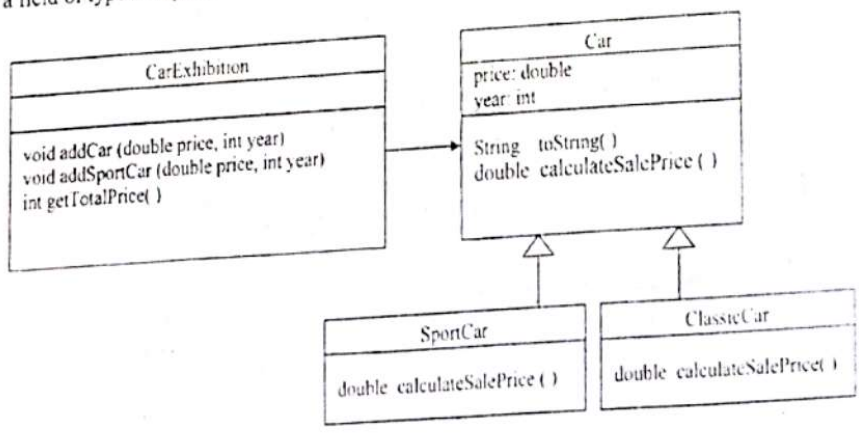
```
try {
 String name = null;
 System.out.printf("The length of the string is - %d",
name.length());
} catch (Exception e) {
 System.out.printf("Runtime Exception");
} catch (NullPointerException e) {
 System.out.println("Null Pointer Exception ");
}
```

b. Write the **bin2Dec(String binaryString)** method to convert a binary string into a decimal number. Implement the **bin2Dec** method to throw a **NumberFormatException** if the string is not a binary string. 4 4

c) Explain why the following code displays [1, 3] rather than [2, 3].

```
ArrayList list = new ArrayList<>();
list.add(1);
list.add(2);
list.add(3);
list.remove(1);
System.out.println(list);
```

7. Consider the following class hierarchy where Class Car is the superclass and the classes ClassicCar and SportCar are two subclasses derived from Car. Class **CarExhibition** contains a field of type ArrayList that stores objects of type Car.



Write a Java version of class **Car** assuming it has this constructor: **public Car(double price, int year)** and that the method **calculateSalePrice ( )** is abstract. 3

b. Write a Java version of class **ClassicCar** assuming it has this constructor: public **ClassicCar (double price, int year)** and that the method **calculateSalePrice ( )** returns 10,000 as the sale price of the car. 3

c. Write a Java version of class **SportCar** assuming it has this constructor: **public SportCar(double price, int year)** and that the method **calculateSalePrice ( )** which calculates the sale price of the car as follow: if year > 2000 then the sale price is 0.75 * its original price; if year > 1995 then the sale price is 0.5 * its original price; otherwise the sale price is 0.25 * its original price . 3

d. Write a Java version of class **CarExhibition** assuming it has this constructor: **public CarExhibition ( )** where CarExhibition has cars of different types stored in an arraylist and getTotalPrice method that returns the total prices of all cars in the exhibition. 3

University of Dhaka
Institute of Information Technology
Bachelor of Science in Software Engineering (BSSE)
1st Year 2nd Semester Final Examination, 2023
CSE 1215: Data Structure

Marks: 60 Time: 2 hours

Professionalism Excellence Respect

[Answer any **Four** of the following questions. When answering a question, please answer all the subsections of it at once]

1. a. While analyzing the complexity of an algorithm why do you need to consider the worst-case scenario instead of the best or average case? Explain briefly. 3

   b. i. Write a code snippet to insert an element in a given 2-way linked list *DUPhoneBook*. Each element in the *DUPhoneBook* is a structure called *node* as follows: 4 + 4

```
struct node
{
    int index;
    string name, phoneNumber;
    node *next, *previous;
};
```

   ii. Suppose you want to insert a node *newNode* in *DUPhoneBook* after an element pointed by node type pointer *current* (i.e. *node *current*). We have *newNode.index = 8, newNode.name = "xyz"* and *newNode.phoneNumber = "01672441139"*.

   c. *Stable sorting algorithms* maintain the relative order of records with equal keys (i.e. values). That is, a sorting algorithm is stable if whenever there are two records *R* and *S* with the same key (i.e. value) and with *R* appearing before *S* in the original list, *R* will appear before *S* in the sorted list. Consider *Selection Sort*, *Radix sort*, *Merge Sort* and *Quick Sort*. Which of these is a stable sorting algorithm, and which is not? Justify your answer. 4

2. a. What do you think is the safest method to choose a pivot element for the quick sort algorithm? Justify your answer. 3

   b. For each of the following scenarios choose the "best" data structure from the following list or a combination of data structures: an unsorted array, linked list, stack, queue. In each case, justify your answer briefly. 4

      i. A grocery store decided that customers who come first will be served first
      ii. A list must be maintained so that any element can be accessed randomly
      iii. A program needs to remember operations it performed in opposite order
      iv. The size of a file is unknown. The entries need to be entered as they come in. Entries must be deleted when they are no longer needed. It is important that the structure has flexible memory management

   c. Sort the following array using the Heap sort algorithm

      A = <16, 14, 26, 20, 54, 29, 16, 31, 18, 12, 24>.

      Show all the steps. 8

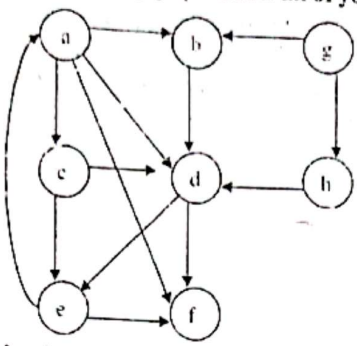
3. a. Discuss the time complexity of bubble sort and quick sort briefly 4

   b. In the Quick Sort algorithm, the choice of pivot element is crucial for the efficiency of the sort. Different strategies can be used to select the pivot. You can select first, last, or median value in a list as a pivot element. Discuss your opinion on selecting pivot elements in different cases, e.g., when the data are randomly distributed, sorted, and unsorted. 6

   c. Given the following unsorted array of integers, simulate the process of sorting the array using the Merge Sort algorithm. Illustrate each step of the process including the division of the array, the merging of subarrays, and the final sorted array. 5

[38, 27, 43, 3, 9, 82, 10]

a. Find the component graph of the following graph. **Show all of your work.** 6



b. What does *Topological order* do? What are the properties of a graph to have a *Topological Order*? 3

c. Consider the following queue of characters, where QUEUE is a circular array which is allocated six memory cells FRONT =2 REAR= 4 QUEUE: _ , A,C,D , _, _ . Describe the queue as the following operations take place. 6

i. F is added to the queue
ii. two letters are deleted
iii. K, L, M are added to the queue
iv. two letters are deleted
v. R is added to the queue
vi. vi) two letters are deleted

a. Consider the following infix expression. Convert it to postfix notation and evaluate the postfix expression. Show the status of the stack at each step. 6

Expression: ((A+B)*C−D)/(E+F)

b. Write a recursive function to traverse a linked list. 4

c. Consider a simulation system for managing tasks in a software development team using stacks and queues. The system handles incoming tasks and assigns them to developers based on priority. Each task has an identifier and a priority level. 5

i. Implement a stack-based solution to manage incoming tasks. Describe how you would push tasks onto the stack and how you would pop and assign tasks to developers for processing.

ii. Implement a queue-based solution to manage incoming tasks. Describe how you would enqueue tasks into the queue and how you would dequeue and assign tasks to developers for processing.

a. Given the values {2341, 4234, 2839, 430, 22, 397, 3920}, a hash table of size 7, and hash function h(x) = x mod 7, show the resulting tables after inserting the values in the given order using *linear probing*. 4

b. Differentiate between the *adjacency matrix* and the *adjacency list*. Which one of these is a suitable representation to represent a *sparse graph*, and what is the limitation of that representation? 5

c. Under what circumstances it will be faster to use Insertion Sort to sort an array than to use Quick Sort? 3

d. If you had an unsorted list of one million unique items, and knew that you would only search it once for a value, which of the following algorithms would be the fastest? Justify your answer. 3

i Use linear search on the unsorted list
ii Use insertion sort to sort the list and then binary search on the sorted list

Institute of Information Technology, University of Dhaka
Bachelor of Science in Software Engineering
MATH 1216: Calculus II
1st Year 2nd Semester Final Examination 2023

Marks: 60 **Time: 3 Hours**

Professionalism Excellence Respect

Answer any **FIVE(5)** *of the following questions.*

1. (a) What is function of two variables? Sketch the graph of $f(x, y) = 4x^2 + y^2 + 1$. [3]

(b) Find and sketch the domain of the function $f(x, y) = \sqrt{1 - x^2 - y^2 - z^2}$ [3]

(c) Sketch the level surface $f(x, y) = K$, where, $f(x, y) = y^2 - x^2$, and $K = -4, 0, 4$. [3]

(d) Find the limit, if exists, of [3]

$$\lim_{(x,y)\to(0,0)} (x^2 + y^2)\ln(x^2 + y^2).$$

[6]

2. (a) Let

$$f(x, y) = \begin{cases} \frac{x^3y - xy^3}{x^2 - y^2}, & \text{if } (x, y) \neq (0, 0) \\ 0, & \text{if } (x, y) = (0, 0) \end{cases}$$

(i) Find $f_x(x, y)$ and $f_y(x, y)$ when $(x, y) \neq (0, 0)$

(ii) Find $f_x(0, 0)$ and $f_y(0, 0)$

(iii) Show that $f_{xy}(0, 0) = -1$ and $f_{yx}(0, 0) = 1$

(b) The temperature at a point (x, y, z) is given by $T(x, y, z) = 200e^{-x^2-3y^2-9z^2}$ where T measured in °C and x, y, z in meters. [6]

(i) Find the rate of change of temperature at the point $P(2, -1, 2)$ in the direction toward the point $(3, -3, 3)$.

(ii) In what direction does the temperature increases fastest at P?

(iii) Find the maximum rate of increase at P.

3. (a) What do you mean by linear approximation of a function $f(x, y)$ at (x_0, y_0)? Verify $\frac{2x-3}{4y+1} \approx 3 + 2x - 12y$ using linear approximation at $(0, 0)$. [4]

(b) Find the equations of the tangent plane and the normal line to the curve $z + 1 = xe^y \cos z$ at $(1, 0, 0)$. [4]

(c) The base radius and height of a right circular cone are measured as 10 cm and 25 cm, respectively, with a possible error in measurement of as much as 0.1 cm in each. Use differentials to estimate the maximum error in the calculated volume of the cone. [4]

4. (a) Use Lagrange multipliers to determine the dimensions of a rectangular box, open at the top, having a volume of 32 ft^3, and determine the requiring the least amount of material for its construction. [6]

(b) Write the algorithm for Runge-Kutta methof of fourth order. Apply this method to the following initial value problem, choosing $h = 0.2$ and computing two steps: [6]

$$y' = x + y, \quad y(0) = 0.$$

5. (a) Use spherical coordinates to evaluate the integral $\int\int\int (x^2 + y^2 + z^2)dxdydz$ taken over the volume enclosed by the sphere $x^2 + y^2 + z^2 = 1$. [4]

(b) Use the transformation $u = \frac{1}{2}(x + y)$, $v = \frac{1}{2}(x - y)$ to find

$$I = \int_R \int \sin\frac{1}{2}(x + y)\cos\frac{1}{2}(x - y)\, dA,$$

where R is the triangular region with vertices $(0, 0), (2, 0), (1, 1)$. [4]

(c) Evaluate the integral [4]

$$\int_0^1 \int_0^x y\sqrt{x^2 - y^2}dydx.$$

6. (a) Determine the critical points and discuss the stability of the critical points of the following system of differential equations. [6]

$$x' = -y - x^2, \quad y' = -x + y^2.$$

(b) Solve the following Bernoulli differential equation. [6]

$$\frac{dy}{dx} - \frac{4}{x}y = x^3y^2, \quad y(2) = -1, \quad x > 0.$$

7. (a) A 100-volt electromotive force is applied to an RC-series circuit in which the resistance is 200 ohms and the capacitance is 10^{-4} farad. Find the charge $q(t)$ on the capacitance if $q(0) = 0$. Determine the current $i(t)$. [4]

(b) Determine the type and stability of the critical point $(0, 0)$ of the nonlinear system [4]

$$\begin{aligned} \frac{dx}{dt} &= x + x^2 - 3xy \\ \frac{dy}{dt} &= -2x + y + 3y^2 \end{aligned}$$

(c) A mass weighing 2 pounds stretches a spring 6 inches. At $t = 0$ the mass is released from a point 8 inches below the equilibrium position with an upward velocity of $4/3$ ft/ sec. Determine the equation of the motion. [4]