MBA 515 – Prof. Richard B. Goldstein – HW Answers – Anderson – 12th Ed (15)

Chapter 6

#7

Origin	Destination: Boston	Dallas	Los Angeles	St Paul	Capacities
Denver	7	11	8	13	100
Atlanta	20	17	12	10	100
Chicago	8	18	13	16	150
Demands	50	70	60	80	

Denver + Atlanta capacities: 350; total demands: 260

let x_{ij} = # units shipped from origin $\underline{i}$ to destination $\underline{j}$

$$\text{Min } 7x_{11} + 11x_{12} + 8x_{13} + 13x_{14} + 20x_{21} + 17x_{22} + 12x_{23} + 10x_{24} + 8x_{31} + 18x_{32} + 13x_{33} + 16x_{34}$$

s.t.

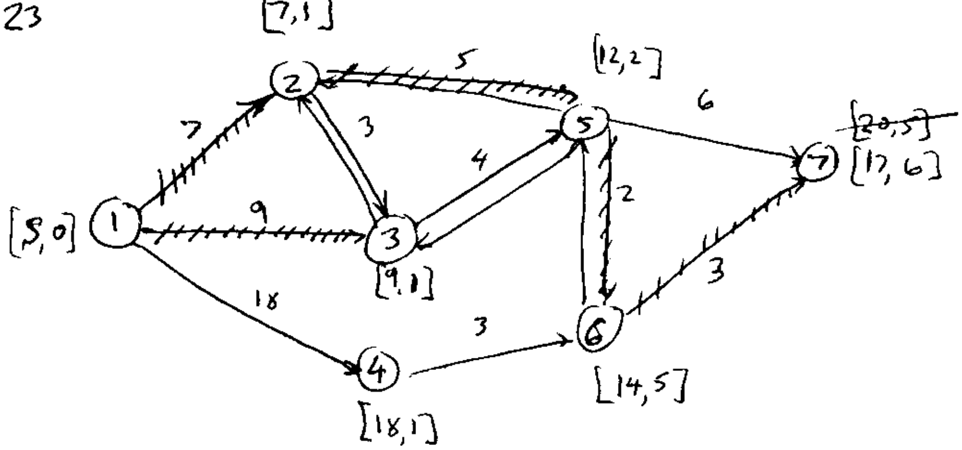
$$x_{11} + x_{12} + x_{13} + x_{14} \le 100$$
$$x_{21} + x_{22} + x_{23} + x_{24} \le 100$$
$$x_{31} + x_{32} + x_{33} + x_{34} \le 150$$
$$x_{11} + x_{21} + x_{31} = 50$$
$$x_{12} + x_{22} + x_{32} = 70$$
$$x_{13} + x_{23} + x_{33} = 60$$
$$x_{14} + x_{24} + x_{34} = 80$$

Solution

	Boston	Dallas	LA	St. Paul	
Denver	0	70	30	0	100
Atlanta	0	0	20	80	100
Chicago	50	0	10	0	60
	50	70	60	80	

Total Cost
\$2,580

#23



Solution
$x_{12} = x_{25} = x_{56} = x_{67} = 1$
all others are 0

Done as Lin. Prog.

$$\text{Min } 7x_{12} + 9x_{13} + 18x_{14} + 3x_{23} + 5x_{25} + 3x_{32} + 4x_{35} + 3x_{46} + 5x_{52} + 4x_{53} + 2x_{56} + 6x_{57} + 2x_{65} + 3x_{67}$$

St.

$$x_{12} + x_{13} + x_{14} = 1$$
$$x_{57} + x_{67} = 1$$

and

$$-x_{12} + x_{23} + x_{25} = 0$$
$$-x_{13} - x_{23} + x_{32} + x_{35} = 0$$
$$-x_{14} + x_{46} = 0$$
$$-x_{25} - x_{35} + x_{52} + x_{53} + x_{56} + x_{57} = 0$$
$$-x_{56} - x_{46} + x_{65} + x_{67} = 0$$

#32 (also as a Power Point – old chap 9 #18)

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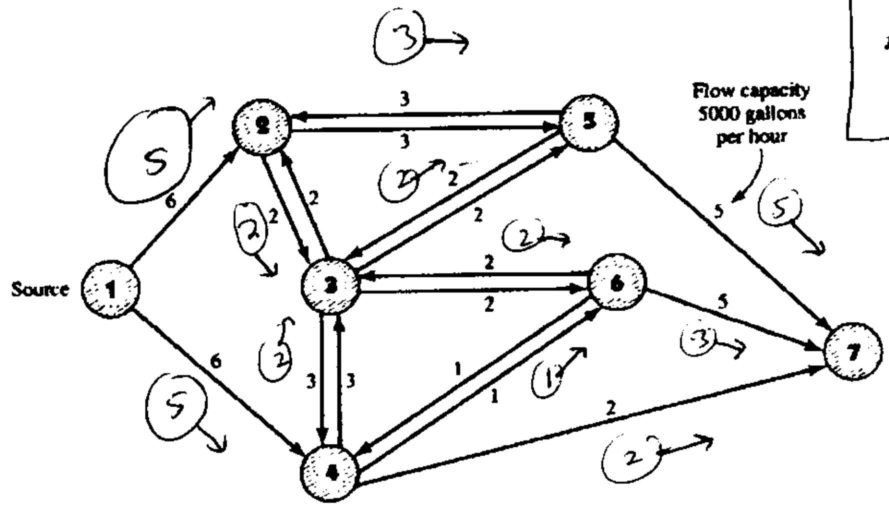


MAX 1x71

s.t.

Node (1) 1x12+1x14-1x71=0
Node (2) -1x12+1x23-1x32+1x25-1x52=0
Node (3) -1x23+1x32+1x34-1x43+1x35-1x53+1x36-1x63=0
Node (4) -1x14-1x34+1x43+1x46-1x64+1x47=0
Node (5) -1x25+1x52-1x35+1x53+1x57=0
Node (6) -1x36+1x63-1x46+1x64+1x67=0
Node (7) -1x47-1x57-1x67+1x71=0
(8) 1x12<6
(9) 1x14<6
(10) 1x23<2
(11) 1x32<2
(12) 1x25<3
(13) 1x52<3
(14) 1x34<3
(15) 1x43<3
(16) 1x35<2
(17) 1x53<2
(18) 1x36<2
(19) 1x63<2
(20) 1x46<1
(21) 1x64<1
(22) 1x47<2
(23) 1x57<5
(24) 1x67<5

OPTIMAL SOLUTION

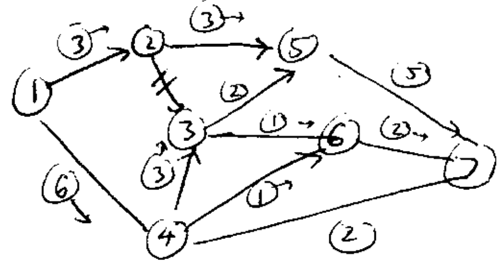
Objective Function Value = 10.000

Variable	Value
x12	5.000
x14	5.000
x23	2.000
x32	0.000
x25	3.000
x52	0.000
x34	0.000
x43	2.000
x35	2.000
x53	0.000
x36	2.000
x63	0.000
x46	1.000
x64	0.000
x47	2.000
x57	5.000
x67	3.000
x71	10.000

(a) 100,000/10,000 = 10 hrs

(b) See Power Point 100,000/9,000 = 11.1 hrs.

new solution has



Chapter-9

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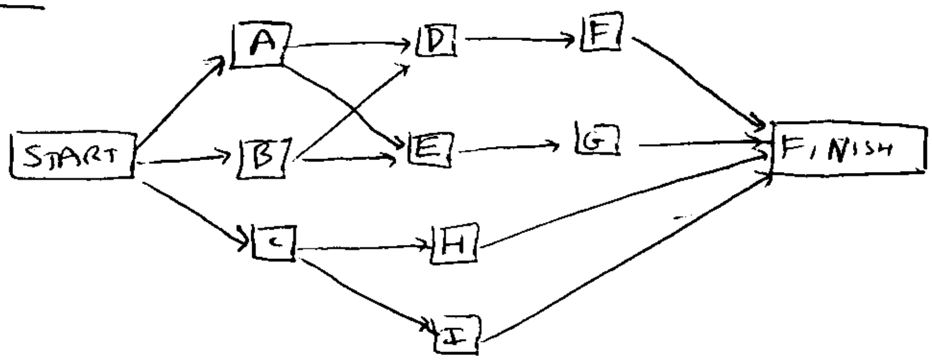
#2



(6) possible paths

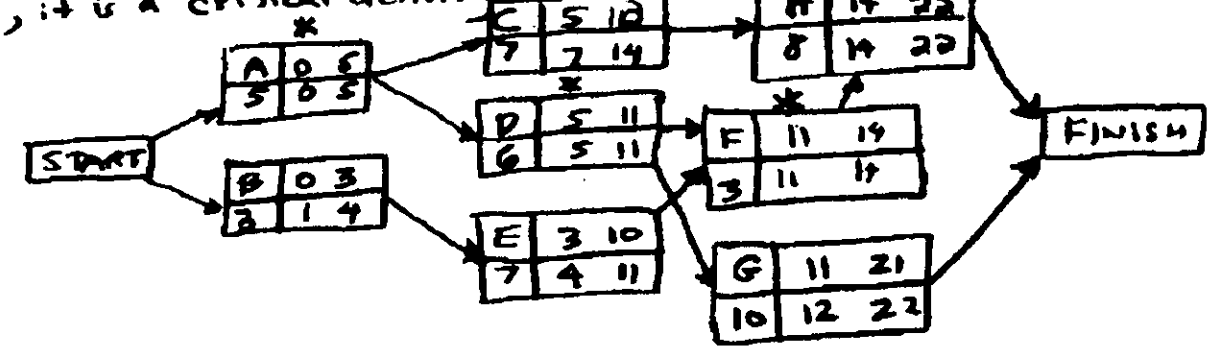
(a)

A - C - H	5 + 7 + 8	= 20
$\boxed{\text{A - D - F - H} \quad 5+6+3+8 \quad = 22 \ast}$		
A - D - G	5 + 6 + 10	= 21
B - E - F - H	3 + 7 + 3 + 8	= 21
B - E - G	3 + 7 + 10	= 20

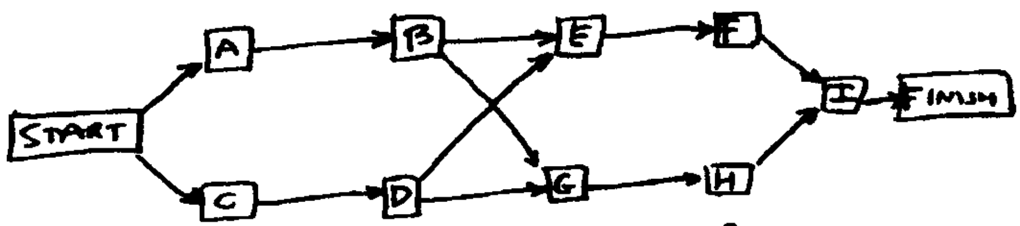
(b) 22 weeks

(c) NO, it is a critical activity

(d)



(15) (a)



(b)

Activity	$t = \frac{a+4m+b}{6}$	$V = \frac{(b-a)^2}{36}$
A	2	0,03
B	$\frac{2+4(2,5)+6}{6}$ = 3	0,44
C	2	0,11
D	2	0,03
E	1	0,03
F	2	0.11
G	4	0,44
H	4	0,11
I	2	0,03

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Activity	ES	EF	LS	LF	Slack	
A	0	2	0	2	0	*
B	2	5	2	5	0	*
C	0	2	1	3	1	
D	2	4	3	5	1	
E	5	6	10	11	5	
F	6	8	11	13	5	
G	5	9	5	9	0	*
H	9	13	9	13	0	*
I	13	15	13	15	0	*

(c) E(T) A-B-G-H-I (15)

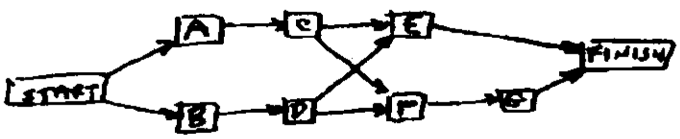
(d) $\sigma^2 = 0.03 + 0.44 + 0.44 + 0.11 + 0.03 = 1.05$

NORMAL/Gauss Dist

$$z = \frac{T - 15}{\sqrt{1.05}} = 2.33$$

$T = 15 + 2.33\sqrt{1.05} = \underline{17.4 \text{ weeks}}$

(21)



Activity	A	B	C	D	E	F	G
Time	3	2	5	5	6	2	2

(a)

Activity	ES	EF	LS	LF	Slack	
A	0	3	0	3	0	*
B	0	2	1	3	1	
C	3	8	3	8	0	*
D	2	7	3	8	1	
E	8	14	8	14	0	*
F	8	10	10	12	2	
G	10	12	12	14	2	

A-C-E

3+5+6 = 14 days

(b) Cost total = \$ 8,400

(22)
(a)

Activity	Max Crash Days	Cost/Day
A	1	600
B	2	400
C		400
D	2	400
E	2	500
F	1	400
G	1	500

(b)

Act.	Crash	Crash Cost
C	1	\$400
E	1	500
		900

(c) Total Cost

$= 8400 + 900 = \boxed{\$9,300}$

	plan #1	plan #2	plan #3
ACE	14	13	12
ACFG	12	11	11
BDE	13	13	12
BDFG	11	11	11

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HW SOLUTIONS
A, S, & W

CHAP 11

(1) (a) $\lambda = 0.4(5) = 2$ per five minute period

(b) $P(x) = \dfrac{\lambda^x e^{-\lambda}}{x!}$

x	$P(x)$
0	0.1353
1	0.2707
2	0.2707
3	0.1804

$\left.\begin{matrix}0.1353\\0.2707\\0.2707\end{matrix}\right\}$ .8571

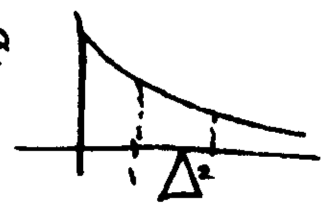
(c) P(Delay Problems) $= P(x > 3) = 1 - P(x \le 3) = 1 - .8571 = \boxed{0.1429}$

(2) (a) $\mu = 0.6$ customers/min

$P(\text{service time} \le 1) = 1 - e^{-0.6(1)} = \underline{0.4512}$

(b) $P(\text{S.T.} \le 2) = 1 - e^{-0.6(2)} = \underline{0.6988}$

(c) $P(\text{S.T.} > 2) = 1 - .6988 = \underline{0.3012}$



(3) (a) $P_0 = 1 - \dfrac{\lambda}{\mu} = 1 - \dfrac{0.4}{0.6} = \underline{0.3333}$

(b) $L_q = \dfrac{\lambda^2}{\mu(\mu-\lambda)} = \dfrac{(0.4)^2}{0.6(0.6-0.4)} = \underline{1.3333}$

(c) $L = L_q + \dfrac{\lambda}{\mu} = 1.3333 + \dfrac{0.4}{0.6} = \underline{2}$

(d) $W_q = \dfrac{L_q}{\lambda} = \dfrac{1.3333}{0.4} = \underline{3.333 \text{ min}}$

(e) $W = W_q + \dfrac{1}{\mu} = 3.333 + \dfrac{1}{0.6} = \underline{5 \text{ min}}$

(f) $P_w = \dfrac{\lambda}{\mu} = \dfrac{0.4}{0.6} = \underline{0.6667}$

(22) $\lambda = 24 \ \frac{\text{cust}}{\text{hr}}$

[A] $\mu = 30 \ \frac{\text{cust}}{\text{hr}}$ (2 mins)

[B] $\mu = 48 \ \frac{\text{cust}}{\text{hr}}$ (1.25 mins)

[C] $K = 2$ $\mu = 30 \ \frac{\text{cust}}{\text{hr}}$ (2 mins) for each channel

	A	B	C
(a) $P_0 =$	0.2	0.5	0.4286
(b) $L_q =$	3.2	0.5	0.1524

(A) $P_0 = 1 - \frac{\lambda}{\mu} = 1 - \frac{24}{30} = 0.2$

(B) $P_0 = 1 - \frac{\lambda}{\mu} = 1 - \frac{24}{48} = 0.5$

(C) from table $\lambda/\mu = 0.8$ $K = 2$

(A) $L_q = \dfrac{\lambda^2}{\mu(\mu-\lambda)} = \dfrac{24^2}{30(30-24)} = \dfrac{576}{180} = 3.2$

(B) $L_q = \dfrac{24^2}{48(48-24)} = \dfrac{576}{1152} = 0.5$

for (C) $L_q = \dfrac{\left(\frac{\lambda}{\mu}\right)^2 \lambda\mu}{1!(2\mu-\lambda)^2} P_0 = \dfrac{\left(\frac{24}{30}\right)^2 24(30)}{1(60-24)^2} P_0 = \dfrac{16}{45}(0.4286) = 0.1524$

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		A	B	C	
(c)	$L =$	4.0	1.0	0.9534	$L = L_q + \frac{\lambda}{\mu}$ for all cases
(d)	$W_q =$	0.1333 hr (8 mins)	0.0208 hr (1.25 mins)	0.0063 hr (0.38 min)	$W_q = \frac{L_q}{\lambda}$ for all
(e)	$W =$	0.1667 (10 mins)	0.0417 (2.5 mins)	0.0397 (2.38 mins)	$W = W_q + \frac{1}{\mu}$
(f)	$P_W =$	0.8	0.5	0.2286 best service	

(A) $P_W = \lambda/\mu = 24/30 = 0.8$

(B) $P_W = \lambda/\mu = 24/48 = 0.5$

(C) $P_W = \frac{1}{2!}\left(\frac{24}{30}\right)^2\left(\frac{2(30)}{2(30)-24}\right)P_0 = 0.2286$

(.4286)

(24) Customer time $25/hr for waiting time

Employee $6.50/hr

Channel Costs $20/hr each

(A) L_q

3.2 (25) = $80.00 (all customers in 1 hr)
\+ (1) (6.50) = 6.50
\+ (1) (20) = 20.00
$106.50 /hr

(B) 0.5 (25) = 12.50
(2) (6.50) = 13.00
(1) (20) = 20.00
$45.50 /hr ⟸ best bottom line

(C) 0.1524 (25) = 3.81
(2) (6.50) = 13.00
(2) (20) = 40.00
$56.81 /hr

Chapter 15

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#2

(A)

Week	Sales	4 wk mov avg	$error^2$	5 wk mov avg	$error^2$
1	17				
2	21				
3	19				
4	23				
5	18	20.00	4.00		
6	16	20.25	18.06	19.6	12.96
7	20	19.00	1.00	19.4	0.36
8	18	19.25	1.56	19.2	1.44
9	22	18.00	16.00	19.0	9.00
10	20	19.00	1.00	18.8	1.44
11	15	20.00	25.00	19.2	17.64
12	22	18.75	10.56	19.0	9.00
			77.19		51.84

(B) $MSE_4 = \frac{77.19}{8} = 9.65$

$MSE_5 = \frac{51.84}{7} = 7.41$

(C) 5-Week Moving Average is Better

#3

Week	Sales	Weighted Mov Average	$error^2$
1	17		
2	21		
3	19		
4	23	19.33	13.44
5	18	21.33	11.11
6	16	19.83	14.69
7	20	17.83	4.69
8	18	18.33	0.11
9	22	18.33	13.44
10	20	20.33	0.11
11	15	20.33	28.44
12	22	17.83	17.36
			103.42

(B) wt. $MSE_3 = \frac{103.42}{9} = 11.49$

Unweighted MSE = 10.22 ⇐ better

(C) There is always some weighted average that is at least as good (note $w_1 = w_2 = w_3 = \frac{1}{3}$ is a special case)

USING SOLVER in EXCEL

$w_1 = 0.1257$ $w_2 = 0.3603$ $w_3 = 0.5140$ most recent

produces MSE = 9.696

#4

Week	Sales	Exp Moving Avg α = 0.1	$error^2$	Exp Moving Avg α = 0.2	$error^2$	α 0.1744	$error^2$
1	17						
2	21	17.00	16.00	17.00	16.00	17.00	16.00
3	19	17.40	2.56	17.80	1.44	17.70	1.70
4	23	17.56	29.59	18.04	24.60	17.92	25.76
5	18	18.10	0.01	19.03	1.07	18.81	0.66
6	16	18.09	4.38	18.83	7.98	18.67	7.12
7	20	17.88	4.48	18.26	3.03	18.20	3.23
8	18	18.10	0.01	18.61	0.37	18.52	0.27
9	22	18.09	15.32	18.49	12.34	18.43	12.77
10	20	18.48	2.32	19.19	0.66	19.05	0.90
11	15	18.63	13.18	19.35	18.94	19.22	17.77
12	22	18.27	13.94	18.48	12.38	18.48	12.39
	Sum		101.78		98.80		98.56
	MSE		9.25		8.98		8.96 ⇐ least

⇐ optimal α by SOLVER

α = 0.2 had a lower MSE than α = 0.1

but the best is α = 0.1744

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#14

t	Y
1	20.5
2	20.2
3	19.5
4	19.0
5	19.1
6	18.8

$n=6$ $\quad \sum Y = 117.1$

$\sum t = 21$ $\quad \sum tY = 403.7$

$\sum t^2 = 91$

$$b_1 = \frac{n\sum tY - (\sum t)(\sum Y)}{n\sum t^2 - (\sum t)^2} = \frac{6(403.7) - 21(117.1)}{6(91) - (21)^2} = -0.3514$$

$$b_0 = \bar{Y} - b_1\bar{t} = 19.5167 - (-0.3514)(3.5) = 20.7466$$

$\boxed{\hat{Y} = 20.7466 - 0.3514t}$ Conclusion enrollment is decreasing by 351/yr

#25

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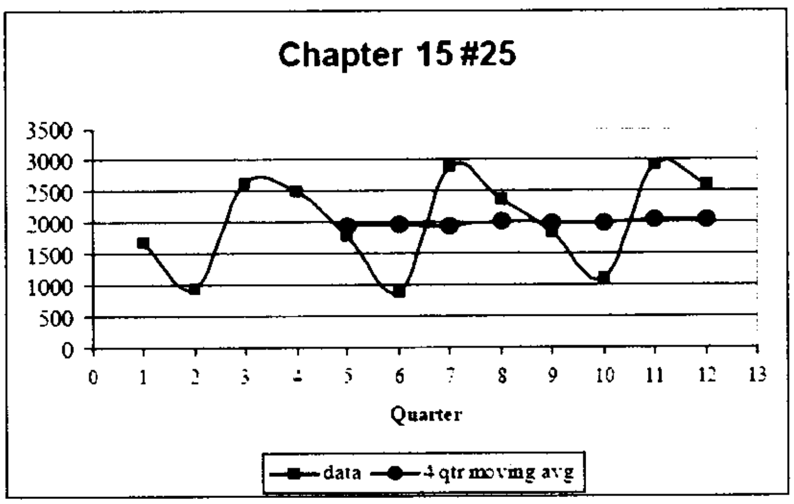
	A	B	C	D	E	F	G	
1					4-Qtr Moving	Ctr Mov	Data/CMA	
2	Period	Year	Qtr	Data	Average	Average	Ratio	
3	1	1	1	1690				
4	2	1	2	940				
5	3	1	3	2625		1952.500	1.34443	
6	4	1	4	2500		1961.250	1.27470	
7	5	2	1	1800	1938.75	1990.625	0.90420	E7: =AVERAGE(D3:D6)
8	6	2	2	900	1966.25	2007.500	0.44832	F5: =(D3+2*SUM(D4:D6)+D7)/8
9	7	2	3	2900	1956.25	1996.250	1.45272	G5: =D5/F5
10	8	2	4	2360	2025.00	2027.500	1.16400	
11	9	3	1	1850	1990.00	2056.250	0.89970	
12	10	3	2	1100	2002.50	2091.875	0.52584	
13	11	3	3	2930	2052.50			
14	12	3	4	2615	2060.00			
15	13							
16	14							
17						Seasonal Index		
18						Unadjusted	Adjusted	
19						0.901967	0.900398	F19: =(G7+G11)/2
20						0.487081	0.486234	G19: =F21*4/F$25
21						1.398577	1.396144	
22						1.219346	1.217225	
23						4.006972	4.000000	F23: =SUM(F19:F22)



Chapter 12

#6

Payment	Prob.	Cumul. prob	R interval
\$ 0	0.83	0.83	[0, 0.83]
500	0.06	0.89	[0.83, 0.89]
1,000	0.05	0.94	(0.89, 0.94)
2,000	0.02	0.96	(0.94, 0.96]
5,000	0.02	0.98	(0.96, 0.98]
8,000	0.01	0.99	(0.98, 0.99]
10,000	0.01	1.00	(0.99, 1.00]

0.9850 ⇒ \$ 8,000
0.2122 ⇒ 0
0.5590 ⇒ 0
0.0004 ⇒ 0
0.5177 ⇒ 0

0.0064 ⇒ 0
0.2044 ⇒ 0
0.2390 ⇒ 0
0.7305 ⇒ 0
0.6351 ⇒ 0

0.4971 ⇒ 0
0.9569 ⇒ \$2,000
0.1091 ⇒ 0
0.9907 ⇒ 10,000
0.1900 ⇒ 0

0.9503 ⇒ 2,000
0.7545 ⇒ 0
0.8083 ⇒ 0
0.4704 ⇒ 0
0.5274 ⇒ 0

4 claims totaling
\$ 22,000

#9

(a) base or most likely case:
6 + 5 + 14 + 8 = 33 weeks
Worst case:
8 + 7 + 18 + 10 = 43 weeks
best case:
5 + 3 + 10 + 8 = 26 weeks

(b)

activity	random no.	
A	0.1778 in	(0, 0.25] ⇒ 5 wks
B	0.9617 in	(0.75, 1.00) ⇒ 7
C	0.6849 in	(0.35, 0.75) ⇒ 14
D	0.4503 in	(0.00, 0.60) ⇒ 8
		34 weeks

(c) SIMULATION WILL PROVIDE A DISTRIBUTION OF PROJECT COMPLETION TIME VALUES. IN (b) THERE IS ONE SUCH CASE WITH THE FOUR ACTIVITIES — AT LEAST 100 SUCH CASES SHOULD BE DONE. THEN, THE PERCENTAGE OF SIMULATION CASES WITH COMPLETION TIMES OF 35 WEEKS OR LESS CAN BE USED TO ESTIMATE THE ACTUAL PROBABILITY.

#18

A : U [600,800]

B : Normal $\mu = 700$
$\sigma = 50$

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	A	B	C	D	E	F	G	H
1	**Contactor Bidding**							
2								
3	**Contactor A (Uniform Distribution)**					**Contactor B (Normal Distribution)**		
4	Smallest Value		600			Mean		700
5	Largest Value		800			Standard Deviation		50
6								
7								
8	**Simulation**					**Results**		
9		Contactor	Contactor	Lowest		Contactor's	Number	Probability
10	Trial	A's Bid	B's Bid	Bid		Bid	of Wins	of Winning
11	1	744	717	717		$650	636	0.636
12	2	660	748	660		$625	820	0.82
13	3	693	708	693		$615	893	0.893
14	4	751	713	713				
15	5	623	645	623				
16	6	665	706	665				

Cells:

B11 = C$4 + RAND() * (C$5 − C$4)
C11 = NORMINV (RAND(), H$4, H$5)
D11 = MIN (B11, C11)
} copy to row 1010
G11 = COUNTIF ($D$11:$D$1010, ">650")
H11 = G11 /1000

(a) $650,000 is the winning bid 636/1000 (text ≈ 0.60 to 0.65)
(b) 625,000 " " " " 820/1000 (text ≈ 0.82)
(c) 615,000 " " " " 893/1000 (text ≈ 0.88)

$$P(X_1 > 650 \wedge X_2 > 650) = \left(\frac{150}{200}\right) P\left(Z > \frac{650-700}{50}\right) = 0.75(0.8413) = \underline{\underline{0.631}}$$

$$P(X_1 > 625 \wedge X_2 > 625) = \left(\frac{175}{200}\right) P\left(Z > \frac{625-700}{50}\right) = 0.875(0.933) = \underline{\underline{0.816}}$$

$$P(X_1 > 615 \wedge X_2 > 615) = \left(\frac{185}{200}\right) P\left(Z > \frac{615-700}{50}\right) = 0.925(0.9554) = \underline{\underline{0.884}}$$