

b.

$$E(T) = t_B + t_E + t_H + t_J = 4 + 10 + 7 + 5 = 26$$

$$\sigma^2 = \sigma_B^2 + \sigma_E^2 + \sigma_H^2 + \sigma_J^2 = 0.44 + 1.78 + 1.78 + 0.11 = 4.11$$

$$z = \frac{T - E(T)}{\sigma}$$

$$z = \frac{25 - 26}{\sqrt{4.11}} = -0.49 \quad P(25 \text{ weeks}) = 0.5000 - 0.1879 = 0.3121$$

$$z = \frac{30 - 26}{\sqrt{4.11}} = 1.97 \quad P(30 \text{ weeks}) = 0.5000 + 0.756 = 0.9756$$

20. a.

Activity	Maximum Crash	Crash Cost/Week
A	2	400
B	3	667
C	1	500
D	2	300
E	1	350
F	2	450
G	5	360
H	1	1000

$$\text{Min } 400Y_A + 667Y_B + 500Y_C + 300Y_D + 350Y_E + 450Y_F + 360Y_G + 1000Y_H$$

s.t.

$$\begin{array}{lll} x_A + y_A \geq 3 & x_E + y_E - x_D \geq 4 & x_H + y_H - x_G \geq 3 \\ x_B + y_B \geq 6 & x_F + y_F - x_E \geq 3 & x_H \leq 16 \\ x_C + y_C - x_A \geq 2 & x_G + y_G - x_C \geq 9 & \\ x_D + y_D - x_C \geq 5 & x_G + y_G - x_B \geq 9 & \\ x_D + y_D - x_B \geq 5 & x_H + y_H - x_F \geq 3 & \end{array}$$

Maximum Crashing:

$$\begin{array}{l} y_A \leq 2 \\ y_B \leq 3 \\ y_C \leq 1 \\ y_D \leq 2 \\ y_E \leq 1 \\ y_F \leq 2 \\ y_G \leq 5 \\ y_H \leq 1 \end{array}$$

Chapter 10

b. Linear Programming Solution

Activity	Crash Time	New Time	Crash Cost
A	0	3	—
B	1	5	667
C	0	2	—
D	2	3	600
E	1	3	350
F	1	2	450
G	1	8	360
H	0	3	—
Total Crashing Cost			\$2,427

c.

Activity	Earliest Start	Latest Start	Earliest Finish	Latest Finish	Slack	Critical Activity
A	0	0	3	3	0	Yes
B	0	0	5	5	0	Yes
C	3	3	5	5	0	Yes
D	5	5	8	8	0	Yes
E	8	8	11	11	0	Yes
F	11	11	13	13	0	Yes
G	5	5	13	13	0	Yes
H	13	13	16	16	0	Yes

All activities are critical.

21. a.

Activity	Earliest Start	Latest Start	Earliest Finish	Latest Finish	Slack	Critical Activity
A	0	0	3	3	0	Yes
B	0	1	2	3	1	
C	3	3	8	8	0	Yes
D	2	3	7	8	1	
E	8	8	14	14	0	Yes
F	8	10	10	12	2	
G	10	12	12	14	2	

Critical Path: A-C-E

Project Completion Time =  $t_A + t_C + t_E = 3 + 5 + 6 = 14$  days

b. Total Cost = \$8,400

22. a.

Activity	Max Crash Days	Crash Cost/Day
A	1	600
B	1	700
C	2	400
D	2	400
E	2	500
F	1	400
G	1	500

$$\text{Min } 600y_A + 700y_B + 400y_C + 400y_D + 500y_E + 400y_F + 400y_G$$

s.t.

$$x_A + y_A \geq 3$$

$$x_B + y_B \geq 2$$

$$x_C + y_C - x_A \geq 5$$

$$x_D + y_D - x_B \geq 5$$

$$x_E + y_E - x_C \geq 6$$

$$x_E + y_E - x_D \geq 6$$

$$x_F + y_F - x_C \geq 2$$

$$x_F + y_F - x_D \geq 2$$

$$x_G + y_G - x_F \geq 2$$

$$x_{\text{FIN}} - x_E \geq 0$$

$$x_{\text{FIN}} - x_G \geq 0$$

$$x_{\text{FIN}} \leq 12$$

$$y_A \leq 1$$

$$y_B \leq 1$$

$$y_C \leq 2$$

$$y_D \leq 2$$

$$y_E \leq 2$$

$$y_F \leq 1$$

$$y_G \leq 1$$

$$\text{All } x, y \geq 0$$

b.

Activity	Crash	Crashing Cost
C	1 day	\$400
E	1 day	<u>500</u>
	Total	\$900

c. Total Cost = Normal Cost + Crashing Cost  
 = \$8,400 + \$900 = \$9,300