LECTURE 10

Resource Allocation and Resource Leveling

OUTLINE

- Review Lecture 9
- Introduction
- The Three Categories Of Resources
- What Is Resource Allocation?
- What Is Resource Leveling?
- Why Level Resources?
- The Fluctuation: Example
- Do All Resources Have to Be Leveled?
- Exercise

Review Lecture 9

LSM

Introduction

The term resource is used in many fields and contexts

In project management, we use the term resources to indicate three main categories:

- Labor (human)
- Materials
- Equipment.

The Three Categories Of Resources

LABOR

- Salaried staff: These individuals include the project manager, superintendent, project engineer, secretary, and any other person who is tied to the project.
- Hourly workers: These individuals are hired to perform a specific task or activity. Examples include carpenters, masons, ironworkers, electricians, foremen, and so forth.

The Three Categories Of Resources

Equipment and Materials

- Construction equipment and materials: This type of equipment and materials is used for the construction process but is not permanently installed in the project.
  - Examples of construction equipment are bulldozers, backhoes, cranes.
  - Examples of construction materials are formwork materials and scaffolding.

The Three Categories Of Resources

Equipment and Materials

- Installed equipment and materials: This type of equipment and materials stays permanently in the project after completion.
  - Examples of installed equipment emergency generators (in hospitals, industrial projects)
  - Examples of installed materials are concrete, rebar, brick, mortar, insulation, framing wood.

What Is Resource Allocation?

To **ASSIGN THE REQUIRED RESOURCES TO EACH**

ACTIVITY, in the required amount and timing.

What Is Resource Leveling?

To minimizing the fluctuations in day-to-day resource use throughout the project.

It attempts to make the daily use of a certain resource as uniform as possible.

Why Level Resources?

demand for a certain resource naturally FLUCTUATES during the lifecycle of the project

When the contractor adds the daily total demand for a specific resource for all activities, he or she must provide the required amount,

or

WORK WILL BE DELAYED

The Fluctuation

Say,

- 10 carpenters for the first two weeks,
- 6 carpenters for the week after,
- 18 carpenters for 4th and 5th week,
- 12 carpenters for week 6, and so on

Is Not Practical Or Economical.

The Fluctuation

Leveling may also be necessary for an expensive piece of equipment

- In rental expenses
- The cost of mobilization,
- Setup,
- Maintenance, and
- Demobilization

The Fluctuation: Example

Say, two activities require a tower crane at the same time.

- If you can delay the start of the second activity till the first has finished, you will redirect your resource (the tower crane) to the second activity.

- By doing this, you will :

  have reduced the maximum demand of tower cranes which will save expenses.

Do All Resources Have to Be Leveled?

Not all resources need to be leveled.

WHY!!!

The main idea of resource leveling is to improve work efficiency and minimize cost during the life of the project.

This concept applies to resources that are hired or rented (labor and major construction equipment)

Do All Resources Have to Be Leveled?

In general, materials **DO NOT NEED** to be leveled.

For instance,

- It is common practice to place 100 CY (cubic yards) of concrete in one day,
- Place no concrete for one week, then
- Place more concrete the week after, and so on.

Project managers mainly have to arrange small deliveries in an economical way.

(Materials must be managed using a completely different concept)

Multi Project Resource Leveling

- **Some resources may be shared among projects!!!!**

The Question Is Which Resources And How Much Of Them.

for instance,

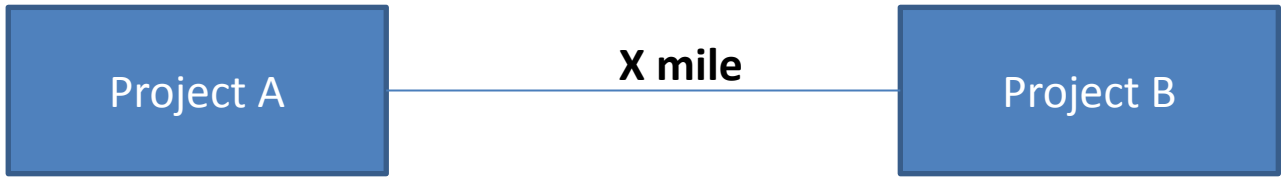
Some staff (project manager, safety manager, secretary, etc.) and equipment may be shared. (Project managers must make decisions)

would it be more efficient **TO HAVE SOMEONE TRAVEL BETWEEN TWO JOBS or TO HIRE ANOTHER PERSON**

Example

Assume a project engineer costs his employer $50 per hour.

Two projects are within x miles of each other.



- The engineer travels at an average speed of 40 miles/hour
- costs the company $0.50 /mile to travel between the two projects.

Example

ASSUME that the following four statements **ARE TRUE**:

1. The engineer is needed a minimum of 3 hours/day in each project.
2. Travel between the two projects occurs only once a day (the Engineer starts his or her day on job A, travels to job B, and then Comes back home near job A).
3. Overtime, if needed, is compensated at 1.5 times the regular rate.
4. And a second engineer costs the same amount as the first one.

What is the maximum distance between the two projects that makes Sharing the same engineer efficient?

Solution

Let's consider two situations.

FIRST, NO OVERTIME:

No overtime means the engineer may travel between the two jobs (roundtrip) for no more than 2 hours

(3 hours at job A + 3 hours at job B + 2 hours' travel = 8 hours per day).

- Maximum distance = 2 hours x 40 mph
  = 80 miles roundtrip or 40 mile one way

- Mileage compensation = 80 x $0.50/mile
  = $40 per day,

- Total cost per day = $50 x 8 +$40
  = $440,

Average cost per hour = $440 : 8
= $55

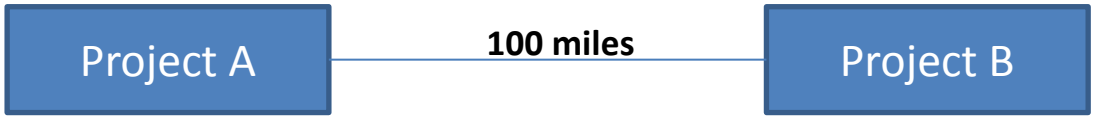
It is clearly much more economical to **USE ONE ENGINEER THAN TO HIRE TWO ENGINEERS** at a combined cost of $100 per hour.

Solution

Let's consider two situations.

SECOND, WITH OVERTIME:

- Let us assume the two jobs are 100 miles apart.



- Assume the engineer will have 5 hours of driving time (2.5 hours each way), or 11hours of work per day (5 driving +working hour)
- Mileage compensation = 200 miles x $0.50/mile
  =$100 per day
- Overtime compensation = 3 hr x $50 x 1.5
  = $2252
- Regular-time compensation = 8 x $50
  = $400

Total cost per day = 100 + 225 + 400
= $725

This cost is still less than $800 per day (the cost of two engineers, one at each job)

Example 2

A subcontractor needs to install flooring in two areas:

- ✓ Area 1: This area has old vinyl tile that must be removed and replaced with new vinyl tile.
- ✓ Area 2: This area has a concrete slab that needs to be topped with ceramic tile. This simple project is broken into the activities shown in the following table,

Activity ID	Activity Description	IPA	Duration (Days)	Laborers
A	Purchase & Deliver Materials	–	5	2
B	Remove Old Vinyl Tile	–	7	4
C	Install Ceramic Tile	A	3	3
D	Install New Vinyl Tile	A, B	5	3
E	Clean Up & Inspect	C, D	2	2

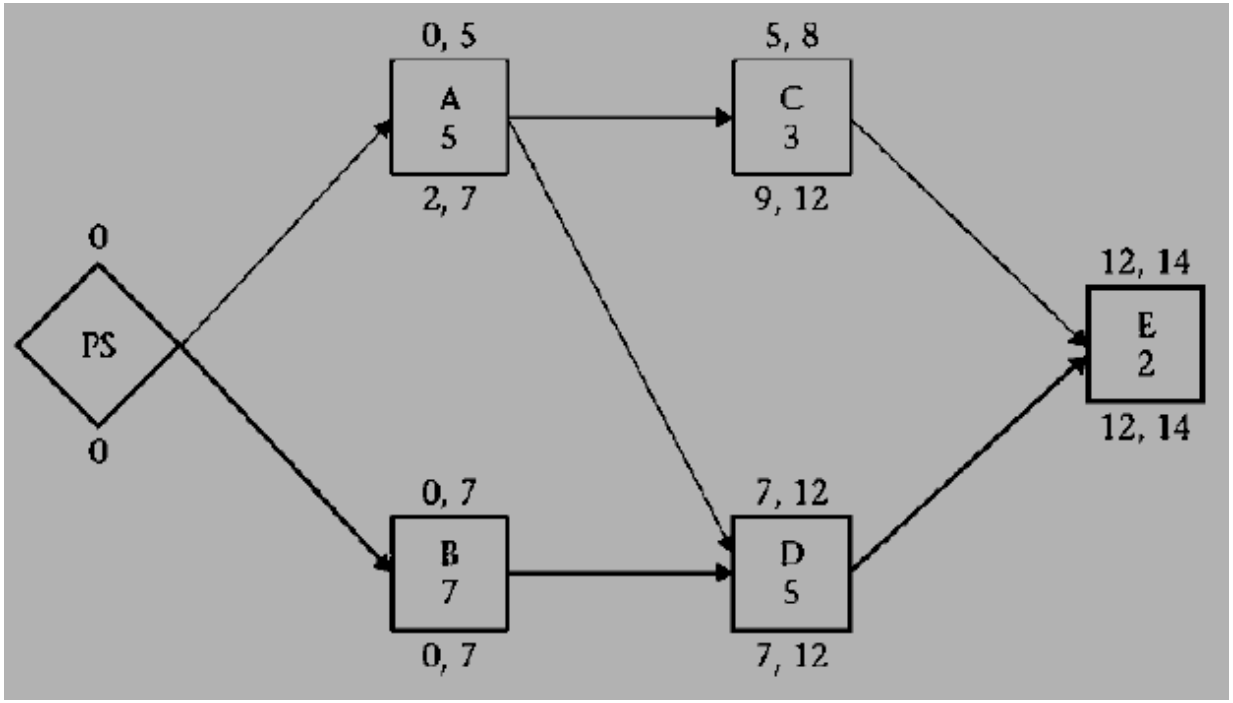
*Immediately Preceding Activity.

Example 2

Steps,

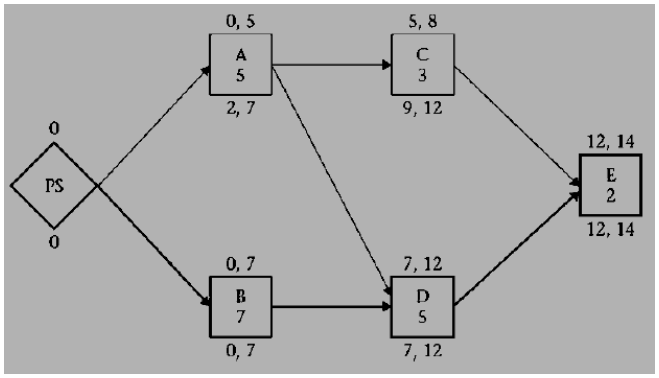
1. Draw the precedence network and perform the CPM calculations.
2. Allocate the required resources, then level them so that the subcontractor does not use more than six laborers at any time.
3. Find ways to improve the labor usage profile.

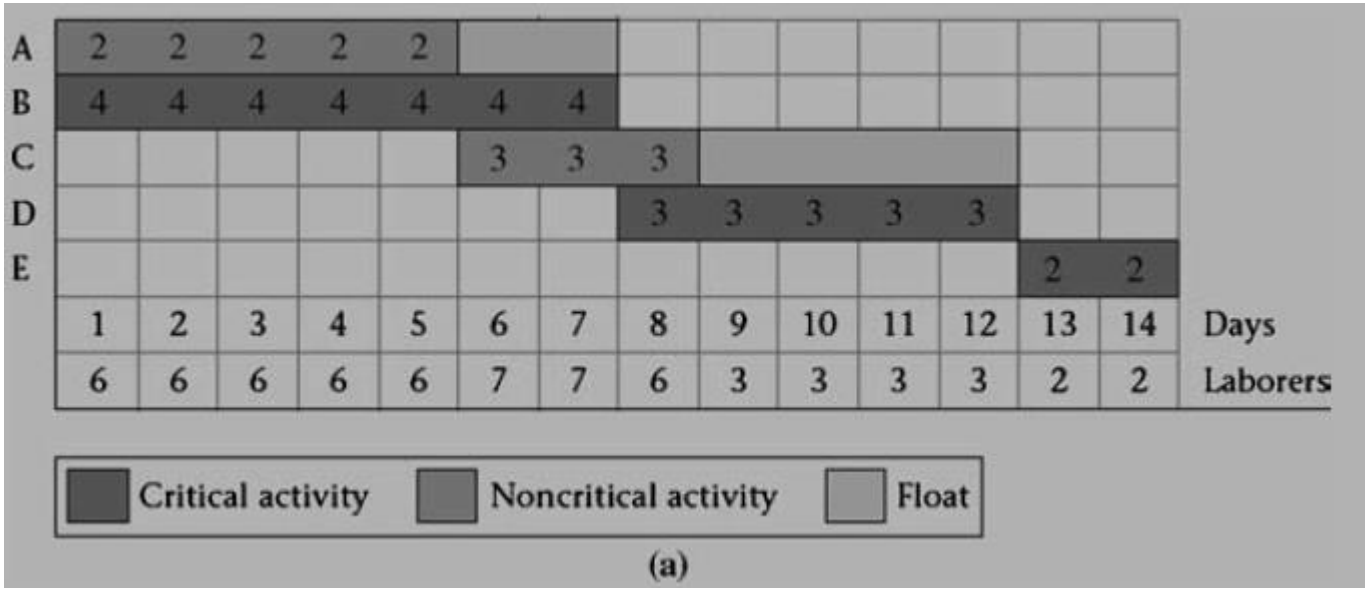
For the sake of simplicity, assume that any laborer can perform any task.



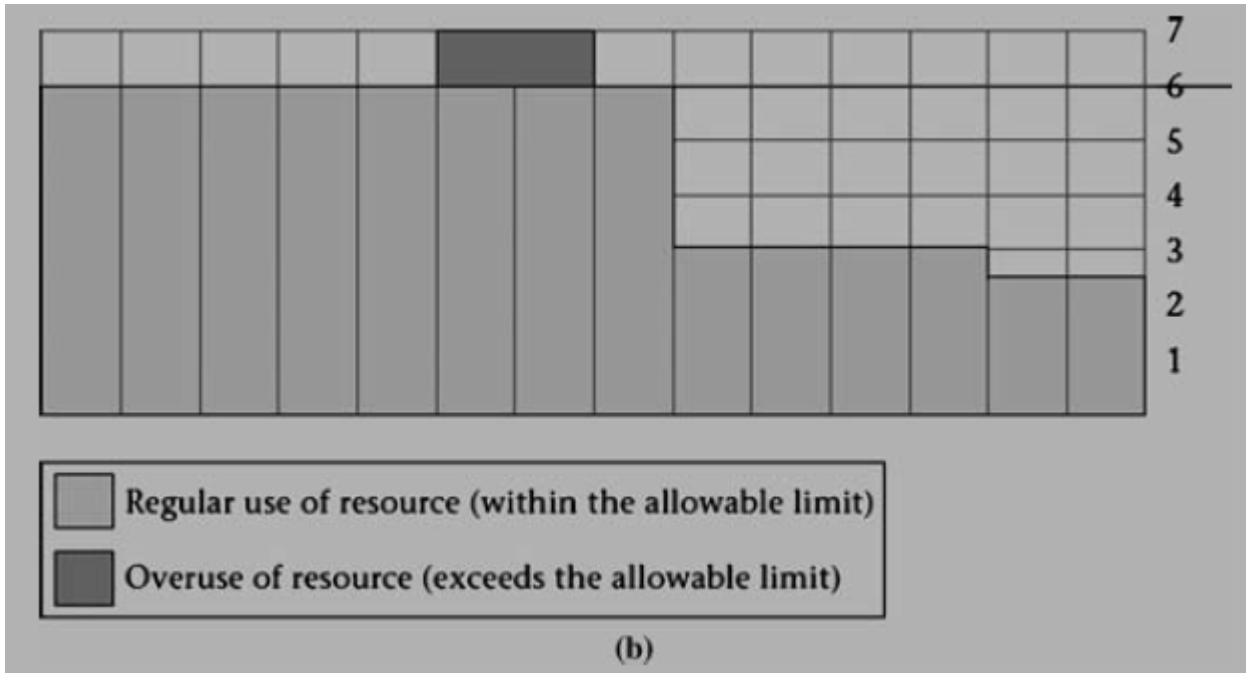
(PS: project start)

Example 2


0, 5
A
5
2, 7
5, 8
C
3
9, 12
0
PS
0
12, 14
E
2
12, 14
0, 7
B
7
0, 7
7, 12
D
5
7, 12


A 2 2 2 2 2
B 4 4 4 4 4 4 4
C 3 3 3
D 3 3 3 3 3
E 2 2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 Days
6 6 6 6 6 7 7 6 3 3 3 3 2 2 Laborers
Critical activity
Noncritical activity
Float
(a)

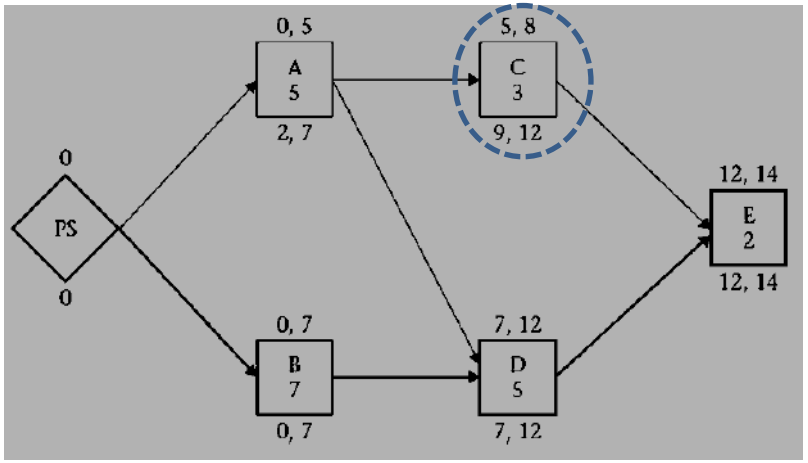
Example 2

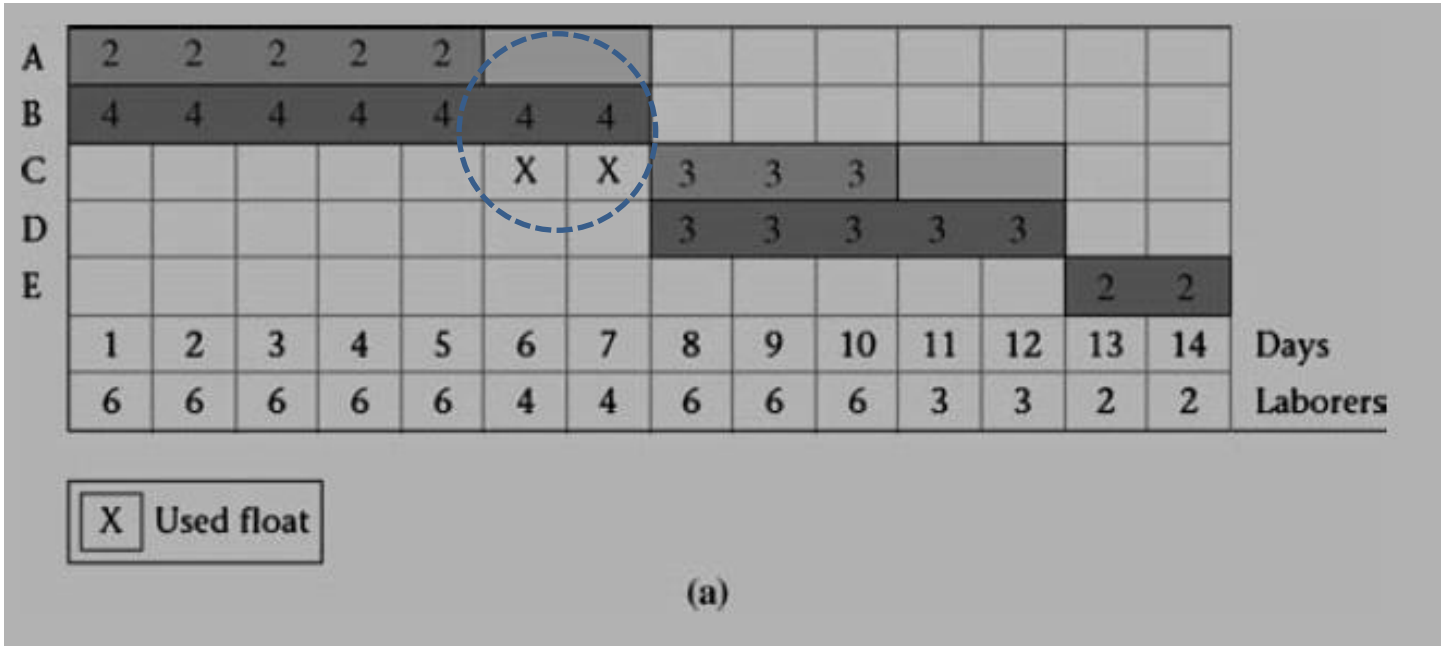


note that on days 6 and 7, the subcontractor needs **SEVEN LABORERS,** one over the limit.

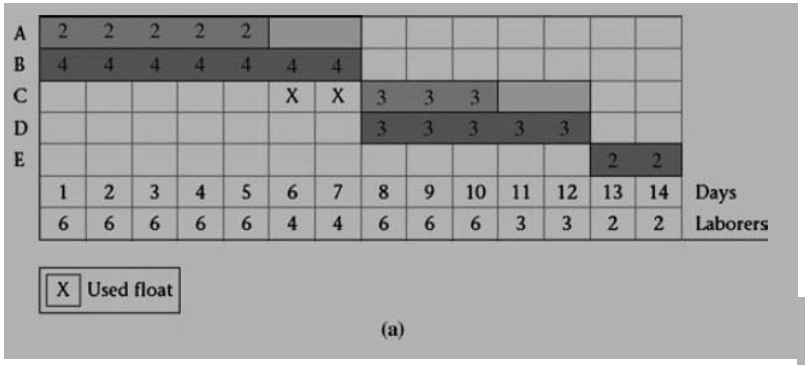
Example 2

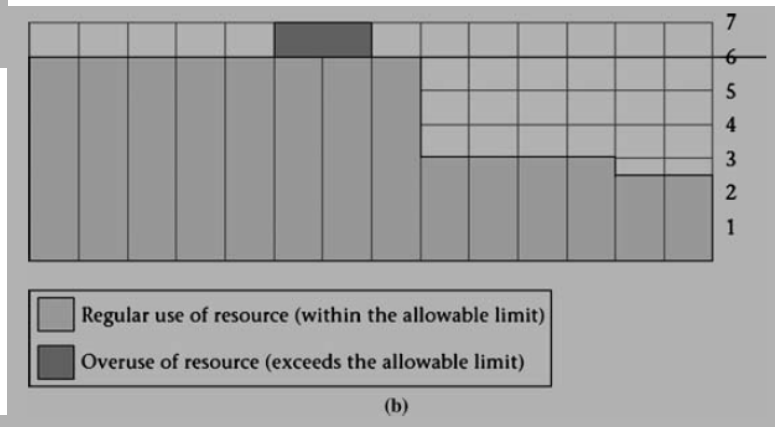
The Contractor decides to use **2 DAYS OF THE FLOAT** for activity

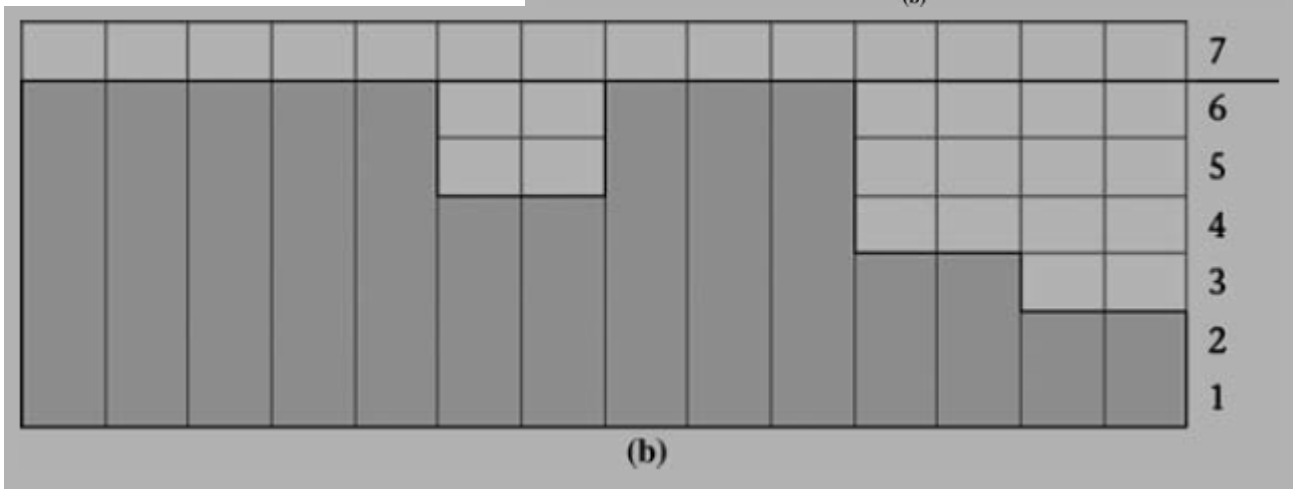




Example 2


A 2 2 2 2 2
B 4 4 4 4 4 4 4
C X X 3 3 3
D 3 3 3 3 3
E 2 2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 Days
6 6 6 6 6 4 4 6 6 6 3 3 2 2 Laborers
X Used float
(a)


7
6
5
4
3
2
1
Regular use of resource (within the allowable limit)
Overuse of resource (exceeds the allowable limit)
(b)


7
6
5
4
3
2
1
(b)

Exercise

In the following network, manually level your resources so that you may not use more than nine laborers per day at any time.

Activity	Duration (Days)	IPA	Laborers
A	2	–	3
B	4	A	2
C	6	A	4
D	9	A	3
E	5	B	4
F	7	B, C	2
G	3	D, E, F	4