RUBRIC

- This exam paper consists of THREE questions.
- Candidates should attempt ALL THREE questions.
- For Question 1 you may use the paper attachments or alternatively use the Excel template supplied.

Question 1

a) You are planning the construction of a new 250MW gas-fired power plant with an estimated cost of approximately £300 million. Table Q1a (below) lists the main construction activities with their durations and required resources. The resources are defined as follows:

- EC = Excavation Crew.
- CC = Concrete Crew.
- SC = Steel Crew.
- EIC = Equipment Installation Crew.

Table Q1a - main construction activities with their durations and required resources

WBS	ID	Description	Duration (months)	Predecessors	Resource Requirements
1		**Boiler**			
1.1	A	Boiler excavating to foundations	8	-	EC
1.2	B	Foundations and concrete work	6	A	CC
1.3	C	Boiler main steel	6	B	SC
1.4	D	Miscellaneous steel and finish	10	C	SC
1.5	E	Boiler pressure parts installation	10	D	EIC
2		**Turbine**			
2.1	F	Turbine building excavating	6	A	EC
2.2	G	Discharge tunnel and foundation concrete	8	F	CC
2.3	H	Main steel frame installation	6	G	SC
2.4	I	Turbine generator base mat concrete	8	G	CC
2.5	J	Turbine generator installation	10	H, I	EIC
3		**Commissioning**			
3.1	K	Chemical cleaning and cold clean up	2	E, J	EIC
3.2	L	Steam blow-out	8	K	EIC
3.3	M	Boiler and auxiliary system test	8	L	EIC
3.4	N	Firing test	2	M	EIC
3.5	O	Turbine generator and auxiliary system test	2	L	EIC
3.6	P	Trial Operation	6	N, O	EIC

The information in Table Q1a was used to develop an initial Gantt chart of the project that is presented in the worksheet in Attachment 1, with construction planned to start on the 1st January 2022.

(i) In the worksheet in Attachment 1, complete the bottom rows of the template document ("Resource Requirements") to establish the resource requirements over time. **(3)**

(ii) You have now identified the initial resource availabilities to be: 1 EC, 1 CC, 1 SC and 1 EIC. Does this raise any issues? If so, propose an optimal solution to address this(these) issue(s), by considering the information in Table Q1b (below) and the fact that any extension to the currently planned project

duration would result in additional costs of £0.4 million per month.

Table Q1b – Resource Mobilisation Costs

Monthly (e.g. overhead) cost of mobilising an additional crew of:	
Excavation Crew (EC)	£ 0.6 million
Concrete Crew (CC)	£ 0.6 million
Steel Crew (SC)	£ 0.5 million
Equipment Installation Crew (EIC)	£ 0.3 million

(15)

b) In a maximum of 100 words, compare the benefits and drawbacks of the "Milestone Monitoring" and "Earned Value Analysis (EVA)" methods. **(6)**

c) The Earned Value Analysis (EVA) method is employed for the monitoring of the gas-fired power plant for which you considered the planning in Part (a).

Disregard all information about resources in Question 1 and assume now that the Gantt chart in Attachment 1 reports how the project was actually delivered up until the end of April 2024, at which point the EVA table provided in Attachment 2 is also produced.

Analyse the overall performance of the project and advise the project management team on what, if anything, they should focus their attention. **(16)**

Question 2 [Note: for this question you should, where possible, provide examples in your answers that demonstrate your understanding. You may use examples that have been discussed during the lectures and seminars in the course, though greater weight and value will be given to your own examples, derived from either your own reading or experience.

Value is also given to the effectiveness of your communication of your understanding.]

a) George H. Heilmeier, a prominent 20th Century American Electrical Engineer, posed a series of questions that he believed should be asked of every engineering project. His questions were later known as the Heilmeier Catechism.

The second and third of his questions were:

- How is it done today, and what are the limits of current practice?
- What's new in your approach and why do you think it will be successful?

i. What concept was George referring to here?
ii. Why is this so important in Engineering Projects?
iii. How do you think this concept might be enabled? **(10)**

b) George H. Heilmeier also suggested these two questions be asked, clearly about time and cost:

- How much will it cost?
- How long will it take?

Provide a discussion that considers why George poses these questions, and how they may interact with the concept of *Quality*. **(10)**

c) The Project Life Cycle may come in many different forms, but most interpretations start with the concept of *Project Demand*.

i. Why is the concept of Project Demand so important?
ii. Who is responsible for the identification of project demand, and why?
iii. What are the consequences of not *identifying* project demand correctly?
iv. What are the consequences of not *delivering* project demand correctly? **(10)**

Question 3 [Note: for this question you should, where possible, provide examples in your answers that demonstrate your understanding. You may use examples that have been discussed during the lectures and seminars in the course, though greater weight and value will be given to your own examples, derived from either your own reading or experience.

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a) Engineering projects will have several different *parties*, that is organisations and roles, that are critical to the delivery of the project. Sometimes these parties are separate organisations who fulfil separate roles; sometimes the same organisation might fulfil multiple roles.

i. List five different parties and for each provide a brief description of what their responsibility to the project is.
ii. Provide an example of a project where the same person or organisation fulfils more than one role. **(10)**

b) During the early concept and development phases of a project there is often great pressure from the client for a cost estimate of the project.

i. Why is this?
ii. What is needed to provide a useful cost estimate to the client?
iii. How might cognitive biases influence these estimates?
iv. What are the consequences of providing an inaccurate estimate at an early stage? **(10)**

c) Once a project enters its implementation or construction phase, it is important that the parties involved understand the principles of financial resources.

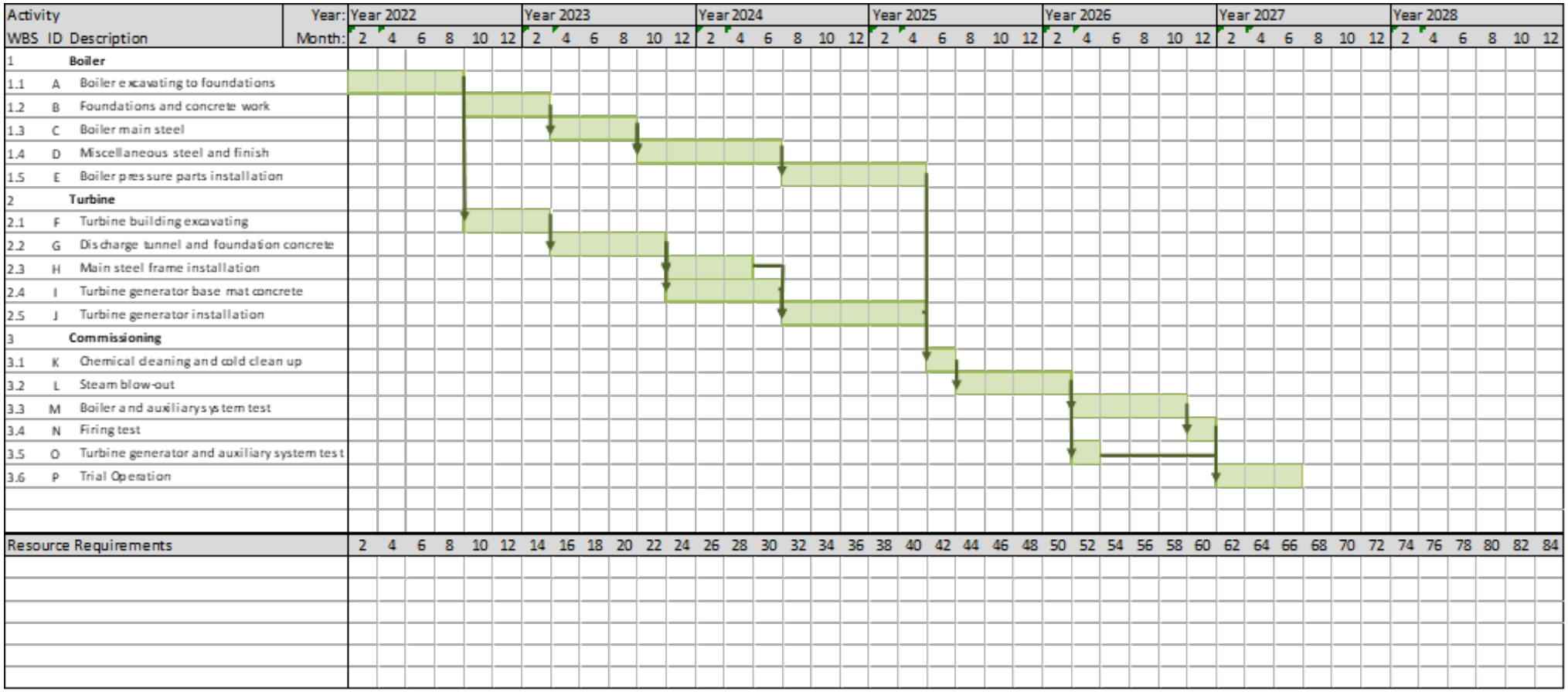
i. What is *surplus* in the context of financial resources, and how does it differ from *profit?*
ii. When a client pays for the work done in the contract, why is the concept of *liability* important?
iii. What is *retention* in the financial process, and why is it such a contentious concept? **(10)**

END OF PAPER

Attachment 1: Gantt chart worksheet (Question 1)

DETACH AND INCLUDE WITH YOUR ANSWER BOOK

Exam Number_____



Attachment 2: EVA Table (Question 3)

Note: Values are in millions of Pounds.

Activities			Budget	Actual %	Last month					Cumulative to Date						
WBS	ID	Description	(£m)	Complet	BCWS	EV	ACWP	SV	CV	BCWS	EV	ACWP	SV	CV	SPI	CPI
1		Boiler														
1.1	A	Boiler excavating to foundations	5	100%	0	0	0	0	0	5	5	6	0	-1	1.00	0.83
1.2	B	Foundations and concrete work	15	100%	0	0	0	0	0	15	15	14.5	0	0.5	1.00	1.03
1.3	C	Boiler main steel	20	100%	0	0	0	0	0	20	20	21	0	-1	1.00	0.95
1.4	D	Miscellaneous steel and finish	5	80%	1	0.9	1	-0.1	-0.1	4	4	4	0	0.1	1.00	1.03
1.5	E	Boiler pressure parts installation	80	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
2		Turbine														
2.1	F	Turbine building excavating	5	100%	0	0	0	0	0	5	5	4.8	0	0.2	1.00	1.04
2.2	G	Discharge tunnel and foundation concrete	15	100%	0	0	0	0	0	15	15	15	0	0	1.00	1.00
2.3	H	Main steel frame installation	20	85%	3	3.2	3.2	0.2	0	20	17	18	-3	-1	0.85	0.94
2.4	I	Turbine generator base mat concrete	15	80%	4	4.2	4.1	0.2	0.1	12	12	12	0	0	1.00	1.00
2.5	J	Turbine generator installation	90	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3		Commissioning														
3.1	K	Chemical cleaning and cold clean up	2	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3.2	L	Steam blow-out	15	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3.3	M	Boiler and auxiliary system test	10	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3.4	N	Firing test	2	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3.5	O	Turbine generator and auxiliary system test	2	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
3.6	P	Trial Operation	6	0%	0	0	0	0	0	0	0	0	0	0	N/A	N/A
		Total:	**307**	**30%**	**8**	**8.3**	**8.3**	**0.3**	**0.0**	**96**	**93**	**95.2**	**-3**	**-2.2**	**0.97**	**0.98**