Strathmore
UNIVERSITY

STRATHMORE BUSINESS SCHOOL
BACHELOR OF SCIENCE IN SUPPLY CHAIN AND OPERATIONS MANAGEMENT (BSCM)
END OF SEMESTER EXAMINATION
MAT 2204: QUANTITATIVE ANALYSIS AND MODELLING

DATE: 13th January,2022 **TIME**: 3 Hours

INSTRUCTIONS

1. This examination consists of **FIVE** questions.
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** questions.
3. You may use a **SIMPLE CALCULATOR**. No **MOBILE PHONES** in the exams room.

Question One (30 Marks)

(i) Clearly explain the steps involved in hypothesis testing. (5 marks)

(ii) Find the maximum value of (5 marks)

$$\begin{aligned} \text{Maximize,} \quad & Z = 20x_1 + 10x_2 \\ \text{subject to} \quad & 4x_1 + x_2 + x_3 = 30, \\ & 2x_1 + 3x_2 + x_3 \leq 60, \\ & x_1 + 2x_2 + 3x_3 \leq 60, \\ & x_1, x_2, x_3 \geq 0. \end{aligned}$$

(iii) Discuss four components of a Time Series. (4 marks)

(iv) A pharmaceutical company conducts an experiment to test the effect of a new cholesterol medication. The company selects 15 subjects randomly from a larger population. Each subject is randomly assigned to one of three treatment groups. Within each treament group, subjects receive a different dose of the new medication. In Group 1, subjects receive 0 mg/day; in Group 2, 50 mg/day; and in Group 3, 100 mg/day. After 30 days, doctors measure the cholesterol level of each subject. The results for all 15 subjects appear in the table below:

Group 1, 0 mg	Group 2, 50 mg	Group 3, 100 mg
2010	210	180
240	240	210
270	240	210
270	270	210
300	270	240

Does dosage level have a statistically significant effect on cholesterol level? (5 marks)

(v) From the following information find the correlation coefficient between advertisement expenses and sales volume and clearly give an interpretation to your solution. (5 marks)

Firm	1	2	3	4	5	6	7	8	9	10
Advertisement Exp. (in thousand dollars)	11	13	14	16	16	15	15	14	13	13
Sales volume (in thousand dollars)	50	50	55	60	65	65	65	60	60	50

(vi) State and explain three different types of decision-making environments. (6 marks)

Question Two (20 Marks)

(i) Acute exposure to cadmium produces respiratory distress and kidney and liver damage (and possibly death). For this reason, the level of airborne cadmium dust and cadmiumoxide fume in the air, denoted by X (measured in milligrams of cadmium per m^3 of air), is closely monitored. A random sample of $n = 35$ measurements from a large factory are given below:

0.044, 0.030, 0.052, 0.044, 0.046, 0.020, 0.066,
0.052, 0.049, 0.030, 0.040, 0.045, 0.039, 0.039,
0.039, 0.057, 0.050, 0.056, 0.061, 0.042, 0.055,
0.037, 0.062, 0.062, 0.070, 0.061, 0.061, 0.058,
0.053, 0.060, 0.047, 0.051, 0.054, 0.042, 0.051.

Find a 99 percent confidence interval for μ, the mean level of airborne cadmium. (6 marks)

(ii) A random sample of 20 nominally measured 2mm diameter steel ball bearings is taken and the diameters are measured precisely. The measurements, in mm, are as follows:

2.02, 1.94, 2.09, 1.95, 1.98, 2.00, 2.03, 2.04, 2.08, 2.07
1.99, 1.96, 1.99, 1.95, 1.99, 1.99, 2.03, 2.05, 2.01, 2.03.

Assuming that the diameters are normally distributed with unknown mean, μ, and unknown variance, σ^2. find a two-sided 95% confidence interval for the variance, σ^2. (7 marks)

(iii) A clinic provides a program to help their clients lose weight and asks a consumer agency to investigate the effectiveness of the program. The agency takes a sample of 15 people, weighing

each person in the sample before the program begins and 3 months later to produce the table in below. Determine whether the program is effective. (7 marks)

Person	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Before	210	205	193	182	259	239	164	197	222	211	187	175	186	243	246
After	197	195	191	174	236	226	157	196	201	196	181	164	181	229	231

Question Three (20 Marks)

(i) What is regression analysis? (2 marks)

(ii) Explain the importance of regression analysis in business. (4 marks)

(iii) Consider the data below on demand estimation of riders based on various variables.

	City	Number of weekly riders	Price per week	Population of city	Monthly income of riders	Average parking rates per month
2	1	192,000	$15	1,800,000	$5,800	$50
3	2	190,400	$15	1,790,000	$6,200	$50
4	3	191,200	$15	1,780,000	$6,400	$60
5	4	177,600	$25	1,778,000	$6,500	$60
6	5	176,800	$25	1,750,000	$6,550	$60
7	6	178,400	$25	1,740,000	$6,580	$70
8	7	180,800	$25	1,725,000	$8,200	$75
9	8	175,200	$30	1,725,000	$8,600	$75
10	9	174,400	$30	1,720,000	$8,800	$75
11	10	173,920	$30	1,705,000	$9,200	$80
12	11	172,800	$30	1,710,000	$9,630	$80
13	12	163,200	$40	1,700,000	$10,570	$80
14	13	161,600	$40	1,695,000	$11,330	$85
15	14	161,600	$40	1,695,000	$11,600	$100
16	15	160,800	$40	1,690,000	$11,800	$105
17	16	159,200	$40	1,630,000	$11,830	$105
18	17	148,800	$65	1,640,000	$12,650	$105
19	18	115,696	$102	1,635,000	$13,000	$110
20	19	147,200	$75	1,630,000	$13,224	$125
21	20	150,400	$75	1,620,000	$13,766	$130
22	21	152,000	$75	1,615,000	$14,010	$150
23	22	136,000	$80	1,605,000	$14,468	$155
24	23	126,240	$86	1,590,000	$15,000	$165
25	24	123,888	$98	1,595,000	$15,200	$175
26	25	126,080	$87	1,590,000	$15,600	$175
27	26	151,680	$77	1,600,000	$16,000	$190
28	27	152,800	$63	1,610,000	$16,200	$200

(a) Key in the data correctly in excel and obtain the mean and standard devaitions of the main variables (number of weekly riders, price per week, population of the city, monthly income of riders and average parking rates per month) (4 marks)

(b) Develop a least-squares regression equation to predict number of weekly riders, based on price per week, population of the city, monthly income of riders and average parking rates per month. (6 marks)

(c) Assess the contribution of each independent variable (i.e., price per week, population of the city, monthly income of riders and average parking rates per month) to the prediction of the weekly riders. (4 marks)

Question Four (20 Marks)

(i) Explain five components of a linear programming problem. (5 marks)

(ii) A small petroleum company owns two refineries. Refinery 1 costs $20,000 per day to operate, and it can produce 400 barrels of high-grade oil, 300 barrels of medium-grade oil, and 200 barrels of low-grade oil each day. Refinery 2 is newer and more modern. It costs $25,000 per day to operate, and it can produce 300 barrels of high-grade oil, 400 barrels of medium-grade oil, and 500 barrels of low-grade oil each day. The company has orders totaling 25,000 barrels of high-grade oil, 27,000 barrels of medium-grade oil, and 30,000 barrels of low-grade oil. How many days should it run each refinery to minimize its costs and still refine enough oil to meet its orders? (6 marks)

(iii) State and explain three properties of Queuing Model. (3 marks)

(iv) The Tool Company's quality control department is manned by a single clerk, who takes an average of 5 minutes in checking parts of each of the machines coming for inspection. The machines arrive once in every 8 minutes on the average. One hour of machine is valued at $15 and a clerk's time is valued at $4 per hour. What is the average hourly queuing system costs associated with the quality control department? (6 marks)

Question Five (20 Marks)

(i) A food processor uses a moving average to forecast next month's demand. Past actual demand(in units) is shown below:

Month	43	44	45	46	47	48	49	50	51
Actual demand in units	105	106	110	110	114	121	130	128	137

(a) Compute a simple five-month moving average to forecast demand for month 52. (4 marks)

(b) Compute a weighted three-month moving average where the weights are highest for the latest months and descend in order of 3, 2, 1. (6 marks)

(ii) Company A owns a track of land that contains oil. A consulting geologist has reported to the company management that she believes that there is one chance in four of land having oil. Due to this prospect another company B has offered to purchase the land for $90,000. However company A can hold the land and drill for oil itself. If oil is found the company?s expected profit is $700,000. A loss of $100,000 will be incurred if the land is dry. Prepare Pay-off table for the two possible actions. (5 marks)

(iii) Getz Products Company is investigating the possibility of producing and marketing backyard storage sheds. Undertake king this project would require the construction of either a large or a small manufacturing plant. The market for the product produced-storage sheds-could be either favorable or unfavorable. Getz, of course, has the option of not developing the new product line at all. Prepare a decision tree for this situation. (5 marks)

END