1. (10%) NCK's plant estimates weekly demand for its many materials held in inventory. One such part, the P2, is being studied. The most recent 12 weeks of demand for the P2 are:

Week	Demand (units)	Week	Demand (units)	Week	Demand (units)	Week	Demand (units)
1	169	4	171	7	213	10	158
2	227	5	163	8	175	11	188
3	176	6	157	9	178	12	169

a) Use the moving average method of short-range forecasting with an average period of three weeks to develop a forecast of the demand for the P2 component in Week 13.

b) If a smoothing constant of 0.25 is used and the exponential smoothing forecast for Week 11 was 170.76 units, what is the exponential smoothing forecast for Week 13?

2. (8%) For a two-machine scheduling problem as follows, use Johnson's algorithm to determine the optimal solution to minimize the makespan. You need to explain clearly how you find the solution.

Job	Time on M1	Time on M2
1	4	9
2	7	10
3	6	5

3. (8%) Suppose the demand for a part is given by the gross requirements from the following master production schedule. The current on-hand inventory is 30 units. The order lot size is 75 units. The production lead-time is one week. Please fill in the blank cells in the following table. You need to copy the following table to your solution sheet and to write your solutions in proper positions.

Week	0	1	2	3	4	5	6	7	8
Gross requirements		15	20	50	10	30	30	30	30
Projected on-hand	30								
Net requirement									
Planned order receipts									
Planned order releases									

4. (12%) Given the following notation.

   t = a time period

   D_t = demand in period t

   c_t = unit production cost (in dollar per unit), not counting setup or inventory costs in period t

   A_t = setup cost to produce a lot in period t (in dollar)

   h_t = holding cost to carry a unit of inventory from period t to period t+1

   Find the optimal lot-sizing policy for the following demand scenario. (Hint: You may use Wagner-Whitin procedure)

t	1	2	3	4	5
D_t	20	50	10	50	50
c_t	10	10	10	10	10
A_t	100	100	100	100	100
h_t	1	1	1	1	1

5. (10%) Just-in-time (JIT) production seeks to achieve the following goals: zero defects, zero set-up time, zero inventories, zero handling, zero breakdowns, zero lead time, and lot size of one. Explain clearly the rationale for these goals.

6. (10%) The Optimized production technology (OPT) philosophy (also known as Theory of Constraints) contends that improving productivity is any step that takes the company closer to its goal. The only goal for a manufacturing company is *to make money*. The goal can be represented by the measurements: throughput, inventory, and expenses.

   a) Explain clearly the relationship between the goal and each of the three measurements.

   b) Are there any conflicts among those three measurements?

7. (14%) A firm produces two products, which we will call products 1 and 2. The following table gives descriptive data for these two products. In addition to the direct raw material costs associated with each product, we assume a $5,000 per week fixed cost for labor and capital. Furthermore, there are 2,400 minutes per week of time available on workstations A to D. We assume that all these data are identical from week to week.

Product	P	Q
Selling price	$90	$100
Raw Material Cost	$45	$40
Max Weekly Sales	100	50
Minutes per unit on Workcenter A	15	10
Minutes per unit on Workcenter B	15	30
Minutes per unit on Workcenter C	15	5
Minutes per unit on Workcenter D	15	5

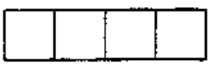
Find the optimal production plan by using a linear programming method.

8. (8%) Part X requires machining on a milling machine (operations A and B are required). Find the number of machines required to produce 2,500 parts per week. Assume the company will be operating 5 days per week, 18 hours per day. The following information is known:

Operation	Standard time	Efficiency	Reliability	Scrap
A	2 min	95%	95%	2%
B	4 min	95%	90%	5%

Note: the milling machine requires tool changes and preventive maintenance after every lot of 400 parts. These changes require 30 minutes.

9. (12%) Consider four departments of equal sizes. The initial layout and the material flows between departments are shown as follows. Use the pairwise exchange method to improve the layout.



	1	2	3	4
1	--	10	15	20
2		--	10	5
3			--	5
4				--

10. (8%) Automatic machinery is used to fill and seal 10-pz cans of a certain liquid product. The process standard deviation is 0.20 oz. To ensure that every can meets or exceeds this 10-oz minimum, the company has set a target value for the process of 11.0 oz. (Hint: You may use the attached normal curve table.)

a) At this process average of 11 oz, what percent of the can will have less than 10.5 oz of product? Assume contained weights are normally distributed.

b) If the quality control section samples these cans in subgroups of four, what will 3-sigma control limits be for the $\overline{X}$ chart?

TABLE 4 Normal Curve Areas

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Source: Abridged from Table I of A. Hald. *Statistical Tables and Formulas* (New York: John Wiley & Sons, Inc.), 1952. Reproduced by permission of A. Hald and the publisher.