**Project Management**

1. A project is an interrelated set of activities that has a definite starting and ending point.

**Answer:** True

**Keywords:** project activities, start, end

1. Projects often cut across organizational lines.

**Answer:** True

**Keywords:** project, organizational lines

1. Projects, and the application of project management, facilitate the implementation of operations strategy.

**Answer:** True

**Keywords:** project management, operations strategy

1. Project managers should be able to organize a set of disparate activities.

**Answer:** True

**Reference:** Defining and Organizing Projects

**Keywords:** project manager, disparate activities

1. A pure project organizational structure houses the project in a specific functional area.

**Answer:** False

**Reference:** Defining and Organizing Projects

**Keywords:** pure project, functional structure

1. Scope creep is one of the primary causes of project failure.

**Answer:** True

**Reference:** Defining and Organizing Projects

**Keywords:** scope creep, project failure

1. The work breakdown structure is a statement of all work that has to be completed.

**Answer:** True

**Keywords:** WBS, work breakdown structure

1. The network diagram is a planning method that is designed to depict the relationships between activities.

**Answer:** True

**Keywords:** network diagram, activities

1. A relationship that determines the sequence for undertaking activities is a precedence relationship.

**Answer:** True

**Keywords:** precedence relationship

1. A critical path is any sequence of activities between a project’s start and finish.

**Answer:** False

**Keywords:** critical path activities

1. The earliest start time is never the same as the latest start time.

**Answer:** False

**Difficulty:** Easy

**Keywords:** earliest start time, latest start time

1. To obtain the latest start and latest finish time, we must work forward through the network.

**Answer:** False

**Keywords:** latest start time, latest finish time

1. A Gantt chart is a project schedule that superimposes project activities on a time line.

**Answer:** True

**Keywords:** Gantt chart, project schedule

1. Risk is a measure of the probability and consequences of not reaching a defined project goal.

**Answer:** True

**Keywords:** risk, probability measure

1. The optimistic time is the probable time required to perform the activity.

**Answer:** False

**Keywords:** optimistic time, probable time

1. The normal cost is the amount of money it normally takes to complete an activity faster than its normal time.

**Answer:** False

**Keywords:** normal cost, activity time, normal time

1. A project manager should stop crashing a project if the time budget has been met or if the crash costs have exceeded the savings in indirect and penalty costs.

**Answer:** True

**Keywords:** crash cost, penalty costs, indirect costs

1. A risk-management plan contains all identified risks to a project plus the ways that they can be circumvented.

**Answer:** True

**Keywords:** risk- management plan

1. The phase of project management that takes the most resources is the execution phase.

**Answer:** True

**Reference:** Monitoring and Controlling Projects

**Keywords:** project management, execution phase

1. Project close out consists of a) completing the remaining deliverables and b) paying the final bills.

**Answer:** False

**Reference:** Monitoring and Controlling Projects

**Keywords:** projectclose out, lessons learned

**MULTIPLE CHOICE**

1. Which one of these steps in implementing changes comes first?
	1. Document the process
	2. Evaluate performance
	3. Define scope
	4. Identify opportunity

**Answer:** d

**Reference:** Defining and Organizing Projects

**Keywords:** project steps, identify opportunity

1. The project’s objective statement should contain:
	1. slack time and activities.
	2. scope, time frame, and allocated resources.
	3. manpower and methods.
	4. activities, completion times, and incentives.

**Answer:** b

**Reference:** Defining and Organizing Projects

**Difficulty:** Moderate

**Keywords:** project objective statement, scope

1. The Project Manager for the installation of new equipment in a plant is likely to do all of the following EXCEPT:
	1. plan team meetings to review progress.
	2. work with the Engineering Manager to gain additional machine design resources.
	3. delegate the responsibility for making tough decisions to the members of the project team.
	4. resolve conflicts between individual team members.

**Answer:** c

**Reference:** Defining and Organizing Projects

**Difficulty:** Easy

**Keywords:** Project Manager, qualities

1. A member of a project team that is implementing a new credit card payment process at a bank has direct responsibility to do all of the following EXCEPT:
	1. be sensitive to conflicts between other team members and help resolve them.
	2. ensure that the project has appropriate resources for the job to be completed.
	3. help solve project problems that spill over into areas outside their expertise.
	4. be called upon to share their expertise in credit card payment processes.

**Answer:** b

**Reference:** Defining and Organizing Projects

**Difficulty:** Moderate

**Keywords:** project team member, characteristics

1. A project organization structure where team members are assigned to the project and work exclusively for the project manager is called:
	1. a matrix structure.
	2. a fixed structure.
	3. a pure project structure.
	4. a Functional structure.

**Answer:** c

**Reference:** Defining and Organizing Projects

**Difficulty:** Moderate

**Keywords:** project,organizational structure

1. In an activity-on-node [AON] network, the nodes represent \_\_\_\_\_\_\_\_\_\_\_\_, whereas the arcs represent \_\_\_\_\_\_\_\_\_\_\_\_.
	1. activities; time
	2. activities; precedence relationships
	3. events; activities
	4. precedence relationships; time

**Answer:** b

**Difficulty:** Moderate

**Keywords:** activity-on- node network, node, activity, arc, precedence relationship

1. In a network diagram, an activity:
	1. is the largest unit of work effort consuming both time and resources that a project manager can schedule and control.
	2. is the smallest unit of work effort consuming both time and resources that a project manager can schedule and control.
	3. should always be something the company has had experience with.
	4. must always have a single, precise estimate for the time duration.

**Answer**: b

**Difficulty:** Moderate

**Keywords:** activity, smallest unit of work

1. Activity times for a project are estimated by all but which of the following methods?
	1. Methods-Time Measurement (MTM) data, which includes predetermined time estimates for different activities
	2. Managerial opinions based on similar prior experiences
	3. Statistical methods based on actual past experience
	4. Estimates using learning curve models to improve replications and estimate accuracy

**Answer**: a

**Difficulty:** Moderate

**Keywords:** activity times, estimating activity times

1. A project has three paths. A–B–C has a length of 25 days. A–D–C has a length of 15 days. Finally, A–E–C has a length of 20 days. Which one of the following statements is TRUE?
	1. A–D–C is the critical path.
	2. A–B–C has the most slack.
	3. The expected duration of this project is 25 days.
	4. The expected duration of this project is 25 + 15 + 20 = 60 days.

**Answer:** c

**Keywords:** project, duration

1. The earliest start time for an activity is equal to the:
	1. smallest earliest finish time of all of its immediate predecessors.
	2. largest earliest finish time of all of its immediate predecessors.
	3. smallest late start time of any of its immediate predecessors.
	4. largest late finish time of all of its immediate predecessors.

**Answer:** b

**Keywords:** activity, earliest start time

1. Assume that activity G has the following times:

Early start time = 7 days

Early finish time = 13 days

Late start time = 15 days

Late finish time = 21 days

Which of the following statements is TRUE about activity G?

* 1. Activity G takes 14 days to complete.
	2. Activity G has a slack time of 8 days.
	3. Activity G is on the critical path.
	4. Activity G takes 2 days to complete.

**Answer:** b

**Keywords:** activity slack

1. Activity slack is defined as:
	1. latest start time minus earliest start time.
	2. earliest start time minus latest start time.
	3. earliest finish time minus latest finish time.
	4. latest finish time minus earliest start time.

**Answer:** a

**Keywords:** activity slack, latest start time, earliest start time

1. Which one of the following best describes the critical path of a PERT/CPM network?
	1. The sequence of activities between a project’s start and finish that takes the longest time to complete
	2. The sequence of activities between a project’s start and finish that has the maximum amount of activity slack
	3. The set of activities that has no precedence relationships
	4. The sequence of activities that has the lowest normal activity cost

**Answer:** a

**Keywords:** critical path

Fig. 2.1

**B**

**2**

**F**

**6**

**A**

**1**

**D**

**5**

**E**

**3**

**C**

**3**

1. For the network shown in Fig. 2.1, which of the following is the critical path?
	1. ABCDEF
	2. ABEF
	3. ACDF
	4. ACEF

**Answer:** c

**Keywords:** activity network, critical path

1. For the network shown in Fig. 2.1, what is the project duration?
	1. 6
	2. 15
	3. 13
	4. 14

**Answer:** b

**Keywords:** activity network, critical path, duration

Figure to accompany Table 2.1

**D**

**7**

**B**

**1**

**A**

**2**

**G**

**4**

**E**

**3**

**C**

**3**

**F**

**6**

 Table 2.1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ACTIVITY  | ACTIVITY TIME | EARLIEST START | EARLIEST FINISH  | LATEST START | LATEST FINISH | SLACK |
| A | 2 | 0 |  | 0 | 2 | 0 |
| B | 1 | 2 | 3 | 3 | 4 | 1 |
| C | 3 | 2 | 5 | 2 | 5 | 0 |
| D | **7** | 3 | 10 | 4 | 11 |  |
| E | 3 | 5 | 8 |  | 11 | 3 |
| F |  | 5 | 11 | 5 | 11 | 0 |
| G | 4 | 11 | 15 | 11 | 15 | 0 |

1. Using the information shown in Table 2.1, what is the slack time for activity D?
	1. 1
	2. 4
	3. 6
	4. 7

**Answer:** a

**Keywords:** activity, network, critical path, activity slack

1. Using the information shown in Table 2.1, what is the earliest finish time for activity A?
	1. 0
	2. 2
	3. 3
	4. 4

**Answer:** b

**Keywords:** activity network, critical path, earliest finish

1. Using the information shown in Table 2.1, what is the latest start time for activity E?
	1. 2
	2. 3
	3. 5
	4. 8

**Answer:** d

**Keywords:** activity network, critical path, latest start

1. Using the information shown in Table 2.1, what is the activity time for activity F?
	1. 5
	2. 11
	3. 6
	4. 1

**Answer:** c

**Keywords:** activity network, critical path, activity time

1. Which one of the following is the critical path?
	1. ABDG
	2. ABEG
	3. ACEG
	4. ACFG

**Answer:** d

**Keywords:** activity network, critical path

1. Using the information shown in Table 2.1, what is the project duration?
	1. 15
	2. 14
	3. 12
	4. 10

**Answer:** a

**Keywords:** activity network, critical path, duration

1. When using the beta probability distribution to estimate activity times, which of the following statements is TRUE?
	1. The project manager is usually the only person involved in making time estimates because obtaining estimates from workers involved in the activities would result in inconsistent estimates.
	2. The beta distribution is used as a way of approximating a normal probability distribution for time estimates.
	3. The use of most optimistic, most likely, and most pessimistic times for an activity will result in a determination of the expected times for that activity.
	4. The larger the difference between most pessimistic time and most optimistic time for an activity, the smaller will be the variance of that time estimate.

**Answer:** c

**Keywords:** beta distribution, activity times

1. When using the beta distribution for estimating activity times:
	1. an advantage is that the mode of the distribution is always equidistant from the end points of the distribution.
	2. the most likely time estimate can be positioned anywhere between the optimistic and pessimistic time estimates.
	3. we assume that the standard deviation is one-third the range between the optimistic and pessimistic time estimates.
	4. the most likely time estimate becomes the mean of the distribution.

**Answer:** b

**Keywords:** beta distribution

1. Following are four sets of most optimistic, most likely, and most pessimistic times (in weeks) for an activity. Which one of the four sets will have a mean estimated time equal to the most likely time?
	1. 1, 9, 9
	2. 1, 5, 9
	3. 1, 1, 9
	4. 1, 5, 5

**Answer:** b

**Keywords:** optimistic times, most likely times, pessimistic times

1. To calculate the probability of completing a project by a certain date:
	1. the expected completion time of the project is taken to be the sum of the activity times on the shortest path.
	2. the variance of the distribution of project completion times is taken to be one-sixth the difference between the latest finish time and the earliest finish time of the last activity in the project.
	3. we assume that the activity durations are independent of each other so that the normal distribution can be used.
	4. we need only the parameters of the beta distribution for the finish node of the diagram.

**Answer:** c

**Keywords:** projectcompletion date, probability

 Fig. 2.2

S

T

U

V

1. Which one of the following statements regarding Figure 2.2 is TRUE?
	1. Activity S cannot finish until activity T finishes.
	2. Activity T cannot begin until activity U is completed.
	3. Activity U cannot begin until activities S and T have been completed.
	4. Activity V cannot begin until activity S has been completed.

**Answer:** c

**Keywords:** activity precedence

1. If a project has exactly one critical path, which one of the following statements is TRUE?
	1. Crashing an activity on the critical path will always result in an increase in total project profits.
	2. Activities on the critical path cannot be crashed.
	3. Crashing an activity on the critical path will always result in a reduced total project completion time.
	4. The best schedule is one in which all activities are crashed as much as possible.
		1. **Answer:** c
		2. **Keywords:** crashing an activity, critical path
2. Which one of the following conditions violates the assumptions of PERT/CPM networks?
	1. Some activities can have zero variance.
	2. Costs increase linearly as activity time is reduced below its normal time.
	3. Two activities tied together by an arc are overlapping and can be worked on simultaneously.
	4. There can be more than one critical path in a network.
		1. **Answer:** c
		2. **Keywords:** assumption, PERT and CPM networks
3. Which one of the following statements is TRUE?
	1. The path in a network having the minimum slack is the shortest path in the network.
	2. There is never more than one critical path in a network.
	3. Crashing an activity on the critical path will always result in an increase in total project profits.
	4. PERT/CPM assumes that two activities tied together by a precedence relationship cannot be worked on simultaneously.
		1. **Answer:** d
		2. **Keywords:** activities, precedence relationships
4. In making an estimate of the most pessimistic time for an activity, a manager deliberately estimates this time too high (i.e., longer than it should be). What is the result of this action, assuming the beta distribution is being used to make time estimates?
	1. The most likely time for this activity will be larger than it should be.
	2. The variance of the activity will be smaller than it should be.
	3. The beta distribution will be symmetric around its mean.
	4. The expected time for this activity will be larger than it should be.
		1. **Answer:** d
		2. **Keywords:** activity, pessimistic time, beta distribution

Table 2.2

* + 1. 
1. Using Table 2.2, what is the earliest expected time of completion of the whole project?
	1. Fewer than or equal to 19 weeks
	2. Greater than 19 but fewer than or equal to 21 weeks
	3. Greater than 21 but fewer than or equal to 24 weeks
	4. Greater than 24 weeks
		1. **Answer:** d
		2. **Keywords:** project completion time
2. Using Table 2.2, which activity will have the largest amount of slack?
	1. Activity F
	2. Activity C
	3. Activity H
	4. Activity A
		1. **Answer:** c
		2. **Keywords:** activity slack
3. Using Table 2.2, if the expected times for activities A, G, and H increased by 2, 3, and 4 weeks, respectively, by how many weeks would the project’s earliest expected time of completion increase?
	1. Fewer than or equal to 2 weeks
	2. Greater than 2 weeks but fewer than or equal to 4 weeks
	3. Greater than 4 weeks but fewer than or equal to 6 weeks
	4. Greater than 6 weeks
		1. **Answer:** c
		2. **Keywords:** expected activity time
		3. Table 2.3

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Time (weeks) |
| Activity | Immediate Predecessor(s) | MostOptimistic | MostLikely | MostPessimistic |
| A | --- | 2 | 4 | 6 |
| B | --- | 1 | 4 | 7 |
| C | A | 2 | 2 | 2 |
| D | B | 1 | 7 | 10 |
| E | D | 2 | 4 | 6 |
| F | E | 1 | 2 | 3 |
| G | C | 3 | 4 | 17 |
| H | D,G | 3 | 7 | 11 |
| I | D | 8 | 9 | 10 |
| J | F,H | 4 | 5 | 6 |
| K | I | 1 | 1 | 1 |

1. Using Table 2.3, what is the earliest expected time of completion of the whole project?
	1. Fewer than or equal to 21 days
	2. Greater than 21 but fewer than or equal to 22 days
	3. Greater than 22 but fewer than or equal to 23 days
	4. Greater than 23 days
		1. **Answer:** d
		2. **Keywords:** project, expected time of completion
2. Using Table 2.3, which activity is on the critical path?
	1. Activity D
	2. Activity F
	3. Activity G
	4. Activity K
		1. **Answer:** c
		2. **Keywords:** activity, critical path
3. Using Table 2.3, if the project is due to be completed in 28 days, what is the probability that the project will be completed on or before the due date?
	1. Less than or equal to 75%
	2. Greater than 75% but less than or equal to 85%
	3. Greater than 85% but less than or equal to 95%
	4. Greater than 95%
		1. **Answer:** c
		2. **Keywords:** project completion time, probability
4. Using Table 2.3, if the project manager wants at least a 98% probability that the project will be completed on or before the due date, what is the shortest project due date that will satisfy the manager?
	1. Fewer than or equal to 28 days
	2. Greater than 28 days but fewer than or equal to 30 days
	3. Greater than 30 days but fewer than or equal to 32 days
	4. Greater than 32 days
		1. **Answer:** b
		2. **Keywords:** due date, probability of completion
		3. Table 2.4

|  |  |  |
| --- | --- | --- |
| **Activity** | **Predecessor** | **Time(weeks)** |
| **A** | **--** | **8** |
| **B** | **A** | **6** |
| **C** | **--** | **4** |
| **D** | **C** | **9** |
| **E** | **A** | **11** |
| **F** | **B** | **3** |
| **G** | **D,E,F** | **1** |

1. Using Table 2.4, what is the earliest completion time for this project?
	1. 18 weeks
	2. 19 weeks
	3. 20 weeks
	4. 21 weeks
		1. **Answer:** c
		2. **Keywords:** completion time
2. Using Table 2.4, what is the largest amount of slack that any activity in the project has?
	1. Zero weeks
	2. Two weeks
	3. Four weeks
	4. Six weeks
		1. **Answer:** d
		2. **Keywords:** activity slack
3. Using Table 2.4, what is the minimum number of activities that would have to be delayed to cause an increase in the project’s earliest completion date?
	1. One activity
	2. Two activities
	3. Three activities
	4. Four or more activities
		1. **Answer:** a
		2. **Keywords:** activity delay, earliest completion time
4. Using Table 2.4, what is the minimum number of activities that would have to be crashed to cause a decrease in the project’s earliest completion date?
	1. One activity
	2. Two activities
	3. Three activities
	4. Four or more activities
		1. **Answer:** a
		2. **Keywords:** crashing an activity, earliest completion time
5. Using Table 2.4, what is the early start time for activity D?
	1. Week 9
	2. Week 4
	3. Week 7
	4. Week 0
		1. **Answer:** b
		2. **Keywords:** activity, early start time
6. Using Table 2.4, what is the latest finish time for activity C?
	1. Week 4
	2. Week 6
	3. Week 8
	4. Week 10
		1. **Answer:** d
		2. **Keywords:** activity, latest finish time
7. Using Table 2.4, what is the slack associated with activity B?
	1. 1 week
	2. 2 weeks
	3. 3 weeks
	4. None of these is the correct activity slack for B.
		1. **Answer:** b
		2. **Keywords:** activity slack

|  |  |  |
| --- | --- | --- |
| Table 2.5 |  | **All times in days** |
| **Activity** | **Predecessor** | **a** | **m** | **b** |
| **A** | **--** | **1** | **2** | **3** |
| **B** | **--** | **2** | **4** | **6** |
| **C** | **A** | **3** | **4** | **5** |
| **D** | **B** | **6** | **7** | **9** |
| **E** | **C** | **7** | **9** | **10** |
| **F** | **D** | **8** | **12** | **16** |
| **G** | **D** | **2** | **4** | **7** |
| **H** | **E,F** | **9** | **11** | **13** |

1. Using Table 2.5, the expected time for activity C is:
	1. three days.
	2. four days.
	3. five days.
	4. more than five days.
		1. **Answer:** b
		2. **Keywords:** activity, expected time
2. Using Table 2.5, what is the latest finish time for activity D?
	1. Between 4 and 6 days
	2. Between 6 and 8 days
	3. Between 8 and 10 days
	4. More than 10 days
		1. **Answer:** c
		2. **Keywords:** probabilistic latest finish time
3. Using Table 2.5, what is the variance for activity F?
	1. 1.33
	2. 1.78
	3. 2.34
	4. 2.69
		1. **Answer:** b
		2. **Keywords:** activity, variance
4. Using Table 2.5, what is the standard deviation for the entire project?
	1. 1.08
	2. 1.17
	3. 1.71
	4. 2.92
		1. **Answer:** c
		2. **Keywords:** critical path, standard deviation
5. Using Table 2.5, what is the chance that the project will be completed within 32 days?
	1. Not bloody likely
	2. About 10%
	3. About 25%
	4. About 40%
		1. **Answer:** b
		2. **Keywords:** probability, project completion
6. Using Table 2.5, which activity is on the critical path?
	1. Activity A
	2. Activity C
	3. Activity E
	4. Activity H
		1. **Answer:** d
		2. **Keywords:** critical path activity

|  |  |  |
| --- | --- | --- |
| Table 2.6 |  |  |
| Activity | Predecessor | Time (days) |
| A | -- | 8 |
| B | -- | 6 |
| C | -- | 3 |
| D | A,B | 10 |
| E | C | 8 |
| F | A | 5 |
| G | D,E | 3 |
| H | G | 4 |

1. Using Table 2.6, what is the earliest completion time of this project?
	1. 23 days
	2. 25 days
	3. 27 days
	4. 29 days
		1. **Answer:** b
		2. **Keywords:** earliest project completion time
2. Using Table 2.6, what is the latest start time for activity E?
	1. Day 8
	2. Day 10
	3. Day 12
	4. Day 14
		1. **Answer:** b
		2. **Keywords:** activity, latest start time
3. Using Table 2.6, what is the earliest that activity D can be finished?
	1. 18 days
	2. 8 days
	3. 13 days
	4. 25 days
		1. **Answer:** a
		2. **Keywords:** activity, earliest finish time
4. Disaster strikes and activity F takes 20 days instead of the anticipated 5 days. Using Table 2.6, how much longer will the project last than initially estimated?
	1. 15 days
	2. 0 days
	3. 7 days
	4. 3 days
		1. **Answer:** d
		2. **Keywords:** project latest finish time
5. Using Table 2.6, every day the construction crew is on-site costs $1000. What activities would you consider crashing to reduce the project completion cost?
	1. Activity E
	2. Activity F
	3. Activity G
	4. All of these activities would be candidates for crashing.
		1. **Answer:** c
		2. **Keywords:** project completion cost, activity crashing
6. Using Table 2.6, how many days can activity C be delayed without changing the whole project’s earliest completion time?
	1. 0 days
	2. 2 days
	3. 5 days
	4. 7 days
		1. **Answer:** d
		2. **Keywords:** activity slack
		3. Table 2.7
		4. 
7. Using Table 2.7, what is the critical path for this project?
	1. B–E–H–K
	2. B–E–H–J
	3. A–E–G–J
	4. C–F–I–L
		1. **Answer:** b
		2. **Keywords:** critical path
8. Using Table 2.7, suppose activity D can be shortened from four days to one day. Assume all other activity times remain the same. How much shorter will the total project earliest completion time become?
	1. Zero days
	2. One day
	3. Two days
	4. Three days
		1. **Answer:** a
		2. **Keywords:** earliest completion time
9. Using Table 2.7, suppose activity I is delayed, taking eight days to complete instead of two days. Assume all other activity times remain the same. How much longer will the total project earliest completion time become?
	1. Zero days
	2. One or two days
	3. Three or four days
	4. Five or six days
		1. **Answer:** c
		2. **Keywords:** project, earliest completion time
10. Using Table 2.7, what is the latest start time for activity A?
	1. Day 0
	2. Day 1
	3. Day 2
	4. Day 3 or later
		1. **Answer:** b
		2. **Keywords:** activity, latest start time

Table 2.8



1. Using Table 2.8, what is the earliest completion time of the project?

Fewer than or equal to 10 weeks

Greater than 10 weeks but fewer than or equal to 13 weeks

Greater than 13 weeks but fewer than or equal to 16 weeks

* 1. Greater than 16 weeks

**Answer:** c

**Keywords:** project, earliest completion time

1. Using Table 2.8, what is the critical path of the above project?
	1. B–C–E–F
	2. B–C–F
	3. A–D–F
	4. A–C–E–F
		1. **Answer:** a
		2. **Keywords:** critical path
2. Using Table 2.8, what is the slack for activity A?
	1. 0 weeks
	2. 1 week
	3. 2 weeks
	4. 3 or more weeks
		1. **Answer:** b
		2. **Keywords:** activity slack

Figure to accompany Table 2.9

**B**

**3**

**F**

**1**

**A**

**4**

**D**

**5**

**E**

**4**

**C**

**4**

 Table 2.9

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ACTIVITY  | NORMAL TIME | CRASH TIME | NORMAL COST ($000s) | CRASH COST ($000s) | AVAILABLE WEEKS OF CRASHING | CRASHING COST / WEEK  |
| A | 4 | 2 | 8 | 14 |  |  |
| B | 3 | 2 | 9 | 11 |  |  |
| C | 4 | 4 | 10 | 10 |  |  |
| D | 5 | 3 | 10 | 15 |  |  |
| E | 4 | 1 | 11 | 14 |  |  |
| F | 1 | 1 | 6 | 6 |  |  |

1. What is the critical path for the project shown in the above network and Table 2.9, using the normal times?
	1. A-B-D-F
	2. A-C-D-F
	3. A-C-E-F
	4. A-B-C-D-E-F

#### Answer: b

* + 1. **Keywords:** critical path

Determine the information missing from Table 2.9, then answer the following questions.

1. How many week(s) of crashing are available for activity D in Table 2.9?
	1. 0
	2. 1
	3. 2
	4. 6

#### Answer: c

* + 1. **Keywords:** crash cost / time
1. How many week(s) of crashing are available for activity B in Table 2.9?
	1. 0
	2. 1
	3. 2
	4. 3

#### Answer: b

* + 1. **Keywords:** crash cost / time
1. How many weeks of crashing are available for activity C in Table 2.9?
	1. 0
	2. 1
	3. 2
	4. 6

#### Answer: a

* + 1. **Keywords:** crash cost / time
1. What is the crashing cost per week for activity A in Table 2.9?
	1. $2,000
	2. $3,000
	3. $4,000
	4. This activity cannot be crashed

#### Answer: b

* + 1. **Keywords:** crash cost / time
1. What is the crashing cost per week for activity E in Table 2.9?
	1. $4,000
	2. $3,000
	3. $2,000
	4. This activity cannot be crashed

#### Answer: a

* + 1. **Keywords:** crash cost / time
1. What is the crashing cost per week for activity F in Table 2.9?
	1. $2,000
	2. $3,000
	3. $4,000
	4. This activity cannot be crashed

#### Answer: d

* + 1. **Keywords:** crash, cost / time
1. If a decision is made to crash activity D in Table 2.9 by one week, what is the cost for this one week of crashing?
	1. $3,000
	2. $2,000
	3. $2,500
	4. This activity cannot be crashed

#### Answer: c

* + 1. **Keywords:** crash cost / time
1. Which activity should be crashed first for the project shown in Table 2.9?
	1. A
	2. B
	3. C
	4. D

#### Answer: d

* + 1. **Keywords:** crash cost / time

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 2.10 |  | **Normal****Time****(days)** | **Crashing****Time (days)** | **Crashing****Cost/day** |
| **Activity** | **Predecessor** |
| **A** | **--** | **5** | **1** | **$200** |
| **B** | **--** | **7** | **1** | **$500** |
| **C** | **--** | **5** | **1** | **$200** |
| **D** | **A** | **10** | **2** | **$300** |
| **E** | **B** | **6** | **1** | **$400** |
| **F** | **A,C** | **7** | **2** | **$650** |
| **G** | **B** | **4** | **1** | **$500** |
| **H** | **E,D,G** | **6** | **1** | **$350** |

1. Using Table 2.10, what is the critical path for this project using the normal times?
	1. A–D–H
	2. C–F
	3. B–E–H
	4. B–G–H

#### Answer: a

* + 1. **Keywords:** critical path
1. Using Table 2.10, what is the minimum completion time for this project after crashing?
	1. 23 days
	2. 21 days
	3. 19 days
	4. 17 days
		1. **Answer:** d
		2. **Keywords:** project, critical path, minimum completion time
2. Using Table 2.10, what is the minimum crashing cost to finish this project in 18 days?
	1. $3,450
	2. $850
	3. $1,150
	4. $1,500
		1. **Answer:** b
		2. **Keywords:** crash cost / time
3. Using Table 2.10, what is the activity with the greatest amount of slack?
	1. A
	2. B
	3. C
	4. D
		1. **Answer:** c
		2. **Keywords:** activity slack
4. Using Table 2.10, what is the latest start time for activity E?
	1. Day 7
	2. Day 8
	3. Day 9
	4. Day 10
		1. **Answer:** c
		2. **Keywords:** activity slack
5. Using Table 2.10, what is the earliest possible completion time for activity E after crashing?
	1. Day 11
	2. Day 13
	3. Day 15
	4. Day 17
		1. **Answer:** b
		2. **Keywords:** activity, earliest completion time

 Table 2.11

* + 1. 
1. Using Table 2.11, what is the earliest completion time of this project without crashing?
	1. Fewer than 11 weeks
	2. 11 weeks
	3. 12 weeks
	4. More than 12 weeks
		1. **Answer:** d
		2. **Keywords:** project, earliest completion time
2. Using Table 2.11, if activity B is crashed by 2 weeks, what is the new earliest completion time of the project?
	1. Fewer than 11 weeks
	2. 11 weeks
	3. 12 weeks
	4. More than 12 weeks
		1. **Answer:** c
		2. **Keywords:** activitycrashing, earliest completion time
3. Using Table 2.11 and assuming all activities except D, F, H, and K are available to be crashed, what is the minimum cost to be incurred in reducing the total project earliest completion time by one week?
	1. $3,000
	2. $6,000
	3. $8,000
	4. $10,000
		1. **Answer:** c
		2. **Keywords:** activity crashing, earliest completion time / cost
		3. Table 2.12

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | TIME (WEEKS) | COST ($) |
| ACTIVITY | IMMEDIATE PREDECESSOR(S) | NORMAL | CRASH | NORMAL | CRASH |
| A | --- | 3 | 2 | 3,000 | 3,300 |
| B | --- | 6 | 4 | 8,000 | 9,000 |
| C | A | 1 | 1 | 4,000 | 4,000 |
|  |  |  |  |  |  |
| D | A | 5 | 4 | 3,500 | 4,000 |
| E | B | 4 | 3 | 4,750 | 5,500 |
| F | C | 2 | 2 | 2,000 | 2,000 |
|  |  |  |  |  |  |
| G | D | 1 | 1 | 4,000 | 4,000 |
| H | D,F | 3 | 2 | 3,500 | 3,750 |
| I | E,G | 3 | 2 | 3,000 | 4,250 |
| J | E | 2 | 1 | 5,000 | 7,000 |

1. Using Table 2.12, what is the earliest completion time of this project if normal times are used for all activities?
	1. Fewer than 13 weeks
	2. 13 weeks
	3. 14 weeks
	4. More than 14 weeks
		1. **Answer:** b
		2. **Keywords:** earliest completion time
2. Using Table 2.12, what is the minimum time schedule for this project?
	1. Fewer than 8 weeks
	2. 8 weeks
	3. 9 weeks
	4. More than 9 weeks
		1. **Answer:** c
		2. **Keywords:** minimum time schedule
3. Using Table 2.12, if the project completion time has to be reduced by one week, which of the following activities should be crashed to minimize the extra cost of earlier completion?
	1. Activity B
	2. Activity E
	3. Activity H
	4. Activity J
		1. **Answer:** a
		2. **Keywords:** activity crashing, project, completion time
4. Using Table 2.12, what is the difference, in dollars, between the minimum-time schedule and the schedule created by crashing all activities to their limits? Assume that there are no indirect or penalty costs.
	1. Less than or equal to $1,000
	2. Greater than $1000 but less than or equal to $2,000
	3. Greater than $2000 but less than or equal to $3,000
	4. Greater than $3,000
		1. **Answer:** d
		2. **Keywords:** project crashing cost / time
5. Using Table 2.12, if the project’s normal earliest completion time is to be reduced by two weeks, what is the minimum additional cost that will be incurred in achieving this two-week reduction?
	1. Less than or equal to $1,000
	2. Greater than $1,000 but less than or equal to $1,500
	3. Greater than $1,500 but less than or equal to $2,000
	4. Greater than $2,000
		1. **Answer:** b

#### Keywords: project crashing cost / time

* + 1. Table 2.13 (All activity times for the project are in weeks.)
		2. 
1. Using Table 2.13, what is the critical path of this project?
	1. A–C–F–H
	2. B–D–F–H
	3. B–D–G
	4. B–E–G
		1. **Answer:** b
		2. **Keywords:** critical path
2. Using Table 2.13, what is the expected time of completion of the project?
	1. Fewer than 22 weeks
	2. 22 weeks
	3. 23 weeks
	4. Greater than 23 weeks
		1. **Answer:** c
		2. **Keywords:** project expected completion time
3. Using Table 2.13, what is the probability that the project will be completed in 24 or fewer weeks?
	1. Less than or equal to 55%
	2. Greater than 55% but less than or equal to 65%
	3. Greater than 65% but less than or equal to 75%
	4. Greater than 75%
		1. **Answer:** c
		2. **Keywords:** project completion probability / time
4. Using Table 2.13, if the expected time for activity E is changed to nine weeks, by how many weeks will the project’s expected completion time increase?
	1. It will not change.
	2. It will increase by one week.
	3. It will increase by two weeks.
	4. It will increase by three or more weeks.
		1. **Answer:** b
		2. **Keywords:** activity, project expected completion time

You are responsible for managing a project with the following activities (times are given in weeks).

* + 1. Table 2.14
		2. 
1. Using Table 2.14, what is the critical path and expected completion time for this project?
	1. A–D–E; 17 weeks
	2. A–C; 18 weeks
	3. B–E; 14 weeks
	4. A–D–E; 18 weeks
		1. **Answer:** d
		2. **Keywords:** project critical path
2. Using Table 2.14, which activity has the largest slack, and how large is that slack?
	1. Activity C; five weeks
	2. Activity A; six weeks
	3. Activity B; four weeks
	4. Activity E; three weeks
		1. **Answer:** a
		2. **Keywords:** activity slack
3. Using Table 2.14, what is the probability of completing the project in 17 or fewer weeks?
	1. Less than or equal to 40%
	2. Greater than 40% but less than or equal to 55%
	3. Greater than 55% but less than or equal to 70%
	4. Greater than 70%
		1. **Answer:** a
		2. **Keywords:** project, expected completion time
4. Using Table 2.14, what is the probability that the project will take 16 or more weeks to complete?
	1. Less than or equal to 40%
	2. Greater than 40% but less than or equal to 55%
	3. Greater than 55% but less than or equal to 70%
	4. Greater than 70%
		1. **Answer:** d
		2. **Keywords:** project, expected completion time
5. Using Table 2.14, if the expected time for activity B is changed to 18 weeks, by how many weeks will the project’s expected completion time increase?
	1. It will not change.
	2. It will increase by one or two weeks.
	3. It will increase by three or four weeks.
	4. It will increase by more than four weeks.
		1. **Answer:** c
		2. **Keywords:** project, expected completion time

You are responsible for managing a project with the following activities (times are given in days).

* + 1. Table 2.15
		2. 
1. Using, Table 2.15, what is the critical path and expected completion time for this project?
	1. A–F; 12 days
	2. A–D–G; 12 days
	3. B–G; 10 days
	4. C–E–G; 8 days
		1. **Answer:** b
		2. **Keywords:** critical path
2. Using, Table 2.15, which of the following activities has the largest amount of slack?
	1. Activity B
	2. Activity D
	3. Activity E
	4. Activity F
		1. **Answer:** c
		2. **Keywords:** activity slack
3. Assuming a beta distribution is being used, if the most pessimistic time for an activity increases by six weeks, what will happen to the expected time for that activity?
	1. It will increase by one week.
	2. It will decrease by one week.
	3. It will increase by six weeks.
	4. It will remain the same.
		1. **Answer:** a
		2. **Keywords:** beta distribution, pessimistic activity time
4. The probability that a project will be completed by its earliest expected completion date is:
	1. 50 percent.
	2. 95 percent.
	3. 100 percent.
	4. impossible to determine.
		1. **Answer:** a
		2. **Keywords:** probability, project completion date
5. If the sum of the variances on the critical path (and all other network paths) is equal to zero, what is the probability that the project will be completed by its earliest expected completion date?
	1. 50 percent
	2. 95 percent
	3. 100 percent
	4. It cannot be determined.
		1. **Answer:** c
		2. **Keywords:** critical pathexpected variance, earliest expected completion date
6. A project is currently scheduled to be finished on its normal earliest completion date. The project manager has the opportunity to earn a bonus if the project can be completed three weeks ahead of schedule. The increase in project direct costs related to crashing activities would be $40,000. Also, project indirect costs are $15,000 per week. What is the smallest bonus that the project manager should accept if he or she wants to avoid increasing overall project costs?
	1. Less than or equal to $5,000
	2. Greater than $5000 but less than or equal to $10,000
	3. Greater than $10,000 but less than or equal to $15,000
	4. Greater than $15,000
		1. **Answer:** a
		2. **Keywords:** activity crashing cost
7. You are given the following information about activity A:
	* 1. Normal time = 9 weeks
		2. Crash time = 7 weeks
		3. Normal cost = $20,000
		4. Crash cost = $30,000
		5. What will it cost to complete activity A in 8 weeks?
	1. Less than or equal to $24,000
	2. Greater than $24,000 but less than or equal to $27,000
	3. Greater than $27,000 but less than or equal to $30,000
	4. Greater than $30,000
		1. **Answer:** b
		2. **Keywords:** activity crashing cost
8. You are given the following information about activity B:
	* 1. Normal time = 9 weeks
		2. Crash time = 5 weeks
		3. Cost to crash per week = $2000
		4. Crash cost = $41,000
		5. What will it cost to complete activity B in 6 weeks?
	1. Less than or equal to $34,000
	2. Greater than $34,000 but less than or equal to $36,000
	3. Greater than $36,000 but less than or equal to $38,000
	4. Greater than $38,000
		1. **Answer:** d
		2. **Keywords:** activity crashing cost
9. You are given the following information about activity F:
	* 1. Normal time = 16 weeks
		2. Crash time = 10 weeks
		3. Crash cost = $45,000
		4. Cost to crash per week = $2,000
		5. What is the normal cost for activity F?
	1. Greater than or equal to $55,000
	2. Less than $55,000 but greater than or equal to $47,000
	3. Less than $47,000 but greater than or equal to $40,000
	4. Less than $40,000
		1. **Answer:** d
		2. **Keywords:** activity crashing cost
10. A company could add $10,000 per week in revenues if the project depicted in Table 2.16 could be shortened.
	* 1. Table 2.16
		2. 

Four possible options exist to crash activities: crash A by one week at a cost of $6,000; crash C by two weeks at a cost of $15,000; crash E by one week at a cost of $2,000; and crash I one week at a cost of $7,000. What is the maximum amount of additional profit that can be made by crashing an option (or options)?

* 1. Less than or equal to $4,000
	2. Greater than $4000 but less than or equal to $8,000
	3. Greater than $8000 but less than or equal to $12,000
	4. Greater than $12,000
		1. **Answer:** b
		2. **Keywords:** activitycrashing, project completion
1. A good risk management plan will contain which of these elements?
	1. The project manager’s tolerance level for risk
	2. The number of acceptable outcomes
	3. A prediction of the impact of each risk on the project
	4. The number of unacceptable outcomes
		1. **Answer:** c
		2. **Keywords:** risk management plan
2. A plan that identifies key threats to a project and prescribes ways to circumvent them is called a:
	1. project plan.
	2. contingency plan.
	3. backup plan.
	4. risk management plan.
		1. **Answer:** d
		2. **Keywords:** risk management
3. Which of these is NOT one of the four categories of project risk?
	1. Cost/benefit
	2. Operations
	3. Strategic fit
	4. Project team capability
		1. **Answer:** a
		2. **Keywords:** risk management
4. Information accuracy relative to the completeness of the work breakdown structure and communication of timely information affect the:
	1. strategic fit risk of a project.
	2. operations risk of a project.
	3. service/product attribute risk of a project.
	4. cost/benefit risk of a project.
		1. **Answer:** b
		2. **Keywords:** risk management, operations

**FILL In THE BLANK**

1. A(n) \_\_\_\_\_\_\_\_\_\_\_\_ is an interrelated set of activities that has a definite starting and ending point and that results in a unique outcome for a specific allocation of resources.

**Answer:** project

**Keywords:** project activities

1. The \_\_\_\_\_\_\_\_\_\_\_\_ is a statement of all work that has to be completed.

**Answer:** work breakdown structure (WBS)

**Keywords:** WBS, work breakdown structure

1. \_\_\_\_\_\_\_\_\_\_\_\_ determines the sequence for undertaking activities.

**Answer:** Precedence relationship

#### Keywords: precedence relationship, sequence of activities

1. The \_\_\_\_\_\_\_\_\_\_\_\_ is the sequence of activities between a project’s start and finish that takes the longest time to complete.

**Answer:** critical path

**Keywords:** critical path

1. \_\_\_\_\_\_\_\_\_\_\_\_ is the maximum length of time that an activity can be delayed without delaying the entire project.

**Answer:** Activity slack

**Keywords:** activity slack

1. The \_\_\_\_\_\_\_\_\_\_\_\_ is the shortest possible time to complete the activity.

**Answer:** crash time

**Keywords:** crash time

1. The \_\_\_\_\_\_\_\_\_\_\_\_ is determined by starting with the normal time schedule and crashing activities along the critical path in such a way that the costs of crashing do not exceed the savings in indirect and penalty costs.

**Answer:** minimum-cost schedule

**Keywords:** minimum cost schedule

1. A(n) \_\_\_\_\_\_\_\_\_\_\_\_ identifies the key threats to a project and prescribes ways to work around them.

**Answer:** risk-management plan

**Keywords:** project risk-management plan

1. The \_\_\_\_\_\_\_\_\_\_\_\_ is the shortest time in which an activity can be completed if all goes exceptionally well.

**Answer:** optimistic time

**Keywords:** optimistic time

1. \_\_\_\_\_\_\_\_\_\_\_\_ occurs when the assumptions used to compute planned slack are invalid and activities are pushed beyond their planned latest start dates.

**Answer:** Negative slack

**Reference:** Monitoring and Controlling Projects

**Keywords:** negative slack, start date

1. To find the standard deviation of the critical path, you must first add the \_\_\_\_\_\_\_\_\_\_\_\_ of all activities on the critical path.

**Answer:** variances

**Keywords:** standard deviation, variance, critical path

1. The phase of project management that takes the most resources is the \_\_\_\_\_\_\_\_\_\_\_\_, during which managers focus on activities that pertain to deliverables.

**Answer:** execution phase

**Reference:** Monitoring and Controlling Projects text p. 99

**Keywords:** execution phase, resources

1. \_\_\_\_\_\_\_\_\_\_\_\_ is an attempt to reduce the peaks and valleys in resource needs by shifting the schedules of conflicting activities within their earliest and latest start dates.

**Answer:** Resource leveling

**Reference:** Monitoring and Controlling Projects

**Keywords:** resource leveling

**SHORT ANSWERS**

1. List the three main goals of a project. Use the example of a project to implement a new billing procedure for a small lawn mowing business, describe how project management principles help achieve these goals.

**Answer:** Goals are: 1. Complete the project on time or earlier; 2. Complete it within budget; 3. Meet specs to satisfy the customer. Project Management is a systemized, phased approach to define, organize, plan, monitor and control a project to achieve these goals. Best answers will include these points, and explain them in the context of the lawn service billing procedure.

**Reference:** Project Management (chapter introduction)

**Keywords:** project management goals

1. What are the primary responsibilities of a Project Manager? Briefly describe these responsibilities for a project manager whose team is purchasing a new machine and installing it in a manufacturing process.

**Answer:** Best answers will include the following points, describing the manager’s role in the purchase and installation of the new machine: 1.*Facilitator*: resolves conflicts; leads with a system view; blends project interaction, resources and deliverables with firm as a whole; 2. *Communicator*: informs senior management and other stakeholders of project’s progress and need for additional resources; communicates with project team to achieve best performance; 3. *Decision Maker*: organize team meetings; define how team decisions will be made; determine how to communicate to senior management; make tough decisions if necessary.

**Reference:** Defining and Organizing Projects

**Keywords:** Project Manager, selecting

1. What characteristics should be considered when selecting project team members? Briefly describe these characteristics for members of a project team assigned to improve a teller’s job in a bank.

**Answer:** Best answers should include the following in the context on the job improvement project:1.*Technical Competence*: capable of completing tasks assigned to them; 2. *Sensitivity*: to interpersonal conflicts within the team; help mitigate these issues and any problems dealing with upper level management; 3. *Dedication*: capable of solving problems outside immediate expertise by involving others as needed; display persistence and initiative for completing the project in a timely fashion.

**Reference:** Defining and Organizing Projects

**Keywords:** project team member, selecting

1. Following the project defining and organizing phase, project planning involves five steps. List and briefly describe these five planning steps as applied to writing a term paper for an Operations Management class.

**Answer:** The following points should be included in the best answers: 1.*Define the work breakdown structure*: develop a list of all work to be completed on the project; 2. *Diagram the network*: develop a PERT/CPM diagram showing all activities and precedence requirements for the project; 3. *Develop the schedule*: define the project’s critical path, duration, and earliest and latest start and finish times for each activity; 4. *Analyze cost—time trade-offs*: determine normal time and costs for the project, as well as crash time and costs; using project crashing techniques, find a minimum cost schedule for completing the project; 5. *Assess project risks*: develop a risk management plan, including such areas as strategic fit, service/product attributes, team capabilities and operations risks.

**Keywords:** project planning, steps

1. Why is identifying which path is the critical path important in a project management?

**Answer:** The critical path of activities determines the time duration of the project. Any slippage along the critical path means the project will be delayed. The critical path also defines the activities requiring the team’s attention and focus to assure timely and cost effective completion of the project.

**Keywords:** project critical path

1. Why do managers want to know the slack of activities?

**Answer:** Managers monitor activity slack reports to identify activities that have fallen behind schedule or are dangerously close to doing so. Also, activities with large amounts of slack might afford a reduction in resources so that other activities behind schedule can catch up.

**Keywords:** activity slack

1. Describe how time–cost tradeoffs for project activities should be identified and analyzed.

**Answer:** There are always time–cost tradeoffs in project management situations. Overall project length is driven by the length of the critical path, so if it is necessary to finish the project more quickly, the activities that should be shortened are those on the critical path. Whether the goal is to reduce the project’s length to avoid a penalty, meet a deadline, or to reach an incentive, the cheapest activities on the critical path should be attacked first. If the objective is to minimize costs, then the project manager should reduce the critical path by expediting activities until the increase in direct costs exceeds the savings that can be gained. If the objective is to finish the project in a certain number of days, the project manager must continue to reduce activity lengths until that target is reached regardless of expense.

**Keywords:** time-cost tradeoffs, expediting project activities

1. What options do project managers have to alleviate resource problems? Briefly describe each method.

**Answer**: The methods are resource leveling, resource allocation, and resource acquisition. Resource leveling attempts to reduce the peaks and valleys in resource needs by shifting the schedules of conflicting activities within their earliest and latest start dates. Resource allocation attempts to shift resources from activities with slack to those on the critical path where resources are overloaded. Resource acquisition adds more of an overloaded resource to maintain the schedule of activity.

**Reference:** Monitoring and Controlling Projects

**Keywords:** resource leveling, resource allocation, resource acquisition

**PROBLEMS**

1. Draw the network corresponding to the following information. Also, complete the table, identify the critical path, and specify project completion time.

|  |  |  |
| --- | --- | --- |
| Activity  | ImmediatePredecessor(s) | Time(Weeks) |
| A | --- | 3 |
| B | --- | 4 |
| C | A | 6 |
| D | B | 9 |
| E | B | 6 |
| F | C,D | 6 |
| G | D,E | 8 |
| H | G,F | 9 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Activity  | EarliestStart | EarliestFinish | LatestStart | Latest Finish | Slack |
| A |  |  |  |  |  |
| B |  |  |  |  |  |
| C |  |  |  |  |  |
| D |  |  |  |  |  |
| E |  |  |  |  |  |
| F |  |  |  |  |  |
| G |  |  |  |  |  |
| H |  |  |  |  |  |

**Answer:**



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Activity  | EarliestStart | EarliestFinish | LatestStart | Latest Finish | Slack |
| A | 0 | 3 | 6 | 9 | 6 |
| B | 0 | 4 | 0 | 4 | 0 |
| C | 3 | 9 | 9 | 15 | 6 |
| D | 4 | 13 | 4 | 13 | 0 |
| E | 4 | 10 | 7 | 13 | 3 |
| F | 13 | 19 | 15 | 21 | 2 |
| G | 13 | 21 | 13 | 21 | 0 |
| H | 21 | 30 | 21 | 30 | 0 |

Critical path is B–D–G–H, and project completion time is 30 weeks.

**Keywords:** early and late start and finish times, critical path, completion time

1. Consider the tasks, durations, and predecessor relationships in the following network. Draw the network and answer the questions that follow.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Activity Description | ImmediatePredecessor(s) | Optimistic(Weeks) | Most Likely(Weeks) | Pessimistic(Weeks) |
| A | --- | 4 | 7 | 10 |
| B | A | 2 | 8 | 20 |
| C | A | 8 | 12 | 16 |
| D | B | 1 | 2 | 3 |
| E | D, C | 6 | 8 | 22 |
| F | C | 2 | 3 | 4 |
| G | F | 2 | 2 | 2 |
| H | F | 6 | 8 | 10 |
| I | E, G, H | 4 | 8 | 12 |
| J | I | 1 | 2 | 3 |

* 1. What is the expected time for activity B?
	2. What is the variance for activity B?
	3. Based on the calculation of estimated times, what is the critical path?
	4. What is the estimated time of the critical path?
	5. What is the activity variance along the critical path?
	6. What is the probability of completion of the project before week 42?

Answer:



a. 9 weeks

b. 

c. A–C–F–H–I–J

d. 40 Weeks

e. 1 + 1.78 + .11 + .44 + 1.78 + .11 = 5.22

f. ; therefore, the probability from the standard normal table is approximately .81. Note that the variability of some non-critical path activities is large. Consideration might be given to those paths.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Activity | a | m | b | ExpectedTime | Variance |
| A | 4 | 7 | 10 | 7 | 1 |
| B | 2 | 8 | 20 | 9 | 9 |
| C | 8 | 12 | 16 | 12 | 1.78 |
| D | 1 | 2 | 3 | 2 | 0.11 |
| E | 6 | 8 | 22 | 10 | 7.11 |
| F | 2 | 3 | 4 | 3 | 0.11 |
| G | 2 | 2 | 2 | 2 | 0 |
| H | 6 | 8 | 10 | 8 | 0.44 |
| I | 4 | 8 | 12 | 8 | 1.78 |
| J | 1 | 2 | 3 | 2 | 0.11 |

Keywords: expected time, variance, probability, activity, critical path

1. The following table contains a list of activities, with early- and late-start and finish times and crash costs for the network shown in the figure. All start and finish times and crash costs are on a per-week basis. Each activity can be reduced by one week at the most.
	1. Determine the uncrashed activity lengths for activities A though K.
	2. Determine the minimum completion cost for this project if each week carries a fixed cost of $1,000.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Activity** | **ES** | **EF** | **LS** | **LF** | **Crash Cost/week** |
| A | 0 | 5 | 0 | 5 | $1,100 |
| B | 5 | 9 | 13 | 17 | $250 |
| C | 5 | 11 | 5 | 11 | $1,200 |
| D | 0 | 6 | 1 | 7 | $350 |
| E | 6 | 10 | 7 | 11 | $900 |
| F | 9 | 14 | 17 | 22 | $875 |
| G | 11 | 17 | 16 | 22 | $1,500 |
| H | 11 | 18 | 11 | 18 | $500 |
| I | 18 | 26 | 18 | 26 | $300 |
| J | 17 | 21 | 22 | 26 | $625 |
| K | 26 | 34 | 26 | 34 | $750 |

A

D

B

C

E

F

J

G

I

H

K

Start

**Answer:**

**a.** Activity lengths for A–K can be found by subtracting the early start of each activity from the late start of each activity.

The activity lengths appear in this table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Activity** | **Length** | **LS** | **LF** | **Crash Cost/week** |
| A | 5 | 0 | 5 | $1,100 |
| B | 4 | 13 | 17 | $250 |
| C | 6 | 5 | 11 | $1,200 |
| D | 6 | 1 | 7 | $350 |
| E | 4 | 7 | 11 | $900 |
| F | 5 | 17 | 22 | $875 |
| G | 6 | 16 | 22 | $1,500 |
| H | 7 | 11 | 18 | $500 |
| I | 8 | 18 | 26 | $300 |
| J | 4 | 22 | 26 | $625 |
| K | 8 | 26 | 34 | $750 |

**b.** The critical path is ACHIK = 34 weeks. Other paths are DEHIK = 33; ACGJK = 29; DEGJK = 28; and ABFJK = 26. With a fixed cost of $1,000/week, the initial cost is 34 weeks @ $1,000 = $34,000.

The cheapest critical-path activity is I @ $300, so reducing I from 8 weeks to 7 weeks costs $300 but saves $1,000, resulting in a net savings of $700.

The next cheapest critical-path activity is H @ $500, so reducing H from 7 weeks to 6 weeks costs $500 but saves $1,000, for a net savings of $500.

The next cheapest critical-path activity is K @ $750, so reducing K from 8 weeks to 7 weeks costs $750 but saves $1,000, for a net savings of $250.

The other two activities on the critical path are more expensive to crash than the penalty cost, so the cheapest completion time is 34 weeks – 3 weeks (I, H, K) = 31 weeks for a cost of $31,000 plus the crash costs of $300 + $500 + $750 = $32,550.

**Keywords:** activitycrashing, early and late start and finish times

1. Consider a project that consists of three consecutive activities of equal length as shown in the network diagram. The project manager would like to complete the project as quickly as possible and realizes that the diagram’s logic is misleading. Instead of waiting until activity A is completed before activity B can begin, he can actually begin activity B once activity A has begun. The same reasoning holds for the relationship between activity B and activity C. The project manager decides to divide each activity in half, a technique known as “laddering”. The second diagram shows the new network logic. In this diagram, activity A is divided into activity A1 and A2 where A1 must be finished before A2 can begin and before B1 can begin. The manager still isn’t satisfied with the completion time of the project. Derive an expression or draw a diagram that demonstrates the fastest possible completion time of the project.

A

B

C

A1

B1

C1

A2

B2

C2

**Answer:** The original length of the project is A+B+C. When laddering is performed the first time, the project length becomes A1+B1+C1+C2; this is because A2 can be performed concurrently with B1 and B2 can be performed concurrently with C1. Alternatively, you can choose to focus on the completion of activity A and indicate that the new project length is A1+A2+B2+C2 (or even A1+B1+B2+C2).

If the activities are divided again, the project length will be A1+B1+C1+C2+C3+C4; because A2, A3, A4, B2, B3, and B4 can be performed concurrently with other activities.

In general, the project can be viewed as the length of C plus the waiting time while completing the length of subdivided activities A and B. As the number of iterations of laddering these activities becomes large, the length of sub-activity A1 and B1 becomes small, effectively reducing project length to the length of activity C.

Expressed mathematically where P is the project length:



A Gantt chart showing two halvings of the activities is shown below. The three activities were 4 days long before laddering and are now are effectively twelve activities that are each one day in length.

|  |  |
| --- | --- |
|  | **Activity Finish Time** |
| **Activity** | **1** | **2** | **3** | **4** | **5** | **6** |
| **A1** |  |  |  |  |  |  |
| **A2** |  |  |  |  |  |  |
| **A3** |  |  |  |  |  |  |
| **A4** |  |  |  |  |  |  |
| **B1** |  |  |  |  |  |  |
| **B2** |  |  |  |  |  |  |
| **B3** |  |  |  |  |  |  |
| **B4** |  |  |  |  |  |  |
| **C1** |  |  |  |  |  |  |
| **C2** |  |  |  |  |  |  |
| **C3** |  |  |  |  |  |  |
| **C4** |  |  |  |  |  |  |

**Keywords:** critical path, project length, activity crashing

1. Phoebe B. Beebee is constructing a canal for the annual canoe races and has identified eleven activities that are required to complete this important project. She calculated early and late start times and early and late finish times but spilled coffee all over her printout. Use the remaining information to reconstruct the table for Phoebe B. Beebee and her new canoe canal.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Activity | Predecessor | Length | Early Start | Late Start | Early Finish | Late Finish |
| A | -- |  |  |  | 12 |  |
| B | A | 20 |  |  |  |  |
| C | A |  |  |  |  |  |
| D | B, E |  |  | 42 |  |  |
| E | C |  | 28 |  |  | 42 |
| F | E |  | 42 |  | 50 |  |
| G | D |  | 53 | 53 |  |  |
| H | G |  | 70 |  |  |  |
| I | G |  |  | 72 |  |  |
| J | F | 4 |  |  |  |  |
| K | H, I, J |  |  | 81 |  | 91 |

**Answer:** The completed table appears below:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Task | Predecessor | Length | Early Start | Late Start | Early Finish | Late Finish |
| A | -- | 12 | 0 | 0 | 12 | 12 |
| B | A | 20 | 12 | 22 | 32 | 42 |
| C | A | 16 | 12 | 12 | 28 | 28 |
| D | B, E | 11 | 42 | 42 | 53 | 53 |
| E | C | 14 | 28 | 28 | 42 | 42 |
| F | E | 8 | 42 | 69 | 50 | 77 |
| G | D | 17 | 53 | 53 | 70 | 70 |
| H | G | 11 | 70 | 70 | 81 | 81 |
| I | G | 9 | 70 | 72 | 79 | 81 |
| J | F | 4 | 50 | 77 | 54 | 81 |
| K | H, I, J | 10 | 81 | 81 | 91 | 91 |

**Keywords:** critical path, network, early and late start and finish times