National Exams

May 2002

Production Management
Ind-A4

Notes

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made;

2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a **Closed Book** exam.

3. Any **five** questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.

4. All questions are equal value.

Q.1- Determine whether the following statements are true or false. **[2.5 points each]**

a) The highest level of detail for production planning is the aggregate plan, followed by the master production schedule (MPS), and then the materials requirement plan (MRP).

b) ABC analysis is used for identifying the degree of control appropriate for inventory items.

c) In general, work-in-process inventory is large for a product layout and small for a process layout.

d) One of the first steps toward JIT production involved the development of supplier networks.

e) Time series methods assume that what has occurred in the past will continue to occur in the future.

f) The objective of project crashing is to reduce project duration while minimizing the cost of crashing.

g) MRP was not designed for continuous or repetitive manufacturing, but for systems that produce goods in batches.

h) The EDD dispatching rule is optimal for $1//L_{max}$ problem.

Q.2- Consider the following 11 job, 2-machine problem. Find an optimal schedule that minimizes the makespan and draw the Gannt chart of your schedule. **[20 points]**

jobs	*first machine*	*processing time*	*second machine*	*processing time*
1	M1	5	M2	9
2	M1	4	M2	5
3	M1	6	M2	4
4	M2	4	M1	2
5	M2	2	M1	3
6	M2	7	M1	1
7	M2	4	M1	4
8	M2	7	M1	8
9	M1	6		
10	M1	4		
11	M2	3		

Q.3- Kugellager, Inc. produces ball bearings for several industrial clients. The accounting department has estimated that it costs $50 to initiate a production run, each unit costs the company $2 to manufacture, and uses an annual interest rate of 30% to compute holding costs. The ball bearing is produced at a rate of 10,000 units per year. The company experienced a relatively flat demand of 2,500 units per year for the product.

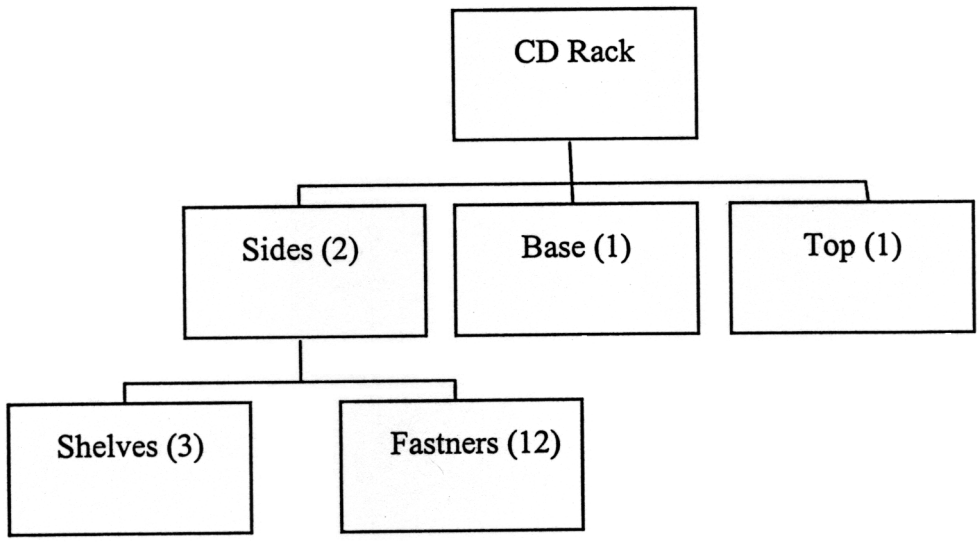
a) Determine the optimal size of a production run **[5 points]**

b) Determine the length of each production run **[5 points]**

c) Estimate the average annual cost of holding and set up. **[5 points]**

d) What is the maximum level of the on-hand inventory? **[5 points]**

Q.4- Your CD-Rack business is in danger of going under unless you address the costs associated with your supply chain. You have been producing the CD-Rack in house according to the following product structure diagram. The number in parentheses represents the number of the respective components in one unit of the final assembly.



Production or lead times and shipping times (between plants and/or warehouses) are given below for each component or sub-assembly.

Part	Production (Lead) Time	Shipping Time
	1/2 week	1/2 week
	1/4 week	3/4 week
	1 week	1 week
Top	1 week	2 weeks
CD Rack (Final Assembly)	1 week	0 week

Predicted demand, scheduled receipts and inventory for the final assembly are as follows:

Period	0	1	2	3	4
Gross Requirements		400	350	100	225
Scheduled Receipts		0	50	0	10
Beginning Inventory		50			
Net Requirements					
Time Phased Net Req.					

a) Consider the Base. Assume a set-up cost of $500 in each period of production and a holding cost of $1.00 per unit per period. Use the Part-Period Balancing heuristic to determine the lot-sizes to meet the demand requirements. Use the inventory and scheduled receipt information provided in the following table. Complete the table with your solution. What is the total cost of your lot-sizing solution (set-up plus holding costs) for the Base? **[10 points]**

Period	-2	-1	0	1	2	3	4
Gross Requirements							
Scheduled Receipts			0	0	0	30	
Beginning Inventory			50				
Net Requirements							
Time Phased Req.							
Planned Order Release							
Planned Delivery							
Ending Inventory							

b) Consider the Sides. Assume a set-up cost of $250 in each period of production and a holding cost of $1.00 per unit per period. Use the Silver-Meal heuristic to determine the lot-sizes to meet the demand requirements. Use the inventory and scheduled receipt information for the Sides provided in the following table. Complete the table with your solution. What is the total cost of your lot-sizing solution (set-up plus holding costs) for the Sides? **[10 points]**

Period	-2	-1	0	1	2	3	4
Gross Requirements							
Scheduled Receipts			0	0	0	30	
Beginning Inventory			50				
Net Requirements							
Time Phased Req.							
Planned Order Release							
Planned Delivery							
Ending Inventory							

Q.5- Consider the assembly line balancing problem with the given data below:

Task	Time (min)	Immediate Predecessor(s)
1	0.22	-
2	0.70	1
3	0.42	1
4	0.38	1,3
5	0.48	2,3
6	0.12	5
7	0.63	3,5
8	0.52	4
9	0.34	6,7
10	0.80	7,8
11	0.70	9,10

Assume that the planned cycle time is 0.9 minute and the planned production rate is 500 units per day.

a) Draw the precedence diagram. **[5 points]**

b) Using Ranked Positional Weight (RPW) Procedure, balance the tasks with the minimal number of stations. **[10 points]**

c) Find the efficiency and actual production rate of the line you found in part a. **[5 points]**

Q.6- A computer consultant is developing a software project. Before embarking on the project, she decides that it is important to consider the uncertainty of the times required for certain tasks. As with any software project, unanticipated bugs can surface and cause significant delays. Based on her past experience, the programmer decides that the minimum/maximum/most likely ($a/b/m$) number of weeks for each task follow as in the following table.

Task	Immediate Predecessor(s)	a	b	m
A	-	2	4	3
B	A	2	10	4
C	A	2	2	2
D	B,C	4	12	6
E	C	2	8	5
F	C	2	8	3
G	E	3	10	7
H	E,F	3	9	5
I	D,G,H	5	18	8

a) Find the critical path and the expected project completion time. **[10 points]**

b) Find the number of weeks required to complete the project with probability 0.90. **[10 points]**

Q.7- Demand for T-shirts at your store over the past seven years is shown below. A consulting firm has used a linear regression model to fit a line of the form $y=a+bx$ to the data where the independent variable is the year and the dependent variable is demand. The consulting firm has determined the best values of a and b as a=-40.27 and b=119.89

Year	Demand	Estimated Demand *(y=-40.27+119.89x)*
1	154	79.62
2	188	199.51
3	268	319.4
4	382	439.29
5	502	559.18
6	782	679.07

a) Determine whether or not the consulting firm's model is a good fit for the data by calculating R^2 value. Is their model a good fit? **[5 points]**

b) Suppose you believe that a time series model would be better suited for this situation. You believe that there is a trend present, but no seasonality. Use an appropriate exponential smoothing model to forecast demand for year 10. (You may use smoothing parameters of 0.4 – *Note that the calculations are started below)* **[5 points]**

Year	F(t)	T(t)
1	154.00	0.00
2	167.60	5.44
3	211.02	20.63
4	291.79	44.69

c) Calculate the BIAS for the time series model. What does this tell you about the model? **[5 points]**

d) If you used a 3 period moving average, what would you predict demand to be in year 10? Do you believe that a moving average would be an appropriate model for this data? Why or why not? **[5 points]**

TABLE Cumulative Probabilities of the Standard Normal Distrib

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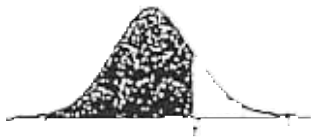

z	0,00	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08	0,09
−3,4	0,0003	0,0003	0,0003	0,0003	0,0003	0,0003	0,0003	0,0003	0,0003	0,0002
−3,3	0,0005	0,0005	0,0005	0,0004	0,0004	0,0004	0,0004	0,0004	0,0004	0,0003
−3,2	0,0007	0,0007	0,0006	0,0006	0,0006	0,0006	0,0006	0,0005	0,0005	0,0005
−3,1	0,0010	0,0009	0,0009	0,0009	0,0008	0,0008	0,0008	0,0008	0,0007	0,0007
−3,0	0,0013	0,0013	0,0013	0,0012	0,0012	0,0011	0,0011	0,0011	0,0010	0,0010
−2,9	0,0019	0,0018	0,0017	0,0017	0,0016	0,0016	0,0015	0,0015	0,0014	0,0014
−2,8	0,0026	0,0025	0,0024	0,0023	0,0023	0,0022	0,0021	0,0021	0,0020	0,0019
−2,7	0,0035	0,0034	0,0033	0,0032	0,0031	0,0030	0,0029	0,0028	0,0027	0,0026
−2,6	0,0047	0,0045	0,0044	0,0043	0,0041	0,0040	0,0039	0,0038	0,0037	0,0036
−2,5	0,0062	0,0060	0,0059	0,0057	0,0055	0,0054	0,0052	0,0051	0,0049	0,0048
−2,4	0,0082	0,0080	0,0078	0,0075	0,0073	0,0071	0,0069	0,0068	0,0066	0,0064
−2,3	0,0107	0,0104	0,0102	0,0099	0,0096	0,0094	0,0091	0,0089	0,0087	0,0084
−2,2	0,0139	0,0136	0,0132	0,0129	0,0125	0,0122	0,0119	0,0116	0,0113	0,0110
−2,1	0,0179	0,0174	0,0170	0,0166	0,0162	0,0158	0,0154	0,0150	0,0146	0,0143
−2,0	0,0228	0,0222	0,0217	0,0212	0,0207	0,0202	0,0197	0,0192	0,0188	0,0183
−1,9	0,0287	0,0281	0,0274	0,0268	0,0262	0,0256	0,0250	0,0244	0,0239	0,0233
−1,8	0,0359	0,0352	0,0344	0,0336	0,0329	0,0322	0,0314	0,0307	0,0301	0,0294
−1,7	0,0446	0,0436	0,0427	0,0418	0,0409	0,0401	0,0392	0,0384	0,0375	0,0367
−1,6	0,0548	0,0537	0,0526	0,0516	0,0505	0,0495	0,0485	0,0475	0,0465	0,0455
−1,5	0,0668	0,0655	0,0643	0,0630	0,0618	0,0606	0,0594	0,0582	0,0571	0,0559
−1,4	0,0808	0,0793	0,0778	0,0764	0,0749	0,0735	0,0721	0,0708	0,0694	0,0681
−1,3	0,0968	0,0951	0,0934	0,0918	0,0901	0,0885	0,0869	0,0853	0,0838	0,0823
−1,2	0,1151	0,1131	0,1112	0,1093	0,1075	0,1056	0,1038	0,1020	0,1003	0,0985
−1,1	0,1357	0,1335	0,1314	0,1292	0,1271	0,1251	0,1230	0,1210	0,1190	0,1170
−1,0	0,1587	0,1562	0,1539	0,1515	0,1492	0,1469	0,1446	0,1423	0,1401	0,1379
−0,9	0,1841	0,1814	0,1788	0,1762	0,1736	0,1711	0,1685	0,1660	0,1635	0,1611
−0,8	0,2119	0,2090	0,2061	0,2033	0,2005	0,1977	0,1949	0,1922	0,1894	0,1867
−0,7	0,2420	0,2389	0,2358	0,2327	0,2296	0,2266	0,2236	0,2206	0,2177	0,2148
−0,6	0,2743	0,2709	0,2676	0,2643	0,2611	0,2578	0,2546	0,2514	0,2483	0,2451
−0,5	0,3085	0,3050	0,3015	0,2981	0,2946	0,2912	0,2877	0,2843	0,2810	0,2776
−0,4	0,3446	0,3409	0,3372	0,3336	0,3300	0,3264	0,3228	0,3192	0,3156	0,3121
−0,3	0,3821	0,3783	0,3745	0,3707	0,3669	0,3632	0,3594	0,3557	0,3520	0,3483
−0,2	0,4207	0,4168	0,4129	0,4090	0,4052	0,4013	0,3974	0,3936	0,3897	0,3859
−0,1	0,4602	0,4562	0,4522	0,4483	0,4443	0,4404	0,4364	0,4325	0,4286	0,4247
−0,0	0,5000	0,4960	0,4920	0,4880	0,4840	0,4801	0,4761	0,4721	0,4681	0,4641
0,0	0,5000	0,5040	0,5080	0,5120	0,5160	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	0,7852
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	0,8810	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	0,9278	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	0,9772	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	0,9864	0,9868	0,9871	0,9875	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	0,9925	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	0,9979	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
3,0	0,9987	0,9987	0,9987	0,9988	0,9988	0,9989	0,9989	0,9989	0,9990	0,9990
3,1	0,9990	0,9991	0,9991	0,9991	0,9992	0,9992	0,9992	0,9992	0,9993	0,9993
3,2	0,9993	0,9993	0,9994	0,9994	0,9994	0,9994	0,9994	0,9995	0,9995	0,9995
3,3	0,9995	0,9995	0,9995	0,9996	0,9996	0,9996	0,9996	0,9996	0,9996	0,9997
3,4	0,9997	0,9997	0,9997	0,9997	0,9997	0,9997	0,9997	0,9997	0,9997	0,9998

Selected Percentiles

Cumulative probability	$\Phi(z)$	.99	.95	.9	.05	.01	.005	.001
		1.282	1.645		2.054	2.326		