BITS, PILANI – DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
(III YEAR – II SEMESTER 2007-2008)

COMPREHENSIVE EXAMINATION (CB)

OPERATIONS RESEARCH
(AAOC UC 312)

Max. marks: 120 **Weightage: 40%** **Date: 31-5-2008** **Time: 3 Hours**

Notes:

- SECTION-A and SECTION – B should be answered in separate answer books. BLUE colour answer book is for SECTION-A and GREEN colour answer book is for SECTION-B.
- Attempt the questions in sequential order.
- Non-programmable calculator is permitted
- Necessary ***statistical table*** *values* are given in the last page

SECTION-A

1 A company is considering the construction of two repair facilities, each with different characteristics. On the average, 24 trucks require repairs each month and the arrivals are Poisson distributed. The loss of revenue (opportunity cost) to the firm of having a truck in repairs is estimated to be Rs. 300 per month. The two facilities which are under consideration have the following characteristics:

Characteristics	Facility A	Facility B
Installation cost	Rs.200,000	Rs.600,000
Labour cost per month	Rs.80,000	Rs.80,000
Repair rates (estimated)	30 trucks/month	60 trucks/month
Arrival rates (estimated)	24 trucks/month	24 trucks/month
Economic life	4 years	4 years

Determine which facility should be built by the company. [12]

2. (i) Generate a value of Geometric variable with parameter p=0.4. Use the following random numbers in the order of occurrence:
0.352, 0.25, 0.546, 0.852, 0.125.
(ii) Simulate a value of a gamma variable with n = 5 and $\alpha = 2$. Take the random numbers: 0.654, 0.55, 0.412, 0.900, and 0.712. [12]

3 In the past a production process used to produce items with a proportion of defectives $p \leq 0.1$. It is suspected that the p value has increased. To test the relevant hypotheses the following procedure is proposed: A random sample of 100 items will be taken. If the number X of defective items found satisfies $X \geq 15$, the null hypotheses will be rejected otherwise it will be accepted. What is the level of significance of this test? What is the probability of committing type II error when p =0.2? [12]

4. A company claims that the mean lifetime of its light bulbs are superior to those of its main competitor. If a study showed that a sample of 40 bulbs has a mean lifetime of 647 hours of continuous use with a standard deviation of 27 hours, while a sample of 40 bulbs made by its competitor had a mean lifetime of 638 hours of continuous use with a standard deviation of 31 hours. Does this substantiate the claim at 5% level of significance? [10]

5. There are four cars available for this comparative study of tyre performance. It is believed that tyres wearing out in a different rate at different location of a car. Tyres were installed in four different locations: Right-Front (RF), Left-Front (LF), Right-Rear (RR) and Left-Rear (LR). The measurements of the wearing of tyres in this investigation are listed in the following table from a Latin Square Design setting. Three factors are considered in this study. They are tyre position, car and the different tyres studied in this investigation.

	Positions			
Cars	RF	LF	RR	LR
1	A(32)	B(33)	C(47)	D(53)
2	B(36)	D(53)	A(42)	C(54)
3	C(51)	A(44)	D(62)	B(49)
4	D(81)	C(78)	B(72)	A(73)

Make an analysis of variance table from these data and test at 1% level of significance the null hypotheses that: i) there is no significant difference in average tyre wearing between different tyre positions, ii) there is no significant difference in average tyre wearing between different cars used, iii) no significant difference in average tyre wearing between different brands of tyres.

[14]

SECTION-B

6. The following table gives the ranges of 25 samples each of size 5:

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Range	2.5	2.8	2.0	2.5	2.2	2.8	1.5	2.6	2.5	1.4	1.8	2.4	1.6
Sample No.	14	15	16	17	18	19	20	21	22	23	24	25	
Range	1.8	2.2	3.0	1.8	2.3	2.6	2.0	2.5				2.5	

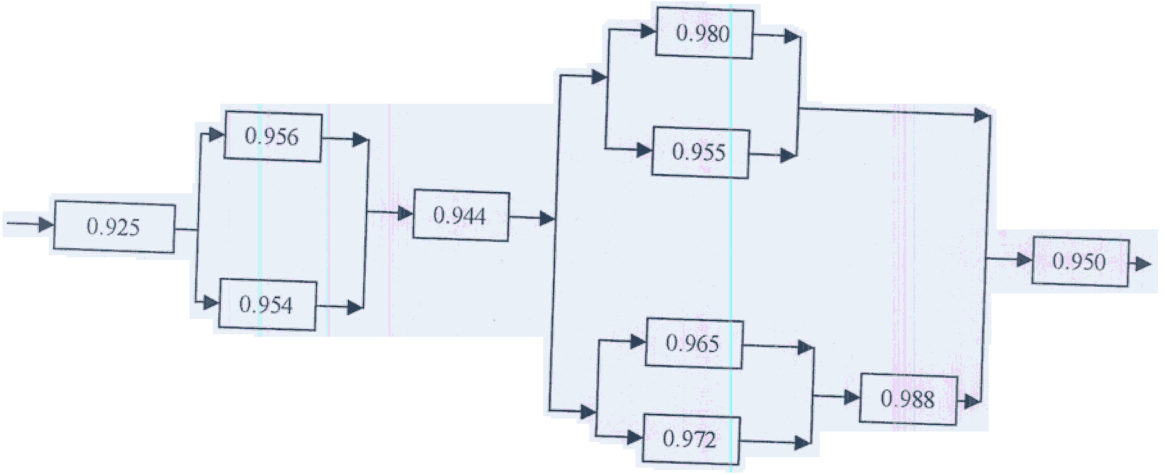
a) Find the control limits for a R-chart.

b) Draw the R-chart. (*Draw in the answer book, graph paper is not required)*

c) Is the process under control? [12]

7. Find the reliability of the system connected as below where the numbers inside the boxes indicate the reliabilities of the corresponding components. Assume that the components function independently. *In all steps at least 4 decimal places must be considered.*:

[12]



8. Consider an infinite horizon inventory model with finite replenishment rate and backlogged shortages. The demand rate is 250 units per day; delivery (replenishment) rate is 450 units per day, ordering cost is AED150.00 per order. It is given that holding cost is 10% of the unit cost (purchase cost) per unit per day and shortage cost is 12% of the unit cost per unit per day. If the TCU* is found to be AED 3915.14, then find

   a) unit cost, holding cost and shortage cost;
   b) EOQ, OOC, EBQ.

[12]

9. In a public opinion poll surveyed a simple random sample of 1000 voters. Respondents were classified by gender (male or female) and by voting preference (Congress(I), BJP, SP or RJD). Results are shown in the contingency table below:

	Voting Preferences			
	Cong(I)	BJP	SP	RJD
Male	190	100	60	50
Female	200	280	70	50

Do the data indicate that voting preferences are independent of the gender (male and female)? Use a 0.05 level of significance.

[12]

10. It is required to compare the marks received by male and female students in a certain standard test. A pair design is adopted with 9 pairs of students. Each pair contains a male and a female student with same IQ. Their marks (out of 100) are recorded below:

Pair No.	1	2	3	4	5	6	7	8	9
Marks (Male)	51	90	68	83	65	75	71	85	79
Marks (Female)	45	55	95	80	70	50	99	88	74

Test the null hypothesis that marks obtained by male and female students are identical versus 2-sided alternative. Use signed rank-sum test with $\alpha = 0.05$. [12]

TABLE VALUES: (As per standard notation)

$F_{3,3,0.99} = 29.5$ $F_{3,6;0.99} = 9.78$ $F_{3,3;0.95} = 9.2766$
$F_{6,3;0.99} = 27.9$ $F_{6,3;0.95} = 8.9406$ $F_{3,6;0.95} = 4.7571$
$Z_{0.05} = -1.645$

For $n = 5$, $D_1 = 0$, $D_2 = 4.918$, $D_3 = 0$ and $D_4 = 2.115$; $\chi^2_{3,0.05} = 0.352$, $\chi^2_{3,0.95} = 7.815$;

Wilcoxon's signed rank-sum values: for n=9, $x^* = 5$ *and* $x = 40$.

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706

BITS, PILANI – DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
(III YEAR – II SEMESTER 2007-2008)

TEST– II (OB)

OPERATIONS RESEARCH
(AAOC UC 312)

Max. marks: 60 **Weightage: 20%** **Date: 04-5-2008** **Time: 50 Minutes**

Note: Prescribed Text Book (EDD Notes) or its photocopy, Statistical tables, hand-written class notes, non-programmable calculator are permitted.

Attempt all the questions

1. In a certain study following observations were recorded for the amount of time (in months) a surveillance camera would run without having to be reset:
   4.1, 6.3, 5.3, 3.5, 0.3
   Use the Kolmogorov- Smirnov test at 5% level to test whether these data could have come from an exponential population mean 4 months. [12]
   [Calculate values up to three decimal places]

2. Samples of three kinds of materials, subjected to extreme temperature changes, produced the following results. The number of materials A, B and C that crumbled were 41, 27 and 22 respectively. The number of materials A, B and C that remained intact were 79, 53 and 78 respectively. Use the 0.05 level of significance to test whether, under the stated conditions, the probability of crumbling is the same for the three kinds of materials. [12]

3. To test the effect of anger management therapy, 15 adolescents are randomly chosen. The Beck Depression Scale was administered to them before applying anger management therapy. The scale readings are recorded. After four weeks of undergoing the therapy the same scale was administered again. The scale readings are recorded again. The readings are shown in the following table:

Scale Reading (before therapy)	14	8	3	6	8	5	10	7	1	11	2	5	3	9	2
Scale Reading (after therapy)	15	4	5	6	6	8	8	8	0	12	2	2	6	4	0

   Test the null hypothesis that anger management therapy reduces the average reading by 2 units on the same scale against 2-sided alternative. Take $\alpha = 0.05$. Assume the normality. [Calculate up to 3 decimal places] [12]

4. After you turn in your report, you regret not having been able to make more confident statements about the validity of a car manufacturer's claim on average mileage (miles per gallon) of their cars. You have decided that in future test of cars if the sample mean is at least one mile per gallon less than the manufacturers claim, you would like to reject their claim. Assume that car mileage has normal distribution with variance 9.

a) How many tankful cars must you sample in future test to make the probability at most 0.05 that you will reject their claim when it is actually true?
b) If in the same problem sample size is taken as 40, then what is the level of significance? [12]

5. Two medicines are available to treat the patients having a particular disease. A medicine will be called more efficient if it takes less recovery time. To test the efficiency of the medicines, 24 patients (having that disease) are randomly chosen. Ten are treated with medicine-1 and remaining are treated with medicine -2. The recovery times are listed below:
Recovery Time (days): 5, 4, 7, 5, 3, 2, 2, 6, 5, 10
(Medicine-1)
Recovery Time (days): 4, 2, 5, 2, 8, 9, 1, 1, 3, 6, 9, 7, 1, 4
(Medicine-2)
Do the data indicate that medicine-2 is more efficient than medicine-1? Use Wilcoxon's rank-sum test at 5% level of significance. Define appropriate null and alternative hypotheses. [12]
[Calculate up to 3 decimal places]

BITS, PILANI – DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
(III YEAR – II SEMESTER 2007-2008)

TEST– I (CB)

OPERATIONS RESEARCH
(AAOC UC 312)

Max. marks: 75 Weightage: 25% Date: 23-3-2008 Time: 50 Minutes

Attempt all the questions.

a) Use Box-Muller method to generate a pair of values of a random variable X having normal distribution with $\mu = 4$ and $\sigma = 2$. Use the random numbers $u_1 = 0.254$ and $u_2 = 0.568$ to generate the values. [8]

b) Simulate a value of Weibull variate with $\alpha = 2, \beta = 0.2, \eta = 2$. Use the random number 0.534. [7]

2. In an inventory system, the replenishment rate is 200 units per day, demand rate is 125 units per day. If the unit cost is AED 5 per unit, carrying cost is AED1.25 per unit per day and the setup cost is AED 60 per order, then find EOQ, OOC and TCU*. Assume that shortages are not permitted. [15]

The demand of a certain commodity is 250 units per month. The set up cost is AED 350 per run and the carrying cost is AED 2 per unit per month. The unit cost depends on the ordering quantity Q and is as follows:

$$C_0 = \begin{cases} AED\ 6 & if \quad Q < 200 \\ AED\ 5 & if \quad 200 \le Q < 300 \\ AED\ 4 & if \quad 300 \le Q < 400 \\ AED\ 3 & if \quad Q \ge 400 \end{cases}$$

Assume that replenishment is instantaneous and shortages are not allowed. Find EOQ, OOC and TCU*. [15]

All messages are passing through a switch. The switch has infinite buffer. Messages come in a Poisson process with an average arrival rate of 20 per minute. The switch takes on average 2 seconds to pass a message. This passing time has exponential distribution.

a) Find the fraction of time that the switch is idle.
b) Find the expected number of messages in the system at any instant.
c) What is the average waiting time of a message in the queue? [15]

5. Customers arrive at a single-window drive-in restaurant according to a Poisson distribution with mean 10 per hour. Service time per customer is exponential with mean 5 minutes. The space in front of the window, including that for the in-service car can accommodate a maximum of 3 cars.

i) What is the probability that an arriving customer can drive directly to the window for service?
ii) What fraction of customers is lost?
iii) What is the mean effective rate of arrival in the system? [15]