MBA 511 – Problem Set Solutions

Problem Set 1 Chapter 1: 9, 12 Chapter 2: 14, 15, 16, 17, 18, 23

9.

a. Compute the *receivable turnover ratio*.

$$\frac{\$18{,}785{,}000}{\$3{,}445{,}000} = 5.453$$

b. Compute the *inventory turnover ratio*.

$$\frac{\$12{,}600{,}000}{\$2{,}875{,}000} = 4.383$$

c. Compute the *asset turnover ratio*.

$$\frac{\$24{,}324{,}000}{\$10{,}550{,}000} = 2.306$$

12. Quicker payments will reduce the average amount of accounts receivables, so the receivables turnover ratio will increase.

Chapter 2

14. To answer this we need to realize that the measure of hours given is per machine, so we have to multiply that by the number of machines in each period to get the total machine hours in each period. Those figures are used in the calculations below.

Average productivity: (2300/975 + 1800/1000 + 2800/1600 + 3000/1280)/4

Average productivity (2.36+1.80+1.75+2.34)/4= 2.06 units per machine hour

15. We have to do some interim calculations here. Sales revenue is calculated by multiplying units sold by the unit sales price. Labor expense is calculated by multiplying labor hours by the wage rate.

(1217*1700) / (46672*12) = 3.69

16. Total productivity could be expressed two ways here based on how you express output: in units sold, or dollars of sales.

Units sold:
50,000 / ((620 * $7.50) + 30,000 + 15,350) = 1.00 units sold per dollar input

Dollars of sales:
(50000*3.5) / ((620 * $7.50) + 30,000 + 15,350) = 3.5 dollars in sales per dollar input

17. *Labor Productivity – units/hour*

Model	Output in Units	Input in Labor Hours	Productivity (Output/Input)
Deluxe Car	4,000	20,000	0.20 units/hour
Limited Car	6,000	30,000	0.20 units/hour

Labor Productivity – dollars

Model	Output in Dollars	Input in Dollars	Productivity (Output/Input)
Deluxe Car	4,000($8,000)= $32,000,000	20,000($12.00)= $240,000	133.33
Limited Car	6,000($9,500)= $57,000,000	30,000($14.00)= $420,000	135.71

The labor productivity measure is a conventional measure of productivity. However, as a partial measure, it may not provide all of the necessary information that is needed. For example, increases in productivity could result from decreases in quality, and/or increases in material cost.

18. Calculate partial labor and capital productivity figures for the parent and subsidiary. Do the results seem misleading?

Labor Productivity

Country	Output in Units	Input in Hours	Productivity (Output/Input)
U.S.	100,000	20,000	5.00 units/hour
LDC	20,000	15,000	1.33 units/hour

Capital Equipment Productivity

Country	Output in Units	Input in Hours	Productivity (Output/Input)
U.S.	100,000	60,000	1.67 units/hour
LDC	20,000	5,000	4.00 units/hour

Yes. You might expect the capital equipment productivity measure to be higher in the U.S. than in a LDC. Also, the measures seem contradictory. Each plant appears to be far more productive than the other on one measure, but much worse on the other.

b. Compute the multifactor productivity figures for labor and capital together. Do the results make more sense?

Multifactor – Labor and Capital Equipment

Country	Output in Units	Input in Hours	Productivity (Output/Input)
U.S.	100,000	20,000 + 60,000= 80,000	1.25 units/hour
LDC	20,000	15,000 + 5,000= 20,000	1.00 units/hour

Yes, labor and equipment can be substituted for each other. Therefore, this multifactor measure is a better indicator of productivity in this instance.

c. Calculate raw material productivity figures (units/$ where $1 = FC 10). Explain why these figures might be greater in the subsidiary.

Raw Material Productivity

Country	Output in Units	Input in Dollars	Productivity (Output/Input)
U.S.	100,000	$20,000	5.00 units/$
LDC	20,000	FC 20,000/$10 = $2,000	10.00 units/$

The raw material productivity measures might be greater in the LDC due to a reduced cost paid for raw materials, which is typical of LDC's, especially if there are local sources for the raw materials.

23.

Part	Output in Hamburger Equivalents	Input in Hours	Productivity (Output/Input)
700 Hamburgers 900 Cheeseburgers (1.25) 500 Chicken Sandwiches (.80)	2225	200	11.125
700 Hamburgers 700 Cheeseburgers (1.25) 700 Chicken Sandwiches (.80)	2135	200	10.675

Problem Set 2
Chapter 3: 10

5. Tuff Wheels Kiddy Dozer

a. Base case

Project Schedule	Year 1				Year 2				Year 3				Year 4			
Kiddy Dozer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development	333.3	333.3	333.3													
Pilot Testing			100	100												
Ramp-up			200	200												
Marketing and Support				37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Production Volume					15	15	15	15	15	15	15	15	15	15	15	15
Unit Production Cost					100	100	100	100	100	100	100	100	100	100	100	100
Production Costs					1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Sales Volume					15	15	15	15	15	15	15	15	15	15	15	15
Unit Price					170	170	170	170	170	170	170	170	170	170	170	170
Sales Revenue					2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550
Period Cash Flow	**-333**	**-333**	**-633**	**-338**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**	**1013**
PV Year 1 r = 8	**-326**	**-320**	**-597**	**-312**	**917**	**899**	**881**	**864**	**847**	**831**	**814**	**798**	**783**	**767**	**752**	**738**
Project NPV	**8336**															

b. The results are shown below for both scenarios. If sales are only 50,000 then the project is still worthwhile since the NPV decrease to $6,626,570. If Tuff Wheels has under estimated the sales and it ends up being 70,000 per year then NPV will increase from $8,503,000 base case to $10,046,063 with the higher sales rate.

Sales Revised to 50,000 per Year

Project Schedule	Year 1				Year 2				Year 3				Year 4			
Kiddy Dozer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development	333.3	333.3	333.3													
Pilot Testing			100	100												
Ramp-up			200	200												
Marketing and Support				37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Production Volume					12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Unit Production Cost					100	100	100	100	100	100	100	100	100	100	100	100
Production Costs					1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250	1250
Sales Volume					13	13	13	13	13	13	13	13	13	13	13	13
Unit Price					170	170	170	170	170	170	170	170	170	170	170	170
Sales Revenue					2125	2125	2125	2125	2125	2125	2125	2125	2125	2125	2125	2125
Period Cash Flow	**-333**	**-333**	**-633**	**-338**	**838**	**838**	**838**	**838**	**838**	**838**	**838**	**838**	**838**	**838**	**838**	**838**
PV Year 1 r = 8	**-327**	**-320**	**-597**	**-312**	**759**	**744**	**729**	**715**	**701**	**687**	**674**	**660**	**647**	**635**	**622**	**610**
Project NPV	**6627**															

Sales Revised to 70,000 per Year

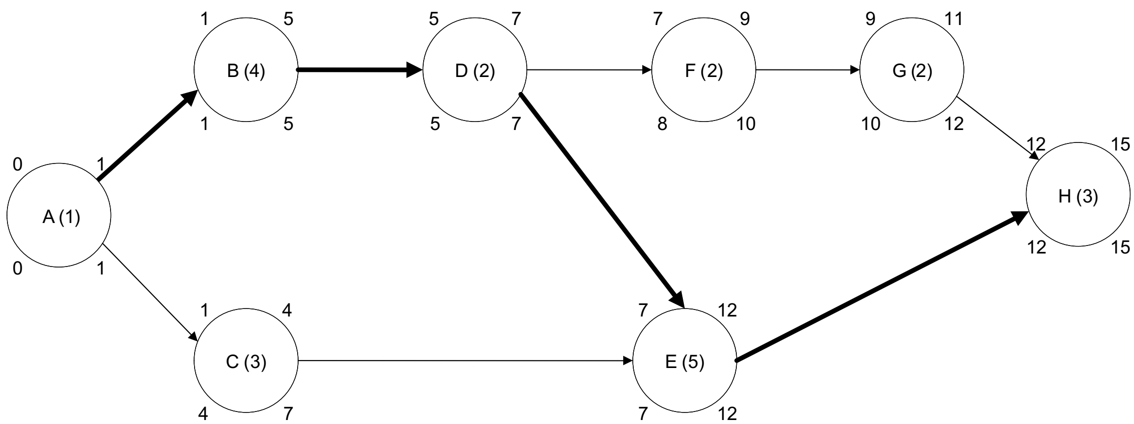
Project Schedule	Year 1				Year 2				Year 3				Year 4			
Kiddy Dozer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development	333.3	333.3	333.3													
Pilot Testing			100	100												
Ramp-up			200	200												
Marketing and Support				37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Production Volume					17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Unit Production Cost					100	100	100	100	100	100	100	100	100	100	100	100
Production Costs					1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Sales Volume					17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Unit Price					170	170	170	170	170	170	170	170	170	170	170	170
Sales Revenue					2975	2975	2975	2975	2975	2975	2975	2975	2975	2975	2975	2975
Period Cash Flow	**-333**	**-333**	**-633**	**-338**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**	**1188**
PV Year 1 r = 8	**-327**	**-320**	**-597**	**-312**	**1076**	**1054**	**1034**	**1014**	**994**	**974**	**955**	**936**	**918**	**900**	**882**	**865**
Project NPV	**10046**															

c. The impact of changing the interest rate is shown below. There is still a positive NPV but it shrinks the interest rate increases. This would be expected since a higher the interest rate reduces the present value of future cash flows.

Base Case	8%	$8,336,316
	9%	$8,100,970
	10%	$7,872,845
	11%	$7,651,694

Problem Set 3
Chapter 4: 6, 8

6. a. Draw the network path.



b. What is the critical path?

A-B-D-E-H, also shown in the network above as the bold path.

c. How many weeks will it take to complete the project?

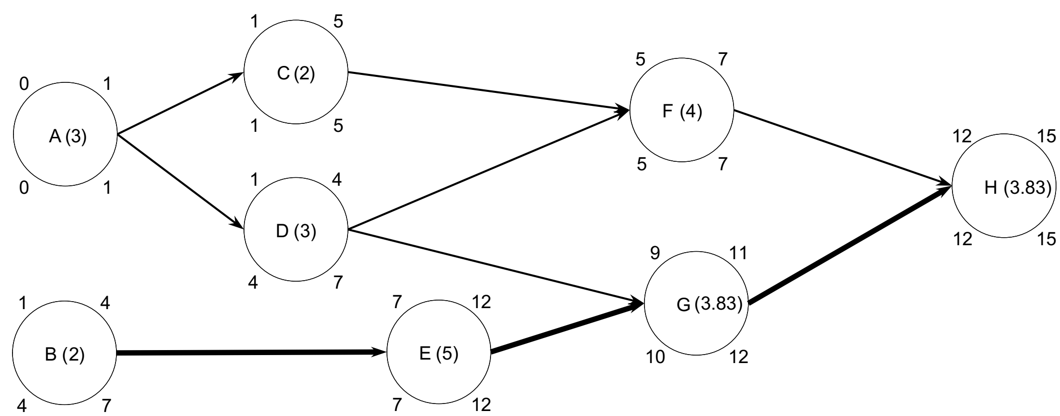
15 weeks, 1+4+2+5+3

d. Which activities have slack, and how much?

C, 3 weeks; F, 1 week; and G, 1 week.

8. a. Draw the network.

		TIMES (DAYS)				
ACTIVITY	IMMEDIATE PREDECESSORS	a	m	b	ET	σ^2
A	—	1	3	5	3	0.4444
B	**—**	**1**	**2**	**3**	**2**	**0.1111**
C	A	1	2	3	2	0.1111
D	A	2	3	4	3	0.1111
E	**B**	**3**	**4**	**11**	**5**	**1.7778**
F	C, D	3	4	5	4	0.1111
G	**D, E**	**1**	**4**	**6**	**3.833**	**0.6944**
H	**F, G**	**2**	**4**	**5**	**3.833**	**0.2500**



b. What is the critical path?

B-E-G-H

c. What is the expected project completion time?

2.00+5.00+3.833+3.833 = 14.67

d. What is the probability of completing this project within 16 days?

Variance of project completion time is found by adding the variances of activities on the critical path. .1111 + 1.7778 + .6944 + .2500 = 2.833

$$Z = \frac{(16 - 14.67)}{\sqrt{2.833}} = .79$$

P(T<16) = P(Z<.79) = .7852 (From Excel's NORMSDIST() function)

Problem Set 4
Chapter 5: 2, 4, 5, 9

2. $Capacity\ utilization\ rate = \frac{10{,}925}{15{,}000} = 72.83\%$

4.

Plastic	Year 1	Year 2	Year 3	Year 4
Demand for plastic sprinklers	97	115	136	141
Percentage of capacity used	48.5%	57.5%	68.0%	70.5%
Machine requirements	.485	.575	.680	.705
Labor requirements	1.94	2.30	2.72	2.82

Bronze	Year 1	Year 2	Year 3	Year 4
Demand for bronze sprinklers	21	24	29	34
Percentage of capacity used	58.3%	66.7%	80.6%	94.4%
Machine requirements	1.75	2.00	2.42	2.83
Labor requirements	3.50	4.00	4.83	5.66

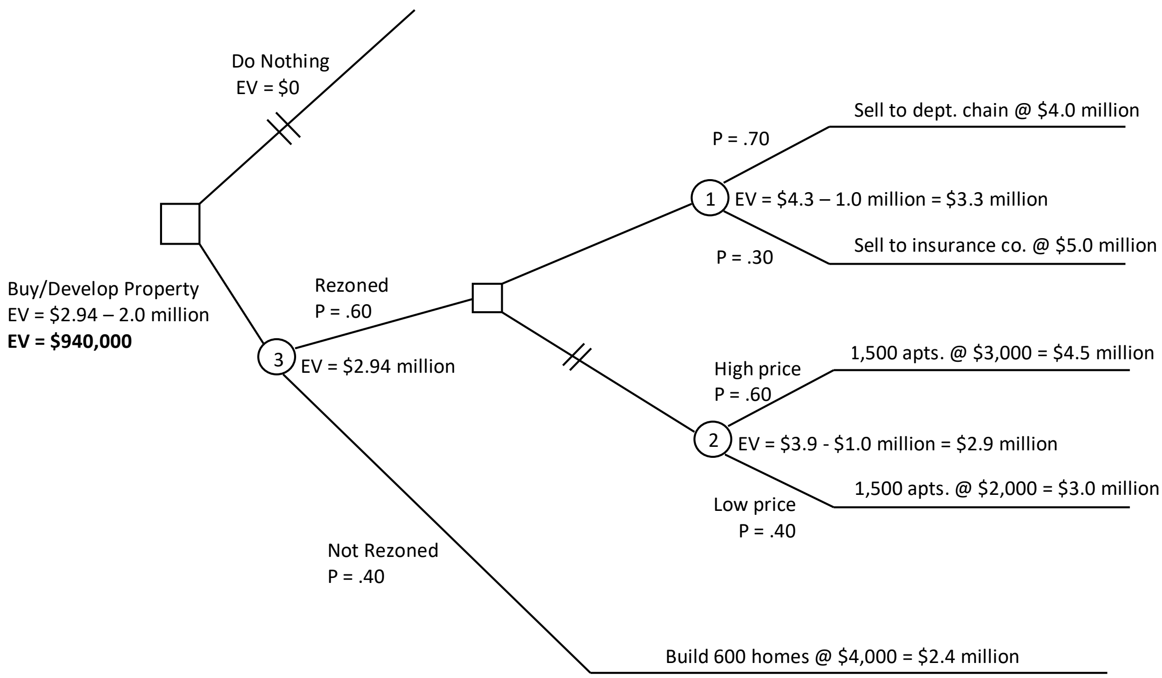
There is sufficient capacity to meet expected demand over the 4-year planning horizon. The only concern might be year 4 on the bronze line. Capacity is approaching 100% in that year, and forecast error might lead to an over-capacity situation. It is probably not a large concern at this point in time, but management should pay special attention to that point in time as forecasts are updated in the future.

5. Requirements for plastic remain unchanged.

Bronze	Year 1	Year 2	Year 3	Year 4
Demand for bronze sprinklers	32	36	41	52
Percentage of capacity used	88.9%	100.0%	113.9%	144.4%
Machine requirements	2.67	3	3.42	4.33
Labor requirements	5.33	6	6.83	8.67

It is obvious that not enough capacity is available after year two to meet the increased demand. AlwaysRain will have to consider purchasing additional machines for the bronze operations.

9.



The “Do Nothing” option is included here for completeness.

Rezoned shopping center (includes $1.0 rezoning costs):

Point 1: Expected value = .70($4 Million) + .30($5 Million) - $1.0 million = $3.3 Million

Rezoned apartments:

Point 2: Expected value = .60($4.5 Million) + .40($3 Million) - $1.0 million = $2.9 Million

Since a shopping center has more value, prune the apartment choice. In other words, if rezoned, build a shopping center with a revenue of $4.3 Million - $1 Million = $3.3 Million. (The purchase cost could be included here if desired, but would need to be included in the calculations for all development options. This solution shows it at the leftmost part of the tree.)

If not rezoned the revenue will be $2.4 million from building homes:

Point 3: Expected value of developing the land is .6*($3.3 million) + .4*($2.4 million) = $2.94 million.

Expected profit of buying and developing the land is $2.94 million - $2 million purchase cost = $940,000. Since this is a positive expected value, prune the option of doing nothing.

Problem Set 5 Ch. 7: 8, 9, 10

8.

a. FC = (P - VC) * Break-even (where FC = fixed cost, P = price, and VC = variable cost)
   $300,000 = ($23.00 - $8.00) * Break-even
   Break-even = 20,000 books
b. Higher
c. Lower

9.

FC = (P - VC) * Break-even (where FC = fixed cost, P = price, and VC = variable cost)
$150,000 = ($90 - $70) * Break-even
Break-even = 7,500 units.

10.

a. FC = (P - VC) * Break-even (where FC = fixed cost, P = price, and VC = variable cost).
   $900 = ($5.50 - $4.50) * Break-even
   Break-even = 900 units.
b. FC + profit = (P - VC) * V
   (where FC = fixed cost, P = price, and VC = variable cost, and V = Volume)
   $900 + $500 = ($5.50 - $4.50) * V
   V = 1400 units.
c. $0.25 Profit per unit = (P-VC)*V - FC)/V
   $.25 = (($5.50 - $4.50)*V - $900)/V
   .25V = V - 900
   .75V = 900
   V = 1,200 units.

   $0.50 Profit per unit = ((P-VC)*V - FC)/V
   $.50 = (($5.50 -$4.50)*V - $900)/V
   .50V = V - $900
   .50V = 900
   V = 1,800 units.

   $1.50 Profit per unit = ((P-VC)*V - FC)/V
   $1.50 = (($5.50 -$4.50)*V - $900)/V
   1.5V = V - 900
   .50V = -900
   V = -1,800 units. Not possible.

Problem Set 6
Ch. 10: 8, 9, 14

8. Use Model 1.

$\lambda =$ 100 per hour $\mu =$120 per hour

a. $L_s = \frac{\lambda}{\mu - \lambda} = \frac{100}{120-100}$= 5 customers

$W_s = \frac{L_s}{\lambda} = \frac{5}{100}$ = .05 hours or 3 minutes

b. Now, $\mu =$180 per hour

$L_s = \frac{\lambda}{\mu - \lambda} = \frac{100}{180-100}$= 1.25 customers

$W_s = \frac{L_s}{\lambda} = \frac{1.25}{100}$ = .0125 hours or .75 minutes or 45 seconds

c. Using model 3, $\lambda =$ 100 per hour $\mu =$120 per hour

S =2 , and $\rho = \frac{\lambda}{\mu} = \frac{100}{120} = .8333$, from spreadsheet, L_q = .1756

$L_s = L_q + \frac{\lambda}{\mu} = .1756 + \frac{100}{120}$= 1.01 customers

$W_s = \frac{L_s}{\lambda} = \frac{1.01}{100}$ = .0101 hours or .605 minutes or 36.3 seconds

9. Use model 2.

$\lambda =$ 10 per hour $\mu =$12 per hour

a. $L_q = \frac{\lambda^2}{2\mu(\mu - \lambda)} = \frac{10^2}{2(12)(12-10)}$ = 2.083 people

b. $L_s = L_q + \lambda/\mu$ = 2.083 + 10/12 = 2.917 people

c. $W_q = \frac{L_q}{\lambda} = \frac{2.083}{10} = .2083$ hours.

d. $W_s = \frac{L_s}{\lambda} = \frac{2.917}{10}$ = .2917 hours

e. It will cause it to increase, at $\lambda =$ 12 per hour, $L_q = \frac{\lambda^2}{2\mu(\mu - \lambda)} = \frac{12^2}{2(12)(12-12)} \rightarrow \infty$

14. Use model 1.

$\lambda = 2$ per hour $\mu = 3$ per hour

a. $L_q = \dfrac{\lambda^2}{\mu(\mu-\lambda)} = \dfrac{2^2}{3(3-2)}$ = 1.333 customers waiting

b. $W_q = \dfrac{L_q}{\lambda} = \dfrac{1.333}{2}$ = .667 hours or 40 minutes

c. $L_s = \dfrac{\lambda}{\mu-\lambda} = \dfrac{2}{3-2} = 2, \quad W_s = \dfrac{L_s}{\lambda} = \dfrac{2}{2}$ = 1 hour

d. $\rho = \dfrac{\lambda}{\mu} = \dfrac{2}{3}$ = .67 or 67% of the time

Problem Set 7
Ch. 11: 7, 13, 14, 16, 18

7.

a. TR = 60 per week, TT = 2/7 weeks.
*WIP = TT *TR = 60*2/7 = 120/7 = 17.1*
On average there are 17.1 new mothers in the Children's Hospital.

b. TR = 210 per week, TT = 2/7 weeks.
*WIP = TT * TR = 210*2/7 = 60.*
On average there are 60 new mothers in Swedish Hospital.

c. TR = 270 per week, TT = 2/7 weeks.
*WIP = TT * TR = 270*2/7 = 540/7 = 77.1*
On average there will be 77.1 new mothers in the unified hospital. No, it will not decrease the total number of mothers in the hospital.

13.

a. One operator per project: 10 projects per day/8 hours per day = 1.25 projects/hour. The productivity of this option is also 1.25 projects/hour. For the two-operator approach, the second operator will limit the system to a rate of 2 projects/hour (this assumes 30 minutes per project). The first operator would be idle for an average of 10 minutes each project. The productivity for the two-operator approach is 2 projects per hour/2 hours of labor = 1 project/hour.

b. With the one operator, 1000 projects would take 1000 projects/1.25 project per hour = 800 hours or 100 days. With two operators, it would take 1000 projects/2 projects per hour = 500 hours or 62.5 days. The labor content for the first option is 800 hours. The second option requires 1000 hours of labor.

14. Current plans are to make 100 units of component A, then 100 units of component B, then 100 units of component A, then 100 units of component B, etc, where the setup and run times for each component are given below.

Component	Setup / Changeover Time	Run Time/unit
A	5 minutes	0.2 minutes
B	10 minutes	0.1 minutes

5 + 10 + .2(100) + .1(100) = 15 + 30 = 45 minutes/100 units

45/100 = 60/X

X = 133.3 units/hr.

16.

a.

Take Order = 100 per hour * 12 hours = 1200
Pick Order = 80 per hour * 24 hours = 1920
Pack Order = 60 per hour * 24 hours = 720

Assuming that no one works more than 12 hours, the maximum output is determined by "Pack Order" (720) since it is the slowest operation.

b. If we take the maximum of 1200 orders then:
Pick Order = 1200 orders/80 per hour = **15 hours**
Pack Order = 1200 orders/60 per hour = **20 hours**

c. Orders can be taken at a rate of 100/hours and can be picked at the rate of 80/hour so they build at the rate of 20/hour. Orders are taken for 12 hours. Maximum orders waiting for picking = 20/hour * 12 hours = **240**

d. Orders can be picked at a rate of 80/hours and can be packed at the rate of 60/hour so they build at the rate of 20/hour. Orders are picked for 15 hours.

Maximum orders waiting for packing= 20/hour * 15 hours = **300**

e. (b. revisited) If we take the maximum of 1200 orders then:

Pick Order = 1200 orders/80 per hour = **15 hours**
Pack Order = 1200 orders/120 per hour = 10 hours
However, Packing has to wait for the orders to be picked so it would be 15 hours

(c. revisited) This answer does not change.
Orders can be taken at a rate of 100/hours and can be picked at the rate of 80/hour so they build at the rate of 20/hour. Orders are taken for 12 hours.

Maximum orders waiting for picking = 20/hour * 12 hours = **240**

(d. revisited)
Orders can be picked at a rate of 80/hours and can be packed at the rate of 120/hour so they build at the rate of 0/hour. Orders are picked for 15 hours.

Maximum orders waiting for packing= 0/hour * 15 hours = **0**

18.

a. Maximum output is 21.6 patients a day

A. Greet/Register the patient (60 min. per hr/2 min per patient)* 10 hours = 300 patients/ day
B. Optometrist (60 min. per hr/25 per patient) * 9 hours (one hour for lunch) = 21.6 patients/day
C. Frame/lenses selection (60 min. per hr/20 min per patient)* 10 hours = 30 patients/ day
D. Wait for glasses to be made (60 min per hr/ 60 min per set of glasses * 6) * 10 hours/day = 60 pairs
E. Final fitting (60 min. per hr/5 min per patient)* 10 hours = 120 patients/ day
The bottleneck limiting out is task B.

b. Adding another optometrist would allow more patients to be processed.
c. Capacity would be the same, but the time to fill an order would increase to 5-7 days.

Problem Set 8
Ch. 13: 7, 8, 9

7.

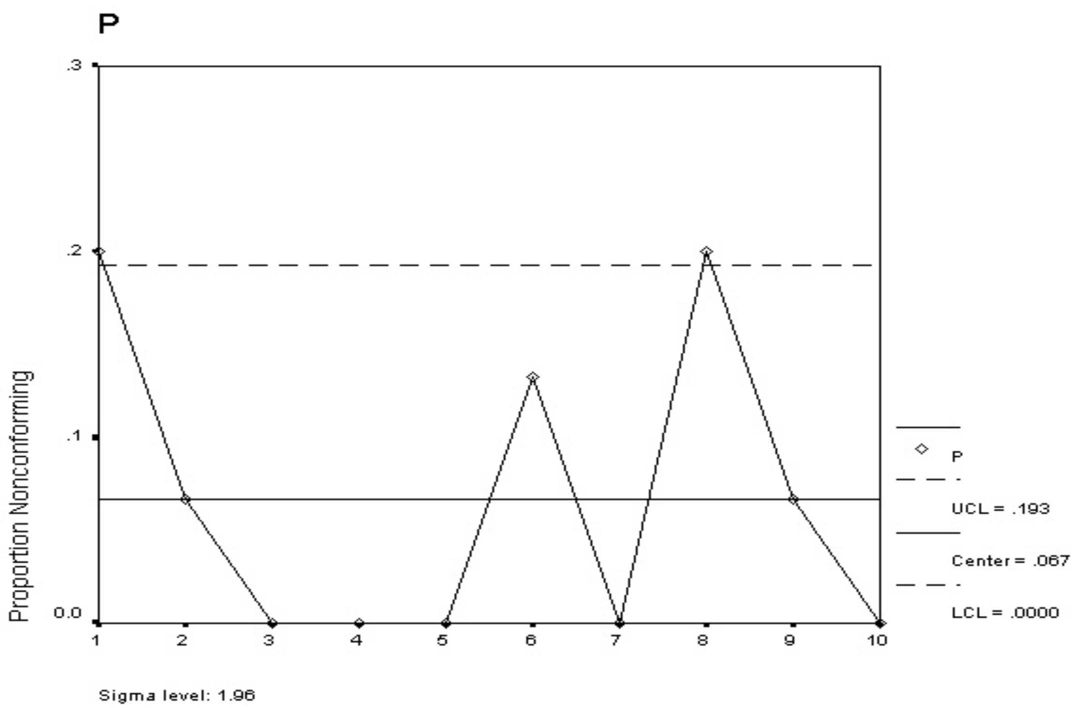
a. Ten defectives were found in 10 samples of size 15.

$$\overline{P} = \frac{10}{10(15)} = .067$$

$$S_p = \sqrt{\frac{\overline{P}(1-\overline{P})}{n}} = \sqrt{\frac{.067(1-.067)}{15}} = 0.0646$$

UCL = $\overline{P} + 1.96\, S_p$ = .067 + 1.96(.0646) = .194

LCL = $\overline{P} - 1.96\, S_p$ = .067 - 1.96(.0646) = -.060 $\rightarrow$ zero



b. Stop the process and look for the special cause, it is out of statistical control.

8.

Sample	Irregularities
1	3
2	5
3	2
4	6
5	5
6	4
7	6
8	3
9	4
10	5
Total	43

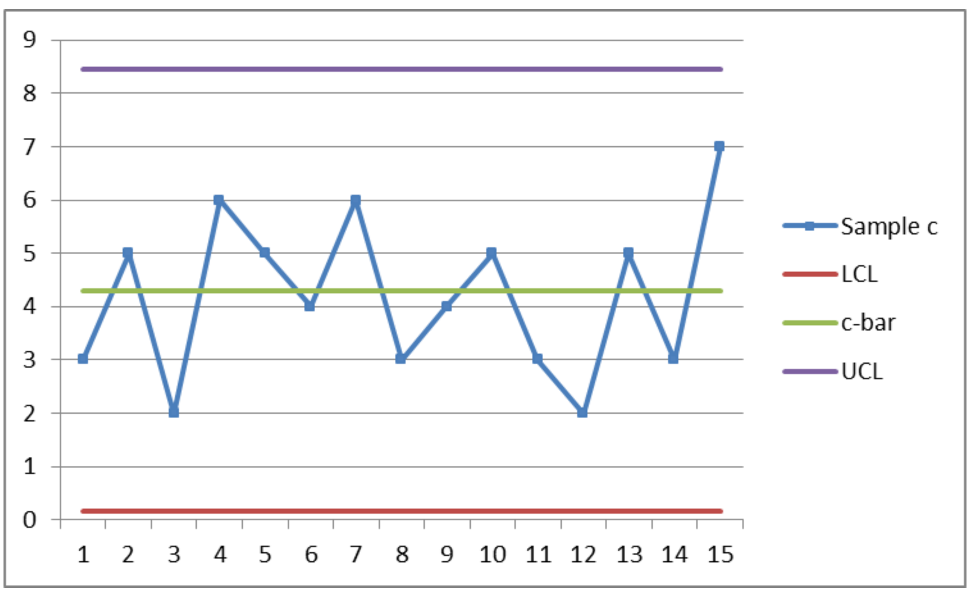
a.

Average Number of Defects $\bar{c} = 4.3$

$$s_p = \sqrt{\bar{c}} = 2.07$$

$$UCL = \bar{c} + z\sqrt{\bar{c}} = 4.3 + 2(2.07) = 8.44$$

$$LCL = \bar{c} - z\sqrt{\bar{c}} = 4.3 - 2(2.07) = 0.16$$



b. The process is under control. The UCL is 8.44

9.

Sample	1	2	3	4	mean	range
1	1010	991	985	986	993.00	25
2	995	996	1009	994	998.50	15
3	990	1003	1015	1008	1004.00	25
4	1015	1020	1009	998	1010.50	22
5	1013	1019	1005	993	1007.50	26
6	994	1001	994	1005	998.50	11
7	989	992	982	1020	995.75	38
8	1001	986	996	996	994.75	15
9	1006	989	1005	1007	1001.75	18
10	992	1007	1006	979	996.00	28
11	996	1006	997	989	997.00	17
12	1019	996	991	1011	1004.25	28
13	981	991	989	1003	991.00	22
14	999	993	988	984	991.00	15
15	1013	1002	1005	992	1003.00	21

$\overline{\overline{X}} = 999.1$, $\overline{R} = 21.733$

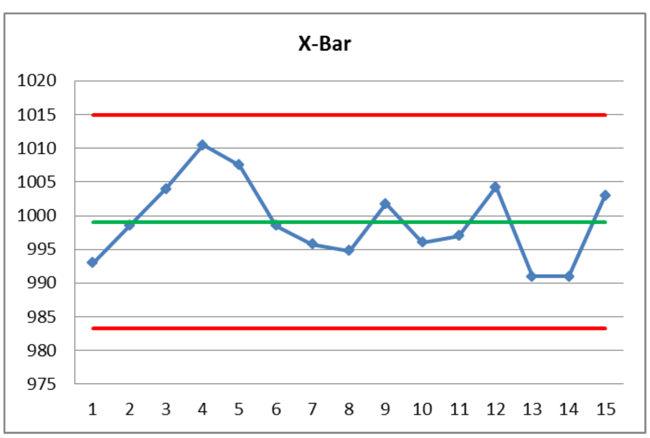
Control limits for X-bar chart:

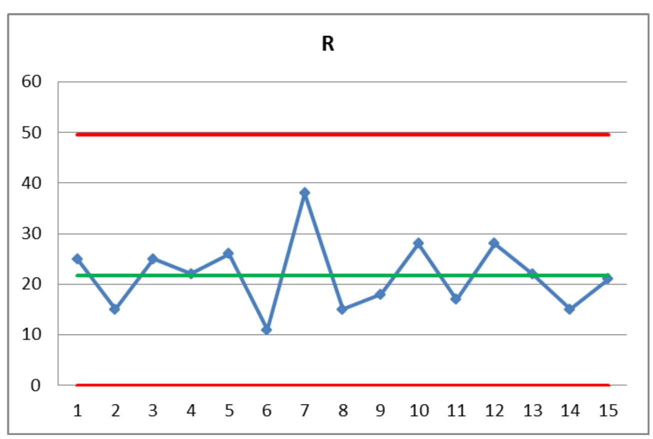
UCL, LCL = $\overline{\overline{X}} \pm A_2 \overline{R}$ = 999.1 ± .73(21.733) = 1014.965, 983.235

Control limits for R chart:

UCL = $D_4 \overline{R}$ = 2.28(21.7333) = 49.552

LCL = $D_3 \overline{R}$ = 0(21.7333) = 0.00





The process is in statistical control. Students may not samples 4-8 on the X-bar chart, but strictly speaking there are only 4 decreases in a row there.

Problem Set 9 Ch. 18: 3, 4, 10, 25a&b

3.

Three quarters ago (Oct, Nov, Dec last year) = 200 + 225 + 250 = 675
Two quarters ago (Jan, Feb, Mar this year) = 125 + 135 + 135 = 395
One quarter ago (Apr, May, Jun this year) = 190 + 200 + 190 = 580

For Jul Aug Sep, using a three-quarter average the forecast would be = (675 + 395 + 580)/3 = 550

4. Third most recent quarter 275 + 375 +350 = 1000
Second most recent quarter 425 +400 + 350 = 1175
Most recent quarter 350 + 275 + 350 = 975

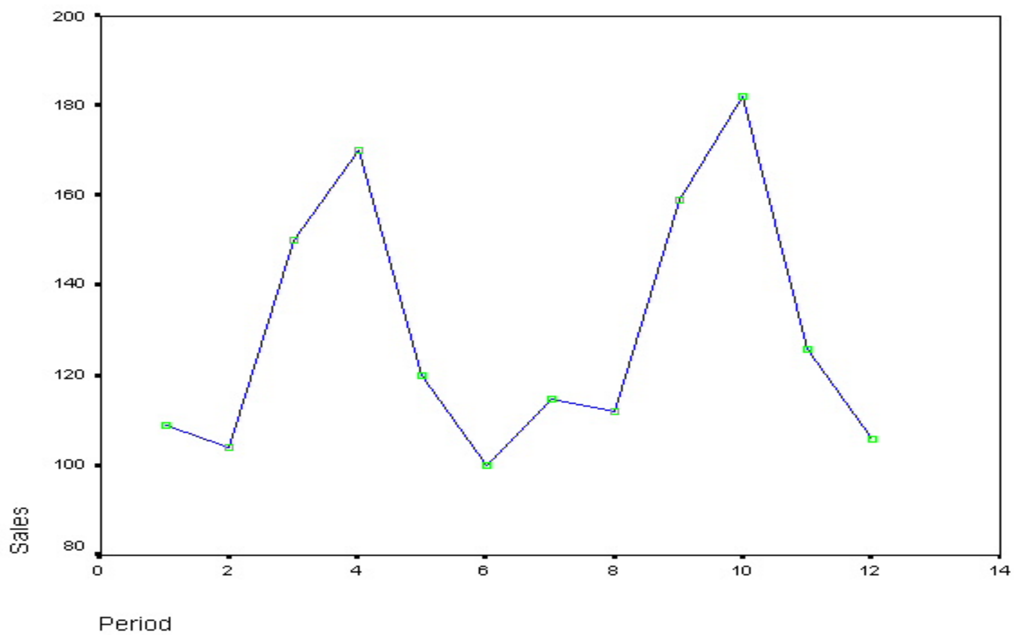
WMA = (.25*1000) + (.25 * 1175) + (.50 * 975) = 1031.25

10.

Year	Demand	*F*(*t*)*
2005	270	
2006	356	
2007	398	
2008	456	341
2009	358	364
2010	500	363
2011	410	390
2012	376	394

* Forecasts have been rounded to integer values, which may result in minor rounding differences.
F(2008) is calculated as average demand from years 2005-07. Later forecasts are based on
a simple exponential smoothing model with alpha = .20.

25.



Problem Set 10 Appendix A: 3, 10

3. a. Maximize $Z = 20X_1 + 6X_2 + 8X_3$

s.t.

$$8X_1 + 2X_2 + 3X_3 \leq 800$$

$$4X_1 + 3X_2 \leq 480$$

$$2X_1 + X_3 \leq 320$$

$$X_3 \leq 80$$

$$X_1, X_2, X_3 \geq 0$$

b. Excel solution

	X1	X2	X3	Total
Decision	45	100	80	
Profit	$20	$6	$8	$2,140

				Resources	
	X1	X2	X3	Used	Capacity
Milling	8	2	3	800 <=	800
Lathes	4	3		480 <=	480
Grinders	2		1	170 <=	320
Sales			1	80 <=	80

c. Solution is $X_1 = 45$ $S_1 = 0$ $Z = \$2140$

$X_2 = 100$ $S_2 = 0$

$X_3 = 80$ $S_3 = 150$

$S_4 = 0$

d. $S_1 = 0$ implies milling machines at capacity

$S_2 = 0$ implies lathes at capacity

$S_3 = 150$ implies grinders not at capacity, with 150 hours available

$S_4 = 0$ implies that X_3 is at maximum sales capacity

e. The shadow price for the milling machine department is \$2.25 per hour. Since it only cost \$1.50 per hour to work overtime in this department, it is worthwhile to do so. The allowable increase in overtime is 400; however, only 200 hours are available. Therefore, it is recommended that 200 hours of overtime in the milling machine department be used.

10. She should plant 700 acres in corn and 100 acres in soybeans.

	Corn	Soybeans	Wheat	Total
Decision	700	100	0	800
Profit per acre	$2,000	$2,500	$3,000	$1,650,000

	Corn	Soybeans	Wheat	Resources Used		Capacity
Labor (workers)	0.1	0.3	0.2	100	<=	100
Fertilizer (tons)	0.2	0.1	0.4	150	<=	150
Acres Planted	1	1	1	800	<=	900

Problem Set 11
Ch. 19: 11, 12, 13

11.There is more than one solution. The following solution assumes no backordered work at the end of the plan.

	January	February	March	April	May	June
Forecast work hours	5,000	4,000	6,000	6,000	5000	4,000
Beginning inventory (work done earlier)		200	1,400	600	(200)	-

Work hours required	5,000	3,800	4,600	5,400	5,200	4,000
Regular work hours available	4,000	4,000	4,000	4,000	4,000	4,000
Overtime hours	1,200	1,200	1,200	1,200	1200	-
Total planned hours	5,200	5,200	5,200	5,200	5,200	4,000
Ending inventory (early work completed)	200	1,400	600	-		
Ending backorders (work to be done later)	-	-	-	200	-	-
Straight time	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000
Overtime	54,000	54,000	54,000	54,000	54,000	-
Inventory	1,000	7,000	3,000	-	-	-
Backorder	$0	$0	$0	$2,000	$0	$0
Total	$175,000	$181,000	$177,000	$176,000	$174,000	$120,000
						$1,003,000

Allowing backordered work at the end of the plan can reduce the cost but will leave work to be done in the second half of the year. Following allows up to 500 hours backordered work.

	January	February	March	April	May	June
Forecast work hours	5,000	4,000	6,000	6,000	5000	4,000
Beginning inventory (work done earlier)		(0)	1,200	400	(400)	(500)
Work hours required	5,000	4,000	4,800	5,600	5,400	4,500
Regular work hours available	4,000	4,000	4,000	4,000	4,000	4,000
Overtime hours	1,000	1,200	1,200	1,200	900	-
Total planned hours	5,000	5,200	5,200	5,200	4,900	4,000
Ending inventory (early work completed)	-	1,200	400	-		
Ending backorders (work to be done later)	0	-	-	400	500	500
Straight time	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000
Overtime	45,000	54,000	54,000	54,000	40,500	-
Inventory	-	6,000	2,000	-	-	-
Backorder	$0	$0	$0	$4,000	$5,000	$5,000
Total	$165,000	$180,000	$176,000	$178,000	$165,500	$125,000
						$989,500

12.The decision variables are how many regular and OT hours to assign to production of each product each month. The constraints are the limits of total regular and OT hours each month, and no backorders. The costs are a combination of production and inventory carrying costs.

	APRIL	MAY	JUNE	JULY
Demand A	800	600	800	1200
Demand B	600	700	900	1100
Demand C	700	500	700	850
Total Demand	2100	1800	2400	3150

Regular hours Available	1500	1300	1800	2000	
Overtime Available	700	650	900	1000	Costs
Regular Hours A	200	100	200	50	4
Regular Hours B	600	700	900	1100	5
Regular Hours C	700	500	700	850	6
Total Regular Hours	1500	1300	1800	2000	
OT Hours A	600	500	750	1000	6
OT Hours B	0	0	0	0	7.5
OT Hours C	0	0	0	0	9
Total OT Hours	600	500	750	1000	
Total Hours A	800	600	950	1050	
Total Hours B	600	700	900	1100	
Total Hours C	700	500	700	850	
Excess Hours A	0	0	150	0	3
Excess Hours B	0	0	0	0	4
Excess Hours C	0	0	0	0	5
Production Costs	11600	9900	14000	16800	
Inventory Costs	0	0	450	0	
				TOTAL COST:	52750

Objective value = $52,750. There may be alternative optimal solutions.

13.

*Number of workers = (6700-200)10/(249*8) = 32.6 or 33 workers*

Monthly production (except July) = 22(8)33/10 = 580 units/month

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
Forecast	600	800	900	600	400	300	200	200	300	700	800	900	6700
Beginning inventory	200	180	0	0	0	180	460	444	824	1104	984	764	
Available Production	580	580	580	580	580	580	184	580	580	580	580	580	6564
Ending inventory	180	-40	-320	-20	180	460	444	824	1104	984	764	444	
Costs													Total
Lost Sales	0	800	6400	400	0	0	0	0	0	0	0	0	7600
Inventory	900	0	0	0	900	2300	2220	4120	5520	4920	3820	2220	26920
Total	900	800	6400	400	900	2300	2220	4120	5520	4920	3820	2220	34520

Problem Set 12
Ch. 23: 12

12. a. Product C has the highest selling price; therefore, sell only product C.

b.

Product	Price per unit	Cost per unit	Gross profit per unit
A	$50	$40	$10
B	$60	$45	$15
C	$70	$60	$10

The answer is to sell only B with the highest gross profit of $15.

c.

Product	Limiting work center	Processing time (minutes)	Output per hour	Profit per unit	Profit per hour
A	Y	3	20	$10	$200
B	X	6	10	$15	$150
C	W	5	12	$10	$120

The answer is to sell only A, with the highest profit per hour.

Note: this can be solved as an LP problem. The best solution may very well be a combination of products rather than a single product.