**44-618- Project Management in Business & Technology Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Task Scheduling, Critical Path and Slack Time Assignment**

**20 points**

Project managers often use a graphical representation of project tasks to show the relationship between tasks. The graphical task network form shown below includes Tasks A, B, C, D, E and F for which each node represents a particular task and the number of days to complete the task.

Some terms are often used to describe this network form are listed below with explanations.

*Critical Path:* The path that takes the most time units to complete.

*Critical Task:* A task that resides on the critical path.

*Non-critical Path:* Any path that is not a critical path and thus takes less effort (time) to complete.

*Early Start (ES):* Earliest possible start time

*Early Finish (EF):* Earliest possible finish time

*Late Start (LS):* Latest possible start time

*Late Finish (LF):* Latest possible finish time

Note: Early Start (ES) and Early Finish (EF) are found by taking a forward pass through the tasks of the project. Late Start (LS) and Late Finish (LF) times are found by taking a backward pass through the tasks of the project.

*Calculating the Early Start and Early Finish (Using Forward Pass):*

The early start of a task is the same as the early finish of the preceding task. If there is more than one predecessor task, then there are several possible early start figures. Select the largest of these. The early finish for each task is equal to the early start plus the duration of the task. The final calculation is for the earliest completion time for the project. This is calculated in the same way as the early start date.

*Calculating the Late Start and Late Finish (Using Backward Pass):*

The late finish is the same as the late start of the succeeding task. (The final task in the project is equal to the early finish date of the final task.) If there is more than one successor task, then there are several possible late figures. Select the smallest of these. The late start for each task is the late finish minus the duration of the task. The final calculation is for the earliest completion time for the project. This is calculated in the same way as the early start date.

The *total slack time* measures the maximum allowable delay that can occur for all non-critical activities. Total slack time of an activity is calculated one of two ways.

*Total Slack Time = LS – ES*

or

*Total Slack Time = LF – EF*

Sometimes project managers need to know if a non-critical activity with a non-zero total slack time can be delayed without affecting the start time of its successors, which is called *free slack time*.

*Free Slack Time of X (an activity) = ES (of the earliest successor of X) – EF of X*

Use the example below to understand the critical path, total slack time and free slack time.

*Task Network Diagram*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tasks** | **Task Precedence** | **Task Length** | **Early Start ES** | **Early Finish EF** | **Late Start LS** | **Late Finish LF** |
| A | None | 12 | 0 | 12 | 0 | 12 |
| B | A | 6 | 12 | 18 | 12 | 18 |
| C | A | 13 | 12 | 25 | 16 | 29 |
| D | B | 11 | 18 | 29 | 18 | 29 |
| E | B | 5 | 18 | 23 | 24 | 29 |
| F | C, D, E | 3 | 29 | 32 | 29 | 32 |

What is the critical path? ABDF

*For Task B:*

Total Slack Time = LS – ES = 12 – 12 = 0

Free Slack time = earliest successor ES – EF of the Task B

= ES of Task D – EF of Task B

= 18 – 18 = 0

*For Task D:*

Total Slack Time = LS – ES = 18 - 18 = 0

Free Slack Time = earliest successor ES – EF of Task D

= ES of Task F – EF of task D

= 29 – 29 = 0

*For Task E:*

Total Slack Time = LS – ES = 24 – 18 = 6

Free Slack Time = earliest successor ES – EF of task E

= ES of task F – EF of task E

= 29 – 23 = 6

*Example adapted from Managing Software Projects by Frank Tsui (2004). Sudbury, MA: Jones and Bartlett, pp. 296-297.*

Given a graphical representation of a set of tasks, shown below, answer the following questions about these tasks.

*Task Network Diagram*

Fill in the Early/Late Start and Early/Late Finish for the sequence diagram above:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tasks** | **Task Precedence** | **Task Length** | **Early Start ES** | **Early Finish EF** | **Late Start LS** | **Late Finish LF** |
| A |  |  |  |  |  |  |
| B |  |  |  |  |  |  |
| C |  |  |  |  |  |  |
| D |  |  |  |  |  |  |
| E |  |  |  |  |  |  |
| F |  |  |  |  |  |  |
| G |  |  |  |  |  |  |
| H |  |  |  |  |  |  |
| I |  |  |  |  |  |  |

1. What is the critical path? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the total slack time for Task B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total Slack Time for B =

1. What is the free slack time for Task D? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Free Slack Time of D =