CANDIDATE NUMBER: _____ **(write in from your letter)**

EXAMINATION: ELECTRICAL ENGINEER

EXAM PAPER: CEE3 – Legislation, Australian Standards and electrical engineering applicable to open-cut mining

DATE: 4 September 2024 – 12:50pm – 4:00pm

DURATION: 3 hours (excluding 10 minutes reading time)

EXAMINATION FOR CERTIFICATE OF COMPETENCE TO BE AN ELECTRICAL ENGINEER OF COAL MINES OTHER THAN UNDERGROUND COAL MINES

Issued under the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*

INSTRUCTIONS TO CANDIDATES:

Unless otherwise stated all references to Act, Regulations and standards are to the

Work Health and Safety Act 2011

Work Health and Safety Regulation 2017

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2022

Australian/New Zealand Standards (the standards)

Candidates shall be seated in the exam room no later than 12:45pm for exam instructions.
10 minutes reading time is allowed prior to the start of the examination. Candidates can use a **highlighter only** to mark points of importance during the reading time, but may not begin answering the questions. You must NOT use any other writing item during the reading time such as a pen.

After reading time is over place your identification number only, **NOT** your name, on the cover of this paper at the commencement of the exam. Electronic aids may not be used, apart from a non-programmable calculator.

It is expected that candidates will present their answers in an engineering manner, making full use of diagrams, tables, and schematics as appropriate, and showing full workings in calculations. **Poor legibility in diagrams and handwriting** may affect the candidate being deemed competent.

Provide answers in point form wherever appropriate. If you are unable to fit your answers in the available space use the two (2) blank pages included at the end of the paper. Ensure the question you are answering is clearly marked.

All ten (10) questions are to be attempted. All questions are of equal value.

Candidates will be marked, and determined as competent, or not yet competent. If a question is identified as **ESSENTIAL,** then the candidate must get the set number of marks to pass the question. If they do not pass these **ESSENTIAL** questions, they do not pass this paper. Candidate is also required to **score a minimum of 60%** to pass this paper.

This examination is a **closed book** examination and no reference material may be used during the exam. Reference material will be provided in the exam paper as applicable.

EXAMINATION BOOKLET

Paper	Question Number	Essential	Candidate Score	Assessed by *Name*	Comments to justify, as necessary
CEE1	1	Essential 6/10 Required	/10		
	2	Essential Elements in Part b	/10		
	3		/10		
	4		/10		
	5		/10		
	6		/10		
	7		/10		
	8		/10		
	9		/10		
	10		/10		
2024	Verdict		TOTAL	/100	*Marks checked by:*

Question 1 – Work Health and Safety (Mines and Petroleum Sites) Regulation 2022

Essential: Candidates must get 6 out of 10 marks to pass this question

Schedule 10 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 outlines the Statutory functions of the mine Electrical Engineering Manager (UG) and Electrical Engineer (O/C).

a. What are the statutory functions of the Statutory Electrical Engineer (O/C)?

	/ 3

b. What is the requirement for nomination to exercise the statutory function?

	/ 2

Schedule 3 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 lists specific requirements for Electrical work on energised electrical equipment.

c. Is this work permitted at a Coal Mine? If so under what conditions?

	/ 3

d. Is there a waiting period? And if so what is it?

	/ 2

Question 2 – Isolation

Essential Elements

You are new to a site that has multiple types of high voltage electric drive haul trucks with different drive systems. You are required to develop an isolation process to safely work on each of the drive systems.

a. List documentation you would refer to for the development of a safe system of work for the isolation of these drive systems?

	/ 2

b. Describe the process that you would undertake to create a safe system of work to ensure the adequate isolation of these drive systems, include all assumptions.

2 of these elements are essential

	/ 5

c. Briefly outline the safe system of work that you would implement, include all assumptions. Detail the reasons for each item of the safe system of work.

	/ 3

Question 3 – Earthing

You have taken up the role of statutory electrical engineer at an old coal mining operation and it has been brought to your attention through a recent incident that there is no system in place for the life cycle maintenance of your earthing systems on site.
You are unable locate any detail on the original design of the earthing system onsite.

The site is supplied from the Supply Authority with 290A earth fault limitation at 66kV.
The site has 2 x 15MVA transformers 66kV/11kV, each fitted with 10A earth fault limitation.

The 2 transformers can be run in 3 different modes:

1. 1 x transformer supplying the entire 11kV bus (bustie closed) with second transformer powered and on standby (11kV Secondary Side CB open).
2. 2 x transformers supplying half of the 11kV bus each (bustie open).
3. 2 x transformers supplying the entire 11kV bus (bustie closed).

The transformers are supplying all the site loads – via 10 x 11kV feeders:

i. 2 x 11kV feeders are connected in as ring feeder for the CHPP.
ii. 8 x 11kV feeders are radially connected, with 4 of those feeders supplying 1.5MVA 11/0.433kV kiosk substations (each with 5A earth fault limitation).

a. What are the two legislated risks that an effective earthing system must minimise?

	/ 2

b. What steps would you take to develop a life cycle strategy?

	/ 2

c. Who would you consult in this process?

	/ 1

d. From your Risk Assessment, what would you develop?

	/ 1

e. What would be a suitable method for testing the effectiveness of your earth grids? How does this test work?

	/ 2

f. How will you determine the allowable touch voltage?

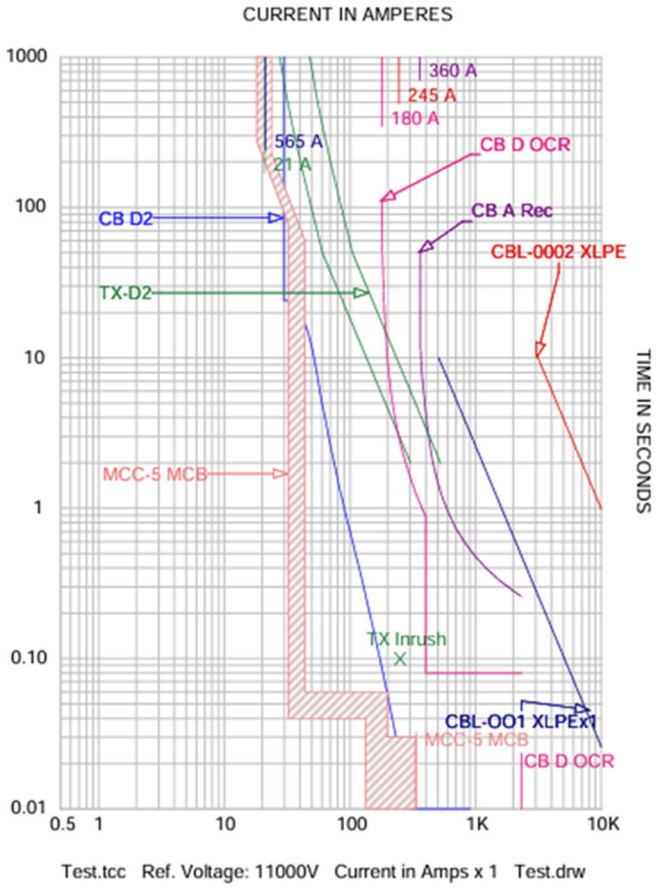
	/ 1

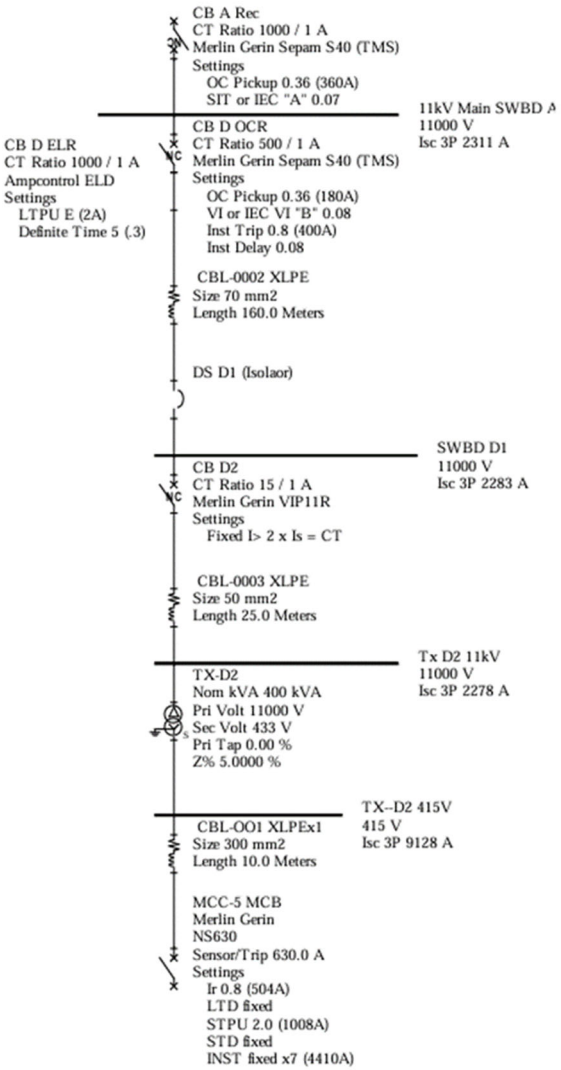
g. Which mode would you base your maximum earth fault protection settings on? Why?

	/ 1

Question 4 – Protection & Arc Flash

a. From the time current curve below, nominate the operating times for the following protection devices to operate at a fault current of 1000 amps at 11kV:
   - CB D2
   - CB A Rec
   - CB D OCR





/ 3

b. Explain how current limiting fuses reduce the energy delivered to an arc fault.

/ 2

c. Above what current rating does a switchboard require protection against internal arcing fault?

/ 1

d. Describe the Arc Flash PPE that you would require for an Arc Rating of 10 cal/cm^2.

/ 1

e. Your Supply Authority notifies you that they are conducting future works which will increase your incoming fault level by approximately 50%.

i. What are your concerns?

/ 2

ii. What actions could you take to manage the risks with your legacy equipment?

	/ 1

Question 5 - Calculations

The following questions relate to a parallel transformer installation with two transformers 20MVA 66/11kV with 5% impedance. A bus tie is also installed on the secondary side. A load is supplied from the bus via a cable that that is 800m in length and has an impedance of 0.39 +j0.1Ω per km. The declared fault level on the line side of the transformers is 375MVA.

a. What are the advantages of installing two 20MVA transformers instead of one 40 MVA transformer?

	/ 1

b. What are some of the disadvantages of installing two 20MVA transformers instead of one 40MVA transformer?

	/ 1

c. How is voltage regulation achieved when operating parallel transformers?

	/ 1

d. Draw the typical mining substation circuit described above using Australian Standard symbols. Show all the necessary hardware and protection devices you would require on this substation. Provide any assumptions made.

	/ 3

e. Calculate the fault level at the end of the cable when the bus tie is both open and closed. Use a base of 5MVA for your calculation

	/ 2

f. Under normal operating conditions, in what position would you want to see the bus tie? Explain the advantages and disadvantages.

	/ 1

g. What labelling/signage would you want on your substation fence/gates?

	/ 1

Question 6 – Lightning

Your site is installing a new in-pit metal clad crib hut facility (two huts) that will also have a heavy vehicle park up area for haul trucks. The power supply for the crib hut facility is provided by a generator.

a. What Australian Standard would you review for information relating to lightning risks in mining?

	/ 1

b. Detail your approach to ensure the risk of lightning is controlled adequately

	/ 2

c. Detail three lightning related hazards and typical controls you would implement in the design or operation to mitigate the risk of lightning at this installation.

	/ 3

d. Draw and explain the rolling sphere protection method in the below space.

	/ 4

Question 7 – Welders & Generators

You have recently commenced as the Electrical Engineering Manager at a large Open Cut Coal Mine. During an initial inspection of the mines workshop welding bays, you find the defects shown below:

a. What concerns if any do you have about the condition of the depicted welding equipment?

	/ 1

b. Detail your approach to addressing the identified issues.

	/ 2

c. You are developing a welding training package for your site, what are the main topics that you would include?

	/ 2

d. Provide examples of the different welding environment categories as defined in AS1674.2.

	/ 3

e. If the equipment was required to be powered by a generator, list 4 requirement that you would specify for compliance of the installation.

	/ 2

Question 8 – AS3000

a. What is the touch voltage limits below which an automatic disconnection of supply does NOT need to occur to achieve compliance to AS3000.

	/ 1

b. What are the six (6) mandatory tests for low voltage systems as defined in AS3000 Section 8.3?

	/ 3

c. What is the minimum permissible Insulation Resistance for Low Voltage circuits?

	/ 1

d. What is the maximum permissible Earth Continuity for any earthing or bonding conductor?

	/ 1

e. Under what circumstances must Earth Fault Loop Impedance testing be carried out?

	/ 1

f. Describe the key differences between Class I and Class II equipment.

	/ 2

g. Why are 2-Pole circuit breakers mandatory for single phase circuits on IT earthed Low Voltage supplies?

	/ 1

Question 9 – AS3007

a. AS/NZS 3007 requires compliance with three Australian standards for high voltage installations, what are they?

	/ 1

b. Electrical interlocking systems which prevent access to energised electrical enclosures must be designed in accordance with AS 4024.1501, AS 62061 or ISO 13849-1. What does this mean?

	/ 1

c. Explain how Overload and Short Circuit protection must be coordinated in regard to the breaking capacity of protective devices.

	/ 1

d. A means shall be provided to isolate all circuits above what voltage?

	/ 1

e. What controls must be implemented to manage the risks associated with Remote Control of mobile mining machinery?

	/ 1

f. What are the requirements for the design of off-load tap changers in transformers for transportable substations?

	/ 1

g. Over Head Lines (OHLs) and their associated equipment should be placed so that normal mining operations can be carried out without affecting the safety integrity of the OHL.

Outline your requirements for routing of OHL's:

	/ 1

h. Where a relocatable building is designed for use on a TN system, but only an IT system is available, what must be done to connect the electricity supply to the building?

	/ 1

i. What are the requirements for a ‘closed electrical operating area’?

	/ 1

j. Where an earth fault current limitation device is not continuously rated, how must it be protected?

	/ 1

Question 10 – AS4871

a. AS/NZS 4871 – is the standard for what?

	/ 1

b. There are six (6) parts to the AS/NZS 4871 Series.
What does each part cover?

	/ 3

c. List four (4) risks associated with the use of Variable Speed Drives (VSDs) in Open-Cut coal mines, and the possible controls for each risk.

	/ 4

d. If an isolation switch is not rated for fault make / fault break, or fault make / load break, can it be used on your site?
Why? Why not?

	/ 2

END OF QUESTIONS

BLANK PAPER TO WRITE ANSWERS THAT YOU COULD FIT INTO THE SPACE PROVIDED – INDICATE QUESTION NUMBER AT START OF ANSWER

END OF PAPER