CB 510
Project Management

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Resources

- What are resources?

  - Resources are everything that is needed to undertake an activity

  - Resources can be consumable (material and money) and non-consumable (equipment and labors)

  - Resources can be classified as general (used by any activity), key (skilled labor or special equipment)

CPM Drawbacks in Resources

- CMP is a duration oriented approach

- CPM assumes resources to be unlimited and can be accesses all the time.

Resource Loading

- After CPM calculation, a planner can allocate (load) the resources on each activity

- The representation can be done graphically through Bar Chart and Histogram
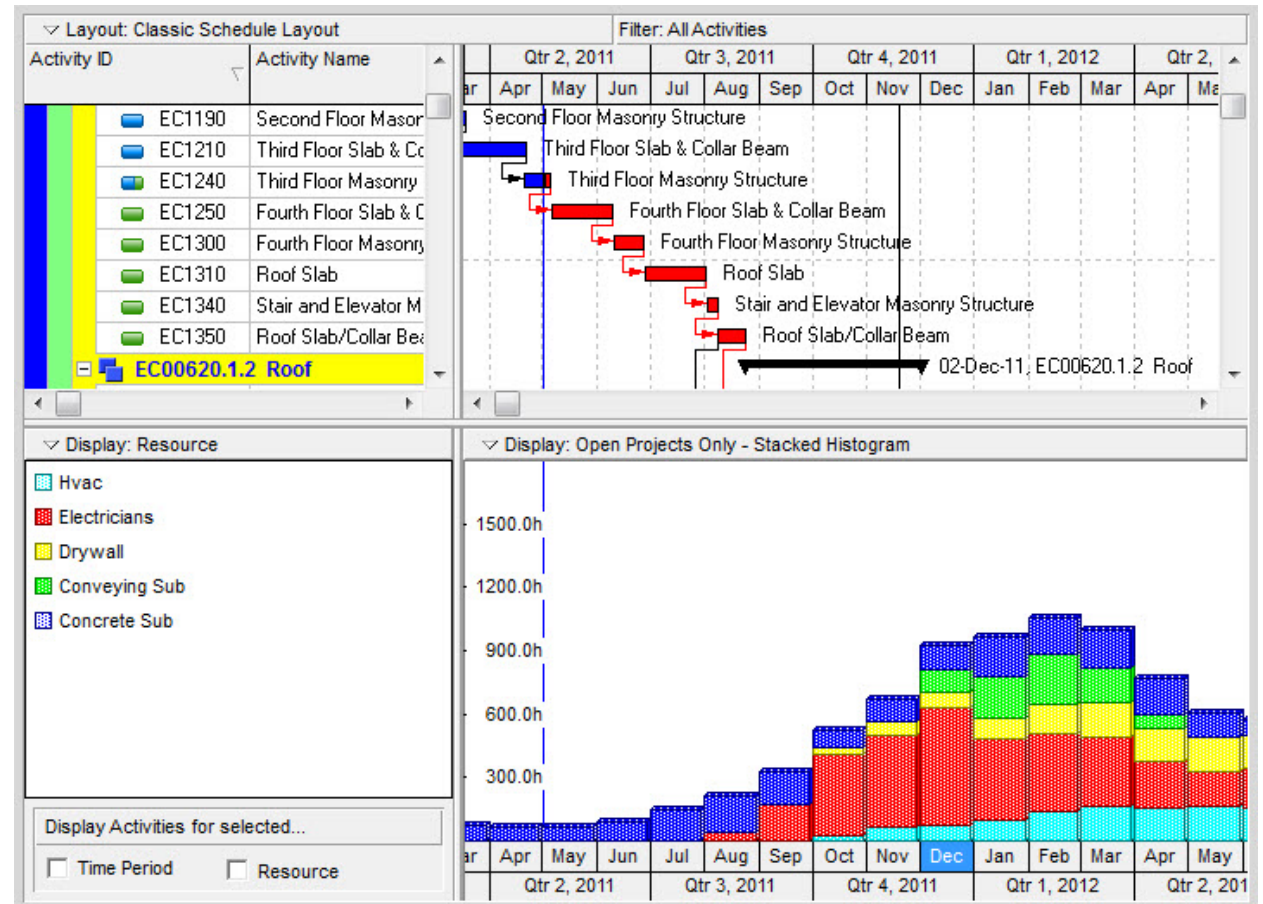
Resource Loading

- Consider the following project and draw a Bar Chart with Resource Histogram

Activity	Predecessor	Duration	Resource
A	--	2	10
B	A (overlap 1 day)	3	8
C	B (overlap 1 day)	2	2
D	B	5	10
E	D (overlap 1 day)	2	6

Resource problems

- Resource fluctuation (firing and hiring)
  - Resource loading profiles need to be smooth
  - Resources unconstrainted
  - Project duration is constrained

- Resource scheduling
  - Resources are constrained
  - Need to schedule start and finish day of each resource
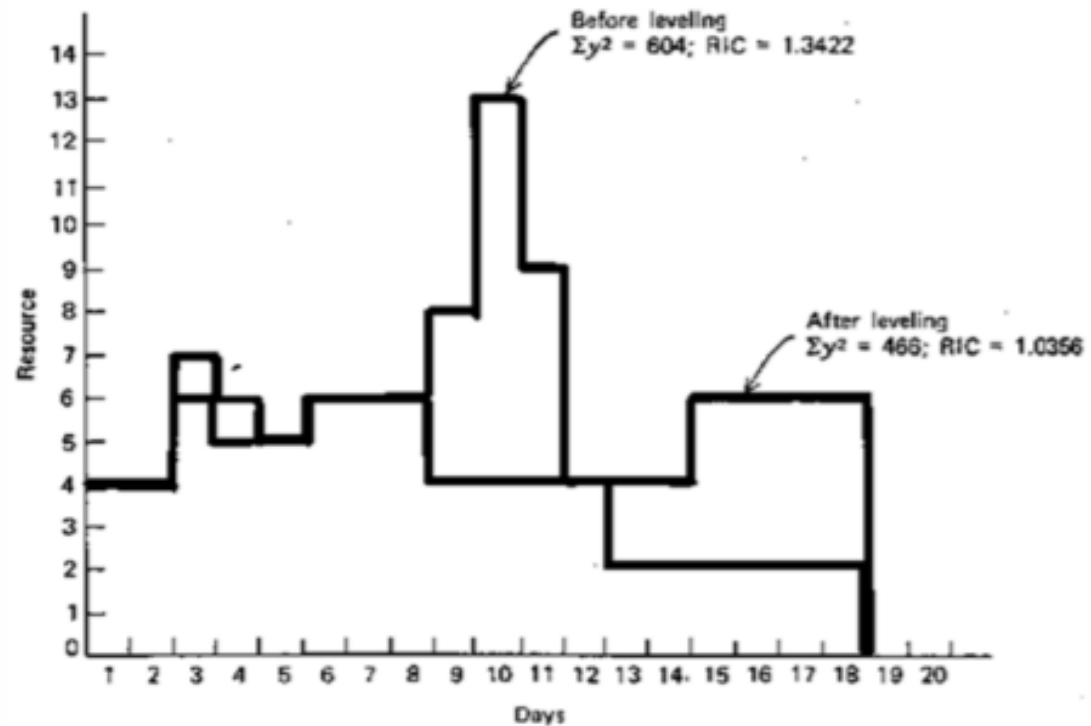 - Project duration can be changed, but minimally

Resource Leveling

- Solving techniques can include

  - Optimization model (LP, evolutionary, dynamic programming, etc.)

  - Heuristic models (rule of thumb)

Resource Leveling

- Minimum Moment Heuristic approach

Minimum Moment Algorithm = $\sum Yi * Yi /2$

Before leveling
$\sum y^2 = 604$; RIC = 1.3422

After leveling
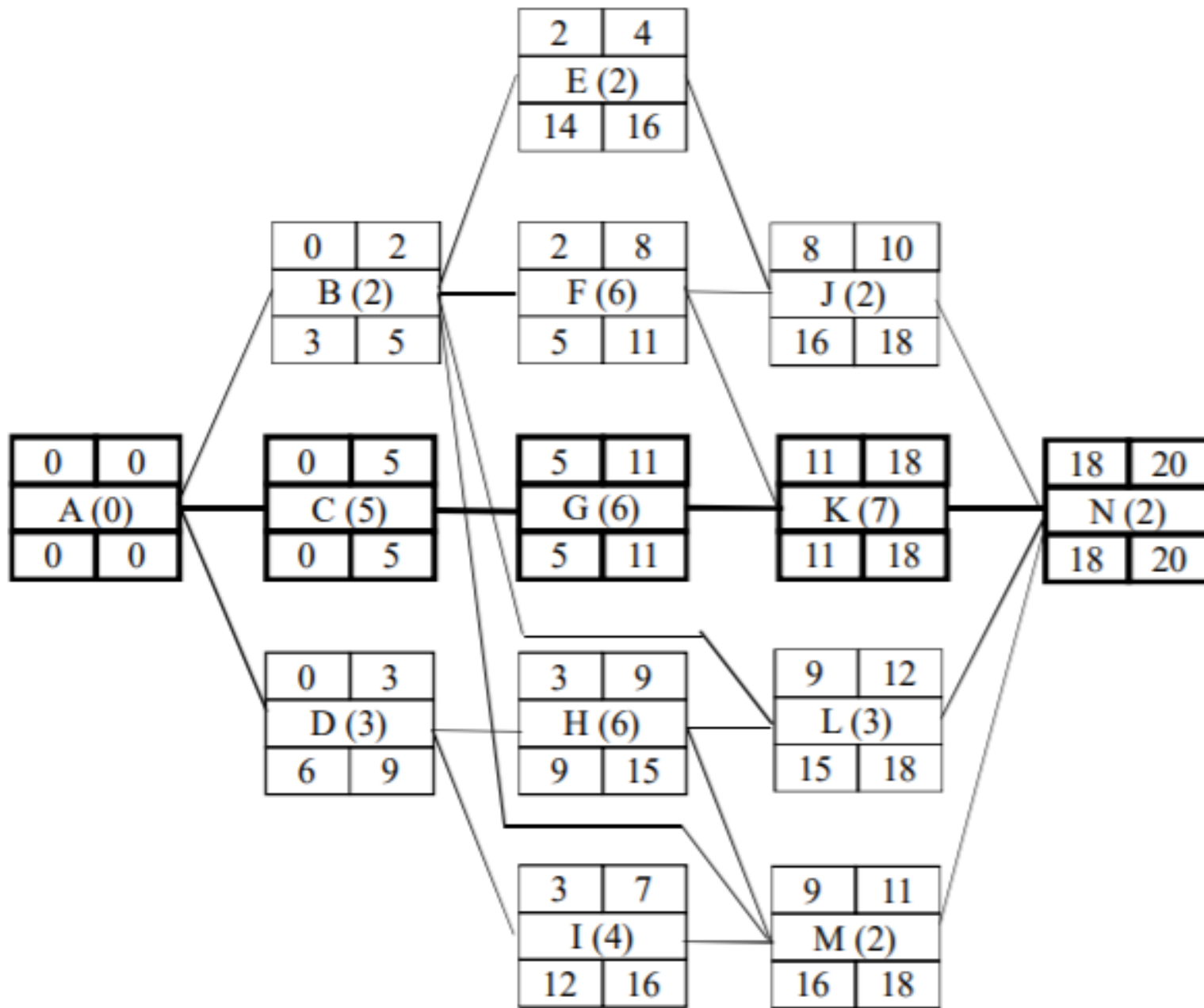$\sum y^2 = 466$; RIC = 1.0356
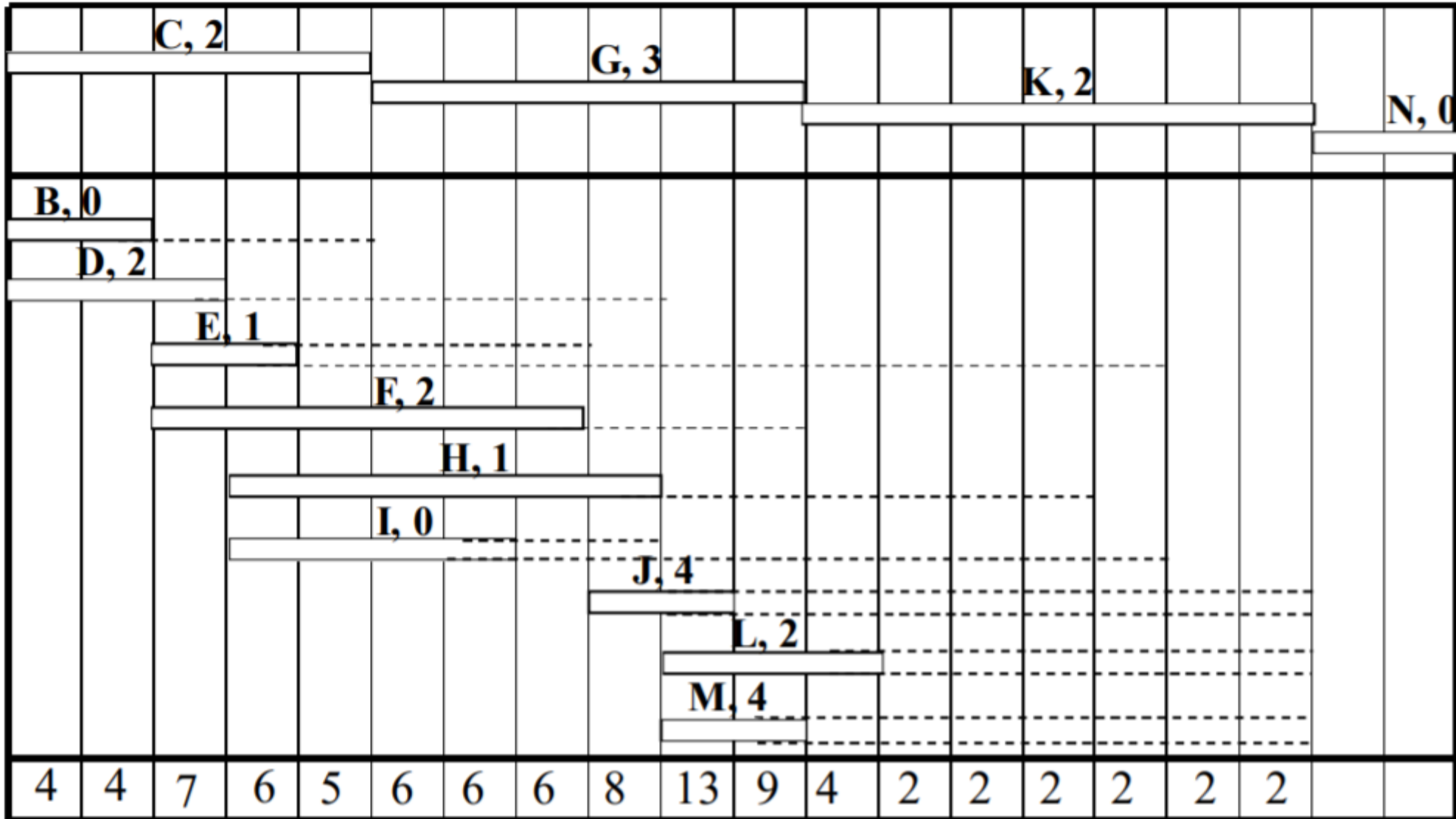
Resource Leveling

- Process
  - Draw a bar chart based on CPM's ES timings
  - Draw critical activities alone so as not to be changed
  - Draw FF and TF on the bar chart
  - Load the resources on each activity
  - Add all resources per period at the bottom of the bar chart
  - Calculate total needed resources
  - Calculate the average resource usage
  - Shift non-critical activities based on their FF then their TF to decrease the resources peaks and raise the resource valleys
  - Revise floats, and repeat till smoothing is achieved

Resource Leveling Example

Activity	Duration (Weeks)	Predecessors	Resource (units/week)
A	0	-	0
B	2	1	0
C	5	1	2
D	3	1	2
E	2	2	1
F	6	2	2
G	6	3	3
H	6	4	1
I	4	4	0
J	2	5, 6	4
K	7	6, 7	2
L	3	2, 8	2
M	2	2, 8, 9	4
N	2	10, 11, 12, 13	0

Credit: Prof. Emad Elbeltagi

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0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

C, 2

G, 3

K, 2

N, 0

B, 0

D, 2

E, 1

F, 2

H, 1

I, 0

J, 4

L, 2

M, 4
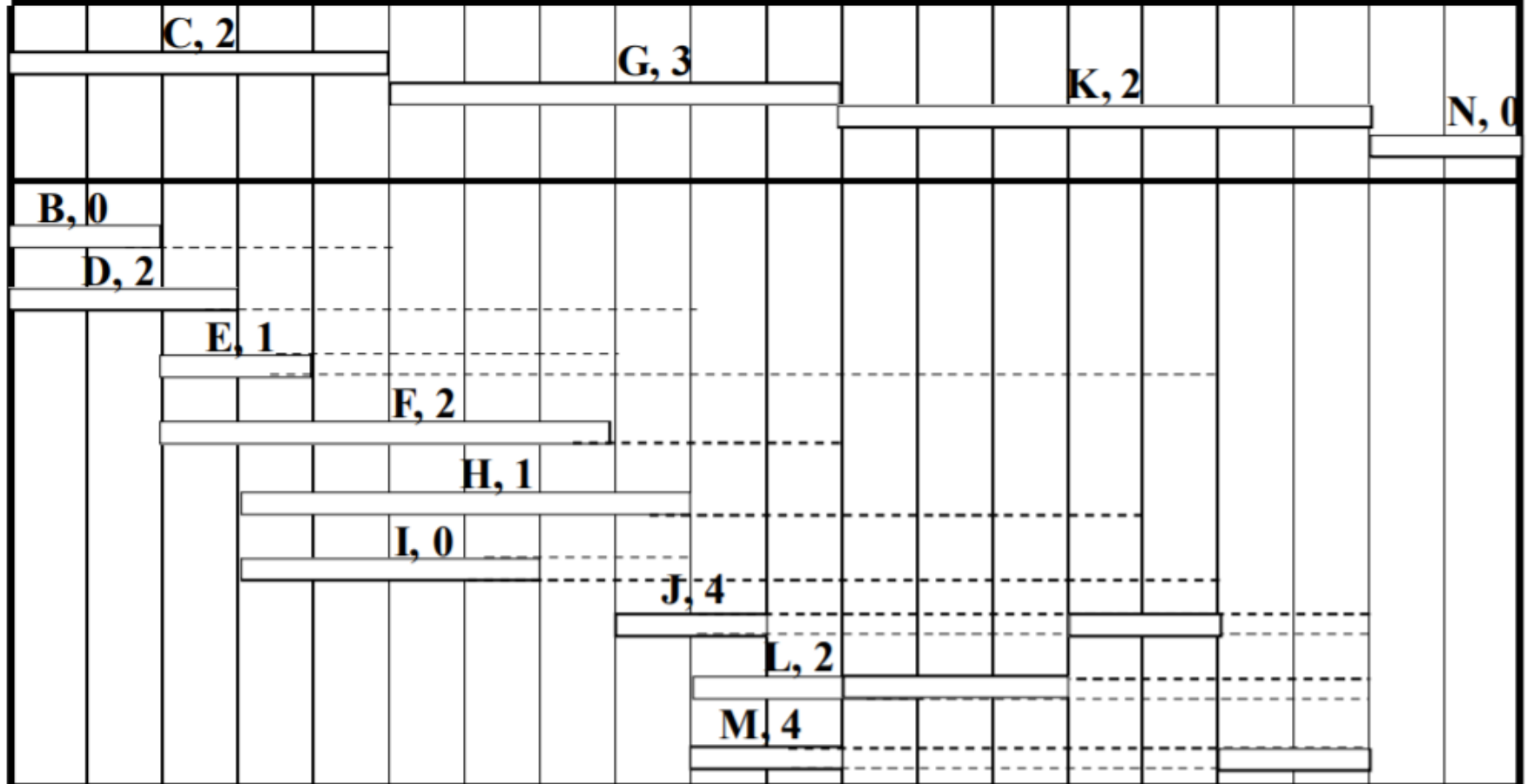
| 4 | 4 | 7 | 6 | 5 | 6 | 6 | 6 | 8 | 13 | 9 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | | | $\Sigma = 90$ |

M (7 days)

| | | | | | | | | | -4 | -4 | | | | | | +4 | +4 | | | |
| 4 | 4 | 7 | 6 | 5 | 6 | 6 | 6 | 8 | 9 | 5 | 4 | 2 | 2 | 2 | 2 | 6 | 6 | | | |

J (6 days)

| | | | | | | | | | -4 | -4 | | | | +4 | +4 | | | | | |
| 4 | 4 | 7 | 6 | 5 | 6 | 6 | 6 | 4 | 5 | 5 | 4 | 2 | 2 | 6 | 6 | 6 | 6 | | | |

L (2 days)

| | | | | | | | | | -2 | -2 | | +2 | +2 | | | | | | | |
| 4 | 4 | 7 | 6 | 5 | 6 | 6 | 6 | 4 | 3 | 3 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | | | |

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Gantt chart with time scale 0–20 and activities: C, 2 · G, 3 · K, 2 · N, 0 · B, 0 · D, 2 · E, 1 · F, 2 · H, 1 · I, 0 · J, 4 · L, 2 · M, 4
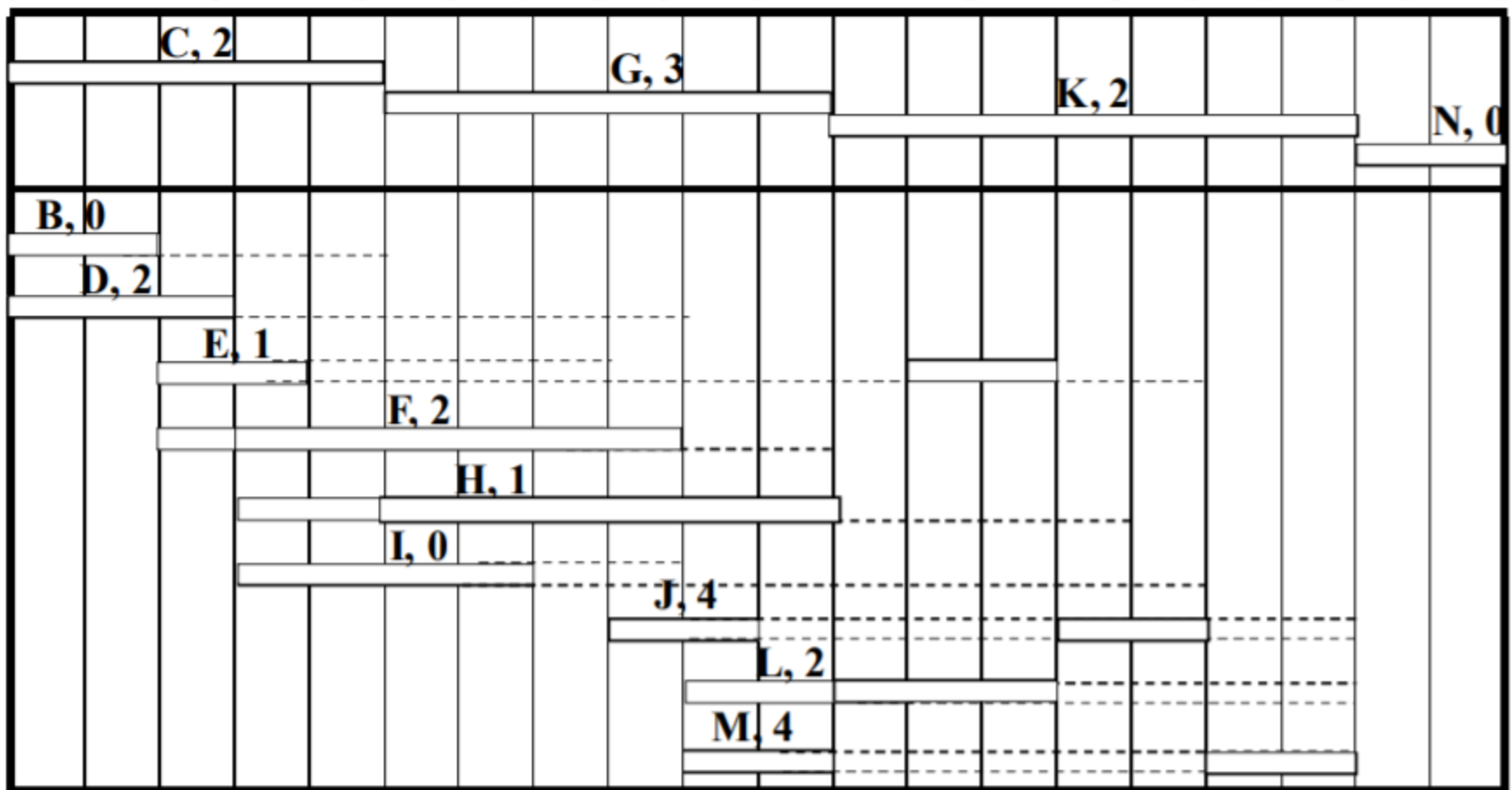
4	4	7	6	5	6	6	6	4	3	3	4	4	4	6	6	6	6	Σ = 90

E (10 days)

		−1	−1									+1	+1				
4	4	6	5	5	6	6	6	4	3	3	4	5	5	6	6	6	6

H (2 days)

		−1	−1						+1	+1							
4	4	6	4	4	6	6	6	4	4	4	4	5	5	6	6	6	6

F (1 days)

		−2						+2									
4	4	4	4	4	6	6	6	6	4	4	4	5	5	6	6	6	6

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