OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS 2016

Guidance on Critical Path Analysis

Unit 24 Project management for engineers

Version 1

ocr.org.uk/engineering

As part of the examination for Unit 24, Project management for engineers, candidates may be asked to demonstrate their knowledge and understanding of critical path analysis.

Critical path analysis is an important project management tool for engineers because it allows the activities in a complex project to be planned in detail. Consider the remedial work to Elizabeth Tower and Big Ben, much work will have gone into the planning stage of the project before any repair work to the clock, bell or tower were actually undertaken. Each task necessary would have been allocated a duration for completion. Each task would have been examined to determine the order that the tasks should be tackled, and which tasks could be undertaken at the same time. This is to ensure that the project is completed successfully in the minimum possible time.

Critical path analysis allows the activities in a complex project to be modelled. The diagrammatic representation produced shows the most efficient order in which the activities should be undertaken. It shows the shortest time in which a project can be completed. In addition, the network diagram shows the earliest acceptable start time and latest acceptable finish time for each activity. This allows for the detailed planning and procurement of the required human, technological and physical resources for the specific times needed. During the planning stage of the project the project manager should communicate with key stakeholders to ensure that they are aware of these timescales and plan accordingly.

Once the project enters the implementation stage, critical path analysis can be used to monitor the progress of the project. The project manager should review issue logs and other monitoring reports on a frequent basis. Remedial action, say by reallocating resources, may be required to keep the project on schedule. The sooner this action is taken, the smaller the deviation from the plan and the lower any additional cost.

Candidates need to be able to:

1. Complete a network diagram from data given in a Gantt chart or table e.g. by inserting task durations
2. Interpret critical path data e.g. to identify activities which may be completed simultaneously or to identify dependent activities which must be completed sequentially
3. Calculate the earliest start times (EST) for given activities
4. Calculate the latest finish times (LFT) for given activities
5. Calculate the float time for a given activity
6. Interpret a network diagram to identify a critical path
7. Determine the minimum time in which a project can be completed
8. Calculate the effects of delays on the completion time of a project
9. Interpret a network diagram to suggest adjustments e.g. the reallocation of resources.

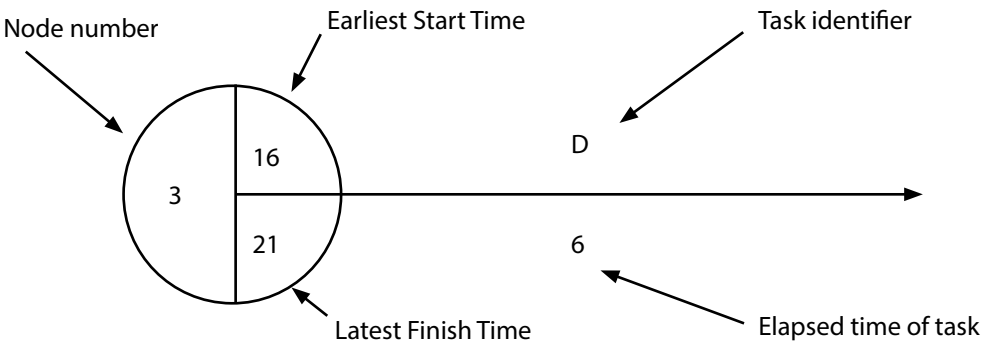
All questions require the candidate to have a sound understanding of the mechanics of critical path analysis in order to access the available marks.

In the examination any network diagram will be presented according to common convention: Nodes will be labelled by number and tasks by letter. Nodes will be shown as circles and elapsed time by arrows. The EST (earliest start time for an activity) is to be positioned in the top right quadrant of the node and the LFT (latest finish time) in the bottom right quadrant.

In the notation diagram which follows (units in days):

The node number is 3.
The earliest start time for the following tasks is day 16.
The latest finish time for the preceding tasks is day 21.
The task which follows node 3 is labelled task D and will take 6 days.

Notation diagram:



In the examination the network diagram itself will vary in composition depending on the number, dependence and concurrency of tasks in the project being illustrated. In all cases, however, candidates should be taught to begin by inserting the EST for each task into the appropriate node working in order from **left to right**. Only when the final node is reached should candidates insert the LFT entries, this time working in order from **right to left**.

The shortest length of time that a project can be completed by is shown in the final node (farthest right).

The formula for calculating the float time for a task is: LFT at end of task – duration of task – EST at start of task.

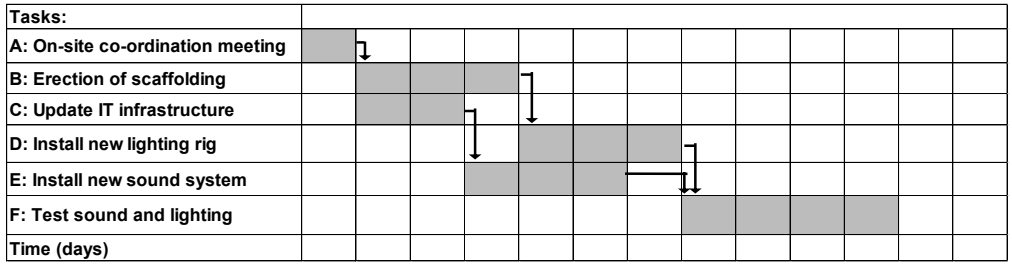
The critical path can be identified by following the path where no float time exists.

Worked example:

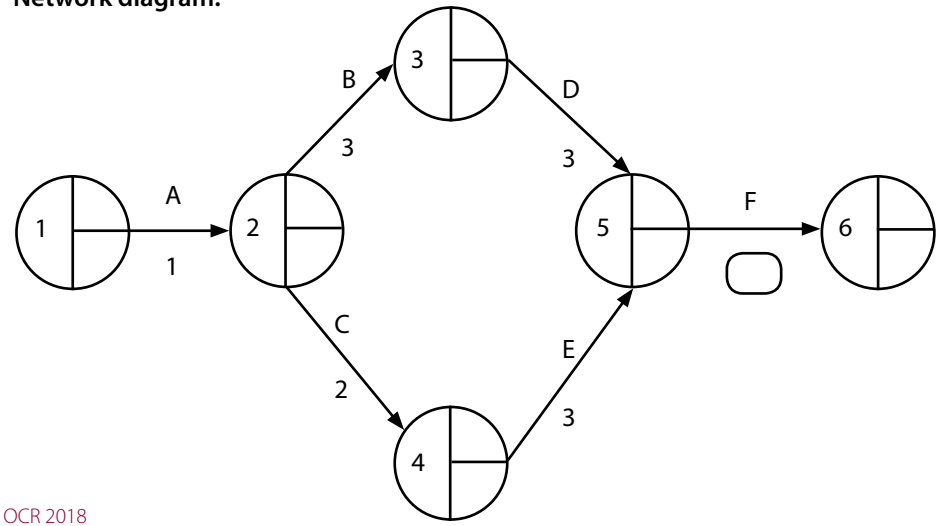
Partridge Theatre has decided to improve its stage lighting and sound. The tasks involved are shown in the table below.

Task	Description	Order/Logic	Duration
A	On-site co-ordination meeting	To be completed first	1 day
B	Erection of scaffolding	Start when A is complete	3 days
C	Update IT infrastructure	Start when A is complete	2 days
D	Install new lighting rig	Start when B is complete	3 days
E	Install new sound system	Start when C is complete	3 days
F	Test sound and lighting	Start when D and E are complete	4 days

This information could also be displayed in a Gantt chart as follows:



Network diagram:



Required:

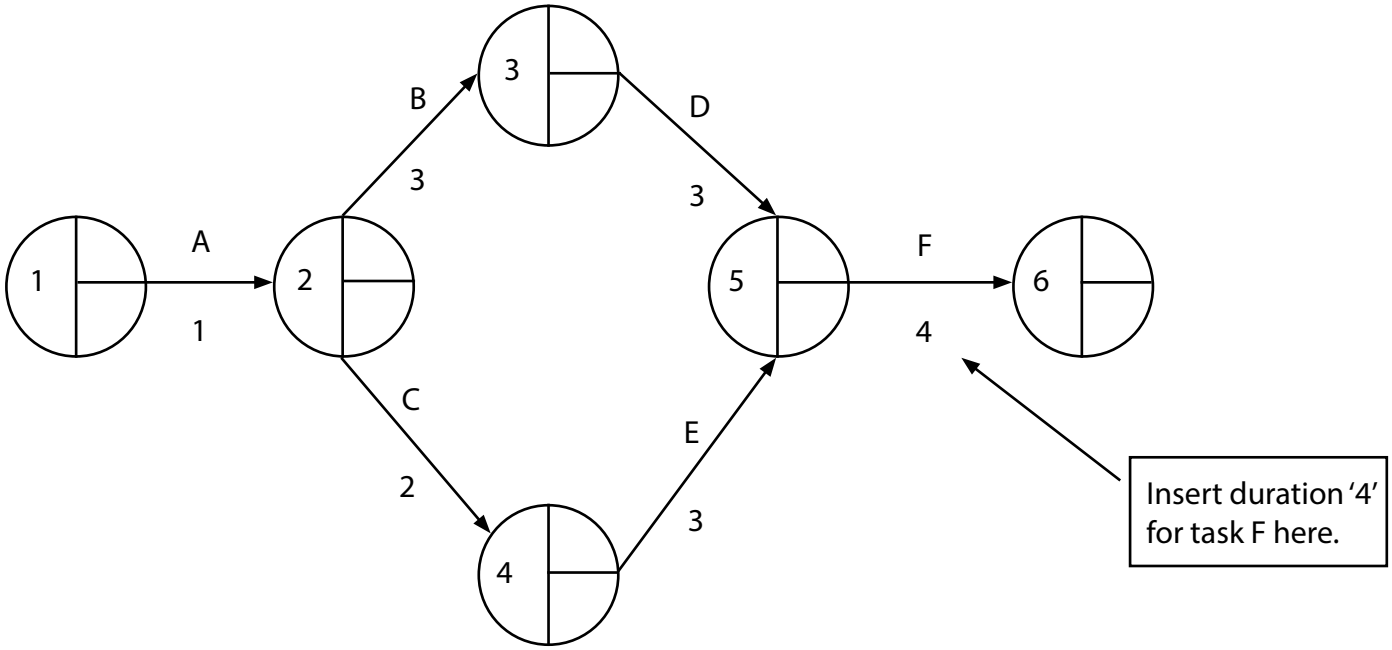
a) Identify which task can be completed simultaneously with task B.
b) Identify which task is directly dependent on the completion of task D.
c) Insert the duration of task F.
d) Complete the network diagram by inserting the EST (earliest start time) and LFT (latest finish time) for each node on the diagram.
e) Calculate the float time for task C.
f) Identify the critical path.
g) Identify the shortest length of time it can take to improve Partridge Theatre's stage lighting and sound.
h) Identify the effect on the completion time of the project if task E takes one day longer than expected.
i) Identify the effect on the completion time of the project if task A takes two days rather than one day.
j) If additional resources were made available from day 4 of the project, identify which tasks the project manager is most likely to allocate these resources to. Give reasons for your answer.

Method:

a) The answer to this question can be found from the table, the Gantt chart or the network diagram. It is important to be able to work out which tasks can be done simultaneously from all three sources. Perhaps the easiest to understand is the visual presentation on the network diagram. The network diagram shows that task B should start immediately after task A has finished. Looking at node 2 where task B commences it can be seen that a second arrow also leads out from node 2 i.e. that another task commences at this point. The other task that begins at node 2 is task C. So, task C can be completed simultaneously with task B.

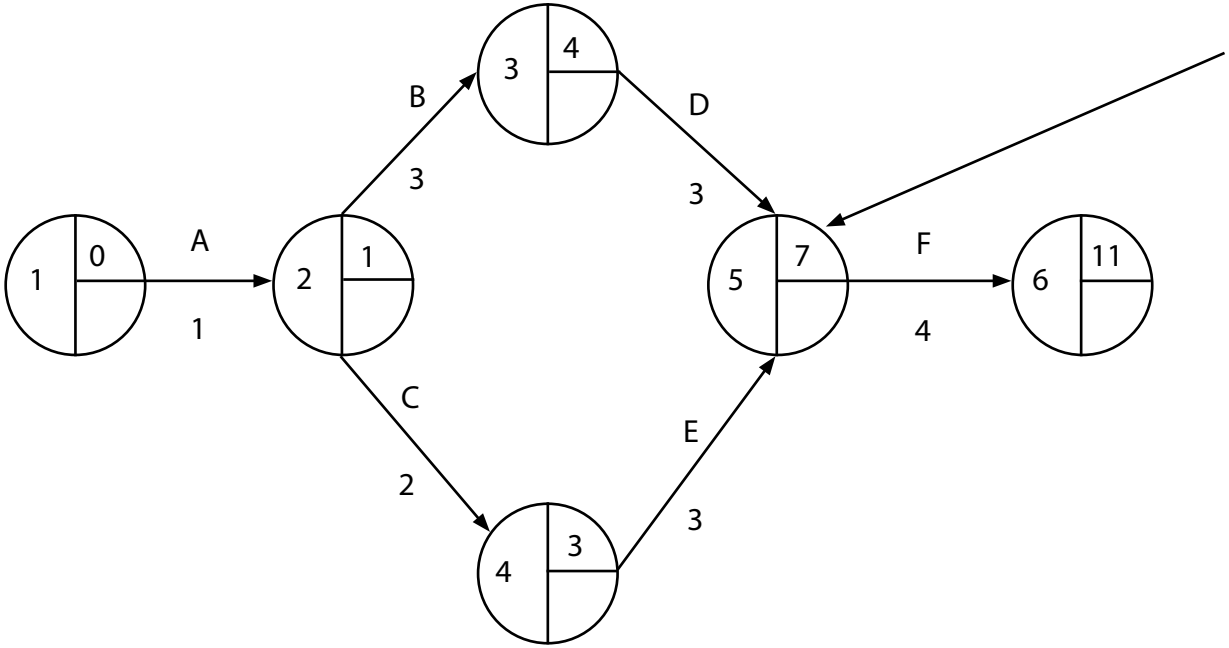
b) The answer to this question can also be found from the table, the Gantt chart or the network diagram. Again, it is important to be able to work out which tasks can be done simultaneously from all three sources. Perhaps the easiest to understand is the Gantt chart where the dependencies are shown by small arrows. The dependency arrow at the end of task D shows that task F cannot start until task D is complete. So, task F is directly dependent on the completion of task D

c) The duration of task F can be found by looking at the table or the Gantt chart. The table states '4 days' and the Gantt chart shows four cells shaded in (equivalent to 4 days). The duration '4' should be inserted into the appropriate space under the arrow for task F, as shown below.



d) (i) First enter the ESTs for all nodes from **left to right** beginning with **node 1**.

NB where two activities lead into a node e.g. node 5, **the higher needs to be used as the EST**.

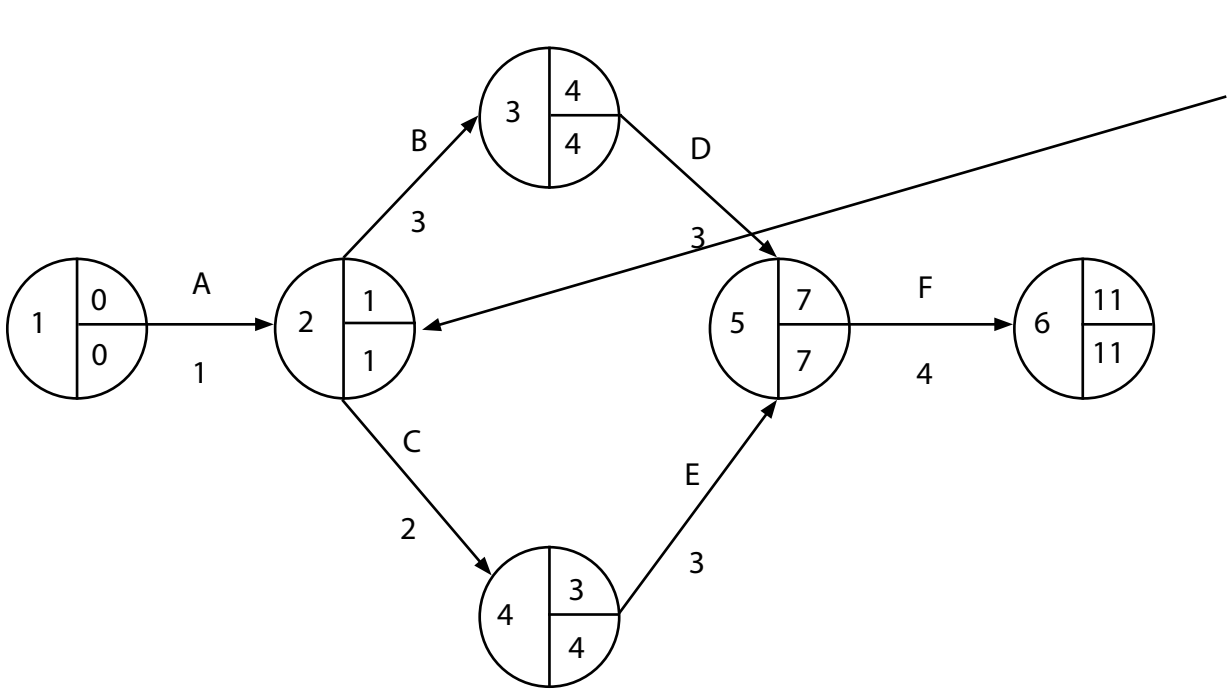


NB: Node 5 has two incoming activities – Task D gives an EST of 7 (i.e. 4 + 3) – Task D gives an EST of 6 (i.e. 3 + 3)

When calculating the **EST** the **higher** number should be used – in this case 7.

(ii) Then enter the LFTs for all nodes from **right to left** beginning with **node 6**.

NB where two activities lead from a node e.g. node 2, **the lower number needs to be used as the LFT**.

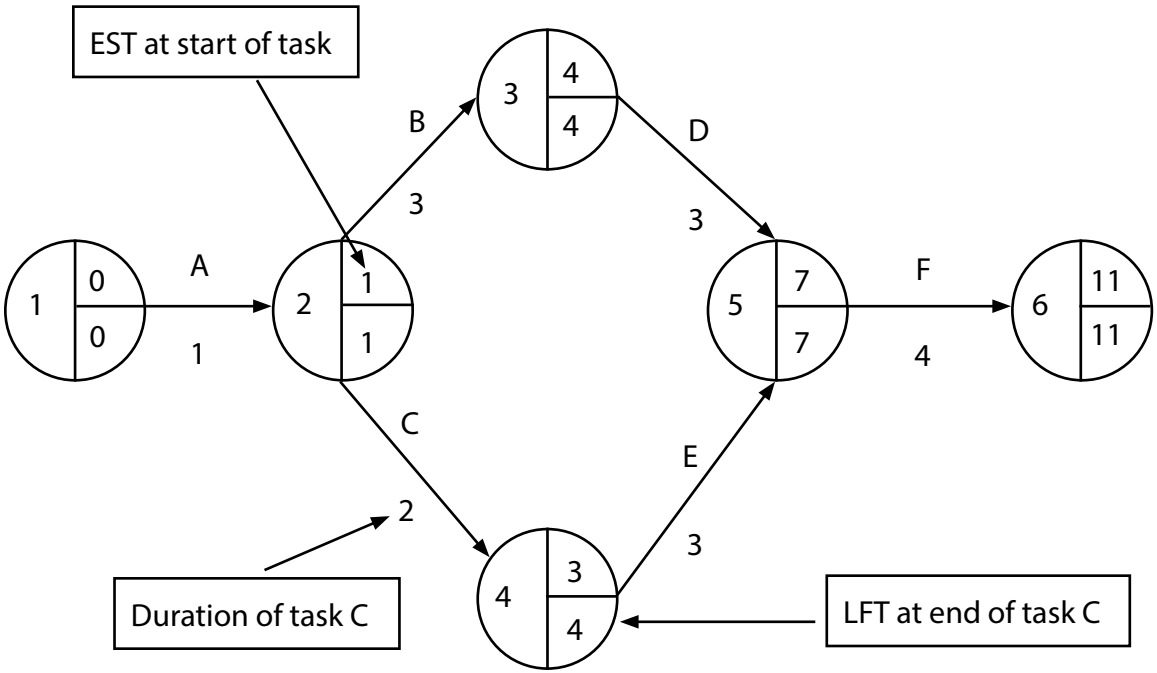


NB: Node 2 has two outgoing activities

– Task B gives an LFT of 1 (i.e. 4 - 3) – Task C gives an LFT of 2 (i.e. 4 - 2)

When calculating the **LFT** the **lower** number should be used – in this case 1.

e) Formula for float time for task C is **LFT at end of task C – duration of task C – EST at start of task C**.



Total float for task C is, therefore: 4 – 2 – 1 = 1 day

f) The critical path consists of all activities that do not have any float time. As activity C and activity E are the only activities to have float time, the critical path is A – B – D – F. Tasks A, B, D and F are said to be critical because any delay in their completion will lead to a delay in completing the entire project.

g) The shortest length of time it can take to improve Partridge Theatre's stage lighting and sound is shown in the final node, node 6.

Shortest time to completion = 11 days

h) If task E takes one day longer than expected there would be no change to the completion time of the project. Task E has slack time of 1 day (7 - 3 - 3) so the one day delay can be absorbed without delaying the overall project. The project should still complete on time i.e. after 11 days.

i) If task A takes two days rather than one day then the EST in node 2 will increase from '1' to '2' and all other ESTs will increase by 1. The EST in node 6 would be 12. The completion of the project would take 12 days rather than 11 days, i.e. the project would be delayed by one day.

i) The project manager is most likely to allocate the resources to tasks D and F. Additional resources should be allocated, where possible, to tasks on the critical path because this has the potential to speed up the project. Tasks A, B, D and F are on the critical path, but since the resources are not available until day 4 they arrive too late for tasks A and B. Thus, the additional resources should be allocated to tasks D and F, as the project manager deems appropriate.

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here:
www.ocr.org.uk/expression-of-interest

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

ocr.org.uk/engineering
OCR customer contact centre

OCR is part of Cambridge Assessment, a department of the University of Cambridge. *For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.*

Cambridge Assessment

LLOYD'S REGISTER · LRQA
ISO 9001
UKAS MANAGEMENT SYSTEMS
001