ENGR3450 – Project Management

Week 6

The Project Planning

Scheduling

2019, İzmir

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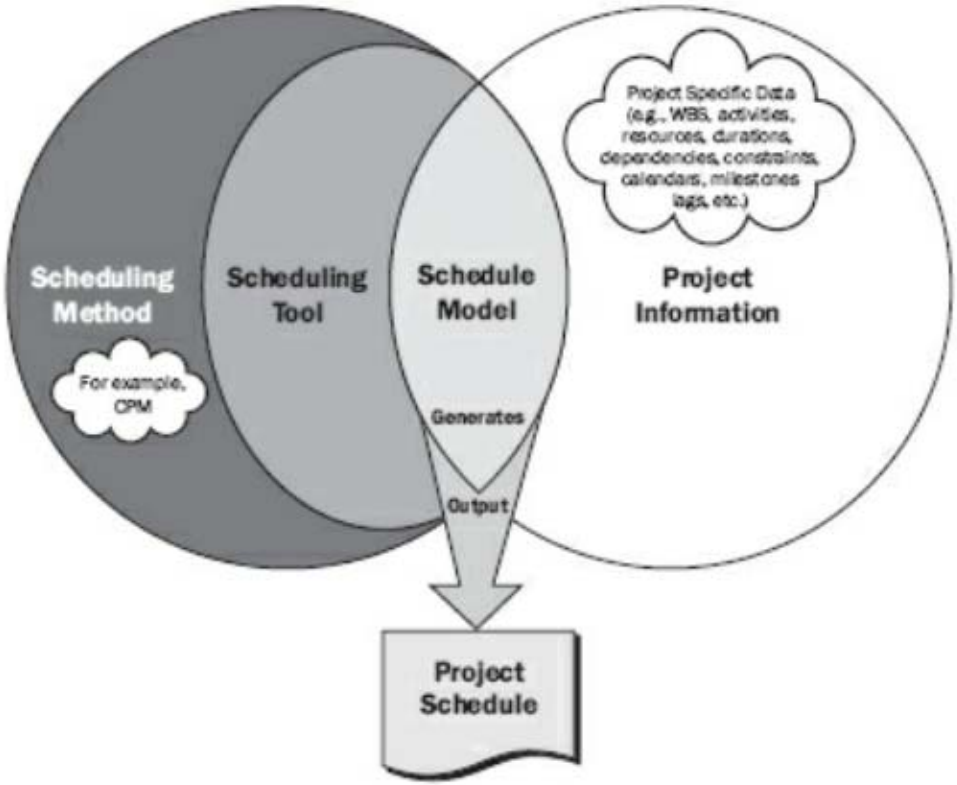
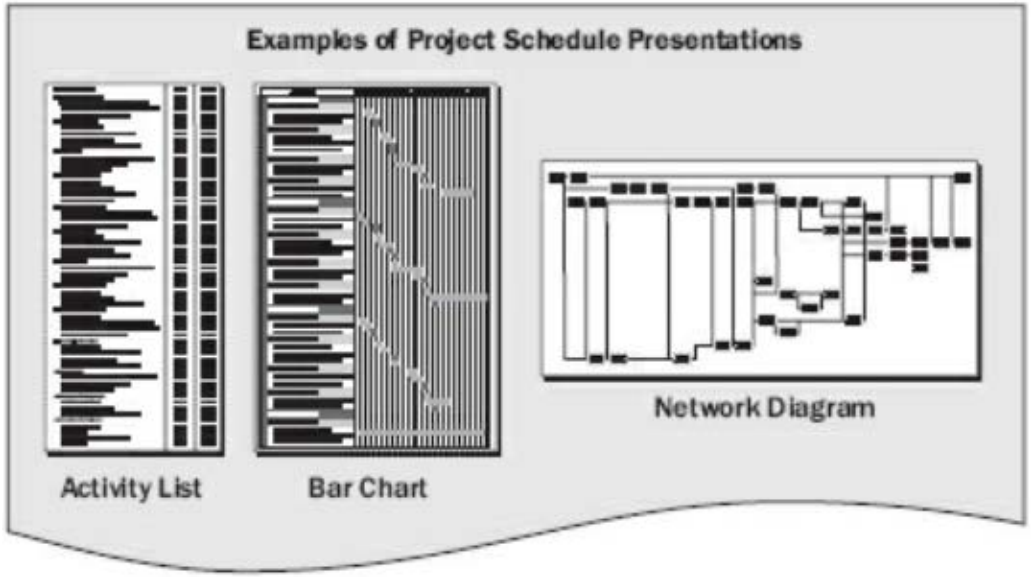
Agenda today

- Project Schedule Management Overview
- Network Techniques
  - PERT (Program Evaluation and Review Technique)
  - CPM (Critical Path Method)
- Constructing the Networks
  - AoA (Activity on Arrow)
  - AoN (Activity on Node)
  - Gannt Chart (bar chart)
- Estimating activity times
- Uncertainties in Completion times
- Problem solutions (for Midterm)

Scheduling Overview

A schedule is the conversion of a project work breakdown structure (WBS) into an operating timetable.





PMBOK®

Overview

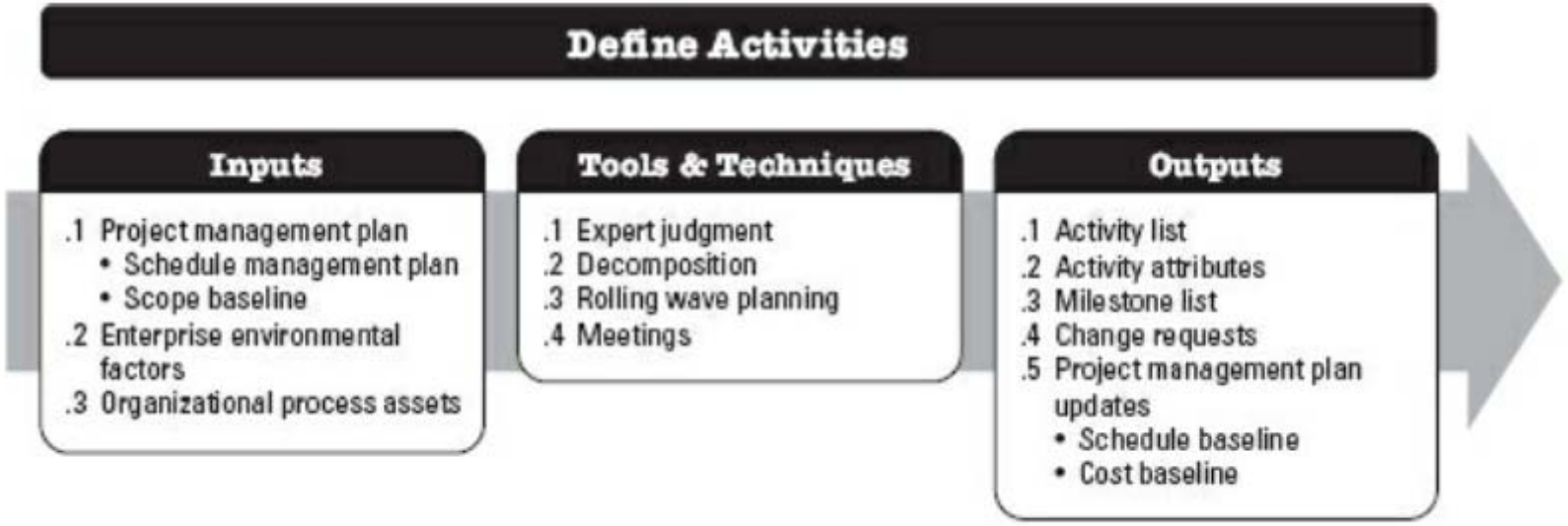


Figure 6-5. Define Activities: Inputs, Tools & Techniques, and Outputs

Overview

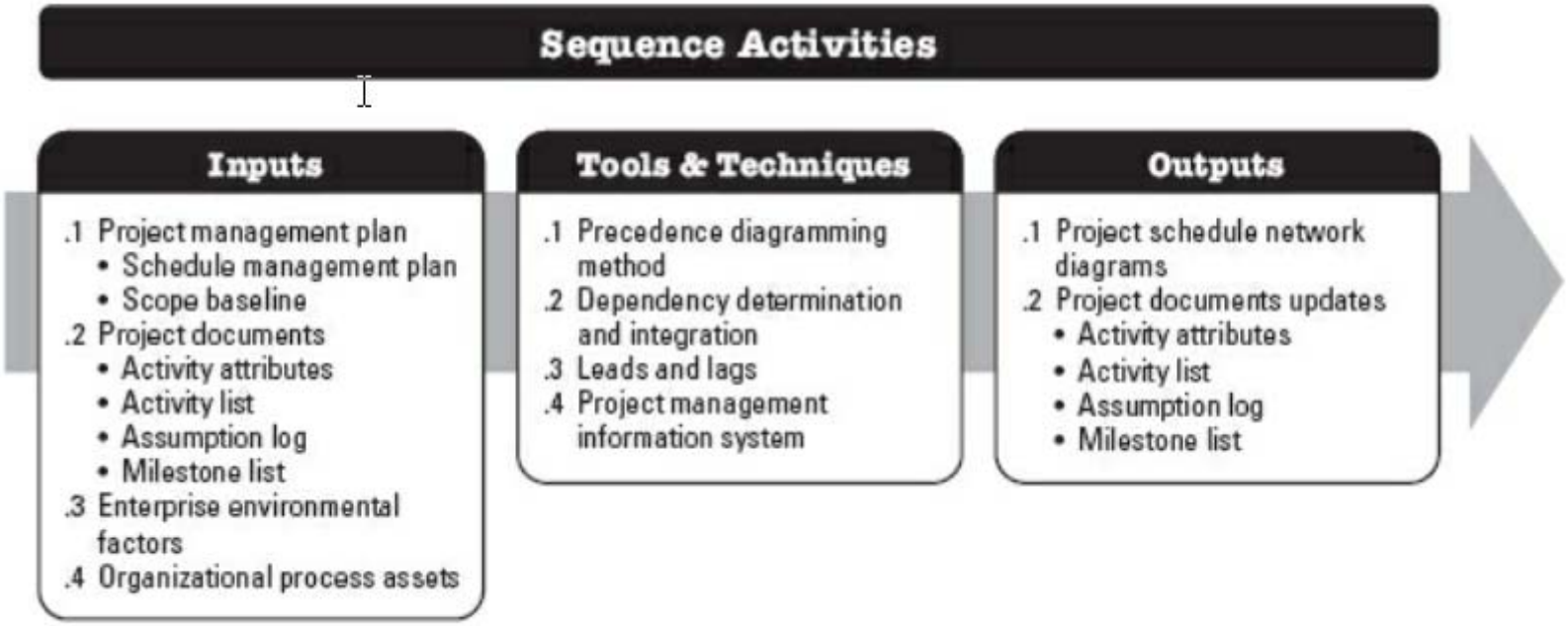


Figure 6-7. Sequence Activities: Inputs, Tools & Techniques, and Outputs

Sequence activities

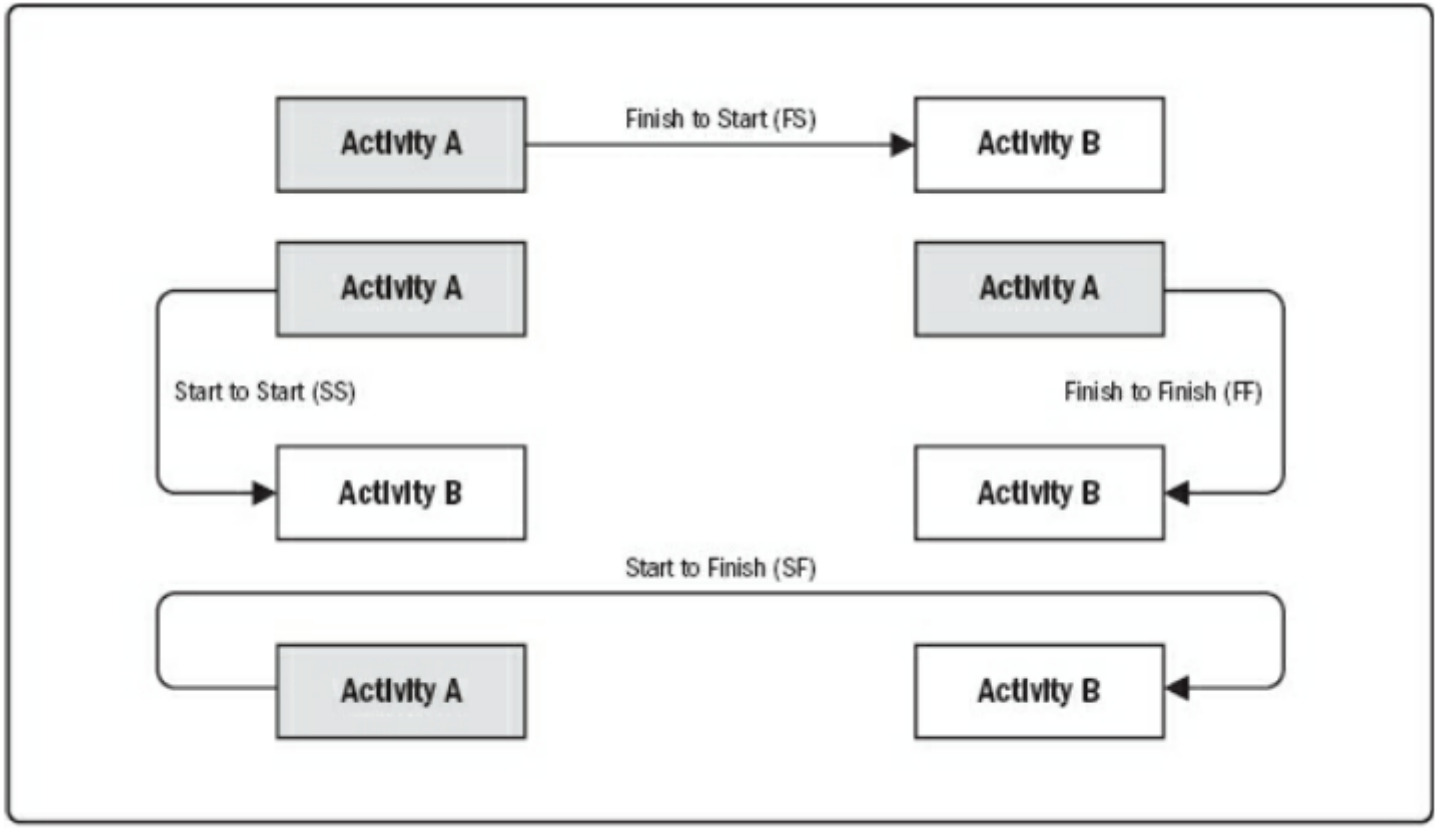


Figure 6-9. Precedence Diagramming Method (PDM) Relationship Types

Sequence activities

- It is a consistent framework for planning, scheduling, monitoring, and controlling the project.
- It illustrates the interdependence of all tasks, work packages, and work elements.
- It denotes the times when specific individuals and resources must be available for work on a given task.
- It aids in ensuring that the proper communications take place between departments and functions.
- It determines an expected project completion date.
- It identifies so-called critical activities that, if delayed, will also delay the project completion time.
- It also identifies activities with slack that can be delayed for specified periods without penalty, or from which resources may be temporarily borrowed without harm.
- It determines the dates on which tasks may be started—or must be started if the project is to stay on schedule.
- It illustrates which tasks must be coordinated to avoid resource or timing conflicts.
- It also illustrates which tasks may be run, or must be run, in parallel to achieve the predetermined project completion date.
- It relieves some interpersonal conflict by clearly showing task dependencies.
- It may, depending on the information used, allow an estimate of the probability of project completion by various dates, or the date corresponding to a particular a priori probability.

Network Techniques

PERT and CPM

- PERT
  - Probabilistic (Mostly for R&D projects)
  - Three time estimates
  - Unpredictable activities
  - Only uses FS relationship
- CPM
  - Deterministic (Mostly for Construction projects)
  - Used by Softwares
  - One time estimate
  - Predictable activities
  - Uses 4 possible relationships

Network Techniques

PERT and CPM Terminology

- Activity

  A specific task or set of tasks that are required by the project, use up resources, and take time to complete.

- Event

  The result of completing one or more activities. An identifiable end state that occurs at a particular time. Events use no resources.

- Network

  The arrangement of all activities (and, in some cases, events) in a project arrayed in their logical sequence and represented by arcs and nodes. This arrangement (network) defines the project and the activity precedence relationships. Networks are usually drawn starting on the left and proceeding to the right. Arrowheads placed on the arcs are used to indicate the direction of flow—that is, to show the proper precedences. Before an event can be realized— that is, achieved—all activities that immediately precede it must be completed. These are called its predecessors. Thus, an event represents an instant in time when each and every predecessor activity has been finished.

- Path

  The series of connected activities (or intermediate events) between any two events in a network.

- Critical

  Activities events, or paths which, if delayed, will delay the completion of the project. A project's critical path is understood to mean that sequence of critical activities (and critical events) that connects the project's start event to its finish event and which cannot be delayed without delaying the project.

Constructing the Networks

- AoN (Activity on Node)
  - Easier to draw
  - Emphasizes Activities
  - Used in softwares
  - Does not show timeline
- AoA (Activity on Arrow)
  - Dummy activities are used
  - Emphasizes Events (Milestones)
  - Can only represent FS relationship
  - No Lag or lead is supported
- Gannt Chart (Bar Chart)
  - Easy to read
  - Provides timeline
  - Difficult to follow activity paths

AoN Format

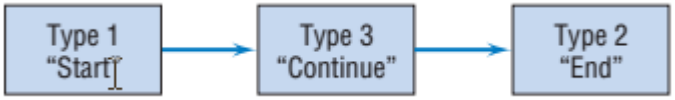


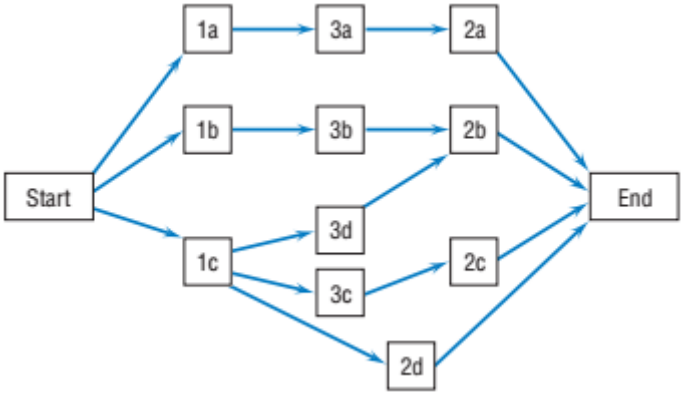
Figure 8-1 Three sequential activities, AON format.

AoN Format

WBS

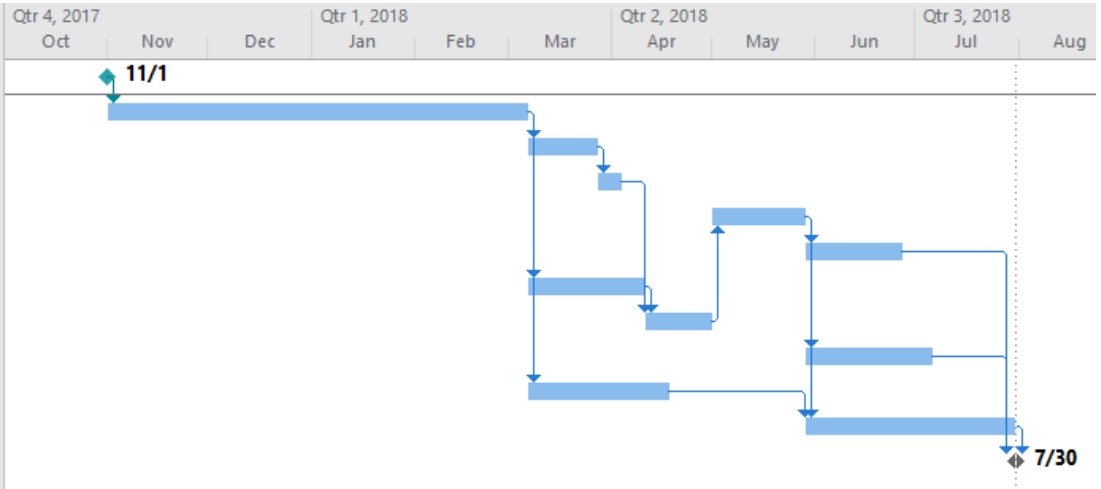
Career Day				
Steps	**Responsibility**	**Time (weeks)**	**Prec.**	**Resources**
1. Contact Organizations				
a. Print form	Secretary	6	–	Print shop
b. Contact organizations	Program manager	15	1.a	Word processing
c. Collect display information	Office manager	4	1.b	
d. Gather college particulars	Secretary	4	1.b	
e. Print programs	Secretary	6	1.d	Print shop
f. Print participants' certificates	Graduate assistant	8	–	Print Shop
2. Banquet and Refreshments				
a. Select guest speaker	Program manager	14	–	
b. Organize food	Program manager	3	1.b	Caterer
c. Organize liquor	Director	10	1.b	Dept. of Liquor Control
d. Organize refreshments	Graduate assistant	7	1.b	Purchasing
3. Publicity and Promotion				
a. Send invitations	Graduate assistant	2	–	Word processing
b. Organize gift certificates	Graduate assistant	5.5	–	
c. Arrange banner	Graduate assistant	5	1.d	Print shop
d. Contact faculty	Program manager	1.5	1.d	Word processing
e. Advertise in college paper	Secretary	5	1.d	Newspaper
f. Class announcements	Graduate assistant	1	3.d	Registrar's office
g. Organize posters	Secretary	4.5	1.d	Print shop
4. Facilities				
a. Arrange facility for event	Program manager	2.5	1.c	
b. Transport materials	Office manager	.5	4.a	Movers

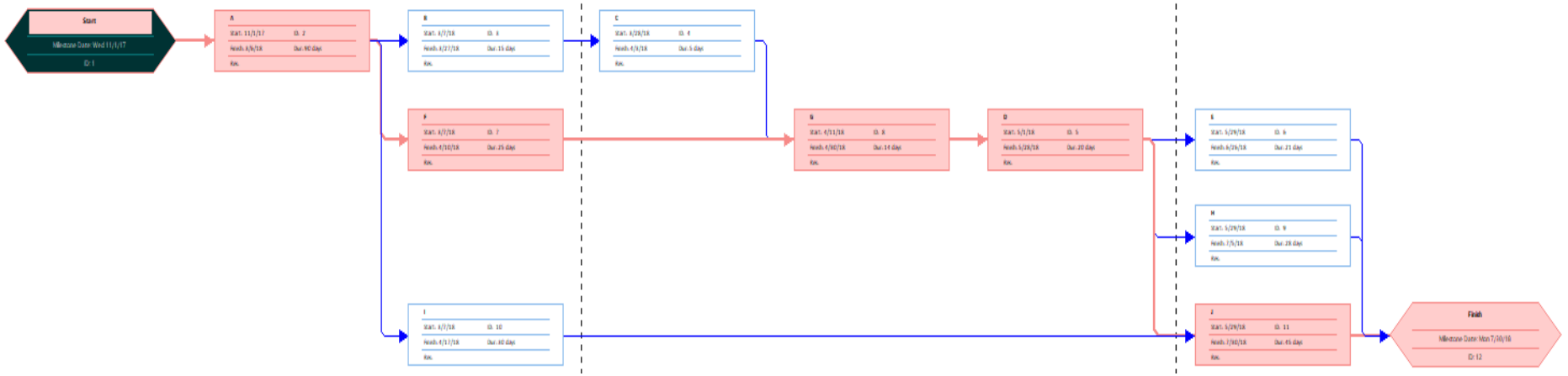
Figure 6-6 Partial WBS for college "Career Day."



AoN

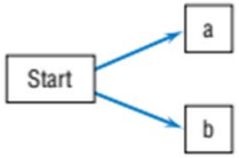
	Task Mode	Task Name	Duration	Start	Finish	Pre
1		Start	0 days	Wed 11/1/17	Wed 11/1/17	
2		A	90 days	Wed 11/1/17	Tue 3/6/18	1
3		B	15 days	Wed 3/7/18	Tue 3/27/18	2
4		C	5 days	Wed 3/28/18	Tue 4/3/18	3
5		D	20 days	Tue 5/1/18	Mon 5/28/18	8
6		E	21 days	Tue 5/29/18	Tue 6/26/18	5
7		F	25 days	Wed 3/7/18	Tue 4/10/18	2
8		G	14 days	Wed 4/11/18	Mon 4/30/18	4,7
9		H	28 days	Tue 5/29/18	Thu 7/5/18	5
10		I	30 days	Wed 3/7/18	Tue 4/17/18	2
11		J	45 days	Tue 5/29/18	Mon 7/30/18	5,1
12		Finish	0 days	Mon 7/30/18	Mon 7/30/18	6,9

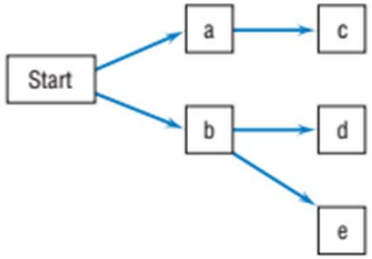


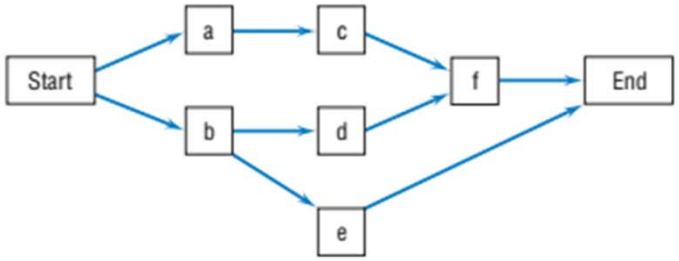


AoN

Tasks	*Precedence*	*Time*	*Cost*	*Who Does*
a	—	5 days	—	—
b	—	4 days	—	—
c	a	6 days	—	—
d	b	2 days	—	—
e	b	5 days	—	—
f	c,d	8 days	—	—

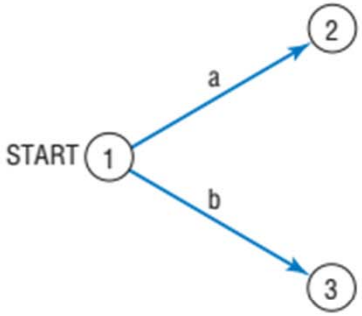


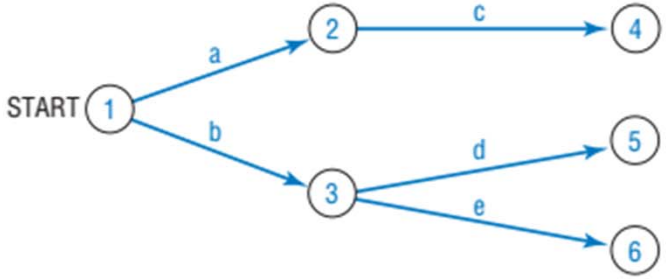


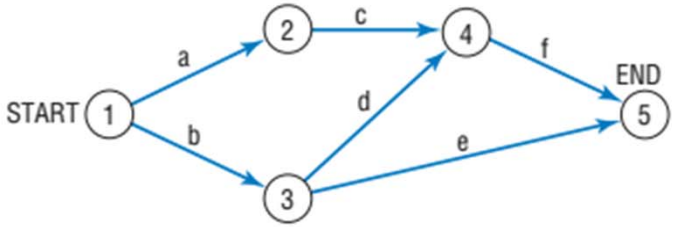


AoA

Tasks	*Precedence*	*Time*	*Cost*	*Who Does*
a	—	5 days	—	—
b	—	4 days	—	—
c	a	6 days	—	—
d	b	2 days	—	—
e	b	5 days	—	—
f	c,d	8 days	—	—

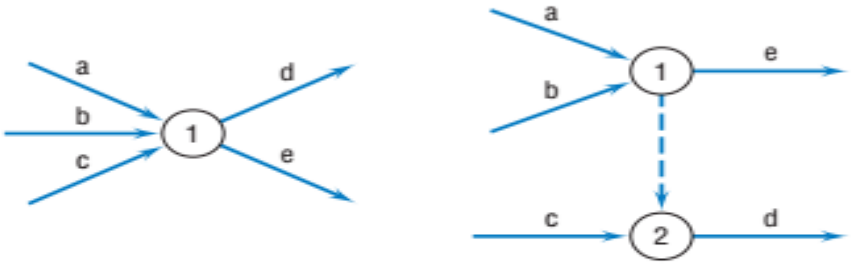


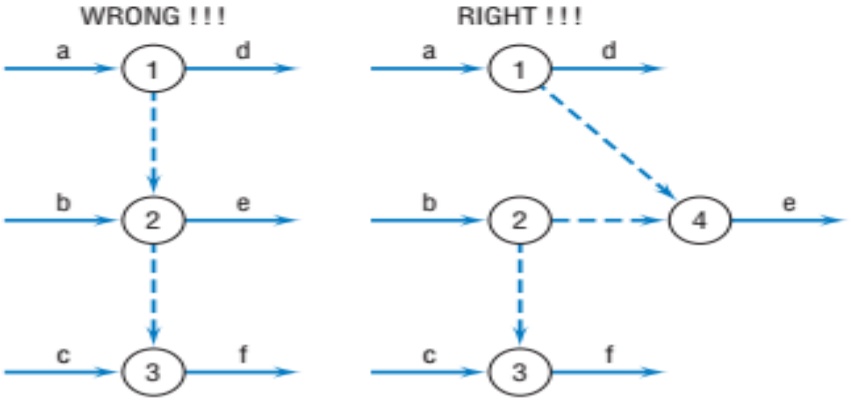




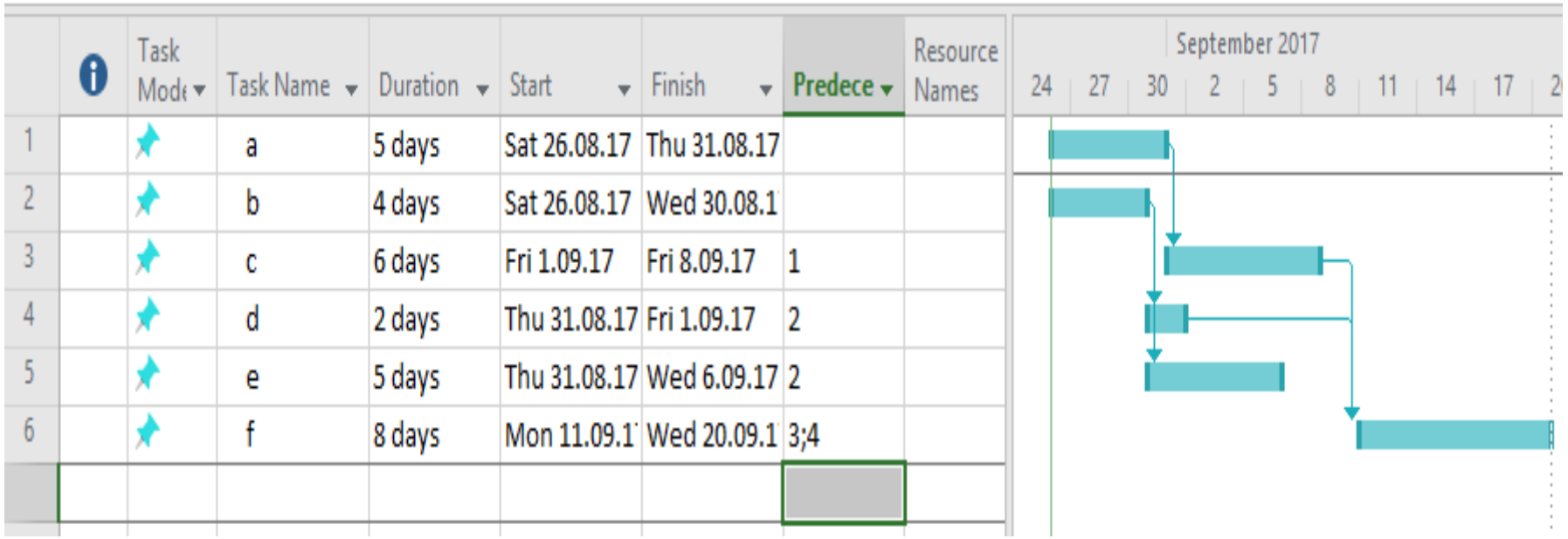
AoA


a
b
1
2
WRONG ! ! !
a
b
Dummy
1
2
3
RIGHT ! ! !


a
b
c
1
d
e
a
b
1
e
c
2
d


WRONG ! ! !
a
1
d
b
2
e
c
3
f
RIGHT ! ! !
a
1
d
b
2
4
e
c
3
f

Gannt Chart – Bar Chart



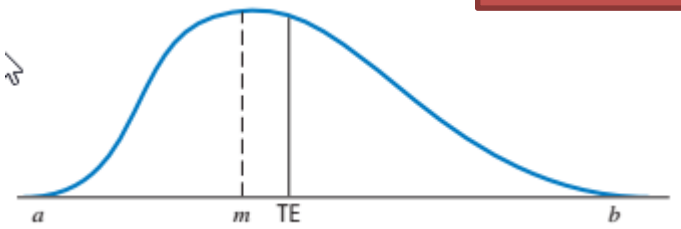
	Task Mode	Task Name	Duration	Start	Finish	Predece	Resource Names
1		a	5 days	Sat 26.08.17	Thu 31.08.17		
2		b	4 days	Sat 26.08.17	Wed 30.08.1		
3		c	6 days	Fri 1.09.17	Fri 8.09.17	1	
4		d	2 days	Thu 31.08.17	Fri 1.09.17	2	
5		e	5 days	Thu 31.08.17	Wed 6.09.17	2	
6		f	8 days	Mon 11.09.1	Wed 20.09.1	3;4	

1917 – Henry Gannt

Estimating Activity Times

Usually a beta distribution is assumed

Pessimistic – Skew left



A, b and m are found by discussions
But PM should cut out at the end.

$$TE = (a+4m+b) / 6$$

TE: Time estimate (Expected Time)
a: Optimistic time estimate
b: Pessimistic time estimate
m: Most likely time estimate, the mode

Three-point Estimating

A technique used in estimating activity durations.
PERT: Program Evaluation and Review Technique

Most Likely (M): Activity duration based on realistic expectations

Optimistic (O): Activity duration based on best-case scenario

Pessimistic (P): Activity duration based on worst-case scenario

1. Triangular Distribution
2. Beta Distribution

Three-point Estimating

Triangular distribution $$\text{Activity Duration} = \frac{O+M+P}{3}$$

Beta distribution $$\text{Activity Duration} = \frac{O+4M+P}{6}$$

We will assume beta for our examples. İt is some better approach.

Three-point Estimating Sample

You are a Project Manager of a software project. You are in the estimate activity durations process of your project. You ask a software developer to estimate, optimistic, most likely, and pessimistic durations of a specific screen. He gives the following information:

	Optimistic	Most Likely	Pessimistic
Duration (days)	5	7	15

Based on these estimates, calculate the activity duration by using triangular and beta distributions of PERT technique.

$$\text{Triangular Distribution Activity Duration} = \frac{O+M+P}{3} = \frac{5+7+15}{3} = 9 \text{ days}$$

$$\text{Beta Distribution Activity Duration} = \frac{O+4M+P}{6} = \frac{5+4x7+15}{6} = 8 \text{ days}$$

PERT Exercise
A sample small Project

Table 8-1 Project Activity Times and Precedences

Activity	Optimistic Time	Most Likely Time	Pessimistic Time	Immediate Predecessor Activities
a	10	22	22	—
b	20	20	20	—
c	4	10	16	—
d	2	14	32	a
e	8	8	20	b, c
f	8	14	20	b, c
g	4	4	4	b, c
h	2	12	16	c
i	6	16	38	g, h
j	2	8	14	d, e

Small may mean agile too

A sample small Project

Activity	Immediate Predecessor Activities
a	—
b	—
c	—
d	a
e	b, c
f	b, c
g	b, c
h	c
i	g, h
j	d, e

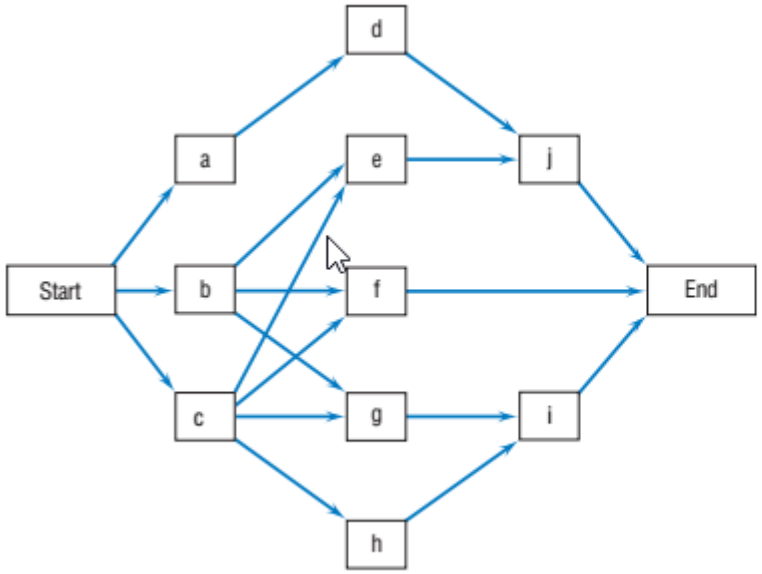


Figure 8-13 The AON network from Table 8-1.

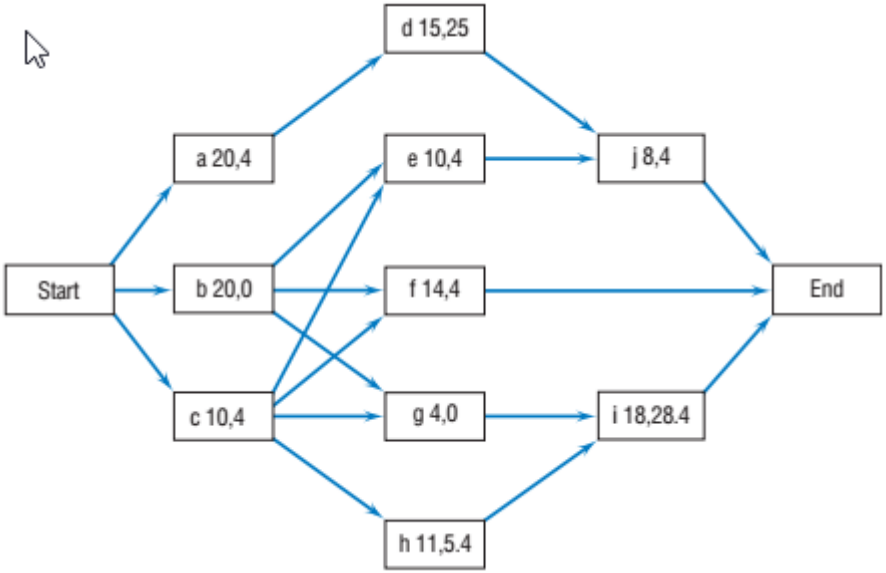
A sample small Project

Table 8-2 Expected Activity Times (TE), Variances (σ^2), and Standard Deviations (σ)

Activity	Expected Time, TE	Variance, σ^2	Standard Deviation, σ
a	20	4	2
b	20	0	0
c	10	4	2
d	15	25	5
e	10	4	2
f	14	4	2
g	4	0	0
h	11	5.4	2.32
i	18	28.4	5.33
j	8	4	2

$$TE = (a + 4m + b)/6$$

$$\sigma^2 = ((b - a)/6)^2$$



Activity code Duration, Variance

Critical Path Method and Floats

Critical Path Method

Determines;

- Longest path in the network diagram
- Earliest and latest an activity can start
- Earliest and latest an activity can be completed

Critical Path

- Longest duration through a network diagram
- Shortest time to complete the project

Near Critical Path

- Closest path to critical path in terms of duration

Critical Path Method and Floats

Critical Path Method

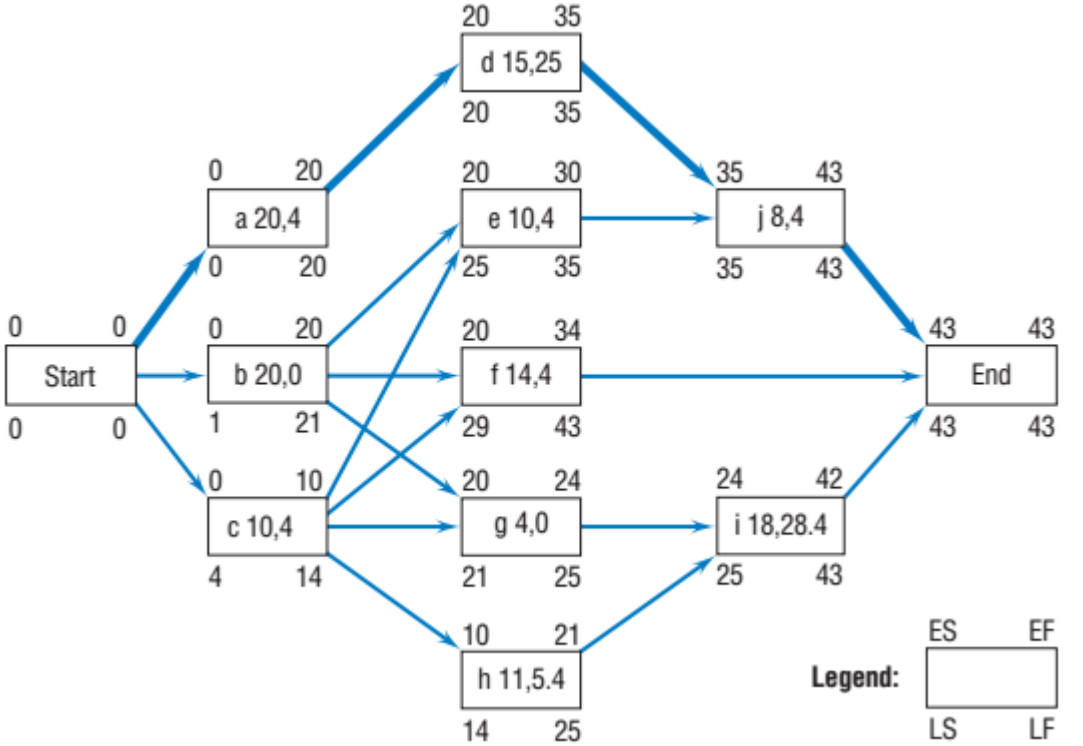
Float (Slack)

- **Total Float:** Delay time without affecting the project end date
- **Free Float:** Delay time without affecting the early start date
- **Project Float:** Delay time without affecting the externally imposed project completion date

✓ Critical path activities should have "0" float !!!

1. Float = Late Start (LS) – Early Start (ES)
2. Float = Late Finish (LF) – Early Finish (EF)

Critical path, time and slacks
A sample small Project



Activity Code, Duration, Variance

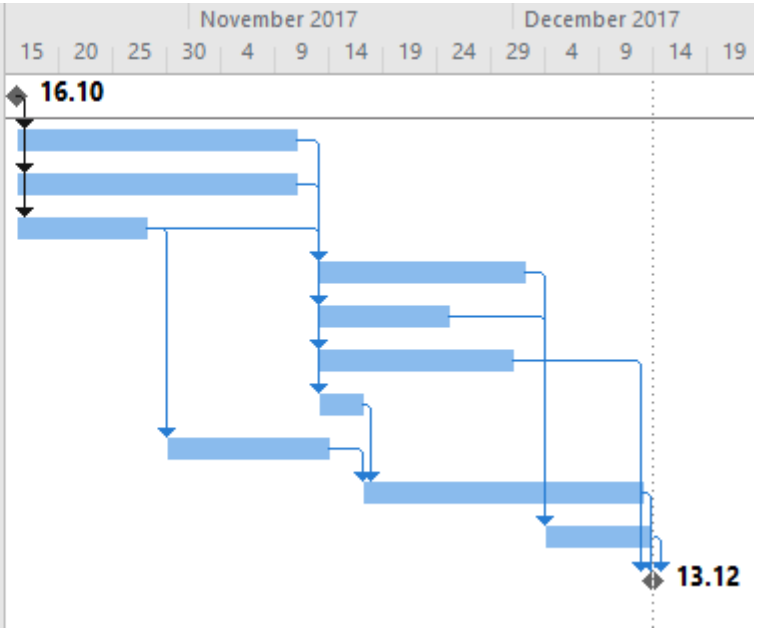
Slack, aka or float are the same thing

Activity	LS	ES	Slack
a	0	0	0
b	1	0	1
c	4	0	4
d	20	20	0
e	25	20	5
f	29	20	9
g	21	20	1
h	14	10	4
i	25	24	1
j	35	35	0

MS Project way-CPM

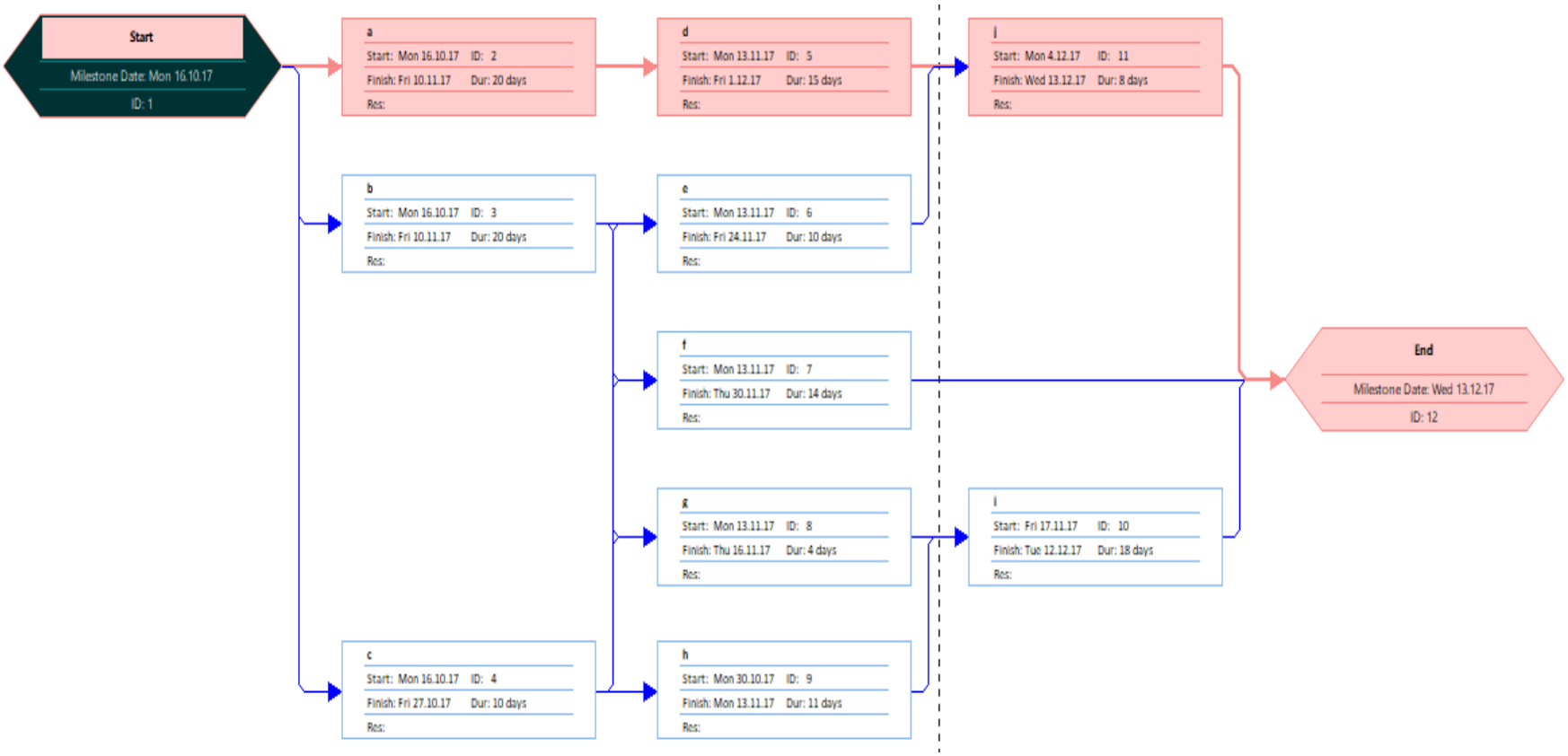
A sample small Project

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Start	0 days	Mon 16.10.1	Mon 16.10.1	
2		a	20 days	Mon 16.10.1	Fri 10.11.17	1
3		b	20 days	Mon 16.10.1	Fri 10.11.17	1
4		c	10 days	Mon 16.10.1	Fri 27.10.17	1
5		d	15 days	Mon 13.11.1	Fri 1.12.17	2
6		e	10 days	Mon 13.11.1	Fri 24.11.17	3;4
7		f	14 days	Mon 13.11.1	Thu 30.11.17	3;4
8		g	4 days	Mon 13.11.1	Thu 16.11.17	3;4
9		h	11 days	Mon 30.10.1	Mon 13.11.1	4
10		i	18 days	Fri 17.11.17	Tue 12.12.17	8;9
11		j	8 days	Mon 4.12.17	Wed 13.12.1	5;6
12		End	0 days	Wed 13.12.1	Wed 13.12.1	11;10;7



MS Project way-CPM

A sample small Project



MS Project way-CPM

A sample small Project

Task Name	Duration	Start	Finish	Predec	Early Start	Early Finish	Late Start	Late Finish	Free Slack
Start	0 days	Mon 16.10.1	Mon 16.10.1		Mon 16.10.17	Mon 16.10.17	Mon 16.10.17	Mon 16.10.17	0 days
a	20 days	Mon 16.10.1	Fri 10.11.17	1	Mon 16.10.17	Fri 10.11.17	Mon 16.10.17	Fri 10.11.17	0 days
b	20 days	Mon 16.10.1	Fri 10.11.17	1	Mon 16.10.17	Fri 10.11.17	Tue 17.10.17	Mon 13.11.17	0 days
c	10 days	Mon 16.10.1	Fri 27.10.17	1	Mon 16.10.17	Fri 27.10.17	Fri 20.10.17	Thu 2.11.17	0 days
d	15 days	Mon 13.11.1	Fri 1.12.17	2	Mon 13.11.17	Fri 1.12.17	Mon 13.11.17	Fri 1.12.17	0 days
e	10 days	Mon 13.11.1	Fri 24.11.17	3;4	Mon 13.11.17	Fri 24.11.17	Mon 20.11.17	Fri 1.12.17	5 days
f	14 days	Mon 13.11.1	Thu 30.11.17	3;4	Mon 13.11.17	Thu 30.11.17	Fri 24.11.17	Wed 13.12.17	9 days
g	4 days	Mon 13.11.1	Thu 16.11.17	3;4	Mon 13.11.17	Thu 16.11.17	Tue 14.11.17	Fri 17.11.17	0 days
h	11 days	Mon 30.10.1	Mon 13.11.1	4	Mon 30.10.17	Mon 13.11.17	Fri 3.11.17	Fri 17.11.17	3 days
i	18 days	Fri 17.11.17	Tue 12.12.17	8;9	Fri 17.11.17	Tue 12.12.17	Mon 20.11.17	Wed 13.12.17	1 day
j	8 days	Mon 4.12.17	Wed 13.12.1	5;6	Mon 4.12.17	Wed 13.12.17	Mon 4.12.17	Wed 13.12.17	0 days
End	0 days	Wed 13.12.1	Wed 13.12.1	11;10;7	Wed 13.12.17	Wed 13.12.17	Wed 13.12.17	Wed 13.12.17	0 days

MS Project take care about Holidays or weekends – SO Be Careful

Precedence Last Review

- Finish-to-start (FS).

  A logical relationship in which a successor activity cannot start until a predecessor activity has finished. For example, installing the operating system on a PC (successor) cannot start until the PC hardware is assembled (predecessor).
- Finish-to-finish (FF).

  A logical relationship in which a successor activity cannot finish until a predecessor activity has finished. For example, writing a document (predecessor) is required to finish before editing the document (successor) can finish.
- Start-to-start (SS).

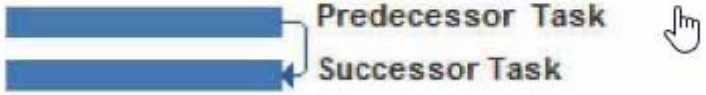
  A logical relationship in which a successor activity cannot start until a predecessor activity has started. For example, level concrete (successor) cannot begin until pour foundation (predecessor) begins.
- Start-to-finish (SF).

  A logical relationship in which a successor activity cannot finish until a predecessor activity has started. For example, a new accounts payable system (successor) has to start before the old accounts payable system can be shut down (predecessor).

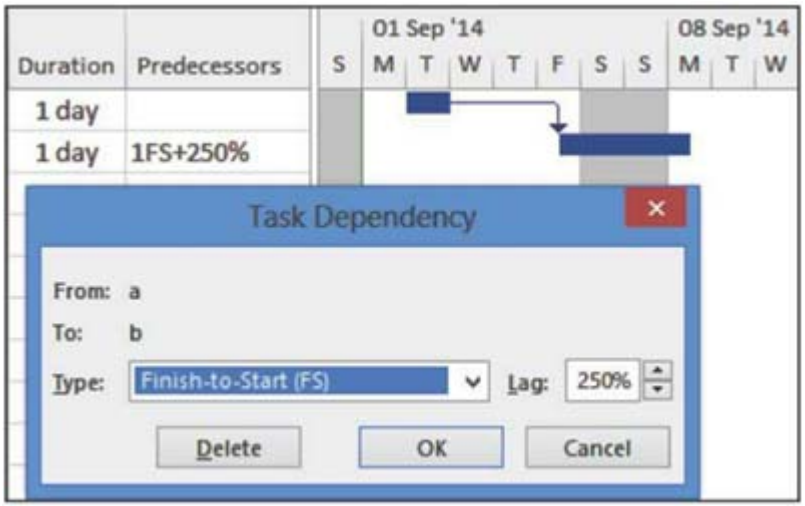
Precedence Diagraming

While the **SS** dependency is like this:

The **FF** dependency would be:



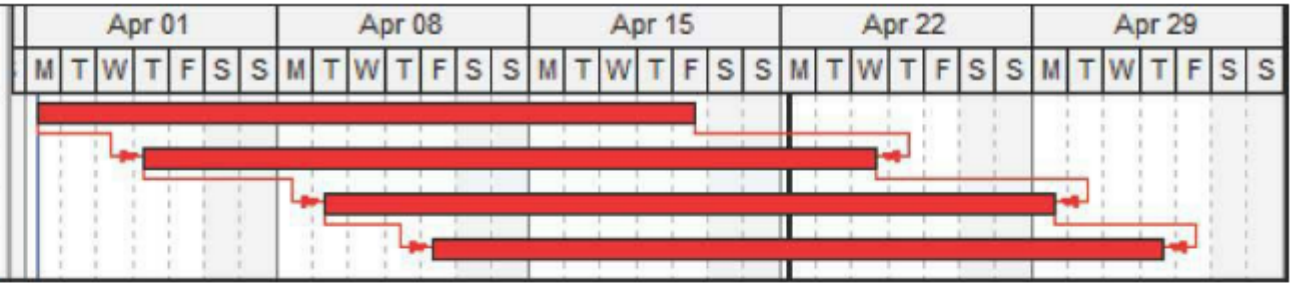
The **SF** dependency looks like:



Be careful:
MS-Project gets week-ends.

Precedence Diagraming

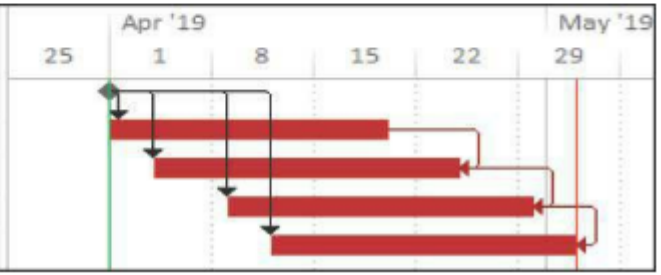
Activity ID	Activity Name	Original Duration
A1000	Trench	15d
A1010	Padding	15d
A1020	Laying	15d
A1030	Backfill	15d



Microsoft Project does not allow two relationships between tasks. Ladder Scheduling may be achieved by:

- Commencing a chain of tasks with a Start Milestone,
- Connect the Start Milestone to each task with a Start to Start plus the appropriate lag and
- Connect each task to their successor with a Finish to Finish relationship plus the appropriate lag:

	Task Name	Dur	Predecessors	Successors
1	Start pipe laying	0d		2,3FS+3d,4FS+6d,5FS+9d
2	Trench	15d	1	3FF+3d
3	Padding	15d	1FS+3d,2FF+3d	4FF+3d
4	Laying	15d	1FS+6d,3FF+3d	5FF+3d
5	Backfill	15d	1FS+9d,4FF+3d	



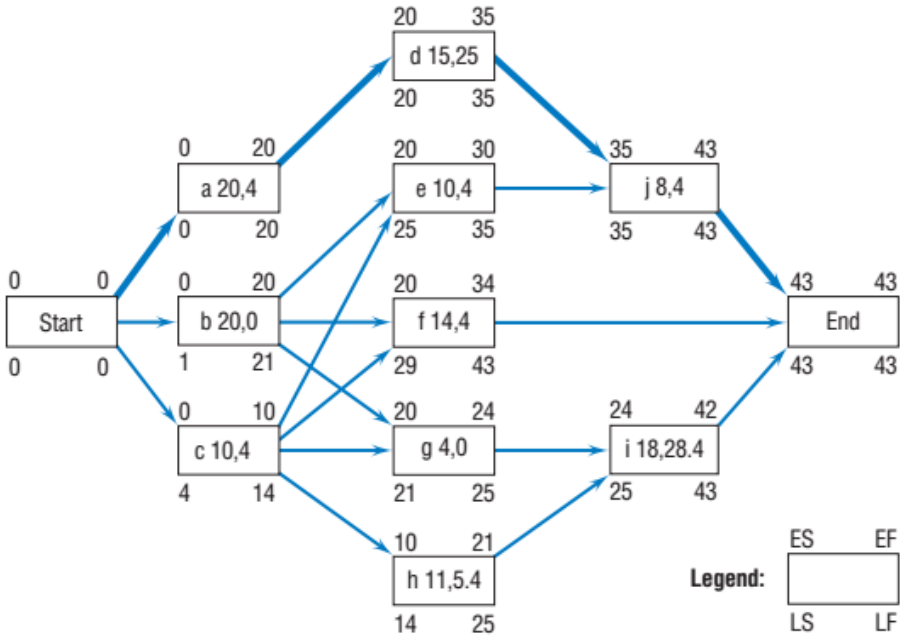
Notes for CPM

Important Notes about Critical Path Method

- There can be more than one critical paths
- Having several critical paths or having several near critical paths mean project has high risk
- Critical path of the project can change over time
- There can be negative float, it means schedule is behind than the planned
- If there is negative float, you should compress the schedule.
- If you need to cut an activity duration in critical path, cut the earlier activity's duration

Uncertainties in Completion Times

When discussing project completion dates with senior management, the PM should try to determine the probability that a project will be completed by the suggested deadline—or find the completion time associated with a predetermined level of risk.



We should do some assumptions to use normal distribution.
(Out of topic – Simply use it)

Using it;
You will gain time as PM

Uncertainties in Completion Times

Table 8-2 Expected Activity Times (TE), Variances (σ^2), and Standard Deviations (σ)

Activity	Expected Time, TE	Variance, σ^2	Standard Deviation, σ
a	20	4	2
b	20	0	0
c	10	4	2
d	15	25	5
e	10	4	2
f	14	4	2
g	4	0	0
h	11	5.4	2.32
i	18	28.4	5.33
j	8	4	2

$$Z = (D - \mu)/\sqrt{\sigma_\mu^2}$$

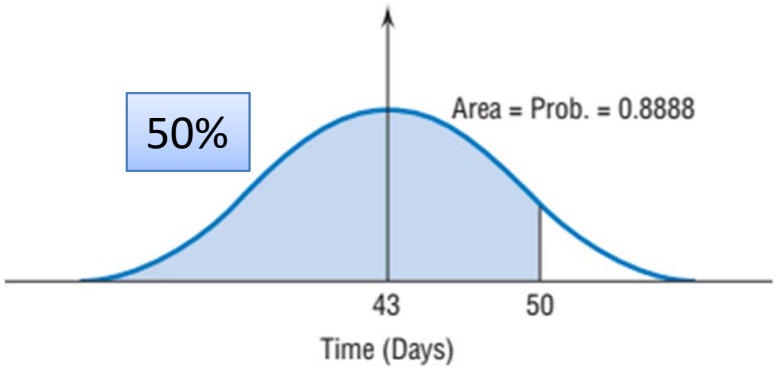


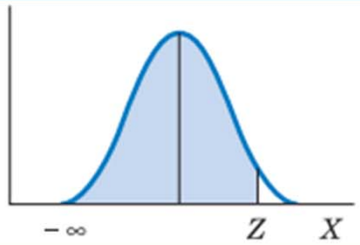
Figure 8-25 Probability distribution of project completion times.

D = the desired project completion time (this time 50 days)
μ= the critical time of the project, the sum of the TEs for activities on the critical path
σ^2_μ = the variance of the critical path, the sum of the variances of activities on the critical path
Z = the number of standard deviations of a normal distribution (the standard normal deviate)

$$Z = (50 - 43)/5.745$$
$$= 1.22 \text{ standard deviations}$$

You will use on the Exam

Table 8-5 Cumulative (Single Tail) Probabilities of the Normal Probability Distribution (Areas under the Normal Curve from $-\infty$ to Z)



Example: the area to the left of $Z = 1.34$ is found by following the left Z column down to 1.3 and moving right to the .04 column. At the intersection read .9099. The area to the right of $Z = 1.34$ is $1 - .9099 = .0901$. The area between the mean (center line) and $Z = 1.34$ is $.9099 - .5 = .4099$.

z	00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8880
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319

Meredith

Uncertainties in Completion Times

N4 =NORM.INV(M4,E$12,G$12)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Activity	Optimistic	Most Likely	Pesimistic	Mean μ	σ^2	Std Dev σ		Durations	P of Comp. Bef.	P of Comp. Later		P of Comp. Bef.	Durations
2	a	10	22	22	20.00	4.00			50	88.85%	11.15%		90%	50
3	b	20	20	20	20.00	-			55	98.16%	1.84%		80%	48
4	c	4	10	16	10.00	4.00			60	99.85%	0.15%		70%	46
5	d	2	14	32	15.00	25.00							60%	44
6	e	8	8	20	10.00	4.00							50%	43
7	f	8	14	20	14.00	4.00								
8	g	4	4	4	4.00	-								
9	h	2	12	16	11.00	5.44								
10	i	6	16	38	18.00	28.44								
11	j	2	8	14	8.00	4.00								
12					43.00	33.00	5.74							

$$\text{Norm.Dist}(50, 43, 5.745, \text{True}) = 0.888$$

= Norm.Dist(D, μ, σ_μ , True)

=NORMINV(P, μ, σ) in EXCEL

Problems
Exam Questions

1. Given the following information, draw the AON diagram:

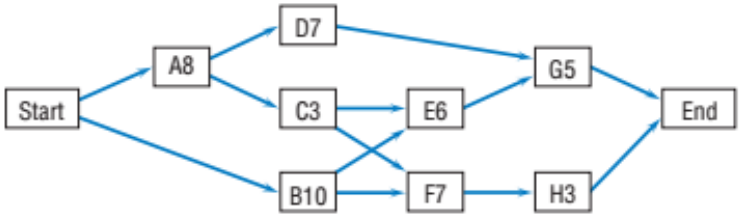
Activity	*Immediate Predecessor*
1	—
2	—
3	1, 4
4	2
5	2
6	3, 5

7. Given the following activities and precedences, draw an AOA or AON diagram:

Activity	*Immediate Predecessor*
A	—
B	—
C	A
D	A, B
E	A, B
F	C
G	D, F
H	E, G

8. Given the following network,

First letter is Activity code
Second is duration



(a) What is the critical path?
(b) How long will it take to complete this project?
(c) Can activity B be delayed without delaying the completion of the project? If so, how many days?

Problems
Exam Questions

12. The Denver Iron & Steel Company is expanding its operations to include a new drive-in weigh station. The weigh station will be a heated/air-conditioned building with a large floor and small office. The large room will have the scales, a 15-foot counter, and several display cases for its equipment.

Before erection of the building, the project manager evaluated the project using AON analysis. The activities with their corresponding times were recorded in Table A.

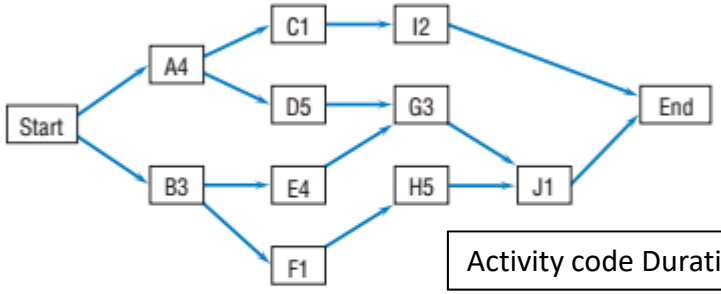
Using AON analysis, find the path with the longest expected duration, the slack times, and the expected completion time.

Table A

		Times			
#	Activity	Optimistic	Most Likely	Pessimistic	Preceding Tasks
1	Lay foundation	8	10	13	—
2	Dig hole for scale	5	6	8	—
3	Insert scale bases	13	15	21	2
4	Erect frame	10	12	14	1, 3
5	Complete building	11	20	30	4
6	Insert scales	4	5	8	5
7	Insert display cases	2	3	4	5
8	Put in office equipment	4	6	10	7
9	Finishing touches	2	3	4	8, 6

Problems
Exam Questions

14. The following chart was prepared at the beginning of a HRM (Human Resource Management) crash hiring project. The project begins with two activities: Assemble interview team (A) and Budget resources (B).



The duration, in days, follows the letter of each activity. What is the critical path? Which activities should be monitored most closely?

At the end of the first week, it was noted that activity **A** was completed in 2.5 days, but activity **B** required 4.5 days. What impact does this have on the project? Are the same activities critical?

16. Given an auditing project with the following activities,

Activity	Standard Deviation	Critical?	Duration
a, add	2	yes	2
b, balance	1		3
c, count	0	yes	4
d, deduct	3		2
e, edit	1	yes	1
f, finance	2		6
g, group	2	yes	4
h, hold	0	yes	2

find:

(a) The probability of completing the critical path in 12 weeks (or less), as the client desires.

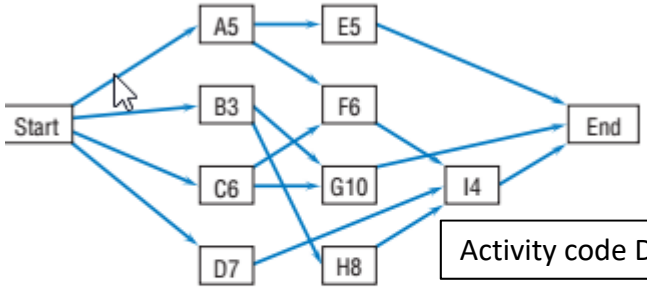
(b) The probability of completing the critical path in 13 weeks (or less).

(c) The probability of completing the critical path in 16 weeks (or less), the client's drop-dead date.

(d) The number of weeks required to assure a 92.5 percent chance of completing the critical path, as guaranteed by the auditing firm.

Problems
Exam Questions

17. The following network is a compressed representation of the prospectus of a start-up firm that plans to develop a new, bioelectronic computer chip.



Activity code Duration

Note that four activities, the biological elements, can start immediately.

Find:

(a) The critical path.

(b) The earliest time to complete the project.

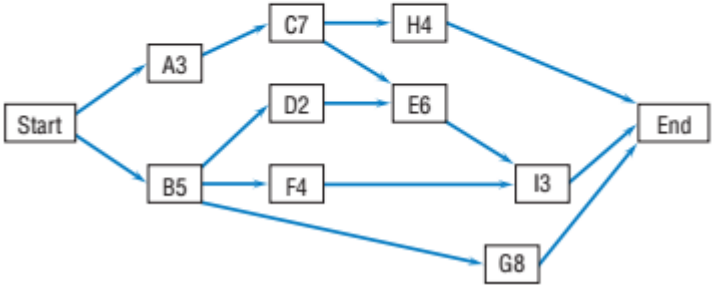
(c) The slack on activities **E**, **F**, and **H**.

19. Given the following network (times are in weeks), determine:

(a) The ES, LS, EF, and LF for each activity.

(b) The slacks on all activities.

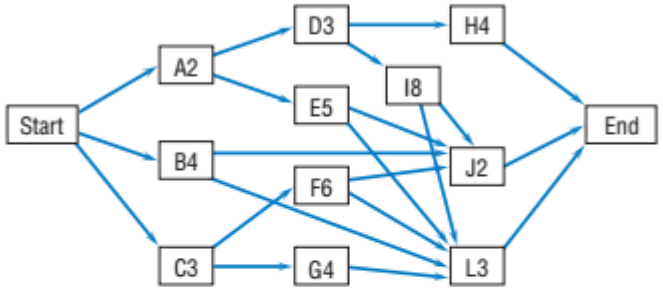
(c) The critical activities and path.



Activity code Duration

Problems
Exam Questions

21. In the website development project network shown in the following figure, the number alongside each activity designates the activity duration (TE) in weeks.



Activity code Duration

Determine:

(a) The ES and LS for each activity.

(b) The earliest time that the website can be completed.

(c) The slack on all activities.

(d) The critical activities.

(e) The critical path.

20. Given the schedule in Table B for a liability work package done as part of an accounting audit in a corporation, find:

(a) The critical path.

(b) The slack time on "process confirmations."

(c) The slack time on "test pension plan."

(d) The slack time on "verify debt restriction compliance."

Table B

Activity	*Duration (days)*	*Preceding Activities*
a. Obtain schedule of liabilities	3	none
b. Mail confirmation	15	a
c. Test pension plan	5	a
d. Vouch selected liabilities	60	a
e. Test accruals and amortization	6	d
f. Process confirmations	40	b
g. Reconcile interest expense to debt	10	c, e
h. Verify debt restriction compliance	7	f
i. Investigate debit balances	6	g
j. Review subsequent payments	12	h, i

Problems
Exam Questions

22. Given the following information regarding a project concerning an initial public offering (IPO),

Activity	TE (weeks)	Preceding Activities
a: Check feasibility	3	none
b: Determine funding	1	none
c: Find possible banks	3	a
d: Select two possibles	4	a
e: Interview two banks	4	b
f: Analyze funding costs	5	b
g: What chance of success?	2	c, e
h: Sign contract	3	f

(a) Draw the network.

(b) What is the critical path?

(c) When will the offering be available (completion of the project)?

(d) What is the effect on the project if activity **e** (approvals) takes an extra week? Two extra weeks? Three extra weeks?

23. Construct a network for the aerospace launch project below and find its critical path.

Activity	TE (weeks)	Preceding Activities
a: Check controls	3	none
b: Check propellants	5	a
c: Check personnel	3	a
d: Assemble items	1	c
e: Move to launch pad	3	h
f: Run system tests	4	b, d
g: Check astronauts	2	c
h: Ground stations go?	3	g, f
i: Countdown	1	e, h

Problems
Exam Questions

28. Draw an AON network using the following data and find the probability of completing the path with the longest expected duration in 44 days, the official opening date.

		Time (days)		
Activity	**Predecessor**	**a**	**m**	**b**
1	—	6	10	14
2	1	0	1	2
3	1	16	20	30
4	2	3	5	7
5	4	2	3	4
6	3	7	10	13
7	4	1	2	3
8	7	0	2	4
9	3, 7	2	2	2
10	9	2	3	4
11	8	0	1	2
12	10, 11	1	2	3

Assume Beta distribution

Resources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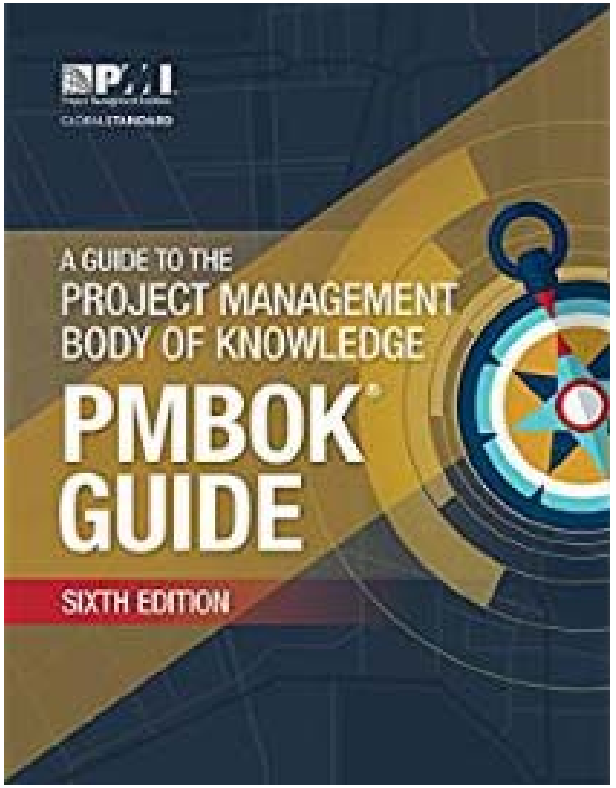
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Questions

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MIDTERM

The WEEK AFTER: Project Planning – Resource Allocation
CPM Crashing – Fast Tracking