

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

N1660(E)(J5)H

**NON-NATIONAL CERTIFICATE:
ENGINEERING CERTIFICATE OF COMPETENCY**

PLANT ENGINEERING: MINES AND WORK

(8190306)

**5 June 2017 (X-Paper)
09:00–12:00**

CLOSED-BOOK EXAMINATION

Candidates may NOT use any notes, textbooks or references. Programmable calculators may also NOT be used.

This question paper consists of 8 pages and 1 answer sheet.



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**DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA**

**NON-NATIONAL CERTIFICATE:
ENGINEERING CERTIFICATE OF COMPETENCY
PLANT ENGINEERING: MINES AND WORKS
TIME: 3 HOURS
MARKS: 100**

NOTE: If you answer more than the required number of questions only the required number will be marked. All work you do NOT want to be marked must be clearly crossed out.

INSTRUCTIONS AND INFORMATION

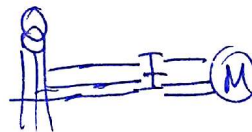
1. SECTION A is COMPULSORY and must be answered by ALL the candidates.
 2. Answer any TWO questions in SECTION B.
 3. Read ALL the questions carefully.
 4. Number the answers correctly according to the numbering system used in this question paper.
 5. Rule off across the page on completion of each question.
 6. Show ALL the calculations.
 7. Results will NOT be accepted and candidates will be disqualified if they had not been accepted by the Commission of Examiners prior to the examination.
 8. Candidates arriving 30 minutes late will NOT be allowed to sit for the examination.
 9. No candidate writing the examination may leave the examination room before ONE hour after commencement has elapsed.
 10. Write neatly and legibly.
-

QUESTION 2

You are an engineer on the shaft where TWO of the 2 MW 6.6 kV main ventilation fans require upgrading. Previously the motors were started direct online. The new motors are 3 MW motors. You need to verify if the motors can be started as previously mentioned. If not, you need to consider an alternative method of starting. Space and costs are limiting factors. You have in store TWO of 3 MVA reactors available that can be used. The Eskom transformer feeding the main fan panel is a 10 MW transformer.

- 2.1 Determine the starting currents of the ^{??} 3 MVA fan motors if you are going to leave the original starting method intact. (4)
- 2.2 If you decide to implement an alternative method of starting what will the starting currents be, proved by calculation? (4)
- 2.3 Draw a simple wiring diagram to show how the alternative method will be implemented. (4)
- 2.4 Give an explanation on how the starter will operate and how it will control the startup of the motor. X (4)
- 2.5 Will the TWO main fans be able to start off simultaneously on the 10 MW ESKOM transformers? Prove by calculation. X (4)

[20]

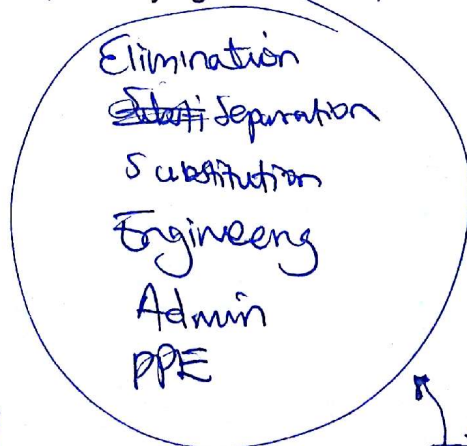


QUESTION 3

As a mine engineer you are responsible for an underground section where you have load haul dumpers (LHDs).

You are required to draw up a risk assessment to determine if you require proximity detection devices in that section.

Write a risk assessment, following the hierarchy of controls to be implemented to address this requirement, identifying all hazards, risks and the necessary controls. [20]



TOTAL SECTION A:

60

hazard/risk	Likelihood	consequence	Rating
lost air			
spillage			
lost water			

SECTION B

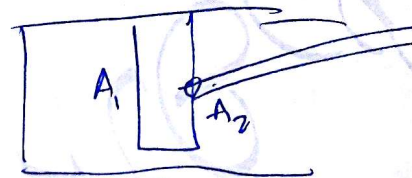
Answer any TWO questions in SECTION B.

QUESTION 4

- 4.1 During a trial on a three-phase electrode boiler the following information was obtained:

Boiler:

Supply volts	500 V ✓
Average current drawn	550 A ✓
Power factor	0,9 ✓
Hot-well temperature	86° ✓
Pressure	600 kPa ✓
Dryness fraction of steam	0,9 ✓



Double-acting pump:

Stroke	87,5 mm	L
Diameter of plunger	47,5 mm	D
Diameter of plunger rod	21,0 mm	d
Speed of motor	25 rev/sec	N
Gearbox reduction	24:1	N _{motor} /N _{pump}
Volumetric efficiency	82%	✓
Overall drive efficiency	85%	✓

$$A_1 = \frac{\pi}{4} D^2$$

$$A_2 = \frac{\pi}{4} (D^2 - d^2)$$

$$\text{total vol} = (A_1 + A_2 \times L)$$

If 25% of the boiler feedwater is bypassed through the level control valve, determine the efficiency of the boiler.

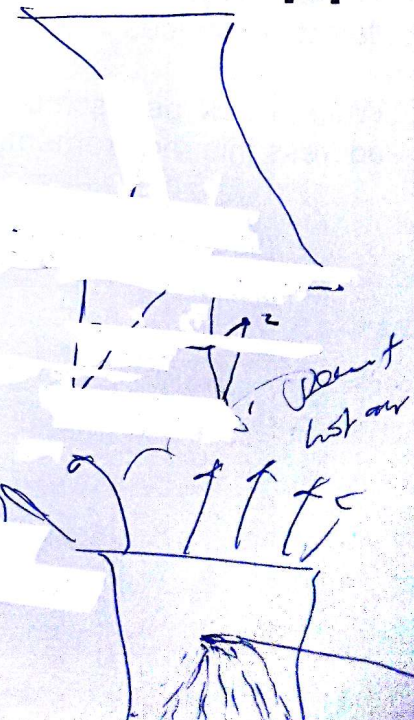
(15)

- 4.2 Explain why it is sometimes necessary to install a cooling tower in a steam plant which uses a surface condenser and state the function of the tower.

(5)

[20]

AND/OR



Handwritten calculations:

$$h_g = 2670$$

$$h_{g2} = 2680$$

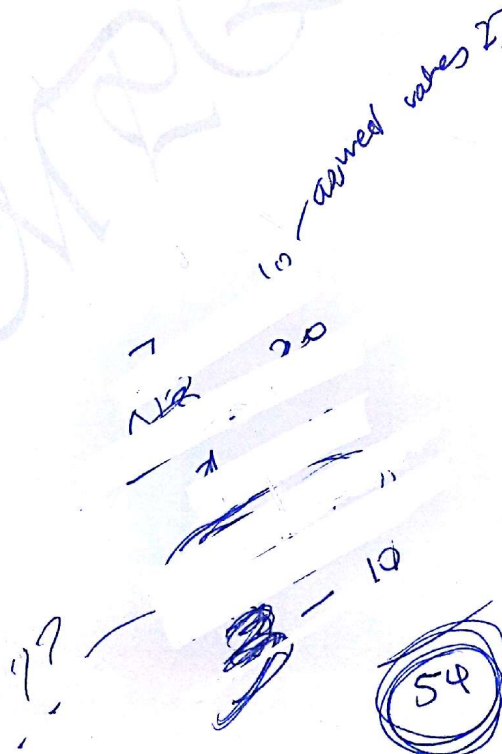
$$h_{f2} = 220$$

SECTION A (COMPULSORY)**QUESTION 1**

You are a newly appointed shaft engineer on a seismic active shaft and you need to make sure that all safety devices are operational on the winders in the shaft. As per legislation you are required to ensure that a slack-rope device is installed on the winders which you have commissioned and it has been working satisfactorily on all the winders for the past SIX months. To ensure the integrity of the water column in the shaft you have replaced some of the pipes as a precautionary measure.

During the night shift you receive a phone call from the driver of the main winder reporting that all winders on a slack or tight rope have tripped out. You have to investigate why all the winders tripped out. Time is of the essence because this happened during the shift change-over.

- 1.1 There are THREE different types of slack-rope devices on the market.
Name them and give a brief description of the working principle of each. (3 × 2) (6)
- 1.2 Why would all the winders in the shaft trip in an event of a slack rope or tight rope? ✓ (1)
- 1.3 How will you test a device for the tight-rope condition? (3)



- 1.4 At the mine you interrogate the slack- or tight-rope device and the following trace is presented to you.

Use the attached ANSWER SHEET to answer the questions. Remember to hand it in with the ANSWER BOOK.

Where would you find the following conditions?

1.4.1 Use the letter A to show the point on the graph indicating the speed of the winder when it tripped.

1.4.2 Use the letter B to indicate on the graph the time at which the winder tripped.

1.4.3 Use the letter C to indicate on the graph where the safety circuit tripped.

1.4.5 How long did it take the winder to come to a standstill?

1.4.6 Use the letter D to indicate on the graph at what point the winder tripped out. What was the actual setting of the trip-out?

(5 × 1) (5)

1.5 After you have analysed the trace, what procedure do you need to follow to ensure that all is well in the shaft? Explain your answer.

(2)

1.6 When you arrive at the scene you see that the detaching hook lies horizontally and that ±50 m of rope has been paid out and is lying on the conveyance roof. There are NO cork screws in the rope.

Explain how you will recover the condition and make it safe again for operation.

(3)
[20]



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03030000

QUESTION 5

- 5.1 Illustrate, by means of suitable sketches, the TWO methods of applying earth leakage protection on feeder cables.

Show how these are connected in the circuit and explain the operation of each. Both methods must ensure that only the cable with the fault will trip.

???

(8)

- 5.2 Explain the significance of the following symbols and specifications related to electrical circuits

5.1.1



5.1.2



5.1.3



(3 × 2)

(6)

- 5.3 What basic precautions are taken to prevent flammable gas explosions and coal dust explosions in a coal mine?

(6)

[20]

AND/OR

store dust
vent
?

QUESTION 6

- 6.1 A 200 mm diameter pipe is fitted with a 30° bend. The pressure at both ends of the bend is similar and equal to 200 kPa.

If the bend is horizontal, calculate the resultant force to be exerted by the pipe system for the bend to remain in position if the flow is 0,15 m³/s.

(10)

- 6.2 A tripod consisting of three steel pipes is to be used to lift a transformer having a mass of 1,8 t. The footings of the tripod are spaced equidistant and are 17 m apart. The pipes, for the purpose of this calculation, may be considered to have pin-jointed struts. Ignore eccentricity and the initial curvature of the pipes.

Factor of safety	5
Young's modulus	200 GPa
Outside diameter of the pipes	150 mm
Wall thickness	6 mm
Length of pipes	12 m

Given: $P_{cr} = \frac{\pi^2 EI}{4 L^2}$ (Euler)

Determine the maximum safe load that may be raised without the pipes buckling.

(10)
[20]

AND/OR

QUESTION 7

A 1 MVA, delta/star 6600/400 volt transformer has an iron loss of 3200 W and a copper loss of 3000 watt at half-full load. The impedance is 4,75%.

Determine the following:

- 7.1 The overall efficiency at full load, 0,8 power factor lagging (10)
- 7.2 The line voltage to be applied to the primary windings with the secondary short-circuited to produce full-load current in both the primary and the secondary windings (5)
- 7.3 The MVA fault value for a short circuit on the secondary terminals of the transformer, assuming infinite capacity in the primary (5)

[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100