EAST WEST UNIVERSITY

CSE347

Information System Analysis and Design

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Topic 04

Software Project Scheduling

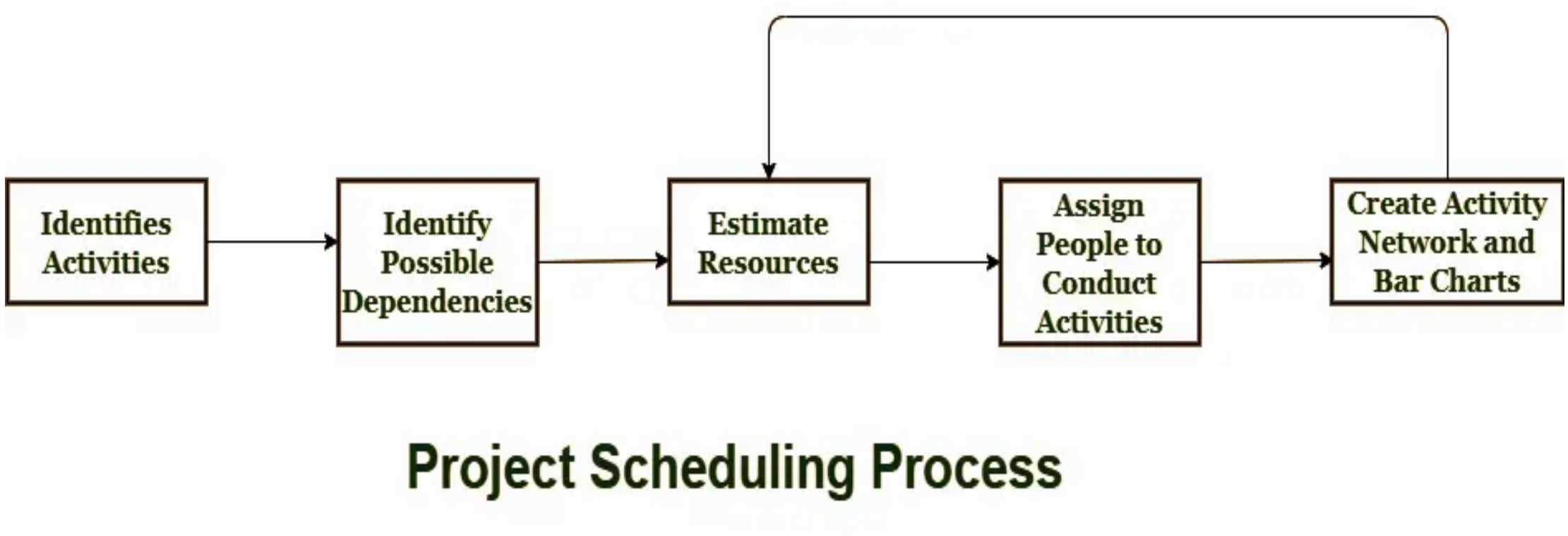
Work Breakdown structure (WBS), Activity chart / Network, CPM and PERT, GANTT Charts

Software Project Scheduling

- Project scheduling is an essential aspect of project management, allowing teams to plan and manage their tasks and resources effectively.
- It involves breaking down the project into smaller tasks, estimating the time required to complete each task, and determining the dependencies between tasks.
- With a well-designed project schedule, project managers can ensure that the project is completed on time, within budget, and to the desired level of quality.
- A project schedule serves as a roadmap for the project team, providing them with a clear understanding of what needs to be done, when, and by whom.

Project Scheduling Process

- Identify all the tasks required to complete the project.
- Break down large tasks into smaller activities.
- Determine the dependencies among various activities.
- Estimate the time required to complete each activity.
- Allocate resources to each activity.
- Determine the critical path, which is the sequence of activities that determine the overall duration of the project.
- Plan the start and end dates for each activity.



Project Scheduling Process

Project Planning

- Managers should consider:
  - Resource availability
  - Resource allocation
  - Staff responsibility
  - Cash flow forecasting
- Mangers need to monitor and re-plan as the project progresses towards its pre- defined goal

Work Breakdown Structure (WBS)

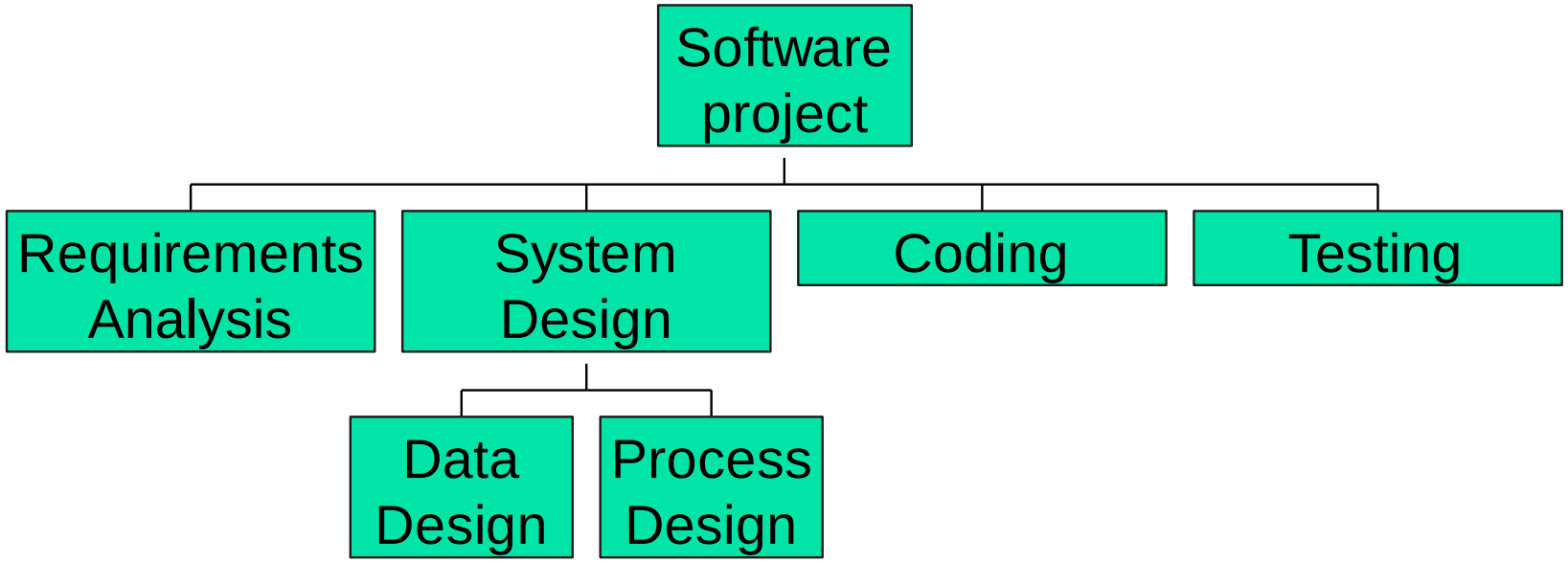
- Contains a list of activities for a project derived from
  - Previous experience
  - Expert brainstorming
- WBS helps in
  - identifying the main activities
  - break each main activity down into sub-activities which can further be broken down into lower-level sub-activities
- WBS problems:
  - Too many levels
  - Too few levels

Creating WBS

- Phase based approach
- Product based approach
- Hybrid approach

Example of Phase-based Approach

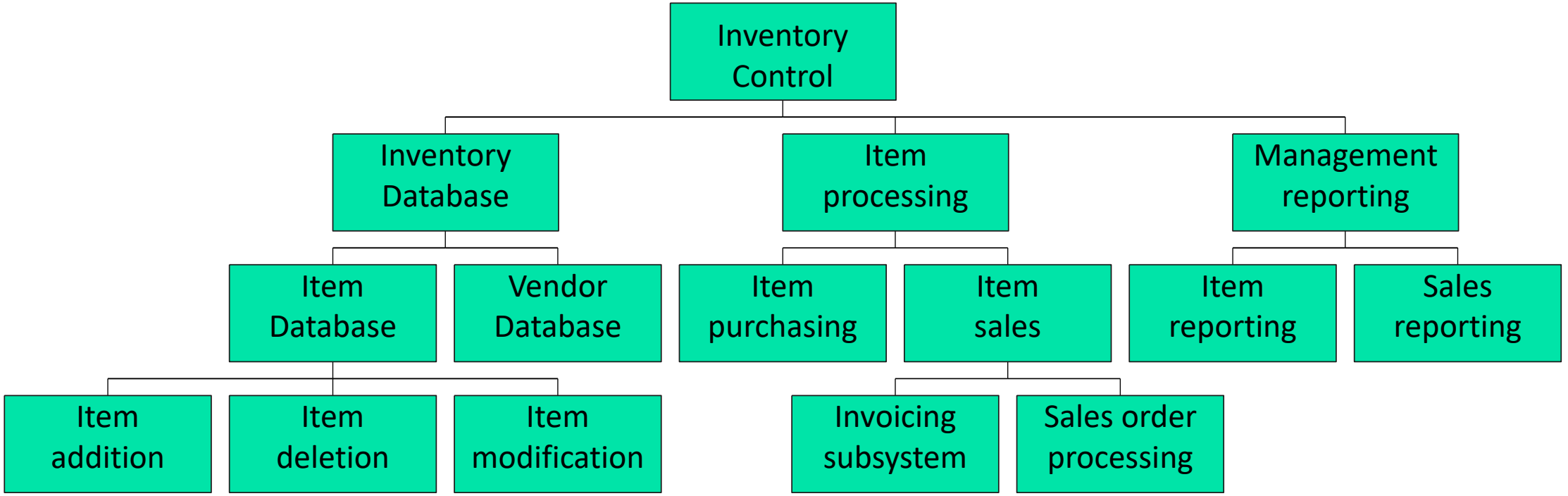
Work Breakdown Structure (an extract)



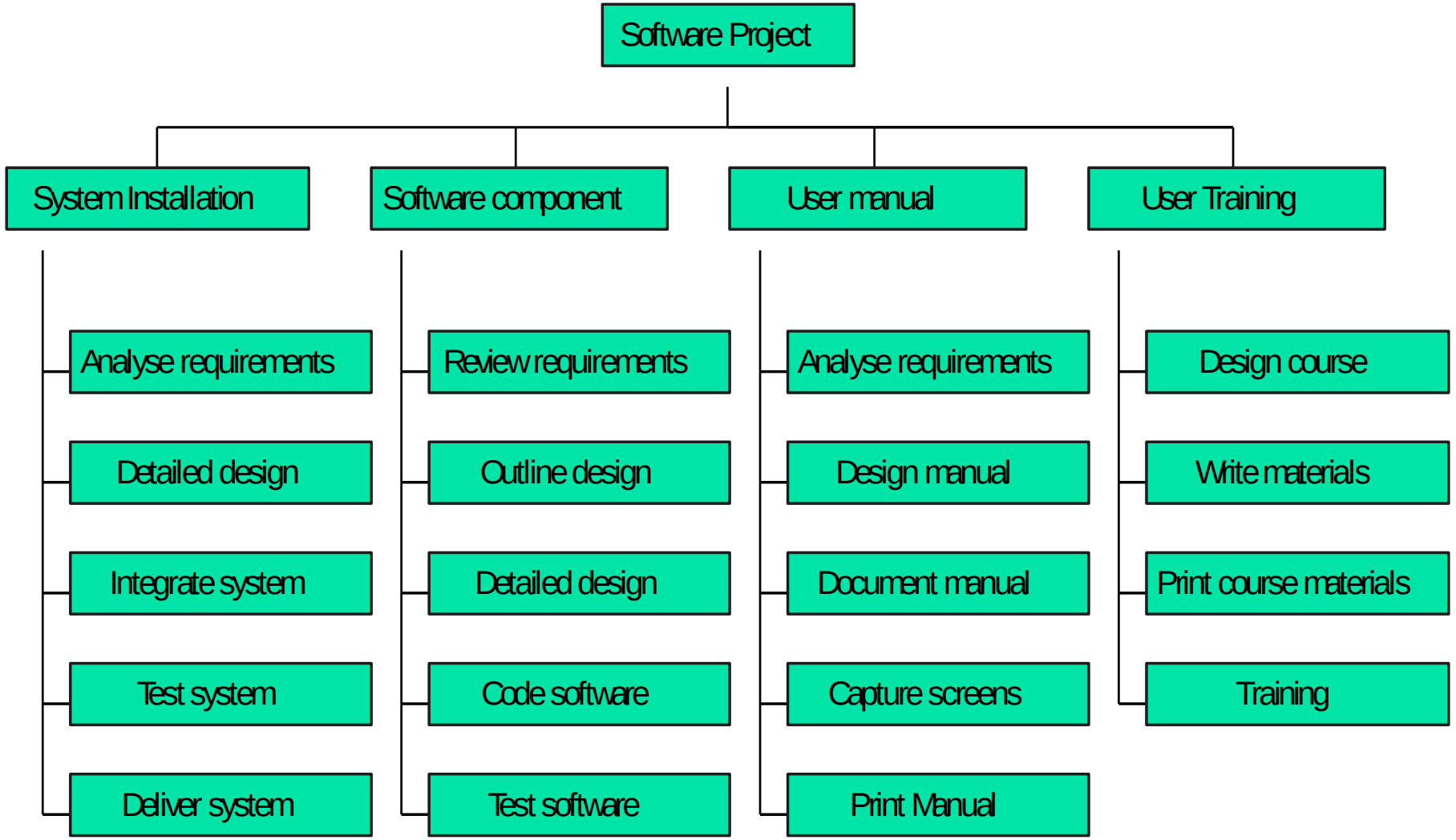
Product based approach

- Product Breakdown Structure (PBS)
  - Shows how a system can be broken down into different products for development

A Product Breakdown Structure (an extract)



Hybrid WBS


Software Project
System Installation
Software component
User manual
User Training
Analyse requirements
Detailed design
Integrate system
Test system
Deliver system
Review requirements
Outline design
Detailed design
Code software
Test software
Analyse requirements
Design manual
Document manual
Capture screens
Print Manual
Design course
Write materials
Print course materials
Training

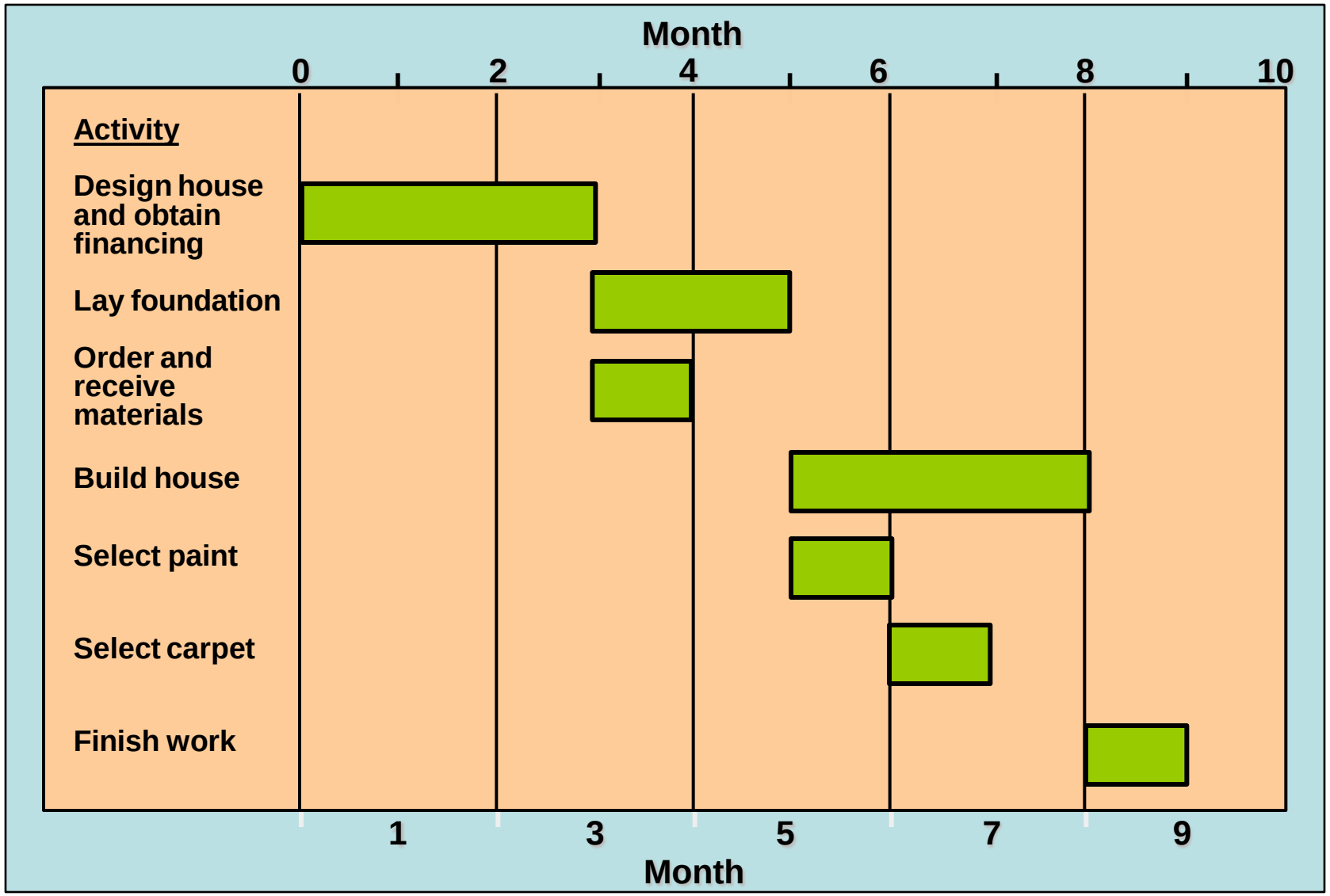
Project Scheduling

- **Steps**
  - Define activities
  - Sequence activities
  - Estimate time
  - Develop schedule
- **Techniques**
  - Gantt chart
  - CPM
  - PERT
  - Activity chart or Network

Gantt Chart

- Developed in 1918 by H.L. Gantt
- Graph or bar chart with a bar for each project activity that shows passage of time
- Provides visual display of project schedule
- Limitations
  - Does not clearly indicate details regarding the progress of activities
  - Does not give a clear indication of interrelation between the activities

Example of Gantt Chart



PERT/CPM

- **PERT (Program Evaluation and Review Technique)**
  - Developed by U.S. Navy for Polaris missile project
  - Developed for R&D projects where activity times are generally uncertain
- **CPM (Critical Path Method)**
  - Developed by DuPont & Remington Rand
  - Developed for industrial projects where activity times are generally known

PERT/CPM

- CPM and PERT have been used to plan, schedule, and control a wide variety of projects:
  - R&D of new products and processes
  - Construction of buildings and highways
  - Maintenance of large and complex equipment
  - Design and installation of new systems

Program Evaluation and Review Technique (PERT)

- Primary objectives:
  - Shortest possible time
  - Coping with uncertain activity completion times, e.g.:
    - For a particular activity
    - The most likely completion time is 4 weeks but
    - It could be anywhere between 3 weeks and 8 weeks
- Developed by the US Navy for the planning and control of the Polaris missile program

Critical Path Method (CPM)

- Primary objectives:
  - Plan for the fastest completion of the project
  - Identify activities whose delays is likely to affect the completion date for the whole project
  - Very useful for repetitive activities with well known completion time
- Developed by Du Pont Chemical Company and published in 1958
  - Can we decrease the completion time by spending more money

CPM Calculation

- The forward pass
  - calculate the **earliest** start dates of the activities
    - to calculate the project completion date
- The backward pass
  - calculate the **latest** start dates for activities
    - to identify the critical path from the graph

Critical Path and Events

- Critical event: an event that has zero *slack*
- Critical path: a path joining critical events
- Benefit of Critical Path Analysis:
  - During planning stage
    - Shortening the critical path will reduce the overall project duration
  - During management stage
    - Pay more attention to those activities which fall in the critical path

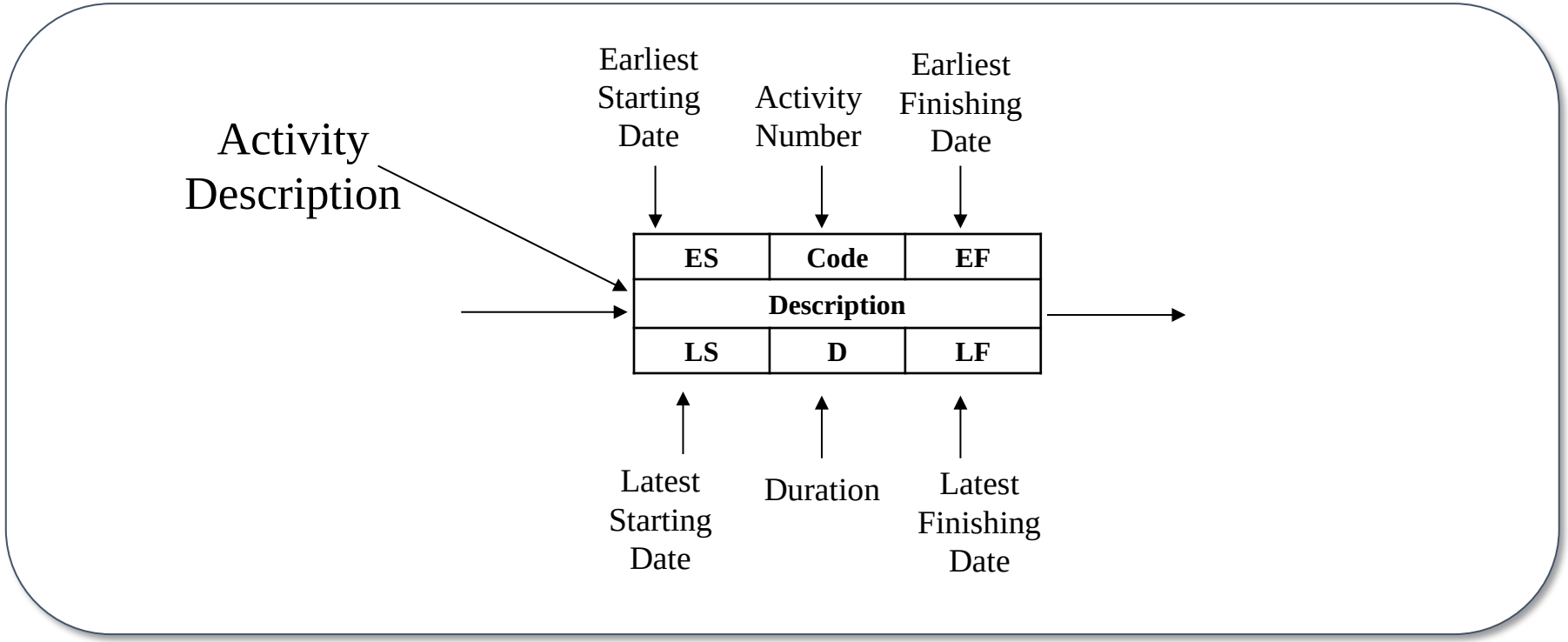
Processes of Time Planning and Control

- Visualize and define the activities.
- Sequence the activities (Job Logic).
- Estimate the activity duration.
- Schedule of the project or phase.
- Allocate and balance resources.
- Compare target, planned and actual dates and update as necessary.
- Control the time schedule with respect to changes.

Activity on Node Notation

- Each time-consuming activity is portrayed by a **rectangular figure**.
- The dependencies between activities are indicated by **dependency lines (arrows)** going form one activity to another.
- Each **activity duration** in terms of working days is shown in the lower, central part of the activity box.
- The principal advantage of the activity on node network is that it **eliminates the need for dummies**.

Activity Box



The left side of the activity box (node) is the start side, while the right side is the finish (end) side.

Activity on Node Network

- Each activity in the network must be preceded either by the start of the project or by the completion of a previous activity.
- Each path through the network must be **continuous** with no gaps, discontinuities, or dangling activities.
- All activities must have at least one activity following, except the activity that terminates the project.
- Each activity should have a unique numerical designation (activity code). Activity code is shown in the upper, central part of the activity box, with the numbering proceeding generally from project start to finish.

Network Format

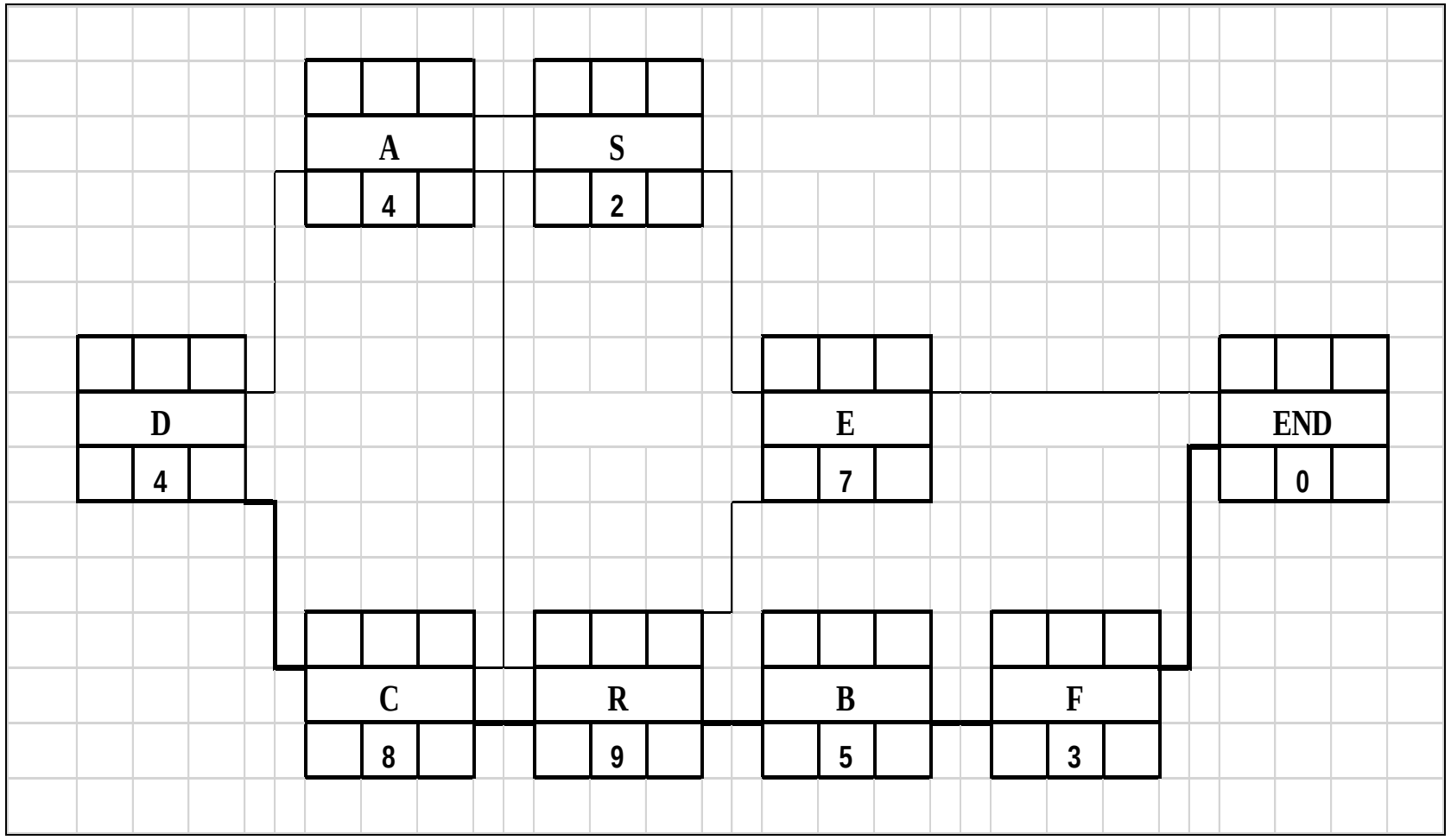
- A horizontal diagram format is the standard format.
- The general developing of a network is from start to finish, from project beginning on the left to project completion on the right.
- The sequential relationship of one activity to another is shown by the dependency lines between them.
- The length of the lines between activities has no significance.
- Arrowheads are not always shown on the dependency lines because of the obvious left to right flow of time.
- Dependency lines that go backward from one activity to another (looping) should not be used.
- Crossovers occur when one dependency line must cross over another to satisfy job logic.

Example

- The activity list shown below represents the activities, the job logic and the activities' durations of a small project. Draw an activity on node network to represent the project.

Activity	Depends on	Duration (days)
A	D	4
B	R	5
C	D	8
E	R, S, A	7
F	B, C	3
D	None	4
S	A, C	2
R	A, C	9

Example



Network Computations

The purpose of network computations is to determine:

- The overall project completion time and
- The time brackets within which each activity must be accomplished (Activity Times).

- In activity on node network, all of the numbers associated with an activity are incorporated in the one node symbol for the activity, whereas the arrow symbols contain each activity's data in the predecessor and successor nodes, as well as on the arrow itself or in a table.

ES	Activity code	EF
Activity Description		
LS	Duration	LF

EARLY ACTIVITY TIMES

1. The "Early Start" (ES) or "Earliest Start" of an activity is the earliest time that the activity can possibly start allowing for the time required to complete the preceding activities.

2. The "Early Finish" (EF) or "Earliest Finish" of an activity is the earliest possible time that it can be completed and is determined by adding that activity's duration to its early start time.

COMPUTATIONS OF EARLY ACTIVITY TIMES

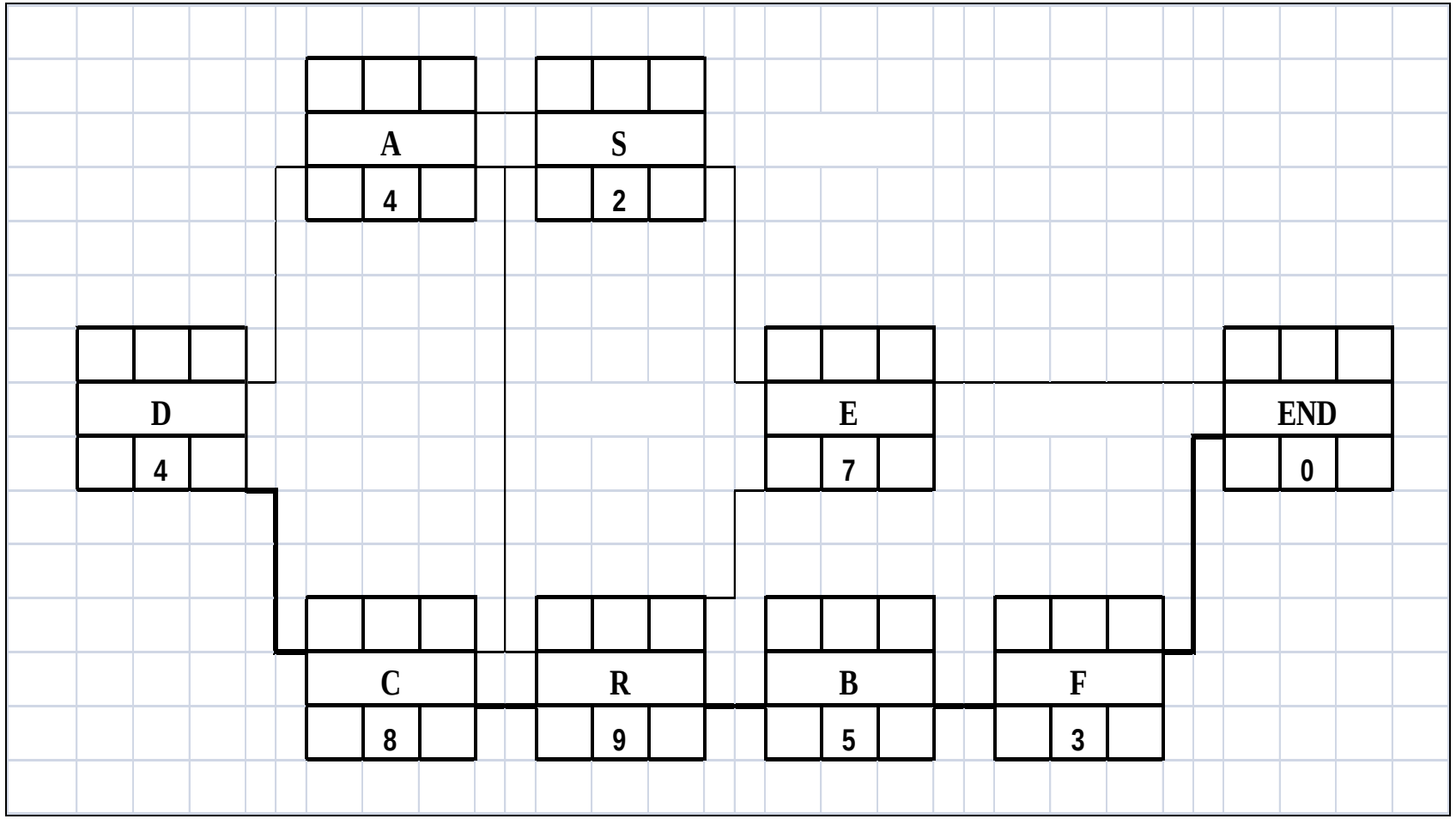
- **Direction**: Proceed from project start to project finish, from **left to right**.
- **Name**: This process is called the "**forward pass**".
- **Assumption**: every activity will start as early as possible. That is to say, each activity will start just as soon as the last of its predecessors is finished.
- The **ES** value of each activity is determined first.
- The **EF** time is obtained by adding the activity duration to the ES time.

$$EF = ES + D$$

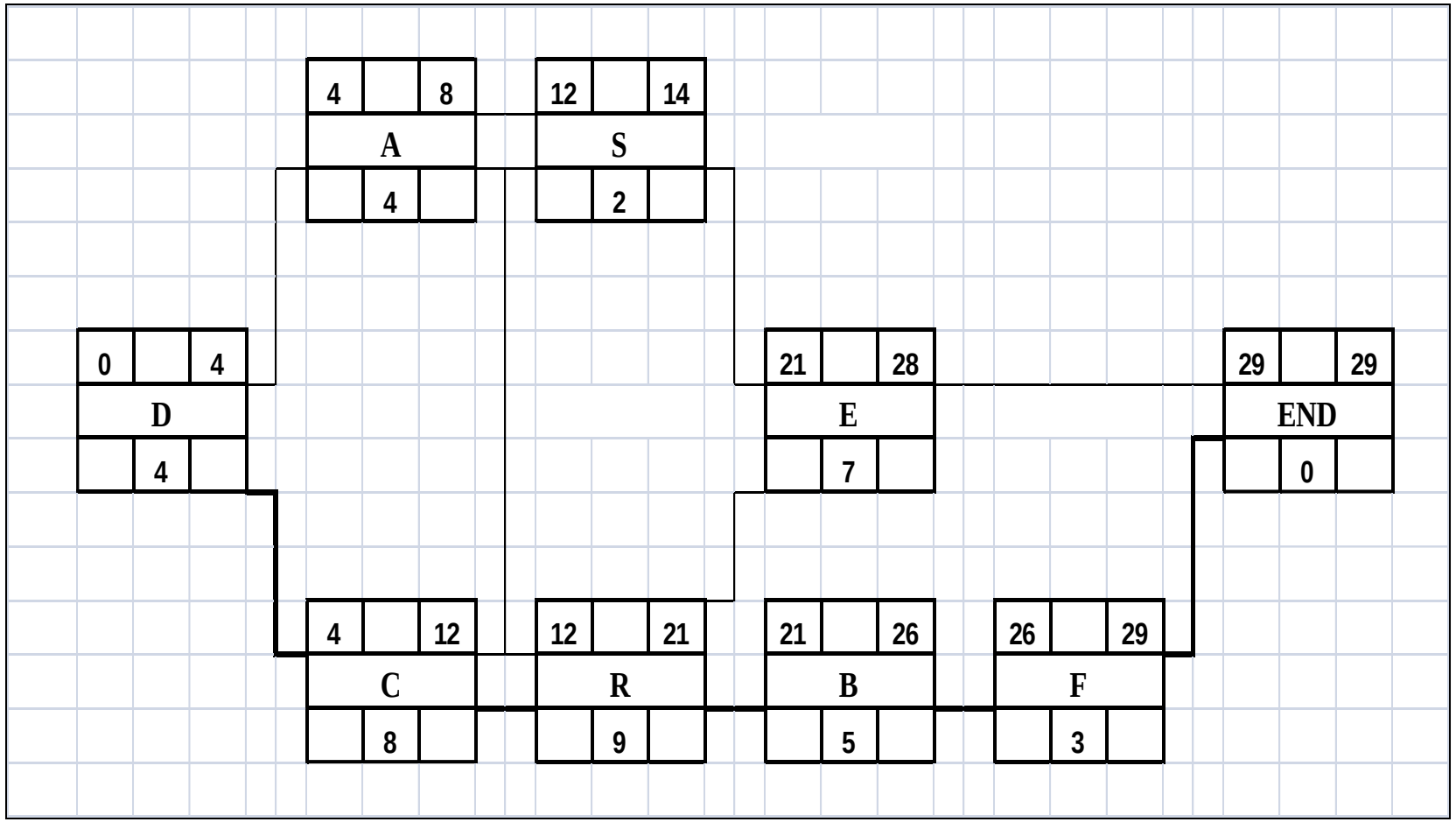
- In case of merge activities the earliest possible start time is equal to the latest (or **largest**) of the EF values of the immediately preceding activities.

Example

Calculate the early activity times (ES and EF) and determine project time.



Example


4
8
A
4
12
14
S
2
0
4
D
4
21
28
E
7
29
29
END
0
4
12
C
8
12
21
R
9
21
26
B
5
26
29
F
3

LATE ACTIVITY TIMES

3. The "late finish" (LF) or "Latest Finish" of an activity is the very latest that it can finish and allow the entire project to be completed by a designated time or date.
4. The “late start” (LS) or "Latest Start" of an activity is the latest possible time that it can be started if the project target completion date is to be met and is obtained by subtracting the activity's duration from its latest finish time.

COMPUTATIONS OF LATE ACTIVITY TIMES

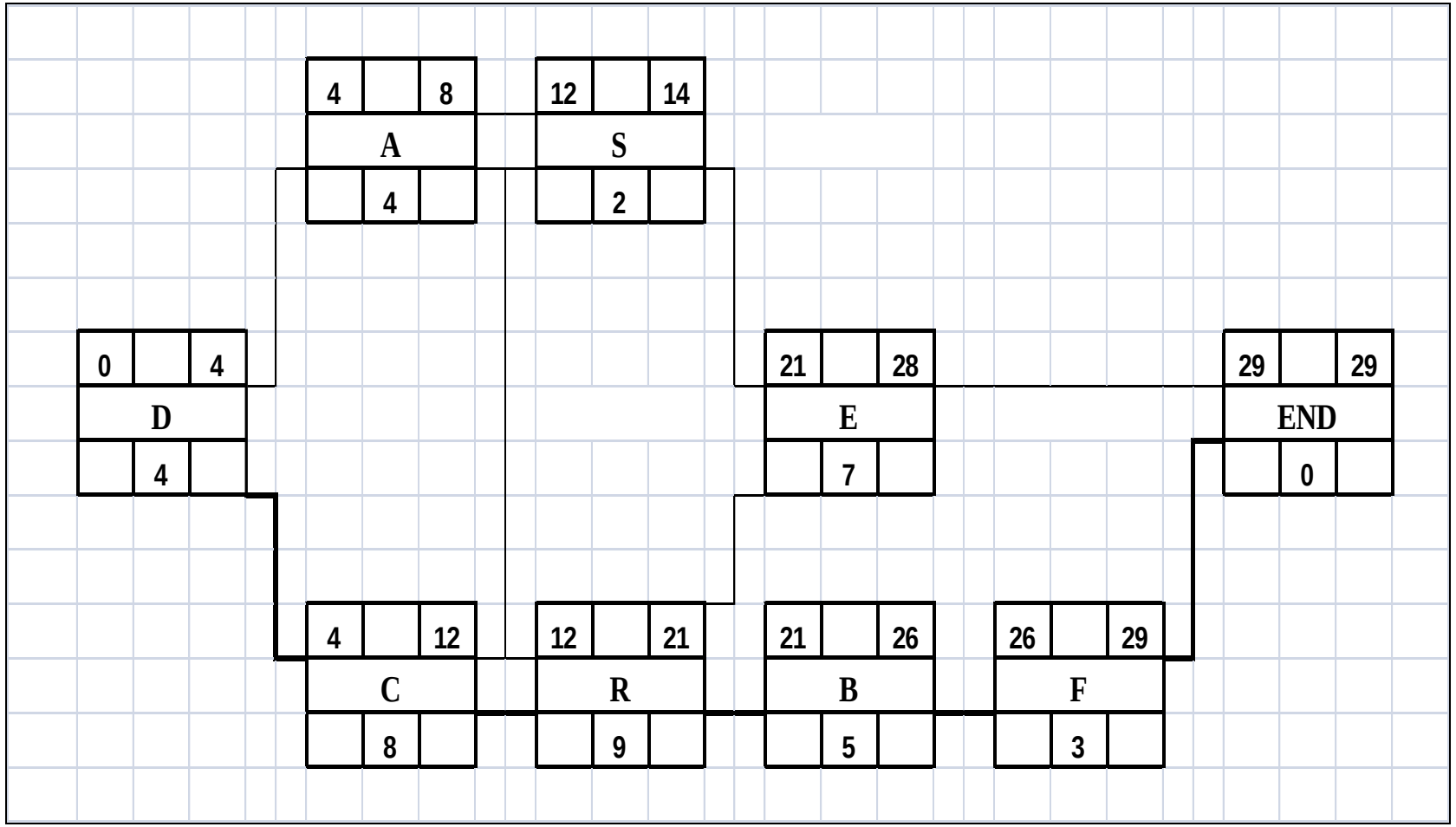
- **Direction**: Proceed from project end to project start, from **right to left**.
- **Name**: This process is called the “**backward pass**".
- **Assumption**: Each activity finishes as late as possible without delaying project completion.
- The **LF** value of each activity is obtained first and is entered into the lower right portion of the activity box.
- The **LS** is obtained by subtracting the activity duration from the LF value.

$$LS = LF - D$$

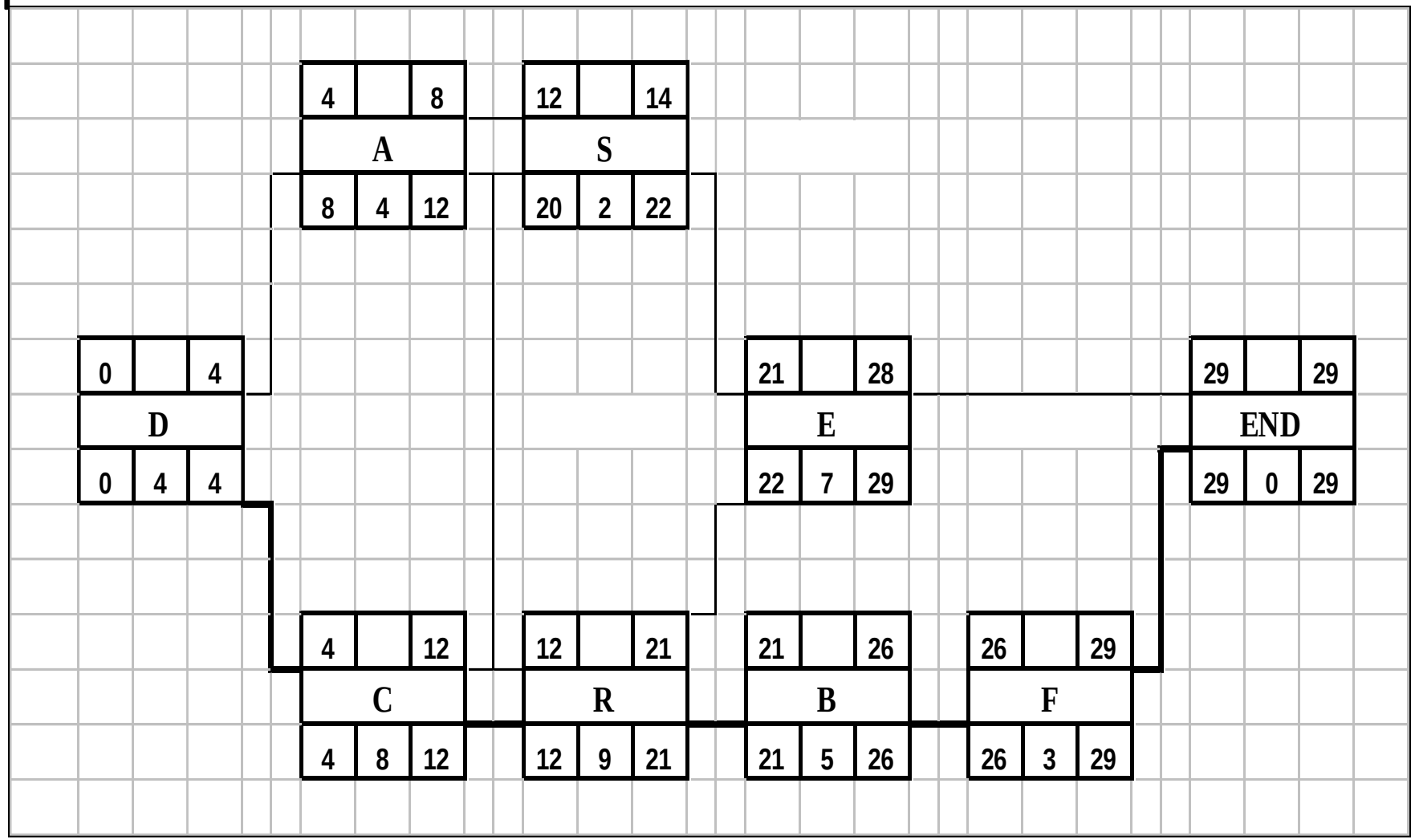
- In case of burst activities LF value is equal to the earliest (or **smallest**) of the LS times of the activities following.

Example

Calculate the late activity times (LS and LF).



Example


4 8
A
8 4 12
12 14
S
20 2 22
0 4
D
0 4 4
21 28
E
22 7 29
29 29
END
29 0 29
4 12
C
4 8 12
12 21
R
12 9 21
21 26
B
21 5 26
26 29
F
26 3 29

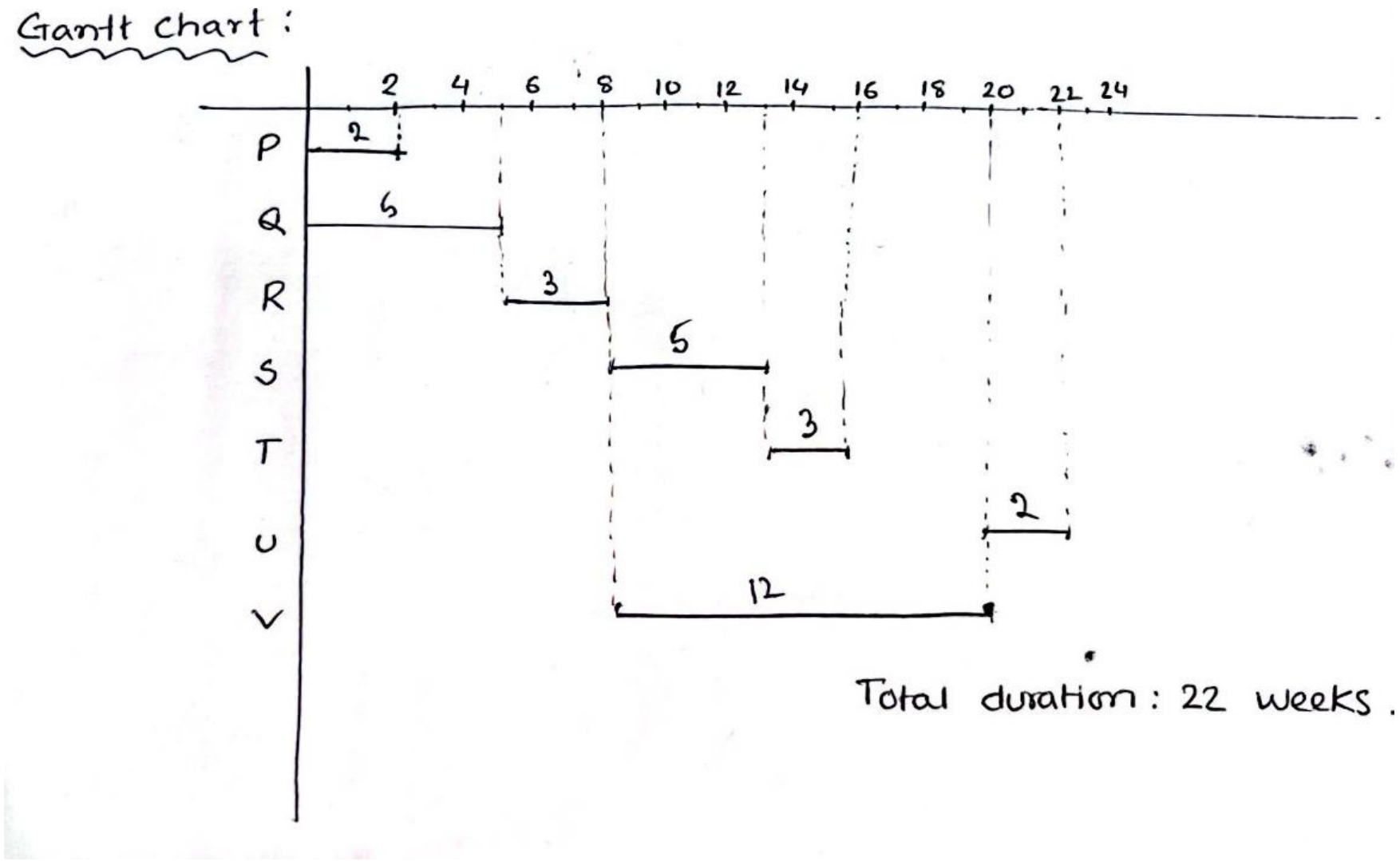
Exercise 1

Activity	Precedence	Duration
P	-	2
Q	-	5
R	P, Q	3
S	R	5
T	S	3
U	T, V	2
V	R	12

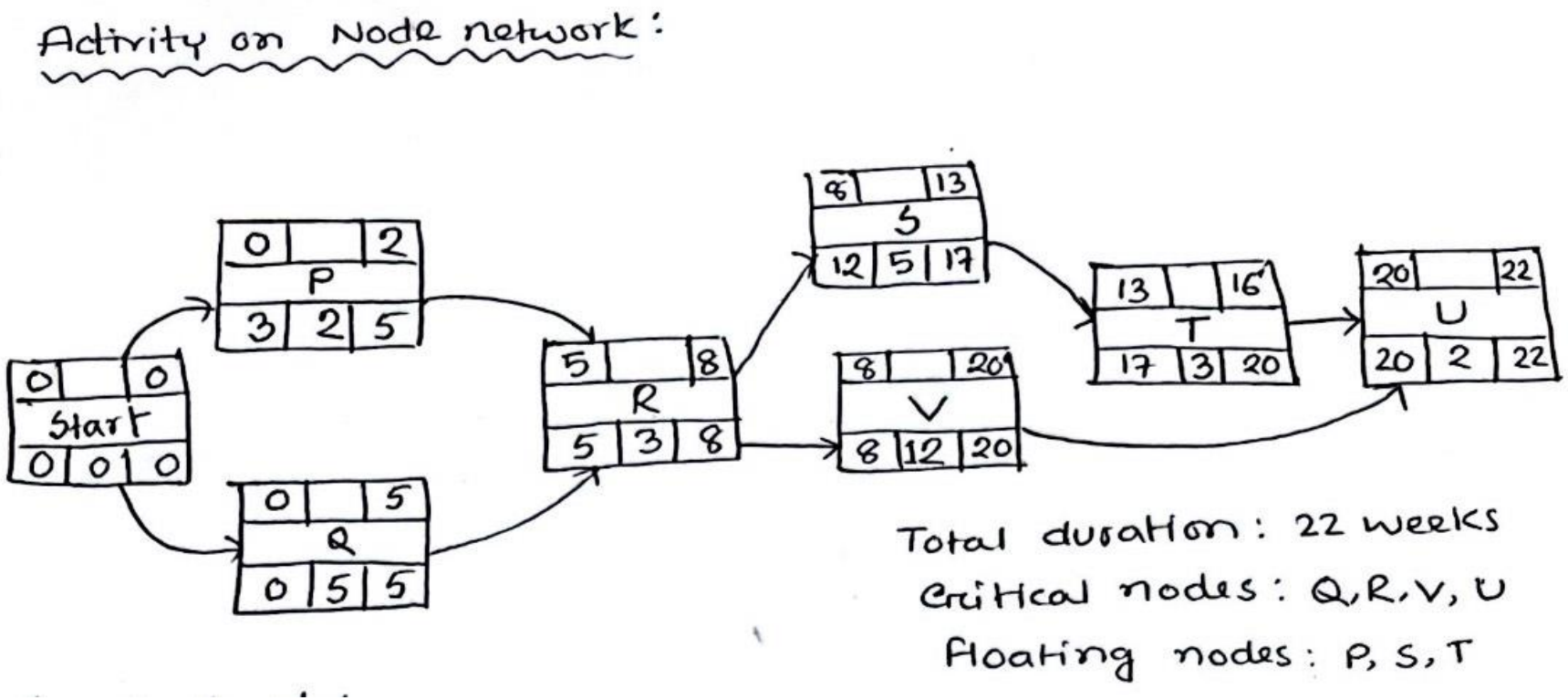
Exercise 2

Activity	Precedence	Duration
S	-	3
A	S	5
B	S	5
C	S	5
D	A	3
E	C	3
F	B, D	5
G	E, F	3

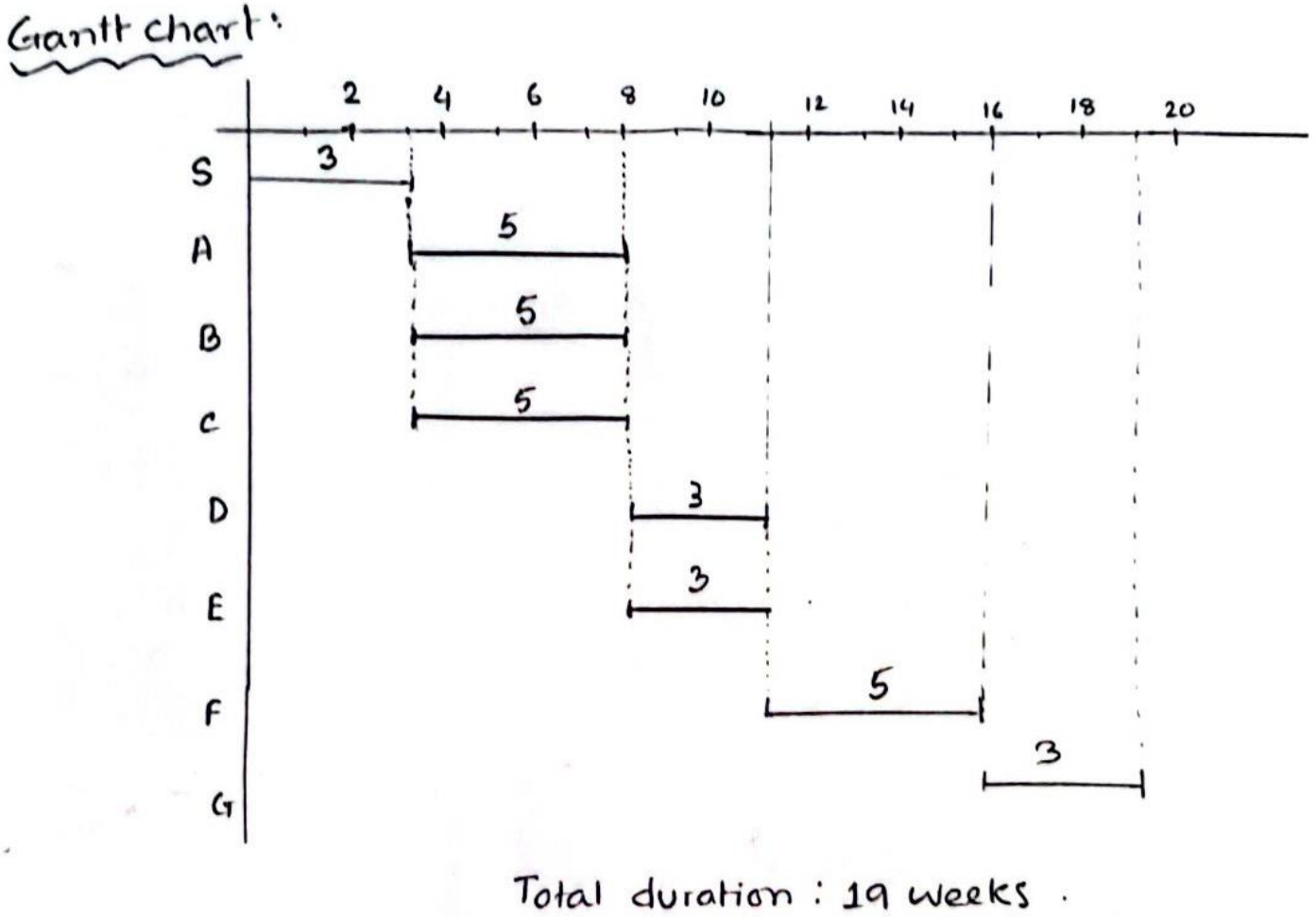
Solution- Exercise 1



Solution- Exercise 1

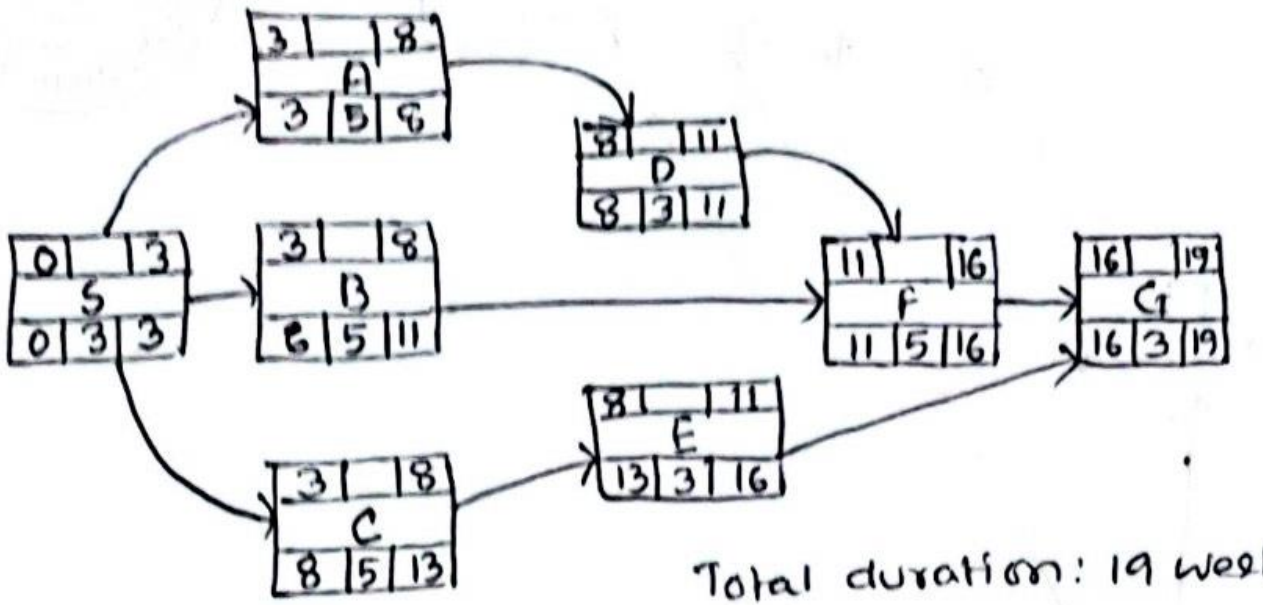


Solution- Exercise 2



Solution- Exercise 2

Activity on Node Network:



Total duration: 19 weeks

Critical points: S, A, D, F, G

Floating points: B, C, E