

Solutions

2.1 Events: start s; A: $s \rightarrow e1$ (2), B: $s \rightarrow e2$ (5); C: $e1 \rightarrow e3$ (3); D: $e1 \rightarrow e3$ and $e2 \rightarrow e3$ – D depends on both A and B, so $e1$ must connect to $e3$ and $e2$ to $e3$ (a dummy from $e2$ to $e1$ if drawn with D leaving a shared node). Durations: $A-C = 2 + 3 = 5$; $B = 5$; D needs both done: D's earliest start $= \max(2, 5) = 5$. Project duration $= \max(5, 5 + 1) = 6$ days.

2.2 Earliest = latest at every event: every activity on the chain is critical, float 0.

2.3 Float $= 16 - 5 - 6 = 5$ days.

3.1 (a) Arcs: A from start to event 2; B from start to event 3; C from event 2 to event 4; D depends on A and B, so a dummy (0) runs from event 2 to event 3 and D leaves event 3 – but D must end at its OWN event 5 (time $4 + 2 = 6$), since F follows D alone and must not inherit C's dependency. A dummy from event 5 to event 4 carries D into E's start (event $4 = \max(\text{C's } 10, \text{D's } 6) = 10$); E runs from event 4 to event 6; F runs from event 5 to event 7; a dummy from event 6 to event 7 gives the single finish. (b) Forward pass: event 1 $= 0$; event 2 $= 4$ (A); event 3 $= \max(3, 4 + 0) = 4$; event 5 $= 4 + 2 = 6$ (D); event 4 $= \max(4 + 6, 6 + 0) = 10$; event 6 $= 10 + 5 = 15$; event 7 $= \max(15 + 0, 6 + 3) = 15$. Backward pass: event 7 $= 15$; event 6 $= 15$; event 4 $= 10$; event 5 $= \min(\text{latest of event 4} - 0, \text{latest of event 7} - 3) = \min(10, 12) = 10$; event 3 $= 10 - 2 = 8$; event 2 $= \min(8 - 0, 10 - 6) = 4$; event 1 $= \min(4 - 4, 8 - 3) = 0$ ✓. (c) Critical events: 1 (0/0), 2 (4/4), 4 (10/10), 6 (15/15), 7 (15/15): critical path A–C–E, duration 15 days. (d) F's earliest start is event 5's earliest time 6, its latest finish 15: float $= 15 - 6 - 3 = 6$ days.

3.2 (a) Bars: A from 0 for 4; B from 0 for 3; C from 4 for 6; D from 4 for 2; E from 10 for 5; F from 6 for 3 with its slack after it. Critical activities A, C, E on one unbroken chain. (b) One worker suffices for the critical chain if nothing else overlaps it in time – but B (0–3) and D (4–6) overlap A (0–4) and C (4–10): at least 2 workers are needed. (c) F's latest finish is 15 and it lasts 3 days, so it can start as late as $15 - 3 = 12$ (its earliest start is 6, giving the 6-day float).

Local review guidance: dummies carry exactly the dependency that shared endpoints cannot; forward pass takes maxima, backward pass minima; float from latest finish – earliest start – duration; Gantt bars from earliest starts with slack trailing. This is authored classroom guidance.