BITS-PILANI, DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
OPERATIONS RESEARCH (AAOC C312)
Comprehensive Examination
(III Year – II Semester 2012-2013)

Date: 30.05.13
Time: 03 Hours

Max. Marks: 120
Weightage: 40%

Attempt all the questions.
Use Separate answer books for Part A, Part B and Part C

Part A

1. Test whether the following data could have come from uniform distribution in [0,30]:

4.8, 4.4, 23.1, 19.5, 28.7, 14.8, 28.2, 2.4, 25.0, 6.2. Use Kolmogorov-Smirnov test at 5% level of significance. **[10]**

2. Consider the following data of profit (in thousand Rupees) for 6 consecutive months:

Month	1	2	3	4	5	6
Profit	71	70	69	68	64	65

Use exponential smoothing technique to forecast the profit for 7^{th} month taking $\alpha = 0.1, 0.4, 0.6$. Calculate MAD for each α value and suggest which α will give the best forecast. **[10]**

3. A retailer faces a demand rate (constant) 450 units per month. He purchases the items from the distributor at the rate of 600 units per month. The holding cost per unit per month is Rs. 2.50. Purchase price (unit cost) per unit is Rs. 5.25 and the ordering cost is Rs. 60.00 per order. Shortages are not allowed. Find **[10]**

i) the economic order quantity (EOQ) and optimum ordering cycle (OOC);
ii) maximum level of inventory in a cycle and minimum cost per month in a cycle.

Part B

4. Two research workers classified some people in income groups of the basis of sampling studies. Their results are as follows:

Investigators	Income Groups		
	Poor	Middle	Rich
A	160	30	10
B	140	120	40

Is there an association in the sampling studies of both the research workers? Use Chi square test at 5% level of significance. **[10]**

5. The following data give the means and ranges of 25 samples, each consisting of 4 compression test results on steel forgings, in thousands of pounds per square inch:

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13
$\bar{X}$	45.4	48.1	46.2	45.7	41.9	49.4	52.6	54.5	45.1	47.6	42.8	41.4	43.7
R	2.7	3.1	5.0	1.6	2.2	5.7	6.5	3.6	2.5	1.0	3.9	5.6	2.7
Sample	14	15	16	17	18	19	20	21	22	23	24	25	
$\bar{X}$	49.2	51.1	42.8	51.1	52.4	47.9	48.6	53.3	49.7	48.2	51.6	52.3	
R	3.1	1.5	2.2	1.4	4.3	2.2	2.7	3.0	1.1	2.1	1.6	2.4	

(a) Use the data to find the central line and control limits for mean ($\bar{X}$) chart.

(b) Plot the given data on $\bar{X}$ chart.

(c) Is the process under control? **[10]**

6. XYZ uses a product in its manufacturing process at the demand rate of 1000 gallons per month. It costs $ 100 to place an order for a new shipment. The holding cost per gallon per month is $2 and the shortage cost per gallon is $ 10. Historical data show that the demand during lead time follows uniform distribution i.e. U (0, 100).

(a) Determine the optimal ordering policy for XYZ (Calculate values only up to three iterations).

(b) Determine expected monthly set up cost.

(c) Determine approximate number of orders per month. **[10]**

Part C

7. A fast food franchise is test marketing 3 new menu items. To find out if they have the same popularity, 6 franchisee restaurants are randomly chosen for participation in the study. In accordance with the randomized block design, each restaurant will be test marketing all 3 new menu items. Furthermore, a restaurant will test market only one menu item per week, and it takes 3 weeks to test market all menu items. The testing order of the menu items for each restaurant is randomly assigned as well. Suppose if each row in the following table represents the sales figures of the 3 new menu items in each of the six restaurants, then test whether the mean sales volume for the 3 new menu items are all equal at 5% level of significance. **[12]**

	Item 1	Item 2	Item 3
Blocks	31	27	24
	31	28	31
	45	29	46
	21	18	48
	42	36	46
	32	17	40

8. A large corporation wants to choose between two brands of light bulbs. Brand A is less expensive than brand B. Hence the corporation would like to buy brand A unless there is a strong evidence to indicate that brand B has a larger life. For this purpose, 7 bulbs of brand A were tested for their life-lengths (in hours) and the following results were recorded as their life-lengths: **[8]**

981, 982, 1342, 1051, 1005, 976, 1016

And 9 bulbs of brand B were found to have the following life-lengths:

1380, 1004, 1032, 1263, 1040, 990, 1102, 1170, 1405

Using the Wilcoxon's Rank-Sum test at a level of significance of 0.05, what decision would be made? Justify.

9. The standard variance of a population is equal to 9 cm^2. It is suspected that the variance of the population has become smaller. A random sample of size 10 from population gave the following observations (in *cms.*) **[10]**

11 9 8 12 6 10 11 10 8 9

Test the relevant hypotheses at 5% significant level.

10. The following sample data are taken from two populations which are not independent of each other. **[10]**

Population I	82	92	103	75	86	99	91	68	105	101
Population II	85	89	94	81	92	101	95	78	100	102

Assuming the sample are drawn from normally distributed population, investigate the claim that the mean of population I is less than the mean of population II with 5% level of significance.

11. Cars arrive at a service station in a Poisson process at a mean rate of 9 cars per hour. The service station has 3 repairmen working in parallel each with mean service rate 12 cars per hour. The service times are exponentially distributed. There is space for only three cars being served and for three in waiting. If all spaces are filled up the cars will go to another service station. **[12]**

i) What is the probability that an arriving customer will be served immediately on arrival?

ii) What fraction of cars are lost?

iii) What is the average number of cars in the system?

12. Find the reliability of the system as below, the number inside the boxes are reliabilities and the number outside the boxes are component number. (*Values up to four decimal places.* **[8]**

P.T.O.

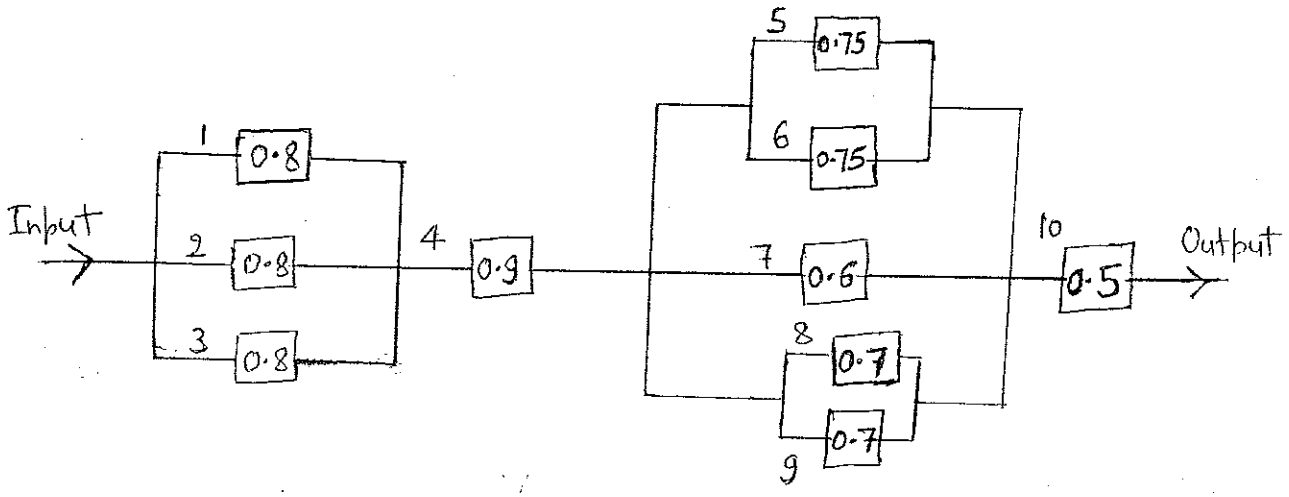

Table values as per standard notation

KS test statistic $D_{10,0.05} = 0.409$ t statistic $t_{9,.05} = -1.833$ and $t_{9,.95} = 1.833$, $\chi^2_{2,0.95} = 5.991$ $\chi^2_{9,0.05} = 3.325$. For $n = 4$ control chart constant $A_2 = 0.729$

$F_{2,10,0.95} = 4.1028$ and $F_{5,10,0.95} = 3.3258$

Wilcoxon's (Wx) table

x	P	x*
75	0·057	44
76	0·045	43
77	0·036	42

For (M/M/s):(FCFS/m/ ∞)

$$P_n = \frac{\rho^n}{n!}P_0 \text{ for } n = 0,1,2,\ldots,s-1 \text{ and } P_n = \frac{\rho^n}{s!s^{n-s}}P_0 \text{ for } n = s, s+1, \ldots, m$$

$$P_0 = \frac{1}{1+\sum_{n=1}^{s-1}\frac{\rho^n}{n!}+\frac{\rho^s\left\{1-\left(\frac{\rho}{s}\right)^{m-s+1}\right\}}{s!\left(1-\frac{\rho}{s}\right)}} \text{ if } \frac{\rho}{s} \neq 1 \text{ and } P_0 = \frac{1}{1+\sum_{n=1}^{s-1}\frac{\rho^n}{n!}+\frac{s^s(m-s+1)}{s!}} \text{ if } \frac{\rho}{s} = 1$$

$$L_q = \frac{\rho^{s+1}}{(s)s!}\left[\frac{1-(m-s+1)U^{m-s}+(m-s)U^{m-s+1}}{(1-U)^2}\right]P_0, \text{ where } U = \frac{\rho}{s}, \text{ if } U \neq 1$$

$$L_q = \frac{s^s}{s!}\frac{(m-s)(m-s+1)}{2}P_0 \quad \text{if } \frac{\rho}{s} = 1$$

$$L = L_q + \rho(1-P_m)$$

BITS-PILANI, Dubai Campus

Operations Research (AAOCC312)

IIIrd Year

Date

30th May 13

MARKING SCHEME

① $F_0(x) = \begin{cases} 0, & x < 0 \\ \frac{x}{30}, & 0 \le x \le 30 \\ 1, & x > 30 \end{cases}$

$H_0: F = F_0$

$H_1: F \neq F_0$ → [7]

i	y_i	$F_{10}(y_i)$	$F_0(y_i)$	$\lvert F_{10}(y_{i-1}) - F_0(y_i) \rvert$ (a)	$\lvert F_{10}(y_i) - F_0(y_i) \rvert$ (b)	Max of (a) and (b)
1	2.4	0.1	0.08	0.08	0.02	0.08
2	4.4	0.2	0.14667	0.04667	0.05333	0.05333
3	4.8	0.3	0.16	0.04	0.14	0.14
4	6.2	0.4	0.20667	0.09333	0.19333	0.19333
5	14.8	0.5	0.49333	0.09333	0.00667	0.09333
6	19.5	0.6	0.65	0.15	0.05	0.15
7	23.1	0.7	0.77	0.17	0.07	0.17
8	25.0	0.8	0.83333	0.13333	0.03333	0.13333
9	28.2	0.9	0.94	0.14	0.04	0.14
10	28.7	1.0	0.95667	0.05667	0.04333	0.05667

$\therefore D_{Obs.} = 0.19333$ — [1]

critical region is $C = \{D > D_{10,0.05}\} = \{D > 0.409\}$ — [1]

$\therefore$ Data $\notin C$; Hence H_0 is accepted.

Data have come from $U[0,30]$ dist^n. — [1]

(2) In exponential smoothing technique,

$$y^*_{t+1} = \alpha y_t + (1-\alpha) y^*_t$$

where '*' indicates forecast value and suffix indicates period. $y^*_2 = y_1$ and $y^*_1 = y_1$

Period	Profit (in ₹)	Forecast y^*_t		
		$\alpha = 0.1$	$\alpha = 0.4$	$\alpha = 0.6$
1	71	71	71	71
2	70	71	71	71
3	69	70.9	70.6	70.4
4	68	70.71	69.96	69.56
5	64	70.439	69.176	68.624
6	65	69.795	67.106	65.850
y^*_7 =		69.316	66.263	65.340
		L(1)	L(1)	L(1)

(3)

$MAD(0.1) = \frac{1}{6} \times 16.844 = 2.807$ —— (1)

$MAD(0.4) = \frac{1}{6} \times 11.842 = 1.974$ —— (1)

$MAD(0.6) = \frac{1}{6} \times 9.434 = 1.572$ —— (1)

MAD(0.6) is minimum.

So, $\alpha = 0.6$ will be advisable. (1).

(3) $D = 450$, $A = 600$, $C_1 = 2.50$, $C_0 = 5.25$, $K = 60$.

i) $EOQ = Q^* = \sqrt{\frac{2KD}{C_1(1-\frac{D}{A})}} = 293.939$ units — [3]

$OOC = \frac{EOQ}{D} = 0.653$ month. — [2]

ii) S^* = Maximum level of inventory in a cycle

$= \sqrt{\frac{2KD(1-\frac{D}{A})}{C_1}}$

$= EOQ \times (1-\frac{D}{A})$

$= 73.485$ units — [3]

iii) $TCU^* = C_0 D + \sqrt{2KDC_1(1-\frac{D}{A})}$ — [2]

$= Rs. 2546.21$

(4) H_0: There is an association in the sampling studies of both the research workers

H_1: H_0 is false.

$$\chi^2 = \frac{(160-120)^2}{120} + \frac{(30-60)^2}{60} + \frac{(10-20)^2}{20}$$

$$+ \frac{(140-180)^2}{180} + \frac{(120-90)^2}{90}$$

$$+ \frac{(40-30)^2}{30}$$

$$= 55.54$$

$$\chi^2 \geq \chi^2_{(3-1)(2-1);\,0.95}$$

$$55.54 \geq 5.991$$

Reject H_0.

$\Rightarrow$ There is no association in the sampling studies of both the research workers.

[10]

(5) $\bar{\bar{x}} = 48.1$ $\bar{R} = 2.9$

a) Central line $= \bar{\bar{x}} = 48.1$

$$UCL = \bar{\bar{x}} + A_2 \bar{R}$$
$$= 48.1 + (0.729)(2.9)$$
$$= 50.3$$

$$LCL = \bar{\bar{x}} - A_2 \bar{R}$$
$$= 46.$$

(b)

[Plot the pts. for 25 samples]

(c) Process is out of control.

[10]

(6) $D = 1000$, $K = 100$, $C_1 = 2$, $C_2 = 10$, $X \sim U(0, 100)$

$$f(x) = \frac{1}{100} \quad ; \quad 0 \le x \le 100$$

$$E(x) = \frac{100}{2} = 50.$$

a) We need to check ~~whether~~ whether the problem has feasible solut^n. i.e. $\tilde{y} \ge \hat{y}$

$$\hat{y} = \sqrt{\frac{2(1000)\{100 + 10(50)\}}{2}} = 774.6 \text{ gallons}$$

$$\tilde{y} = \frac{10(1000)}{2} = 5000 \text{ gallons.}$$

$\Rightarrow \because \tilde{y} > \hat{y} \Rightarrow$ unique solut^n exists.

Expected shortage cost per month.

$$S = \int_R^{100} (x - R) f(x) \, dx$$

$$= 50 + \frac{R^2}{200} - R. \quad \text{——} \quad (1).$$

Now,

$$y_i = \sqrt{\frac{2(1000)\{100 + 10S\}}{2}}$$

$$= \sqrt{100000 + 10000S} \quad \text{——} \quad (2)$$

& $R_i = \frac{100 - y_i}{50}$ ——— (3).

using ①, ②, ③ in iterat^n.

Iterat 1 : $y_1 = \sqrt{\frac{2(100)(1000)}{2}} = 316.23$ gallons

$R_1 = 100 - \frac{y_1}{50} = 93.68$ gallons.

Iterat 2 : $S = \frac{R_1^2}{200} - R_1 + 50 = 0.19971$ gallons

$y_2 = \sqrt{100,000 + 10,000(0.19971)}$

$= 319.37$ gallons.

$R_2 = 100 - \frac{319.37}{2} = 93.612$

Iterat 3 : $S = \frac{R_2^2}{200} - R_2 + 50$

$= 0.20399$

$y_3 = \sqrt{100,000 + 10,000(0.20399)} = 319.44$ gall.

$R_3 = 100 - \frac{319.44}{50} = 93.611$ gall.

$y_3 \approx y_2$ & $R_3 \approx R_2$

Optimum: $R^* = 93.611$ g; $y^* = 319.44$ g.

(b) Expected monthly set up cost $= \frac{KD}{y^*}$

$= \frac{100(1000)}{319.44} = \$313.05$ / month

c) Approx. no. of orders per month

$D/y^* = \frac{1000}{319.44} = 3.130 \approx 3$

[10]

7)

H_0: All three menu items are generating same sales volume on average (ie) $\mu_1 = \mu_2 = \mu_3$

H_1: H_0 is not true — (1M)

No of Treatments (menu items) $(k) = 3$ No of Blocks $(n) = 6$ — (1M)

$\alpha = 5\%$ $N = 18$

ANOVA TABLE

Sources of variation	sum square	Degrees of freedom	mean sum square	F-ratio
Treatments (menus)	538.778	2	269.389	$F_A = 4.959$
Blocks (Restaurants)	559.778	5	111.956	
Error	543.222	10		
Total	1641.778	17		

— (8M)

critical region $C_A = \{F_A \geq 4.1028\}$ — (1)

Since Computed $F_A = 4.959 \in C_A$, Reject H_0 — (1)

8)

H_0: Brands are identical with respect to their life-lengths.

(vs)

H_1: Life length of Brand-A is lesser than life length of Brand-B

— (4M)

Test statistic

$W_x = 43 = x^*$

Critical region

$C = \{ W_x \leq 43 \}$

Decision: Test statistic $W_x = 43 \in C$

Hence Reject H_0

— (4M)

9)

$H_0 : \sigma^2 = 9$ vs $H_1 : \sigma^2 < 9$

$n = 10, \quad \alpha = 0.05$

$$C = \left\{ s^2 \leq \frac{\sigma_0^2}{n-1} \chi^2_{n-1, 0.05} \right\}$$

$$= \{ s^2 \leq 3.325 \}$$

— (5M)

Test statistic (sample variance) $s^2 = 3.155 \text{ cm}^2$

— (5M)

Decision: Reject H_0.

(10)

(11)

Let mean of population I is μ_1

and mean of population II is μ_2

$H_0: \mu_1 = \mu_2$

Vs

$H_1: \mu_1 < \mu_2$

$\Rightarrow$

$H_0: \mu_D = \mu_1 - \mu_2 = 0$

Vs

$H_1: \mu_D = \mu_1 - \mu_2 < 0$

$$C.R. = \{ t \leq t_{9,.05} \}$$

D_i : $-3, 3, 9, -6, -6, -2, -4, -10, 5, -1$

$\sum_{i=1}^{10} D_i = -15$; $\sum_{i=1}^{10} D_i^2 = 317$

$\bar{D} = -1.5$

$$s_D^2 = \frac{1}{9}\left(317 - \frac{225}{10}\right)$$

$s_D = 5.72$

$$t = \frac{\bar{D}}{s_D/\sqrt{n}} \Rightarrow t = -0.8293$$ — [6m]

$$C.R. = \{ t \leq -1.833 \}$$

$t_{obs.} = -0.8293 \notin C.R.$

$\Rightarrow$ Accept H_0 and Reject H_1

$\Rightarrow$ Population I mean is not less than II. — [4m]

(11)

$\lambda = 9$ cars/hr $\quad m = 6$

$\mu = 12$ cars/hr $\quad s = 3$

$\rho = \frac{\lambda}{\mu} = 0.75$ and $\frac{\rho}{s} = \frac{.75}{3} = 0.25 \neq 1$

$P_0 = 0.47067$ —— [3M]

(i) Arriving customer will be served immediately

$= P_0 + P_1 + P_2$

$= 0.47067 + 0.3530 + 0.13238$

$= 0.95605$ —— [3M]

(ii) Fraction of cars are lost $= P_6$

$P_6 = \frac{\rho^6}{3!\ 3^3} \times P_0$

$P_6 = 0.0005171$ —— [2M]

(iii) $L_q = 0.014651$

Avg. no. of cars in the system

$L = L_q + \rho(1 - P_6)$

$L = 0.7643 \simeq 1$ car

$L = 1$ —— [4M]

Reliability for components 1, 2 & 3

$$R_{123} = 1 - (1-R_1)(1-R_2)(1-R_3)$$

$$R_{123} = 0.992$$

Reliability for components 5 and 6

$$R_{56} = 1 - (1-R_5)(1-R_6)$$

$$R_{56} = 0.9375$$

Reliability for components 8 and 9

$$R_{89} = 1 - (1-R_8)(1-R_9)$$

$$R_{89} = 0.91$$

Reliability of components 5, 6, 7, 8 and 9

$$R_{5,6,7,8,9} = 1 - (1-R_{56})(1-R_7)(1-R_{85})$$

$$= 0.99775$$ —— [5M]

Reliability of the system

$$R(t) = R_{123} \times R_4 \times R_{5,6,7,8,5} \times R_{10}$$

$$R(t) = 0.4454$$ —— [3M]

(11)

(12)

$\lambda = 9$ cars/hr $\quad m = 6$

$\mu = 12$ cars/hr $\quad S = 3$

$\rho = \frac{\lambda}{\mu} = 0.75$ and $\frac{\rho}{S} = \frac{.75}{3} = 0.25 \neq 1$

$P_0 = 0.47067$ —— [3M]

(i) Arriving customer will be served immediately

$= P_0 + P_1 + P_2$

$= 0.47067 + 0.3530 + 0.13238$

$= 0.95605$ —— [3M]

(ii) Fraction of cars are lost $= P_6$

$P_6 = \frac{\rho^6}{3!\ 3^3} \times P_0$

$P_6 = 0.0005171$ —— [2M]

(iii) $L_q = 0.014651$

Avg. no. of cars in the system

$L = L_q + \rho(1 - P_6)$

$L = 0.7643 \simeq 1$ car

$L = 1$

—— [4M]

Reliability for components 1, 2 & 3

$$R_{123} = 1 - (1-R_1)(1-R_2)(1-R_3)$$

$$R_{123} = 0.992$$

Reliability for components 5 and 6

$$R_{56} = 1 - (1-R_5)(1-R_6)$$

$$R_{56} = 0.9375$$

Reliability for components 8 and 9

$$R_{89} = 1 - (1-R_8)(1-R_9)$$

$$R_{89} = 0.91$$

Reliability of components 5, 6, 7, 8 and 9

$$R_{5,6,7,8,9} = 1 - (1-R_{56})(1-R_7)(1-R_{85})$$

$$= 0.99775$$ —— [5M]

Reliability of the system

$$R(t) = R_{123} \times R_4 \times R_{5,6,7,8,5} \times R_{10}$$

$$R(t) = 0.4454$$ —— [3M]

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OPERATIONS RESEARCH (AAOC C 312)
TEST– II (Open Book)

Date: 22.04.13 Max. Marks: 60
Time: 50 Minutes Weightage: 20%

Attempt all the questions.

1) Let μ be the mean of a normal population whose variance is unknown. A sample of size 15 is drawn to test the hypothesis: $H_0 : \mu = 5.2$ against $H_1 : \mu > 5.2$. Sample values are: 4.2, 3.6, 5.8, 6.2, 3.5, 4.8, 7.5, 6.2, 8.4, 7.1, 6.2, 3.8, 5.8, 6.2, 3.2. **15 Marks**

a) Find the values of the sample mean $\bar{x}$ and sample variance S^2.
b) Find the observed/calculated value of the test statistic.
c) What is the critical region at 1% level of significance?
d) Can we reject H_0 at 1% level of significance?

2) The following sample data were taken from two normally distributed independent populations with unknown but equal variances.

SAMPLE I	202	204.5	207	215.5	190.8	215.6	208.8	187.8	204.1	185.7
SAMPLE II	193.5	192.2	199.4	177.6	205.4	200.6	181.8	169.2	172.2	192.8

Investigate the claim that the mean of population II is less than the mean of population I with
a) 5% level of significance
b) 0.5% level of significance
c) Comment about the decisions made in (a) and (b) **12 Marks**

3) In a Poisson queue, there are 4 servers working in parallel. The mean arrival rate is 5 customers per hour and service time required by each server is exponentially distributed with an average time 0.125 hour per customer. There is no restriction on the number of customers who can join the system. Size of the population of the prospective customers is very large. FCFS queue discipline is adopted.

15 Marks

a) Find the probability that there is no customer in the system at any instant.
b) Find the proportion of time that a server is idle.
c) Find the probability that all servers are busy.
d) Find the probability that there are exactly 6 customers in the system at any instant.

4) For a given (M/M/S):(FCFS/K/K) machine repair model, TELCO operates a machine shop with a total of 6 machines. There are three repairmen working in the shop. If probability that all repairmen are idle is 0.11 and also $P_2 = 0.4125$, then

18 Marks

a) What is the probability that at least one repairman is idle?
b) What fraction/ proportion of time repairman is busy?

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TEST– II (Open Book) Date: 22.04.13

MARKING SCHEME

Solution 1.

a) $\bar{X} = 5.5$ ----- [3 marks]
$S^2 = 2.5057.$ ----- [4 marks]

b) Test statistic is : $T_{14} = \frac{(\bar{X}-\mu_0)\sqrt{n}}{S}$ ['or' $\bar{X}$] ..... [2 marks]

$t_{Obs} = 0.734$ ['or' $\bar{x} = 5.5$] ..... [2 marks]

c) Critical region is $C = \{t \geq t_{14,0.99}\} = \{t \geq 2.624\}$ ['or' $\{\bar{X} \geq 6.272\}$. ----- [3 marks]

d) The observed value does not belong to the critical region, so H_0 cannot be rejected. .... [1 mark]

2-

$H_0 : \mu_1 = \mu_2$

V_S ——— [1M]

$H_1 : \mu_1 > \mu_2$

$\bar{X}_1 = 202.18$

$\bar{X}_2 = 188.47$ ——— [1M]

$S_1^2 = 115.728$

$S_2^2 = 156.65$

$t = 2.626$ ——— [4M]

$\sigma = 11.67$

(a) $C = \{ s^2 > 1.734 \}$

$\Rightarrow$ Reject H_0

(b)

$C = \{ s^2 > 2.878 \}$

Accept H_0

——— [6M]

$\lambda = 5/hr$

$\mu = \frac{1}{0.125} = 8/hr$

$\rho = 0.625$ —— [1M]

(a) Prob. that there is no customer in the system $= P_0 = 0.53518$ —— [5M]

(b) Fraction of time server is idle

$= 1 - \frac{\lambda}{\mu s}$

$= 0.8437$ —— [3M]

(c) Prob. that all server are busy $= P(n \geq 4)$

$P(n \geq 4) = 4.03 \times 10^{-3}$ —— [3M]

(d) Exactly 6 customers in the system

$P_6 = 8.304 \times 10^{-5}$ —— [3M]

(4) Given that $P_0 = 0.11$ and $P_2 = 0.4125$

$P_n = {}^{K}C_n f^n \times P_0$ for $n = 0, 1, \ldots, s-1$

$P_2 = {}^{6}C_2 f^2 \times P_0$

$0.4125 = 15 \times f^2 \times 0.11 \Rightarrow f^2 = \frac{1}{4} \Rightarrow f = 0.5$

—— [4M]

(a) Probability that atleast one repairman is idle

$= P_0 + P_1 + P_2$

$= 0.11 + {}^{6}C_1 f^1 \times P_0 + 0.4125$

$= 0.8525$ —— [4M]

(b) $L_q = \sum_{n=3}^{K=6} (n-s) P_n$

$= P_4 + 2P_5 + 3P_6$

$= 0.1375 + 2 \times 0.04583 + 3 \times 0.007639$

$L_q = 0.2521$

$L = \frac{fK + L_q}{1+f} \Rightarrow L = 2.1681$ —— [8M]

Fraction of time repairman is busy $= \frac{\bar{\lambda}}{\mu s} = \frac{\lambda(K-L)}{\mu s}$

$= \frac{f(K-L)}{s} = 0.63865$

[2M]

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312)
TEST– I (Closed Book)

Date: 04.03.13
Time: 50 Minutes

Max. Marks: 75
Weightage: 25%

Attempt all the questions.

1) A company uses a particular raw material in its manufacturing process at the demand rate of 5000 kg per month. It costs Rs 200 to place an order for a new shipment. The holding cost per kg per month is 4 Rs and the shortage cost per kg is 5 Rs. Historical data show that the demand during lead time is uniform over the range (0, 50). Find (Q^*, R^*) i.e. the optimal ordering quantity and optimal re-order inventory. (Calculate values only up to two iterations). **20 Marks**

2) The daily demand for a commodity is 100 units. The item is produced locally with manufacturing cost Rs. 20 per unit and the setup cost Rs 100 per production run. The production rate is 200 units per day. The daily holding cost per unit inventory is 4 paise. If the lead time is 12 days, determine the re-order point. **10 Marks**

3) Nick's Camera Shop carries Zodiac instant print film. The film normally costs Nick $3.20 per roll. Nick's average sales are 250 rolls per day. Inventory holding cost is $0.50 per roll per day and it costs Nick $20 to place an order with Zodiac. Zodiac offers a 5% discount on orders of 700 rolls or more and a 10% discount for 900 rolls or more. Shortages are allowed and are fully backlogged with a shortage cost $0.20 per roll per day. Delivery (replenishment) rate is 300 rolls per day. Determine Nick's optimal order quantity. **20 Marks**

4) The following data represents enrollment in a course in one university for the past 6 semesters.

Semester	1	2	3	4	5	6
Enrollment	87	110	123	127	145	160

Prepare an exponential smoothing forecast using (i) α=0.35 and (ii) α =0.65 to find the forecast for 7th semester. Which value of α gives better forecast ? **15 Marks**

5) The following data give the means & ranges of 10 samples , each consisting of 4 values: **10 Marks**

Sample No	1	2	3	4	5	6	7	8	9	10
$\bar{X}$	38	42	43	29	44	45	49	39	40	41
R	1.3	2	2.7	4	1.5	6	2.1	2.6	3.1	3.2

a) Use the data to find CL, UCL and LCL for $\bar{X}$ chart.

b) Draw the control chart for mean. [Graph sheet is not required]

c) Is the process under control?

[TABLE VALUE: for n =4, $A_1 = 1.880$ & $A_2 = 0.729$]

BITS-Pilani Dubai Campus
Sem II 2012-13
Operations Research (O.R.)
T_1 — Closed Book

Date — 04/03/13

MARKING SCHEME

① $D = 5000$ kg/month $K = 200$/month $C_1 = 4$/kg/month

$C_2 = Rs\,5$/kg $f(x) = \frac{1}{b-a} = \frac{1}{50}$, $E(X) = \frac{a+b}{2} = 25$ kg

— [2M]

Feasibility

$$\frac{C_2 D}{C_1} = 6250 > \sqrt{\frac{2D(K+C_2 E(X))}{C_1}} = 901.39$$

$$\frac{C_2 D}{C_1} > \sqrt{\frac{2D(K+C_2 E(X))}{C_1}} \Rightarrow \text{Solution is feasible}$$

— [4M]

Iteration I

$$Q_1 = \sqrt{\frac{2KD}{C_1}}$$

$$Q_1 = 707.11 \text{ kg}$$

$$R_1 = 50 - \frac{Q_1}{125} \Rightarrow R_1 = 44.34 \text{ kg}$$

$$(Q_1, R_1) = (707.11, 44.34)$$

— [7M]

Iteration 2

$$S = 25 - R + \frac{R^2}{100}$$

$$S = 0.3203$$

$$Q_2 = \sqrt{2500(200+55)}$$

$$Q_2 = 709.93 \text{ kg}$$

$$R_2 = 44.32 \text{ kg}$$

[7M]

$$(Q^*, R^*) = (709.93, 44.32) \simeq (710, 44)$$

2- $D = 100$ units / day

$K = 100$ / run

$A = 200$ units / day

$C_1 = .04$ Rs

$$Q^* = EOQ = \sqrt{\frac{2KD}{C_1(1-D/A)}} \quad \text{—— [6 M]}$$

$Q^* = 1000$ units

$$OOC = t_0^* = \frac{Q^*}{D}$$

$t_0^* = 10$ days

Re-order level $(\ell) = D\ell'$

$= 100(12-10)$

$\ell = 200$ units —— [4M]

3. $D = 250,\ c_1 = 0.5,\ c_2 = 0.2,\ A = 300,\ K = 20$

$$c_0 = \begin{cases} 3.20 & \text{if } Q < 700 \\ 3.04 & \text{if } 700 \le Q < 900 \\ 2.88 & \text{if } Q \ge 900 \end{cases}$$ —— [2]

$$Q^{(0)} = \sqrt{\frac{2KD(c_1+c_2)}{c_1c_2\left(1-\frac{D}{A}\right)}}$$ —— [2]

$= 648.07 \approx 648,$ —— [1]

$TCU(Q^{(0)}) = TCU(648)$

$= 815.43$ —— [5]

$TCU(700) = 775.48$ —— [5]

$TCU(900) = 736.27$

$\therefore\ Q^* = 900$ rolls —— [5]

(4) $F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$

Start with $F_2 = A_1$ ——— [1M]

Semester	Enrolment	Forecast		A.D	
		α=0.35	α=0.65	α=0.35	α=0.65
1	87	87	87.00	0.00	0.00
2	110	87	87.00	23.00	23.00
3	123	95.05	101.95	27.95	21.05
4	127	104.83	115.63	22.17	11.37
5	145	112.59	123.02	32.41	21.98
6	160	123.93	137.31	36.07	22.69
7		136.56	152.06		
		Total deviation		141.59	100.09
		M.A.D		28.32	20.02

As M.A.D for α=0.65 is lesser in value than the M.A.D for α=0.35.

Therefore the better forecast for the 7th semester is 152.06 —— [14M]

(5)

a) $\hat{\mu} = \bar{\bar{x}} = 41$

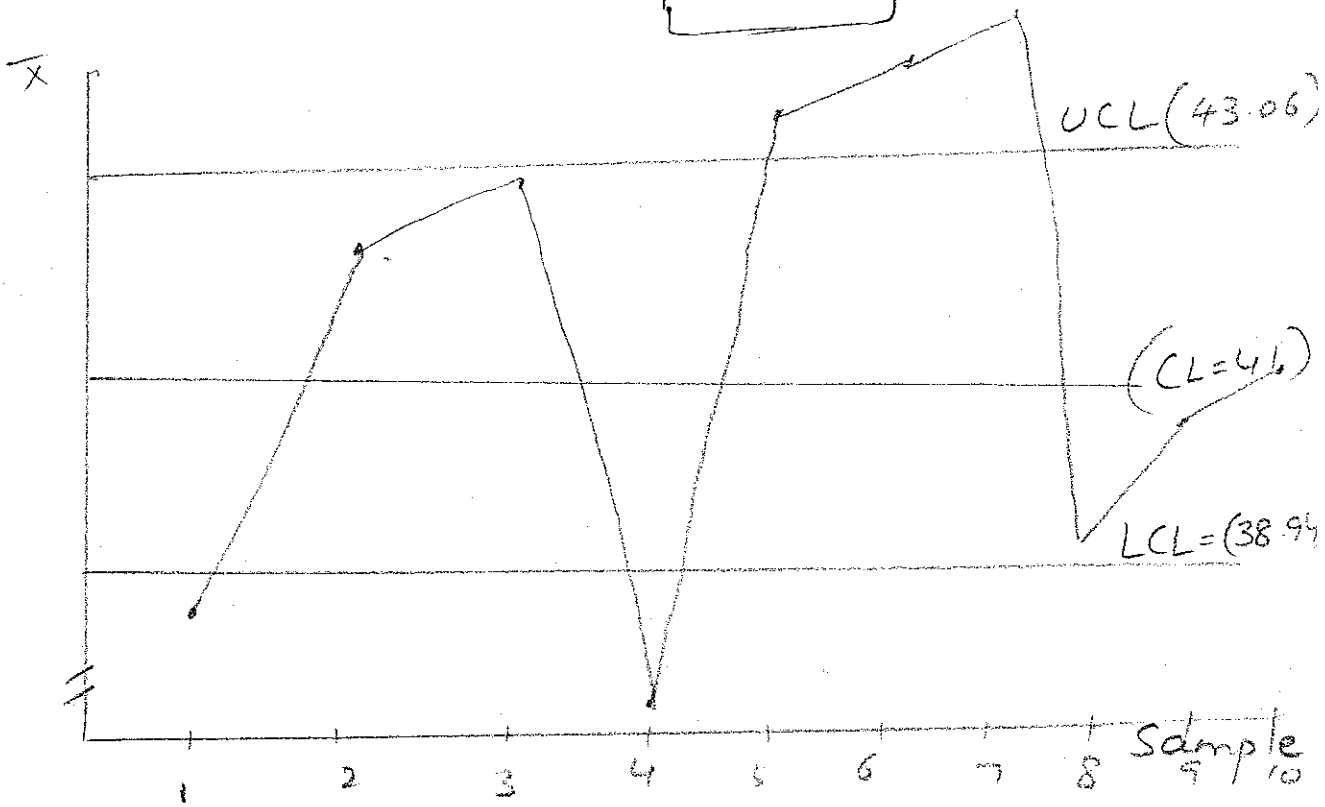
$\bar{R} = 2.83$

$CL = \boxed{41} = \hat{\mu}$

$UCL = \hat{\mu} + A_2 \bar{R} = 41 + (0.729)(2.83)$
$= \boxed{43.06}$

$LCL = \hat{\mu} - A_2 \bar{R} = 41 - (0.729)(2.83$
$= \boxed{38.94}$ — [6M]

b)



— [3M]

c) Process is out of control. — [1M]

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-A**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	11	16	20	12	15	18	11	20	16	11
Program 1	10	20	17	17	13	14	17	18	20	13

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is _____

2. In a Chi-square test for independence, the contingency table is given as follows: **6 Marks**

		A	
		A1	A2
B	B1	13	16
	B2	15	14

expected frequencies $\widehat{e_{11}}$ = _____, $\widehat{e_{12}}$ = _____, $\widehat{e_{21}}$ = _____, $\widehat{e_{22}}$ = _____
and the observed (calculated) value of chi-square test statistic is _____.

3. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 9:3:3:1. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

Then expected frequencies e_1 _____ e_2 _____ e_3 _____ e_4 _____

4. The data of $n = 8$, observations are given by 2.2, 3.1, 4.6, 3.5, 5.1, 2.6, 3.6, 2.7. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [1,3]. **3 Marks**

The value of empirical cdf for the observation 3.1 *i.e.* $F_n(3.1)$ is_____

5. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

Text A: 40, 50, 35, 45, 32, 56,
Text B : 50, 45, 35, 56, 48, 50, 56

If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistics W_x is _____ **4 Marks**

Space for Rough Work

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-A**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	11	16	20	12	15	18	11	20	16	11
Program 1	10	20	17	17	13	14	17	18	20	13

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is 19

2. In a Chi-square test for independence, the contingency table is given as follows: **6 Marks**

		A	
		A1	A2
B	B1	13	16
	B2	15	14

expected frequencies $\widehat{e_{11}}$ = 14, $\widehat{e_{12}}$ = 15, $\widehat{e_{21}}$ = 14, $\widehat{e_{22}}$ = 15
and the observed (calculated) value of chi-square test statistic is 0.27619

3. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 9:3:3:1. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

Then expected frequencies e_1 2159.44 e_2 719.81 e_3 719.81 e_4 239.94

4. The data of $n = 8$, observations are given by 2.2, 3.1, 4.6, 3.5, 5.1, 2.6, 3.6, 2.7. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [1,3]. **3 Marks**

The value of empirical cdf for the observation 3.1 *i.e.* $F_n(3.1)$ is $\frac{4}{8} = 0.5$

5. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

Text A: 40, 50, 35, 45, 32, 56,
Text B : 50, 45, 35, 56, 48, 50, 56

If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistics W_x is 34 **4 Marks**

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-A**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 9:3:3:1. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

   Then expected frequencies e_1_____ e_2_____ e_3_____ e_4_____

2. The data of $n = 8$, observations are given by 2.2, 3.1, 4.6, 3.5, 5.1, 2.6, 3.6, 2.7. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [1,3]. **3 Marks**

   The value of empirical cdf for the observation 3.1 *i.e.* $F_n(3.1)$ is_____

3. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

   Text A: 40, 50, 35, 45, 32, 56,

   Text B : 50, 45, 35, 56, 48, 50, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistics W_x is _____ **4 Marks**

4. In a Chi-square test for independence, the contingency table is given as follows:

6 Marks

		A	
		A1	A2
B	B1	13	16
	B2	15	14

expected frequencies $\widehat{e_{11}}$ = _____, $\widehat{e_{12}}$ = _____, $\widehat{e_{21}}$ = _____, $\widehat{e_{22}}$ = _____
and the observed (calculated) value of chi-square test statistic is _____.

5. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	11	16	20	12	15	18	11	20	16	11
Program 1	10	20	17	17	13	14	17	18	20	13

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is _____

Space for Rough Work

Answer sheet

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-B**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 8:4:2:2. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

   Then expected frequencies e_1 1919.5 e_2 959.75 e_3 479.875 e_4 479.875

2. The data of $n = 8$ observations are given by 3.2, 4.1, 5.6, 3.4, 4.5, 6.1, 3.6, 4.6. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [2,4]. **3 Marks**

   The value of empirical cdf for the observation 4.5 *i.e.* $F_n(4.5)$ is $\frac{5}{8} = 0.625$

3. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

   Text A: 40, 50, 35, 45, 32, 56,
   Text B : 32, 42, 50, 45, 35, 56, 48, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistic W_x is 41 **4 Marks**

4. In a Chi-square test for independence, the contingency table is given as follows:

6 Marks

		A	
		A1	A2
B	B1	14	18
	B2	20	16

expected frequencies $\widehat{e_{11}}$ = 16, $\widehat{e_{12}}$ = 16, $\widehat{e_{21}}$ = 18, $\widehat{e_{22}}$ = 18

and the observed (calculated) value of chi-square test statistic is $\frac{136}{144} = 0.944$

5. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	13	15	11	18	21	19	15	17	18	19
Program 1	11	21	16	25	17	13	23	13	17	16

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is 22.5

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-A**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 9:3:3:1. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

   Then expected frequencies e_1 2159.44 e_2 719.81 e_3 719.81 e_4 239.94

2. The data of $n = 8$, observations are given by 2.2, 3.1, 4.6, 3.5, 5.1, 2.6, 3.6, 2.7. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [1,3]. **3 Marks**

   The value of empirical cdf for the observation 3.1 *i.e.* $F_n(3.1)$ is $\frac{1}{2} = 0.5$

3. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

   Text A: 40, 50, 35, 45, 32, 56,

   Text B : 50, 45, 35, 56, 48, 50, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistics W_x is 34 **4 Marks**

4. In a Chi-square test for independence, the contingency table is given as follows:

6 Marks

		A	
		A1	A2
B	B1	13	16
	B2	15	14

expected frequencies $\widehat{e_{11}}$ = 14, $\widehat{e_{12}}$ = 15, $\widehat{e_{21}}$ = 14, $\widehat{e_{22}}$ = 15
and the observed (calculated) value of chi-square test statistic is 0.27619.

5. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2:

4 Marks

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	11	16	20	12	15	18	11	20	16	11
Program 1	10	20	17	17	13	14	17	18	20	13

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is 19

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-B**
Quiz I1

Date: 20.05.13 Max. Marks: 21
Time: 20 Minutes Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 8:4:2:2. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

   Then expected frequencies e_1 _____ e_2 _____ e_3 _____ e_4 _____

2. The data of $n = 8$ observations are given by 3.2, 4.1, 5.6, 3.4, 4.5, 6.1, 3.6, 4.6. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [2,4]. **3 Marks**

   The value of empirical cdf for the observation 4.5 *i.e.* $F_n(4.5)$ is_____

3. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test.

   Text A: 40, 50, 35, 45, 32, 56,
   Text B : 32, 42, 50, 45, 35, 56, 48, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistic W_x is _____ **4 Marks**

4. In a Chi-square test for independence, the contingency table is given as follows:

6 Marks

		A	
		A1	A2
B	B1	14	18
	B2	20	16

expected frequencies $\widehat{e_{11}}$ = _____, $\widehat{e_{12}}$ = _____, $\widehat{e_{21}}$ = _____, $\widehat{e_{22}}$ = _____
and the observed (calculated) value of chi-square test statistic is _____.

5. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	13	15	11	18	21	19	15	17	18	19
Program 1	11	21	16	25	17	13	23	13	17	16

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is _____

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-B**
Quiz I1

Date: 20.05.13
Time: 20 Minutes

Max. Marks: 21
Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test. **4 Marks**

   Text A: 40, 50, 35, 45, 32, 56,
   Text B : 32, 42, 50, 45, 35, 56, 48, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistic W_x is _____

2. In a Chi-square test for independence, the contingency table is given as follows: **6 Marks**

		A	
		A1	A2
B	B1	14	18
	B2	20	16

   expected frequencies $\widehat{e_{11}}$ = _____, $\widehat{e_{12}}$ = _____, $\widehat{e_{21}}$ = _____, $\widehat{e_{22}}$ = _____
   and the observed (calculated) value of chi-square test statistic is _____.

3. The data of $n=8$ observations are given by 3.2, 4.1, 5.6, 3.4, 4.5, 6.1, 3.6, 4.6. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [2,4]. **3 Marks**

   The value of empirical cdf for the observation 4.5 *i.e.* $F_n(4.5)$ is_____

4. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	13	15	11	18	21	19	15	17	18	19
Program 1	11	21	16	25	17	13	23	13	17	16

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is _____

5. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 8:4:2:2. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

Then expected frequencies e_1 _____ e_2 _____ e_3 _____ e_4 _____

Answer Scheme

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-B**
Quiz I1

Date: 20.05.13
Time: 20 Minutes

Max. Marks: 21
Weightage: 7%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. Two large classes were taught using two different textbooks A and B. The course content was same. The following random samples of marks out of 60 were obtained from these classes in a common test. **4 Marks**

   Text A: 40, 50, 35, 45, 32, 56,
   Text B : 32, 42, 50, 45, 35, 56, 48, 56

   If Wilcoxon's rank sum test is applied, the calculated (observed) value of test statistic W_x is 41

2. In a Chi-square test for independence, the contingency table is given as follows: **6 Marks**

		A	
		A1	A2
B	B1	14	18
	B2	20	16

expected frequencies $\widehat{e_{11}}$ = 16, $\widehat{e_{12}}$ = 16, $\widehat{e_{21}}$ = 18, $\widehat{e_{22}}$ = 18
and the observed (calculated) value of chi-square test statistic is $\frac{136}{144} = 0.944$

3. The data of $n = 8$ observations are given by 3.2, 4.1, 5.6, 3.4, 4.5, 6.1, 3.6, 4.6. Using Kolmogorov Smirnov test at 5% level we would like to test if the data could have come from uniform distribution on [2,4]. **3 Marks**

   The value of empirical cdf for the observation 4.5 *i.e.* $F_n(4.5)$ is $\frac{5}{8} = 0.625$

4. Consider the following 10 pairs of responses in a paired design for testing the null hypothesis that the two programs (P-1 and P-2) are alike against the alternative that Program -1 is superior to program -2: **4 Marks**

Pair No.	1	2	3	4	5	6	7	8	9	10
Program 1	13	15	11	18	21	19	15	17	18	19
Program 1	11	21	16	25	17	13	23	13	17	16

If Wilcoxon's Signed rank sum test is applied, the calculated (observed) value of test statistics T^+ is 22.5

5. In a dihybrid cross (AaBb x AaBb), the expected proportions of 4 phenotypes are 8:4:2:2. Observed frequencies from classic experiment with Starchy/sugary and Green/white seedlings, progeny of 3839 self fertilized heterozygotes (Starchy/green, Starchy/white, Sugary/green, Sugary/white) are $O_1 = 1997$, $O_2 = 906$, $O_3 = 904$, $O_4 = 32$, respectively. **4 Marks**

Then expected frequencies e_1 1919.5 e_2 959.75 e_3 479.88 e_4 479.875

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-B**
Quiz 1

Date: 25.03.13
Time: 20 Minutes

Max. Marks: 24
Weightage: 8%

Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. A queuing system represented by Kendal's notation $(M/M/x):(FCFS/x^2+2x/3x+6)$. If the maximum number of customers allowed in the system are equal to the prospective size of population, then no. of servers working are ---------- **4 M**

2. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 15 minutes. The probability that there are three customers in the system (P_3) is----------. **4 M**

3. Ships arrive at a refinery at the rate of 3 per week. The refinery has one unloading berth with an average service rate of 9 ships per week. Then average number of ships at refinery is----- **3M**

4. In an inventory problem it is estimated that EOQ is 548 units and optimum maximum inventory level of a product is 183 units when the demand for the product is 500 units/week and delivery (replenishment) rate is 1000 units/week. The optimum back ordering quantity is---------- and if the lead time is 0.4 weeks, then the optimum reorder level inventory is ---------- **4 M**

5. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum order quantity and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ---------- **3M**

6. For a given distribution having moment generating function e^{4t+36t^2}, the mean is ----------and its variance is --------- **3 M**

7. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=5X+4$ is ---------- **3 M**

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
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OPERATIONS RESEARCH (AAOC C 312) **SET-B**
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Date: 25.03.13
Time: 20 Minutes

Max. Marks: 24
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Name: **Id No:**

Attempt all the questions. No marks will be awarded for overwriting answers.

1. A queuing system represented by Kendal's notation $(M/M/x):(FCFS/x^2+2x/3x+6)$. If the maximum number of customers allowed in the system are equal to the prospective size of population, then no. of servers working are ---------3---------- **4 M**

2. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 15 minutes. The probability that there are three customers in the system (P_3) is---------$\frac{27}{256}$---------≡. 0.1055 **4 M**

3. Ships arrive at a refinery at the rate of 3 per week. The refinery has one unloading berth with an average service rate of 9 ships per week. Then average number of ships at refinery is---$\frac{1}{2}$ **3M**

4. In an inventory problem it is estimated that EOQ is 548 units and optimum maximum inventory level of a product is 183 units when the demand for the product is 500 units/week and delivery (replenishment) rate is 1000 units/week. The optimum back ordering quantity is----91---------- and if the lead time is 0.4 weeks, then the optimum reorder level inventory is ----109----- **4 M**

5. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum order quantity and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ---------$\frac{C_1+C_2}{C_1}$---------- **3M**

6. For a given distribution having moment generating function e^{4t+36t^2}, the mean is ---4-------and its variance is ----72 **3 M**

7. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=5X+4$ is ------$e^{4t}\cdot M_X(5t)$ **3 M**

BITS, PILANI – DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
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3. A queuing system represented by Kendal's notation $(M/M/x):(FCFS/x^2+2x/3x+6)$. If the maximum number of customers allowed in the system are equal to the prospective size of population, then no. of servers working are ---------- **4M**

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6. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=5X+4$ is---------- **3M**

7. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 15 minutes. The probability that there are three customers in the system (P_3) is---------- **4M**

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INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
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5. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum order quantity and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ----------$\frac{C_1+C_2}{C_1}$---------- **3M**

6. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=5X+4$ is--------$e^{4t}.M_X(5t)$ **3M**

7. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 15 minutes. The probability that there are three customers in the system (P_3) is------$\frac{27}{256}$ = 0.1055 **4M**

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INTERNATIONAL ACADEMIC CITY, DUBAI
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INTERNATIONAL ACADEMIC CITY, DUBAI
(III Year – II Semester 2012-2013)
OPERATIONS RESEARCH (AAOC C 312) **SET-A**
Quiz 1

Date: 25.03.13 Max. Marks: 24
Time: 20 Minutes Weightage: 8%

Name: **Id No:**

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1. A queuing system represented by Kendal's notation $(M/M/x):(FCFS/x^2+2x/3x+12)$. If the maximum number of customers allowed in the system are equal to the prospective size of population, then no. of servers working are ---4--- **4 M**

2. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 10 minutes. The probability that there are three customers in the system (P_3) is---$\frac{1}{16}$---0.0625 **4 M**

3. Ships arrive at a refinery at the rate of 3 per week. The refinery has one unloading berth with an average service rate of 10 ships per week. Then average number of ships at refinery is---$\frac{3}{7}$ = 0.4286 **3M**

4. In an inventory problem it is estimated that EOQ is 548 units and optimum back ordering quantity is 91 units when the demand for the product is 500 units/week and delivery (replenishment) rate is 1000 units/week. The optimum maximum inventory level of the product is ---183--- and if the lead time is 0.25 weeks, then the optimum reorder level inventory is ---34--- **4 M**

5. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum maximum inventory and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ----------$\frac{C_2}{C_1}$----------**3M**

6. For a given distribution having moment generating function e^{2t+18t^2}, the mean is ---2---and its variance is ---36 **3 M**

7. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=2X-3$ is ---$e^{-3t}M_X(2t)$ **3 M**

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5. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum maximum inventory and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ----------**3M**

6. For a given distribution having moment generating function e^{2t+18t^2}, the mean is ----------and its variance is --------- **3 M**

7. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y=2X-3$ is ---------- **3 M**

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1. For a given inventory model with infinite delivery (replenishment) rate and back ordering is allowed, the ratio between optimum maximum inventory and optimum back ordering inventory can be written in terms of holding cost and shortage cost as ----------**3M**

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7. For a given distribution having moment generating function e^{2t+18t^2}, the mean is ----------and its variance is --------- **3 M**

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2. A queuing system represented by Kendal's notation $(M/M/x):(FCFS/x^2+2x/3x+12)$. If the maximum number of customers allowed in the system are equal to the prospective size of population, then no. of servers working are -----4---------- **4 M**

3. Ships arrive at a refinery at the rate of 3 per week. The refinery has one unloading berth with an average service rate of 10 ships per week. Then average number of ships at refinery is---$\frac{3}{7} = .4286$ **3M**

4. If the moment generating function of X is $M_X(t)$, then moment generating function of $Y = 2X - 3$ is -----$e^{-3t} M_X(2t)$ **3 M**

5. In (M/M/1):(FCFS/∞/∞) queuing system, the mean arrival rate is 3 customers per hour and the mean service time for a customer is 10 minutes. The probability that there are three customers in the system (P_3) is------- -------$\frac{1}{16} = 0.0625$ **4 M**

6. In an inventory problem it is estimated that EOQ is 548 units and optimum back ordering quantity is 91 units when the demand for the product is 500 units/week and delivery (replenishment) rate is 1000 units/week. The optimum maximum inventory level of the product is ----183------ and if the lead time is 0.25 weeks, then the optimum reorder level inventory is ---34---- **4 M**

7. For a given distribution having moment generating function e^{2t+18t^2}, the mean is ----2------and its variance is ---36-- **3 M**