EXAMINATION MARKING GUIDELINES YEAR OF STUDY: (Varies)

EXAM TITLE: Engineering Project Management DEC 2023

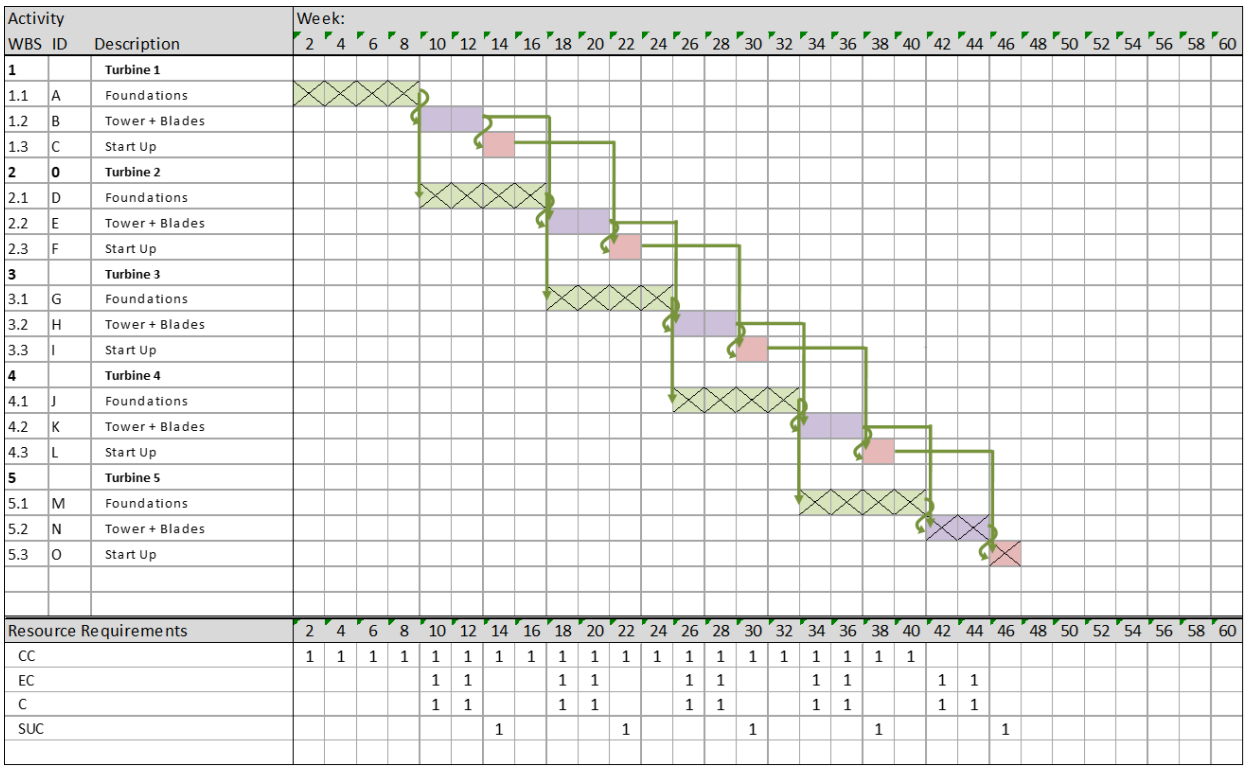
*Important note: this document is the **marking guidelines** for this exam. It is important to understand it is not the exam **solution** as for many of these questions there is no single solution. Therefore, much of the below, apart from purely numerical questions, are general pointers as to how the examiner will mark the question. The examiner will always be flexible in their approach and will provide marks that reflect the level of detail and understanding that the student shows, as well as how effectively they communicate that detail and understanding.*

Question 1 (Fred Bosché)

Part I (CPM):

(a)

The Gantt chart below shows the initial programme and the resource requirements based on it.



Activity WBS	ID	Description
1		**Turbine 1**
1.1	A	Foundations
1.2	B	Tower + Blades
1.3	C	Start Up
2	**0**	**Turbine 2**
2.1	D	Foundations
2.2	E	Tower + Blades
2.3	F	Start Up
3		**Turbine 3**
3.1	G	Foundations
3.2	H	Tower + Blades
3.3	I	Start Up
4		**Turbine 4**
4.1	J	Foundations
4.2	K	Tower + Blades
4.3	L	Start Up
5		**Turbine 5**
5.1	M	Foundations
5.2	N	Tower + Blades
5.3	O	Start Up

Resource Requirements	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
CC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
EC					1	1			1	1			1	1			1	1			1	1								
C					1	1			1	1			1	1			1	1			1	1								
SUC							1				1				1				1				1							

Marks allocation:

- *-3.5 for each major error.*
- *-1.5 for each minor error.*

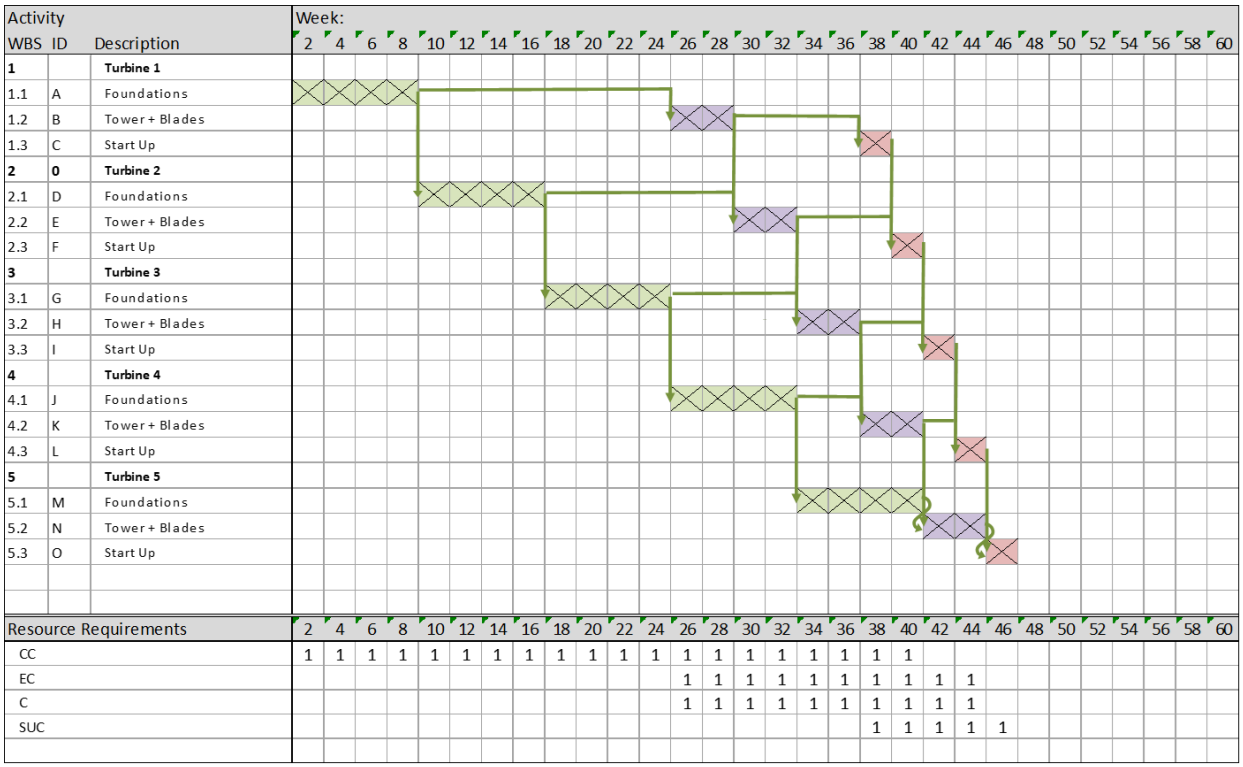
A 50% answer may have a sequentially logical Gantt chart, but fails to achieve the expected (shortest) completion time (46 weeks).
A good answer should have a correct Gantt Chart Diagram, but lack some details, like missing precedence relationships or missing critical path.

(10 marks)

(b)

There is no issue of overallocation. However, there is discontinuous resource demand for EC, CC and SUC, resulting from the fact that the “Tower and Blades” and “Start Up” activities are not scheduled to occur successively across the turbines.

This can be however be addressed by using the Total Float available in the programme. Indeed, by plotting the Late Start Gantt, instead of the Early Start Gantt, as shown in the Gantt chart below, we resolve the issue.
The benefit of this solution is that it only uses the Total Float in the programme so that it results in no delay in the completion of the project. However, it now means that all activities on the schedule become critical. It also means that no turbine is completed before week 38, while in the previous schedule the first turbine was already completed in week 14.



Marks allocation:

- *4 Marks solution. A solution that delays the project complete gets 2 Marks maximum.*
- *2 Marks advantages*
- *4 Marks disadvantages*

(10 marks)

(c)
The purpose of the WBS is to divide the project into technically-coherent blocks of related activities broken down into levels of increasing detail. The blocks may be product-oriented (broken down into levels of hardware) or function-oriented (broken down into levels of organisational disciplines).

The leaves of the WBS represent the individual task that will be planned in detail and subsequently allocated to teams (or contracted out). They must thus represent a clear scope of work that can indeed be planned unambiguously.
From a contractual viewpoint, each task (leaf) in the WBS should include work that will be allocated to a single party. If it is not, it should be divided further for clarity of scope and allocation.

The structure of the higher levels of the WBS should be selected to reflect needs for planning and monitoring the works in accordance to a product decomposition or a organisation/function decomposition.

Marks allocation:

- *2.5 Purpose.*
- *2.5 Characteristics (1.5 for leaves, 1.0 for higher-level)*

(5 marks)

Part II (Milestone Monitoring):

(d)

Milestone Monitoring (MM) is much easier to apply because it doesn't require tracking "Work Performed" continuously, but only assess performance at defined milestones. However, this means that no reliable performance assessment can be obtained in-between milestones. One must also pay attention to define very clear milestones that can unambiguously be identified during delivery.

EVA enables continuous measurement of performance, even between milestones. However, this requires the continuous measurement of "Work Performed", which is not easy to do at all and can be subjective.

Marks allocation:

- *3 for MM;*
- *3 for EVA;*
- *-1.5 for any unclear/incomplete answer in each.*

A 50-60% answer will provide a partial assessment (e.g. clear benefits but unclear drawbacks for one of the methods).
A good answer will discuss the above.
An excellent answer may go beyond and maybe also highlight other issues (e.g. SPI values in EVA).

(6 Marks)

(e)

At M1 (about 1/5 through the project budget and ¼ through it's planned schedule), the project is on budget but with significant delay (approx. 10% of the planned schedule).
At M2 (about ½ through the budget and schedule), delays have been significantly reduced (now <5% of the project schedule), but the project has now become approx. 5% over budget.
At M3 (end of the project), the project has experience new further delays but the costs have never deteriorated further, although they remain at 5% above budget.

So, overall, costs have become over budget between M1 and M2 and remained at 5% above budget until completion. Schedule-wise, delays were experienced early on. They were reduced about halfway through the project, but then increased again in the last part of the project.

Marks allocation:

- *3 marks for the analysis of each Milestone.*

-4 marks if a student discusses performance outside Milestone points.

(9 marks)

Question 2 (Simon Smith)

Part (a)

i) Multiple reasons:

- these methods make big assumptions on project scope and detail which will reflect the level of detail known at that stage;
- they do not need a detailed understanding of the planning details of the delivery phase;
- they do not need a design;
- at an early stage it is not necessary to have a highly accurate estimate
- they also allow a 'backward' calculation that suggests the size of project that is possible with a particular budget.

(5 marks)

ii) Unit-rate Estimating and Operational Estimating. These methods require detailed understanding of the project including its design and, for operational estimating, planning details on how it will be delivered. Therefore, they cannot be used at an early stage and thus reserved for later when more accurate estimates are needed, such as at tendering. Because these methods use so much data they tend to be much more accurate, which is what is needed at a tender stage – better students may identify why it is important for a contractor to be accurate. If their estimate is too high they may not win the contract; too low and they may not make a profit.

(5 marks)

Part (b)

i) A budget is the sum of money that is available to pay for a project. It is determined based upon the financial situation of the client and how they anticipate their income and expenditure developing during the life of the project. A cost estimate is a mathematical forecast of the likely eventual cost of the project. They are fundamentally different things though both expressed as sums of money. The situation is not helped when an estimate is often expressed as an absolute sum of money when a more realistic form would be a range estimate. Thus the two are often confused. A budget should be used to control the scope of a project; on the other hand an estimate is a product of the scope. If a client lets the budget be the controlling factor then the scope will see limited change. But if a client ignores their budget then the estimate is a reflection of scope change. Finally a budget can be exceeded with proper consideration and good governance – it requires approval. An estimate is merely a reflection of the project scope and detail, which may not be subject to the same level of governance.

(Here is the ChatGPT answer:

"A budget and a cost estimate are two distinct financial tools used in the management of engineering projects, and they serve different purposes. The confusion between these terms often arises due to their similarities in dealing with project costs, but there are key differences between them:

1. **Purpose**:
   - **Budget**: A budget is primarily a financial plan or allocation of resources, outlining how much money is available for a project. It sets a limit on the total expenditure and helps in financial planning and control.
   - **Cost Estimate**: A cost estimate is a prediction of what a project is expected to cost. It is an assessment of the likely expenses involved in the project, based on available data and assumptions. Its primary purpose is to provide a detailed breakdown of costs.
2. **Timing**:
   - **Budget**: A budget is typically set at the beginning of a project, often before detailed project planning. It's an early-stage allocation of funds, serving as a guideline for how much the client is willing to invest.
   - **Cost Estimate**: Cost estimates are developed as the project progresses and more detailed information becomes available. They become more accurate and reliable as the project advances through its phases.
3. **Level of Detail**:
   - **Budget**: Budgets are usually high-level and less detailed. They provide an overall spending cap and do not include the granular details of specific project components or activities.
   - **Cost Estimate**: Cost estimates are detailed and itemized. They break down costs into specific elements, such as labor, materials, equipment, and overhead expenses. They are more accurate and comprehensive, providing a basis for making informed decisions about the project.
4. **Accuracy**:
   - **Budget**: Budgets are often less accurate due to their early-stage nature and lack of detailed information. They provide a rough idea of the financial scope of the project.
   - **Cost Estimate**: Cost estimates aim to be as accurate as possible, given the available information. As the project advances and more data becomes available, estimates can be refined and become more precise.
5. **Flexibility**:

- **Budget**: A budget is less flexible, as it sets a fixed limit on spending. It may not account for unforeseen changes or variations in project scope.
- **Cost Estimate**: Cost estimates are used to track and manage costs throughout the project. They allow for adjustments based on changing project conditions, scope modifications, or unexpected issues.

In summary, a budget is an initial financial plan that sets a cap on project spending, while a cost estimate is a detailed assessment of anticipated project costs. Budgets are established early in the project and provide a high-level overview, while cost estimates evolve and become more accurate as the project progresses. Both are important for effective project management, with budgets providing financial constraints, and cost estimates offering detailed insights into project costs.

(5 marks)

ii) There are two main reasons for this, and students should be able to discuss both, and the details. First is that a project will often experience cost growth, which is caused itself by many reasons – scope changes, design changes, resource cost increases, risks being realised, poor management of activities and costs during delivery, external factors (war, pandemic etc.) thus the final cost may be higher than even the most accurate of estimates.

The second reason is that the estimate may not have been accurate in the first place. If it was prepared at a very early stage then its accuracy will be low, as discussed above. But it is also subject to a wide range of human behaviours and biases. The most controversial of these, discussed at length in class, is the presence of strategic misrepresentation, which is where a client will strategically suggest a project will cost less than anticipated in order to secure the funding and allow the project to proceed.

(5 marks)

Part (c)

i) This is a deliberately easy question, allows students to get marks in the bag. Quite simply, total load (35tonnes) divided by the off-load rate per hour (7tonnes) is **5 hours**. At £20/hr the total cost is **£100**.

(3 Marks)

ii) There are two different assumptions that can be made here. I will allow answers based on either as long as students state their assumption and understand why it influences their answer. No acknowledgement will reduce the mark.

- First we assume that offloading and installing can happen concurrently. If so then the activity is that which is longest between either the offloading or installing work. To install 35tonnes of whatsits at 1.5hours per tonne of whatsit will take **52hours and 30 minutes.**
- The second assumption is that the offloading and installing must take place one after the other – thus the duration would be 52.5+5= **57 hours and 30 minutes**.
- In reality it would more likely be that some whatsits need unloading before installation starts and thus the duration will be somewhere between **52.5 and 57.5 hours**.
- The cost here will always be the sum of the offloading and installing activity. At £19 per hour the installation will cost £997.50 so total activity cost will be **£1,097.50**

(4 marks)

iii) Only three marks but students could answer a lot here. The main issue is that the crane will have offloaded the materials for this activity in just 5 hours. But the activity takes a minimum of 23 hours. What does the crane do when it has finished its task? If it is allocated only for that activity then it spends 18 or so hours idle – but still costs money, thus adding an extra £360. Therefore, to make this efficiency greater the crane needs to be planned to have further work to do. This could be a minimum of the remainder of that day – usually a 10-hour day so is there an activity it can move onto for 5 hours? The crane can then be off-hired after just one day. If no other activities are available then the utilisation will be low and the costs much higher – which may not be included in any estimates.

(3 marks)

Question 3 (Simon Smith)

Part (a)

i) This answer requires an indication of why competitive tender is used – this is to provide an element of competition and, theoretically, leads to lower bid prices. One consequence of this – as discussed in Q3(b) below, is that bids may be too low – which is not good for the client in the end. Negotiation is where there are no sealed bids but instead the prices are discussed directly with one or more contractors. The reason is because clients may only have a limited range of contractors who can do the work; or that the abilities and quality of an individual company may be more important than cost; or because the client has worked very successfully with the contractor in the past and values that working relationship.

(5 marks)

ii) If the full details of the project are already specified then this means there is less uncertainty over the final form and thus the final price of the project. Thus a lump-sum, fixed-price contract is best.

(2 marks)

iii) This is the best method because from the client's perspective they get high certainty over the final cost and it also allows the risk of any project uncertainty to be passed to the contractor. It is important in this answer that there is recognition of which party gets the certainty and lowered risk – for the contractor this would be opposite.

(2 marks)

iv) The other methods are (and all three need comments on):

- Measure and Value – this could be used but is better for those situations where there is uncertainty over the final size or quantities in the project – M&V uses rates to determine the price of remeasured quantities.
- Cost reimbursable – this would not be advisable for the client as all the risk is transferred back to them – they pay for everything including project changes. This method is good for the contractor but not the client. It also provides a disincentive for the contractors to work efficiently.
- Target cost – this is a good option as it shares the risk but would often not be chosen for situations where the design is very complete.

(6 marks)

Part (b)

This quote refers to the situation when competitive tendering may lead to low bids. Good students will be able to write a good answer here as it matches not just the discussion on John Ruskin, but also the briefing article linked to on Learn, which states "Lowest-price tendering is forcing contractors to price their work at unrealistically low levels, which is having serious consequences for the (engineering) industry".

The issue is simply that contractors are keen to get the work and so push their prices down to increase their chances of winning. Unfortunately, this means that (a) the quality of the work that is done might be lower than ideal (i.e.'cheaper') which is not good for the client and/or (b) the contractor has so little cashflow that they go out of business – again not good for the contractor. This is essentially what happened on the construction of the AGB building at KB – the contractor went out of business before construction completed. Ruskin's point is that in such situations the client often pays more as a consequence, and thus should have paid more at the start to get a more suitable bid price.

(7 marks)

Part (c)

i) To know what a letter of intent is also needs knowledge of what a letter of acceptance is. The latter is the letter from the client to the contractor indicating that their tender bid is accepted and a contract will be formed. If for some reason it is not possible to issue a Letter of Acceptance, a *Letter of Intent* may be sent to the successful tenderer as a precursor to the Letter of Acceptance. In this situation, Sainsrose presumably are unable to form a contract – perhaps their funding/finance is not in position; perhaps there is no planning permission yet.

Here is the ChatGPT answer: "A client may issue a Letter of Intent (LOI) instead of a Letter of Acceptance for several reasons in the context of procurement and construction projects. It's important to note that the specific reasons can vary depending on the project, client's preferences, and local regulations. Here are some common reasons why a client might choose to issue an LOI:

1. Negotiation: An LOI provides the client with the flexibility to negotiate the terms and conditions of the contract further before formally accepting a bid. This can be useful if the client wants to discuss or clarify specific aspects of the proposal, such as pricing, scope, or timeline, before committing to a final contract.
2. Time constraints: In some cases, there may be time-sensitive projects where the client needs to start work immediately. Issuing an LOI allows the client to signal their intent to award the contract quickly, even before all contract details are finalized. This can expedite the process.
3. Legal and regulatory considerations: Some projects, especially those involving public contracts, may have legal and regulatory requirements that dictate the use of an LOI. For example, specific laws or regulations may require certain steps or approvals before a formal contract can be signed.
4. Pre-contract preparations: An LOI can be used to initiate pre-contract preparations, such as obtaining necessary permits, mobilizing resources, and starting initial project planning, even before a formal contract is in place.
5. Confirming bidder's commitment: An LOI can serve as a way to confirm that the selected bidder is genuinely interested in and committed to the project, which can reduce the risk of the bidder withdrawing their offer at a later stage.
6. Formality and tradition: In some industries or regions, it may be customary to issue an LOI before moving on to a formal Letter of Acceptance. This can be seen as a way of maintaining established business practices.

It's important to note that while an LOI indicates the client's intention to award the contract to a particular bidder, it typically doesn't create a legally binding agreement on its own. The specifics of what constitutes a binding agreement can vary by jurisdiction and may depend on the content and language used in the LOI. In many cases, the final contract will still need to be negotiated and signed to establish the full legal terms and obligations. Clients and contractors should always seek legal advice when dealing with LOIs and contracts to ensure compliance with relevant laws and regulations."

(4 marks)

ii) In this situation a letter of intent would not form a legally binding contract so you should advise Mc&H to not assume they are protected. There is a risk that the continuing contract negotiations breakdown and a full contract might not be formed – so Sainsrose would not be obliged to pay for any work that Mc&H had done since receiving the LoI. However, you should advise to consider the letter itself as it may indicate what works Sainsrose would pay for, or perhaps a maximum sum of spend. You can also advise that it is a good situation as the client has not chosen any other contractor and intends to form a contract – this allows Mc&H to mobilise their resources in time for a LoA to be issued.

(4 marks)

END OF PAPER