mineral resources & energy
Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

MINE ENGINEER'S CERTIFICATE OF COMPETENCY EXAMINATION

MINES AND WORKS – PLANT ENGINEERING

DATE: 9 November 2020

TOTAL MARKS: 100
TO PASS: 50

TIME ALLOWED: 3 HOURS
(09H00 to 12H00)

INSTRUCTIONS:

- This question paper consists of **Ten** pages including cover page.
- Section A, Question 1 to 3 are **COMPULSORY**. Section B, choose 2 questions of your choice.
- All answers are to be presented in a neat and decipherable manner. Papers will not be marked if not decipherable.
- Restrict the use of highlighters.
- Do not use a red pen.
- Read the instructions on the front page of your answer book carefully.
- No cellular phones and any other related devices shall be allowed in the examination venue.
- The use of computers, laptops and any other related devices is prohibited.
- The use of programmable calculators are not allowed

SECTION A: COMPULSORY QUESTIONS

Question 1

(a) State FOUR important qualities of brake lining for a mine winder with calliper type brakes. (4)

(b) During a dynamic test on a double drum winder for a vertical shaft, it was found that the calliper-type brake could not hold the test load for the static test. Calculate the required spring force (on the spring applied hydraulic release) for a single brake to hold double the permitted load with the cage near the lower end of the wind. The brakes are of the pivoted calliper type and the rope is overlay. The coefficient of friction is 0,3 and the brake shoe contact is 110^0

Mass of cage	5 000 kg
Permitted load	3 600 kg
Length of rope from sheave to cage	1 350 m
Mass of rope per metre run	5,45 kg
Diameter of top layer rope	3,014 m

The lines of action for brake shoes, having a large angle of contact from the drum centre

$$= \frac{4\sin\frac{\theta}{2}}{\theta+\sin\theta} \times R$$

(16)

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Question 2

In an underground mine, it is required to develop a rock pass from the reef horizon to the ore tramming level.

In terms of Regulation 10.3 and the DMR Guideline for a Mandatory Code of Practice for the Design, Development, Construction, Safe Operation and Maintenance of Draw Points, Tipping Points, Rock Passes and Box Fronts,

2.1 Define the following:

a. Box Front
b. Draw Point
c. Mud Rush
d. Rock Pass
e. Tipping Point (5)

2.2 In the risk assessment required during the design process of the rock pass, in order to prevent accidents or situations that give rise to a multitude of incidents or accidents to persons at a mine, name at least 10 hazards to consider in the design of the rock pass. (5)

2.3 In the design of the orepass, describe what the diameter of the orepass should be to prevent hang-ups due to rock arching (1)

2.4 In the design of the boxfront for the ore pass, describe three parameters that affect the design, the minimum force that the box front structure should be designed to withstand and how it is calculated, the minimum required factor of safety, and how the effect of over break at the entrance to a box hole will affect the design. (9)

Augment your answer with a sketch.

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Question 3

You are the newly appointed 2.13.1. plant engineer. You have the responsibility to maintain equipment and perform upgrade projects at the plant. Current size of the plant is 20 MVA at 11 kV installed power and your NMD is 12 MW. One of the upgrade projects you are involved with is the commissioning a 2 MW ball mill, additional load to the current load forecast. The ball mill starting method will be via a liquid controller. You need to install an additional 3.5 MVA 11000 / 550 volt Dyn11 transformer that will feed the ball mill. The supply from your distribution transformers to the motor control centres is via 400mm^2 XLPE armoured single core cables. Your motor control centres are equipped with Simocode pro V motor protection devices for the motors throughout the plant.

After the commissioning process you encountered some severe Electromagnetic Interference problems on the plant and within the control systems and devices. The interference is causing unwanted downtime. You have started an investigation and determined a floating / leakage current of 50 Amps on the star point. Furthermore, all cables installed to your MCC`s are laid flat and installed on flat cable trays in air. Your existing cables are running hot. Your Earth cables are also running between the power cables.

3.1 How many feeder cables will you require to be installed and what will be important to check when the cables are installed. (5)

3.2 XLPE cables have a phenomenon called "Water treeing" or "Electrical treeing". Explain what this means (4)

3.3 When terminating the XLPE single core cable at the MCC`s and Transformers, what is the most important factor to remember? (3).

3.4 Considering the determined facts at your disposal, how would you change the installation to prevent the effects of the electromagnetic interference on the system and devices? (5)

3.5 You want to limit your earth return to an acceptable level. What system will you implement in your specific application, explain the working principle with a neat single line diagram. (3)

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SECTION B: ANSWER ONLY 2 QUESTIONS OF YOUR CHOICE

Question 4

4.1 You are an engineer at a mine, and one of your areas of responsibility is a ventilation system, which must circulate a quantity of 500m³ / min. For this fan, the total resistance of the circuit together with dynamic pressure is 45mm W.G. Unfortunately, you have just lost this fan, and the only other fan that is available, can deliver 470 m³ / min at a speed of 400 rev/min, at a maximum pressure of 39mm W.G.

a. Can this fan be used, and if so, what modifications would be necessary? (5)

b. Determine the power input to the fan when running at 400 rev / min and delivering 470 m³ /min and the approximate power input if it is used under the required conditions. Assume an efficiency of 70% in both cases. (5)

4.2 A continuous miner generates a lot of dust, and sometimes sparks, in the process of cutting coal. Methane and coal dust explosions in the coal face, is a real risk whilst cutting coal. In order to mitigate the safety and health risks associated with coal cutting operations, the machine is equipped with devices/circuits. As an engineer, one of your responsibilities is to ensure that these safety systems are always well maintained and kept in good working order so that the machines do not pose any significant health and safety risks to personnel.

a. Explain how the generation of dust is reduced and managed during the coal cutting operation, using the devices/circuits that are installed on the machine. (3)

b. Explain how the devices/circuits in (a) above, are maintained and tested to ensure that they are in good working order. (4)

c. Explain briefly how the methane monitoring system works and how to maintain and test the system to ensure that it is in good working order. (3)

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Question 5

Your mine is supplied from Eskom with a 20MVA 132/6.6kV transformer with 8% impedance. Eskom supplies an earth through a NEC rated at 300A. The maximum fault current on the primary side is 10kA. A pump station is supplied 2km away from the meter panel. Typically switching is done so that one 1000kW pump runs on one 185mm² feeder. The cable has the following specifications:

Impedance per phase: 0.15 Ω/km

1s withstand current: 15kA (withstand [s] $t = (15/If)^2$ for different fault currents)

Continuous rating: 330A

5.1 Determine the maximum fault currents at the meter panel and pump station. (10)

The pump starts DOL and typically takes 4s to ramp up. Feeder protection has one instantaneous and one standard inverse trip. This applies to overcurrent and earth fault. Take the formula for a standard inverse curve as $TMS \times \left(\frac{0.14}{\left(\frac{I}{Is}\right)^{0.02}-1}\right)$ for I/IS above 1.1 and TMS a value between 0 and 1.

5.2 Make assumptions on CTs and protection relay capabilities. Only provide settings for downstream supply, not incomers. Provide the primary current pickup setting and time multiplier setting where relevant for the protection features.
Calculate relevant values and recommend protection settings at the meter panel and at the pump station. (10)

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Question 6

As the responsible engineer you are to ensure that the scraper winches to be used at the mine where you are working, are safe for use and compliant to the requirements of the regulations.

The relevant information of the scraper winches to be used are as follows:

TECHNICAL DESCRIPTION	:	DOUBLE DRUM SCRAPER WINCH	
Kilowatts	:	55 kW	
RPM	:	960 (6 Pole)	1000 rpm Ns
Minimum rope speed	:	0,76 m/s	
Maximum rope pull	:	69 kN	
Mean rope speed	:	0.92 m/s	
Mean rope pull	:	58 kN	
Maximum rope speed	:	1.35 m/s – 1.85 m/s	
Length	:	2 025 mm	
Height	:	1 124 mm	
Width	:	914 mm	
Mass - winch	:	2 110 kg	
- motor	:	420 kg	
Drum capacity	:	Tightly spooled	Loosely spooled
- 13mm		580 m	465 m
- 16 mm		470 m	375 m
- 19 mm		295 m	235 m
- 22.5mm		250 m	195 m

20mm long link chain specifications : Breaking Strength 308kN

Maximum of three 1-ton Diamond Scrapers in tandem, connected using 8.5t D-shackles

Winch hold-down bolts : 4 off (two front and two rear)

Y25 x M24 x 1m long

(protruding 10cm above winch bed)

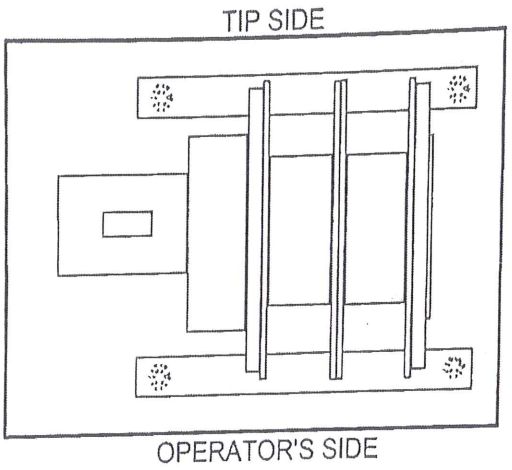
Ultimate tensile strength 619MPa

Resistance factor Θb = 0.67

P is the pitch of thread = 3 mm

d is nominal thread diameter = 21.75 mm

Spacing : 83cm (front / rear) 104cm apart



The bottom of the winch drum is 70cm above the foundation

Scraper Rope specifications :

6x6(6/F)/F	Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (kN)		Outer Wire Diameter (mm)
			1250MPa	1550MPa	
	13	0.55	64	80	1.40
	16	0.86	101	126	1.76
	19	1.19	141	175	2.08
	22.5	1.65	195	241	2.44

6x7(6/1)/F	Nominal Rope Diameter (mm)	Estimated Mass (kg/m)	Estimated Breaking Force (kN)		Outer Wire Diameter (mm)
			1250MPa	1550MPa	
	13	0.62	75	90	1.4
	16	0.97	117	141	1.76
	19	1.34	163	196	2.08
	22.5	1.85	225	271	2.44

You need to verify and confirm, through the necessary calculations, the suitability of the specified standard:

6.1 Specifications of scraping ropes and attachments (6)

6.2 Winch hold-down bolts (14)

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Question 7

The electric load at a plant consists of the following:

Lighting ..... 45 Kw

Heating ..... 80 Kw

Five induction motors each supplying 60 Kw at a power factor of 0,8 and 93% efficiency.

Four induction motors each supplying 120 Kw at a power factor of 0,75 and 91% efficiency.

One synchronous motor of 1 MW, operating at full load and 92% efficiency.

Determine the power factor to which the synchronous motor must be operated to give an overall power factor of unity.

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TOTAL = 100

The End

0,764