AFRICA
UNIVERSITY

(A United Methodist-Related Institution)

"Investing in Africa's Future"

SECTION A: ANSWER ALL QUESTIONS

1. Define the following Operations Research terms:
   (a) Decision variable [2 Marks]
   (b) Sensitivity analysis [2 Marks]
   (c) Steady state [2 Marks]
   (d) Linear programming [2 Marks]
   (e) Queue discipline [2 Marks]

2. The Shader Electronics Company produces two products: the Shader Walkman, a portable CD/DVD player and the Shader Watch-TV, a wristwatch-size internet-connected colour television. The production process for each product is similar in that both require a certain number of hours of electronic work and a certain number of labour-hours in the assembly department. Each Walkman takes 4 hours of electronic work and 2 hours in the assembly shop. Each Watch-TV requires 3 hours in electronics and 1 hour in assembly. During the current production period, 240 hours of electronic time are available and 100 hours assembly department time are available. Each Walkman sold yields a profit of $7 and eac Watch-TV produced may be sold for a $5 profit. Shader's problem is to determine the be possible combination of Walkmans and Watch-TVs to manufacture to reach the maximu profit.

   a) Formulate this product-mix situation as a linear programming problem. [5 marks]
   b) Use the graphical method to find the optimal solution of the linear programming proble you formulated in (a) [9 marks]
   c) Write the dual simplex of the model you formulated in (a) [3 marks]
   d) Formulate the matrix form of the linear programming model [5 marks]

3. Typically, a simulation model will attempt to describe a business system by a number equations. These equations are characterised by four types of variables. State and explain t four variables [8 marks]

SECTION B: ANSWER ANY THREE (3) QUESTIONS

4. The arrival rate of customers at a banking counter follows a Poisson distribution with a mea of 45 per hour. The service rate of the counter clerk also follows a Poisson distribution with mean of 60 per hour.
   (a) What is the probability of having Zero customer in the system (P_0) [2 Marks]
   (b) What is the probability of having 5 customer in the system (P_5) [2 Marks]
   (c) Find L_s, L_q, W_s and W_q [8 Marks]
   (d) Derive the distribution of the number of arrival during a period t given that the inter-arrival time is exponential with mean $\frac{1}{\lambda}$ [8 Marks]

5. A company wants to produce a new product and has identified the following activities:

Activity	(i,j)	Activity predecessor	Activity Time (weeks)
a	(1,2)	-	16
b	(1,3)	-	14
c	(2,4)	a	8
d	(2,5)	a	5
e	(3,5)	b	4
f	(3,6)	b	6
g	(4,6)	c	10
h	(5,6)	d, e	15

a) Construct the project network **[3 marks]**
b) Calculate the earliest start and latest start times and slacks of the project. **[5 marks]**
c) Determine the critical path of the project **[2 marks]**
d) Explain the difference between Project Evaluation and Review Technique (PERT) and ath Method (CPM) **[6 marks]**
information required to crash the project **[4 marks]**

on table is given below. Each cell represents a shipping route (which is an arc rk and a decision variable in the LP formulation) and the unit shipping costs are pper right hand box in the cell.

	D1	D2	D3	SUPPLY
S1	15	30	20	50
S2	30	40	35	30
EMAND	25	45	10	

graphical representation of the transportation problem **[4 marks]**
e the LP model for this transportation problem **[7 marks]**
Iorthwest corner method to solve the transportation problem **[5 marks]**
ow you would apply the Minimum-Cost method to solve the problem **[4 marks]**

6. A transportati
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Critical P
e) State the

D

a) Draw the
b) Formulat
c) Use the N
d) Explain h

7. The Carpet Discount Store stocks carpet in its warehouse and sells it through an adjoining showroom. The store keeps several brands and styles of carpet in stock. However, its biggest seller is Super Shag carpet. The store has an estimated annual demand of 10 000 metres of carpet, an annual carrying cost of $0.75 per metre and an ordering cost of $150. The store opens 311 days annually.

a) Find the estimated quantity **[4 marks]**

b) Determine the following aspects of the inventory policy:

i) The economic order quantity **[2 marks]**

ii) The optimal number of orders per year **[2 marks]**

iii) The optimal time between orders **[3 marks]**

iv) The minimum total annual cost **[2 marks]**

c) Explain any five assumptions of the Economic Order Quantity model **[5 marks]**

d) Briefly explain why the Economic Order Quantity (EOQ) model is robust in terms of its cost parameters. **[2 marks]**

End of paper

ADDITIONAL INFORMATION

1. $K = \frac{C_c - C_n}{M}$

2. $M = T_n - T_c$

3. Let:
   o = optimistic time estimate
   m = most likely time estimate
   p = pessimistic time estimate

   $Mean\ (Expected\ Time)\text{: } t = \frac{o+4m+p}{6}$

   $Variance\text{: } \sigma^2 = \left(\frac{p-o}{6}\right)^2$

4. Social cost = Private costs + Negative Externalities

5. Social benefit = Private benefits + Positive externalities

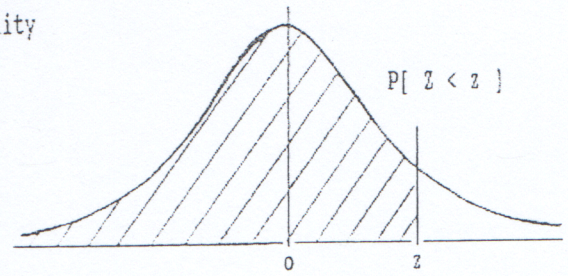
6. $Z = \frac{x-\mu}{\sigma}$

STANDARD STATISTICAL TABLES

1. Areas under the Normal Distribution

The table gives the cumulative probability up to the standardised normal value z

i.e. $$P[\, Z < z \,] = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} \exp(-\tfrac{1}{2}Z^2)\, dZ$$



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5159	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7854
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8804	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
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9773	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9865	0.9868	0.9871	0.9874	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9924	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986

z	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90
P	0.9986	0.9990	0.9993	0.9995	0.9997	0.9998	0.9998	0.9999	0.9999	1.0000