WILFRID LAURIER UNIVERSITY
WATERLOO, ONTARIO
BU385 - Operations Management I
Fall 2012 Mid-Term Exam II

Open Questions

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Indicate your section with an "X" in the appropriate box

Section	Instructor	
A1	M. Wagner	X
A2	M. Wagner	
B	P. Iyogun	
C	M. Wagner	
D	H. Faramarzi	
E	H. Faramarzi	
F	D. Swanston	
G	H. Mayanloo	

Section	Instructor	
H	P. Iyogun	
J	P. Iyogun	
K	E. Nasr	
L	H. Mayanloo	
M	D. Swanston	
N	T. Mahootchi	
P1	H. Mayanloo	

NUMBER OF PAGES: *10 pages (Not including the Cover and Instruction pages*

LENGTH OF EXAMINATION: 2 hours

EXAMINATION AIDS ALLOWED: One 8½" x 11" double-sided formula sheet, Calculator

Q1 (out of 3)	Q2 (out of 10)	Q3 (out of 3)	Q4 (out of 4)	Q5 (out of 5)	Total Mark (out of 25)
0	10	3	4	4	

Question 1 (3 marks)

A manufacturing firm is considering investing in one of the following systems. The company will choose a system that minimizes its total cost for a given volume.

System	Fixed Cost	Variable Cost Per Unit ($)
A	40,000	5
B	25,000	10
C	10,000	20
D	30,000	12

> 3000 > 0-3000
> 1500 > 3001-4500
> 2500 > 4501-7000
> > 7001 +

Determine the range of quantities where each system would be optimal.

TC TC
A = B

$40{,}000 + 5Q = 25000 + 10Q$

$15{,}000 = 5Q$

$3000 = Q$

TC TC
B = C

$25{,}000 + 10Q = 10{,}000 + 20Q$

$15{,}000 = 10Q$

$1500 = Q$

TC TC
C = D

$10{,}000 + 20Q = 30{,}000 + 12Q$

$8Q = 20{,}000$

$Q = 2{,}500$

Would make A up until 3,000 units are produced,
B from 3001 to 4,500 units,
C from 4,500 to 7000units,
and D from 7,000 units and upwards.

X

10

Question 2 (10 marks)

Industrial engineering department has been asked to balance the following assembly operation in order to achieve an hourly output rate of 30 units. Assume that the shop works for 60 minutes per hour (i.e., no breaks). Show all your calculations.

Task	Duration (minutes)	Precedes Task
a	1.5	b
b	0.9	~~c, d, e~~
c	0.6	f
d	0.4	g
e	1.1	g
f	0.8	h
g	1	h
h	0.5	-

Do each of the following:

a) Draw the precedence network.

b) Determine the required cycle time. 2min (1)

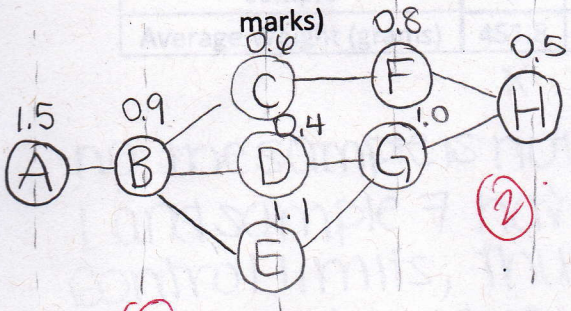
c) Determine the minimum number of workstations needed. 4 (1)

$n = \frac{6.8}{2} = 3.4$ or 4.

d) Assign the tasks to workstations using the heuristic rule "Assign the task with the most followers or largest number of successors." Use the heuristic rule "Assign the task with longest time" as a tie-breaker. If a tie still exists, choose randomly.

e) Calculate the percentage idle time and efficiency for the assignments in part *d*. (2 marks) see pack

a)



(2)

(4)

b) $CT = \frac{\text{production per day}}{\text{required \# of units}}$ (1)

$= \frac{60}{30}$

= 2 minutes per unit.

c)

Work Station	time left	eligible	will fit	assigned	Idle time
1	2.0	A	A	A (1.5)	
	0.5	B	—	—	0.5
2	2.0	B	B	B (0.9)	
	1.1	C, D, E	E	E (1.1)	
	0	C, D	—	—	—
3	2.0	C, D	C	C (0.6)	
	1.4	D	D	D (0.4)	
	1.0	E, G	G	G (1.0)	
	0	F	—	—	—
4	2.0	F	F	F (0.8)	
	1.2	H	H	H (0.5)	
	0.7	—	—	—	0.7

Total idle time = 1.2 minutes

Question 3 (3 marks)

Healthy Alternative (HA) produces all-natural organic breakfast cereal in large batches. HA wishes to monitor the performance of their production line by taking hourly samples of 25 boxes and weighing their contents. The filling process for the filling of cereal boxes is standardized due to automation and the weights are normally distributed with a mean of 450 grams and a standard deviation of 4 grams. Show all your calculations.

a) Determine three sigma control limits for an x-bar chart. (2 Marks)

$UCL = \bar{X} + z\left(\frac{\sigma}{\sqrt{n}}\right)$

$= 450 + 3\left(\frac{4}{\sqrt{25}}\right)$

$= 450 + 2.4$

$= 452.40$ grams

$LCL = \bar{X} - z\left(\frac{\sigma}{\sqrt{n}}\right)$

$= 450 - 3\left(\frac{4}{\sqrt{25}}\right)$

$= 450 - 2.4$

$= 447.60$ grams

b) Assume that the lower and upper limits are 445 and 451 respectively. Based on the results of the eight samples taken the next day, as shown in the table below, does the production process appear to be meeting standards? Why? (1 Mark)

Sample	1	2	3	4	5	6	7	8
Average Weight (grams)	451.8	450.3	448.1	450.1	449.6	447.7	452.2	450.5
	X	✓	✓	✓	✓	✓	X	✓

no, the sample is not meeting the standards. Sample 1 and sample 7 have average weights outside the control limits, thus the process is not 'in control'. This could be due to a number of minor factors, and should be identified and corrected.

3

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There are 4 work stations required with 1.2 minutes of idle time.

e) % idle time = $\frac{\text{Sum of idle times}}{\#\text{of WS} \times \text{Cycle time}}$

$= \frac{1.2}{4(2)}$

$= 0.15$

$= 15\%$ idel

(1)

efficiency = 100% − (idle time)

= 85% efficent.

(1)

Question 4 (4 marks)

R chart

Process time at a workstation is monitored using sample mean and range control charts. Six samples of 20 observations have been obtained and the sample means and ranges computed (in minutes) and shown in the table below. [Use the table provided below for required values].

	Sample						
	1	2	3	4	5	6	
Mean	3.06	3.15	3.11	3.13	3.06	3.09	3.10
Range	.42	.50	.41	.46	.46	.45	0.45

$n = 20$ $A_2 = 0.18$
$\bar{\bar{X}} = 3.10$ $D_3 = 0.41$
$\bar{R} = 0.45$ $D_4 = 1.59$

a) Calculate the upper and lower mean control limits. (2 Marks)

$UCL = \bar{\bar{X}} + A_2\bar{R}$
$= 3.10 + [0.18 \times 0.45]$
$= 3.181$

$LCL = \bar{\bar{X}} - A_2\bar{R}$
$= 3.10 - [0.18 \times 0.45]$
$= 3.019$

b) Calculate the upper and lower range control limits. (2 Marks)

$UCL = RD_4$
$= 0.45(1.59)$
$= 0.7155$

$LCL = RD_3$
$= 0.45(0.41)$
$= 0.1845$

This sample is in control, as all observations recorded are with the calculated sample means and ranges.

4

Number of Observations in Sample, n	Factors for $\bar{X}$ Charts, A_2	Factors for R-Charts: Lower Control Limit, D_3	Factors for R-Charts: Upper Control Limit, D_4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72
13	0.25	0.31	1.69
14	0.24	0.33	1.67
15	0.22	0.35	1.65
16	0.21	0.36	1.64
17	0.20	0.38	1.62
18	0.19	0.39	1.61
19	0.19	0.40	1.60
20	0.18	0.41	1.59

20

7

Question 5 (5 marks)

A town's Fire Department makes regular inspections of fire hydrants to ensure that they are maintaining adequate pressure. Due to naturally occurring fluctuations in pressure, some hydrants are expected to not meet pressure standards at the time of testing, but there are usually other hydrants in the area that could be used if this was to happen during a fire. The Fire Department needs to ensure that there are not too many hydrants that do not meet fire code standards. Each month the Fire Department randomly tests 100 fire hydrants for pressure. The results to date are shown below:

Month	Jan	Feb	Mar	Apr	May	Jun
# of Hydrants Not Meeting Code	5	3	3	7	4	5

a) Calculate the upper and lower three sigma control limits for the above information. Show all your calculations. (4 Marks)

$\bar{p} = \frac{\#\text{of defects}}{\#\text{of observations} \times \text{samples}}$

$= \frac{27}{6(100)}$

$\bar{p} = 0.045$

$n = 100$

$z = 3$

$UCL = \bar{p} + z\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0.045 + 3\sqrt{\frac{0.045(0.955)}{100}}$

$= 0.045 + 3(0.0207)$

$= 0.1071$

$LCL = \bar{p} - 2\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0.045 - 3(0.0209)$

$= -0.0171$

$= 0$

4

b) Assume that the lower and upper limits are 0.036 and 0.117 respectively. The results for the next five months revealed 6, 12, 7, 10 and 5 hydrants not meeting code respectively. Should the Fire Department be concerned? Why? (1 mark)

$\bar{p} = \frac{\#\text{ of defects}}{\#\text{of observations} \times \text{samples}}$

$= \frac{40}{5(100)}$

$= 0.08$

NO, they shouldn't. P is the proportion of defects in a lot, and at 8% in a control limit of 3.6 - 11.7%, it is still in the middle, and thus acceptable.

4