mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

MINE ENGINEER'S CERTIFICATE OF COMPETENCY EXAMINATION

MINES AND WORKS

PLANT ENGINEERING

DATE: 11 NOVEMBER 2019

TOTAL MARKS: 100
TO PASS: 50

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

INSTRUCTIONS:

- This question paper consists of **SEVEN** pages including cover page.
- Questions 1 to 3 in SECTION A are **COMPULSORY** – answer all of them.
- Choose and answer **ANY** 2 questions in SECTION B.
- All answers are to be presented in a neat and readable manner. Papers will not be marked if not readable.
- 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.

Question 1

You have been appointed as the shaft engineer responsible for all the shaft systems on the mine, this includes, amongst other things, ore passes, conveyors and loading silos. The winder, auxiliary equipment and systems to cater for the increased production profile were upgraded by an Engineer just before you took over as the responsible Engineer. The brake systems, ropes and controls of the winders were also upgraded. The ropes were upgraded from 54mm ropes to 58mm on all your winders.

The shaft is a circular shaft with four winders. The configuration is one man and one rock winder on the eastern side and the other two on the western side. Rock winders are Double drum winders with detaching hooks. Man winders do not have detaching hooks but compensating wheels.

Information at your disposal:

Winder permits

East man winder:	**5674**
West Man winder:	**7693**
East rock winder:	**9320**
West rock winder:	**3457**

Loading flask is 100 m above shaft bottom.
Lebus sleeve grooves are 58mm
Length of wind for rock winder is 2630m
Length of wind for man winder is 2600m
Speed for all winders is 18 m/s
Full brake stroke is 200mm
Ropes changed from 1900 MPa to UHT ropes
Quick-drop distance is 90mm
Distance from the centre of the sheave to the tip is 70 m
Distance from the centre of the winder drum to the centre of the shaft is 120 m
Rope angle from the drum to the sheave is 45 deg.
Drum is divided into 26 letters
Distance between letters is 290mm
Previous rope life recorded was ± 84 months for the man winders on average.
Rope life for the rock winders were ± 24 months on average.

The DMR visited the mine and gave you an instruction for not having spare sets of ropes available on site. With the above information available to you, you need to purchase spare ropes for all the winders.

1.1 The ropes between the rock winders and man winders differ. What are the significant differences? (3)

1.2 Give an explanation for the term "Rope reversals". Why will this play a role in the rope life for the different winders? (2)

1.3 Calculate the length of the rope from the drum to the sheave? (3)

1.4 Calculate the length of the spare rope you should purchase for the man winder? (4)

1.5 Calculate the length of the spare rope you should buy for the rock winder? (4)

1.6 What is the most important part on the compensating sheave when changing the size of rope and why? (2)

1.7 Explain the term "Length of the middle layer rope" How would you determine this in practice? (2)

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Question 2

You have been appointed as the Services engineer in a shaft. Capital has been approved and you need to ensure the power supply feeding the expansion project is adequate. You have located three 10 MVA 22 / 11 kV Dd1 ONAN Transformers in the Capital store. The original power requirement with future expansion was 20 MW. The shaft is fed from the utility (ESKOM) and the supply transformer is a 20 MVA 132/ 22kV Yd 11 transformer. There is a Neutral Earthing Compensator (NEC) installed on the utility side with a rating of 300 A for 10 sec.

Your installation underground should be two operational transformers and one spare. The spare should be so positioned such that it can be switched without any effort to feed either of the operational transformers if either one of them is out of commission. The operational transformers have one NEC per transformer installed. Your configuration should also cater for adequate redundancy.

After review the power requirement has changed significantly and the new load forecast is 25 MW.

2.1 Why would they install a Yd11 transformer? Does it have an advantage for you as the customer? (2)

2.2 To reach your power requirement, what changes to the utility transformer would you request the utility to make. Given that you already requested the new transformer. Explain your requested changes? (3)

2.3 You must make changes to your transformers as well, what changes would you make to the three transformers to ensure the power requirement of 25MW is attained? You need to keep the original transformers as you have space restrictions in the transformer bay. Motivate your answer by a neatly drawn sketch of the changes. (5)

2.4 Draw a single line diagram to show your installation configuration and explain your answer why the configuration? (4)

2.5 Is it necessary to install an NEC at your substation? Explain your answer (3)

2.6 With the aid of a neatly drawn sketch, draw the wiring diagram of an NEC explaining its functionality. (3)

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Question 3

It is generally appreciated that safe, efficient and economical mining is very largely dependent on the efficiency of the horizontal transport system employed to convey men, materials and minerals. To this end, the requirements for the correct installation, maintenance and safe use of rail track systems is of paramount importance.

3.1 Explain the following rail track terminology(with sketches where necessitated) and explain how it affects the safety or performance of the rail track system:
- 3.1.1 Gauge (1)
- 3.1.2 Twist (1)
- 3.1.3 Kinks (1)
- 3.1.4 Super-elevation (1)
- 3.1.5 Vertical misalignment (slacks) (1)

3.2 Name and describe the function of at least five track structure components.(5)

3.3 As part of the rail maintenance plan, describe at least ten (10) unacceptable conditions that must be prevented. (5)

3.4 Describe three rail joints and the key aspects thereof that must be monitored to ensure a safe track system. (5)

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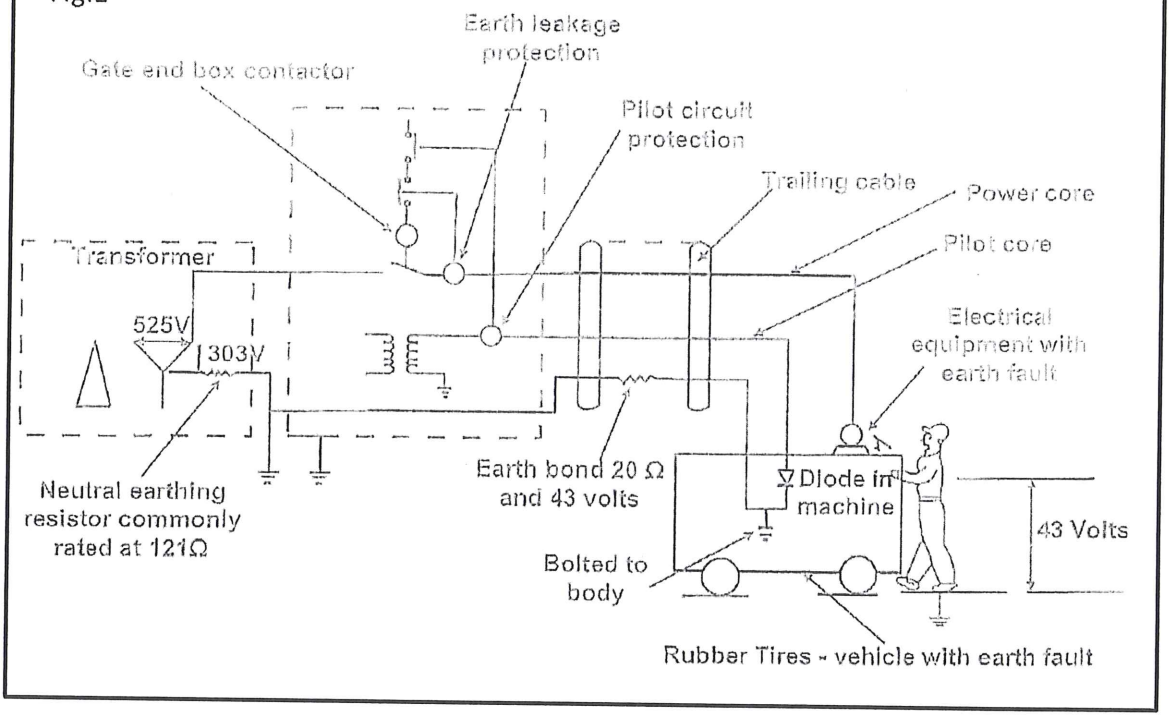
Quesstion 4

You are an underground engineer at a fiery mine, in charge of equipment operating in a harzadous environment. One of your employees, has recently lost his life following an electrocution accident at one of your machines, supplied by a trailing cable from one of the gate end boxes in the section. The machine is equiped with a cable drum for the rolling and un-rolling of the trailing cable as it travels between the phases.

Fig.1



4.1 With the aide of a diagram, explain the basic operation of a core balance earth leakage protection in a 3 Phase AC Circuit, as used in gate end boxes in harzadous areas. 10)

4.2 A Pilot circuit in a trailing cable serves as a safety circuit. Explain how this is achieved with specific reference to:

4.2.1 The diode location. (3)

4.2.2 Earth bond resistance. (3)

4.2.3 Pilot pins in the sockets. (2)

4.2.4 Mushroom switch location. (2)

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Question 5

A non flameproof vehicle at your shaft, with a mass of 2000 kg is travelling on a flat road underground at a velocity of 30km per hour.

5.1 If the brakes are applied causing a constant retarding force of 5kN, at what distance will the vehicle come to rest? (6)

5.2 As the engineer at the shaft, will you be happy with the stopping distance as calculated in (5.1)? (2)

5.3 If the very same vehicle was running freely down an incline of 1 in 80, what will be its speed in km per hour after running 500m down the incline? (5)

5.4 Before a non flameproof vehicle can be certified as being safe for use underground in non harzadous environment, there are certain safety

requirements that it has to comply with. Mention any 4 of these requirements. (4)

5.5 You have just been conducting a brake efficiency test on one of your LDV's, and you obtained a service brake efficiency of 5,6 N/kg. Would you pass or fail this vehicle – and why? (3)

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Question 6

You have been transferred to one of your companies open cast mines. The mine is not fed from any utility. You generate your own power from diesel engines and synchronous alternators. You have a power plant that consist of the following:

- Six CAT diesel engines rated at 5.7 MW each
- Six ABB synchronous Alternators rated at 5.7 MW each
- Phase rotation of the alternators are anticlockwise

The power station in use has been there for many years and is way past its sell by date. It trips erratically and for the mine's LOM it was decided to install a new generation power plant that consist of the following:

- Five 10.5 MW New Generation High efficient (HFO / LFO) Cummins Diesel Engines
- Five Synchronous Star connected Alternators rated at 10 MW
- Phase rotation of the alternators are clockwise.
- The Power station has been built 2 km from the mine.
- The mine is fed via two "Dual Lynx "overhead lines to the main consumer substation.
- The mine load profile at this stage is ±50 MW. Future loading is envisaged to be 60 MW without considering diversity.
- One of the criteria when designing this new power plant was that the Engines could be changed to Natural gas without major modification. Reason being that a natural gas line is being built and completion will only be in the next 5 years.
- Each alternator has its own 60 Amp continuous rated NER.

Considering the complete installation in your review, you came across some oversights:

- The reticulation convention (connection) was not followed on the old power plant (connections to the main consumer substation)
- The phase rotation between the old and new power plants are not the same.
- You need to use two of the old Cat engines and alternators to supplement the power requirements for the system as fall over or emergency when maintenance is required in future.
- The synchronization of the new and old plant is a problem.
- Synchronization equipment on the old plant is still the manual 3-lamp system.

- Cables used between the connection of the new power plant and overhead lines have been done with 4 *630mm^2 XLPE cables. The connections from the old power plant to the main consumer substation are 4 * 185 mm^2 PILCSWA cables.

6.1 Where necessary, explain your answer with the aid of neatly drawn sketches.

6.1.1 What should the reticulation convention be when installing an overhead line or feeders to any electrical system? Explain your answer? (2)

6.1.2 How would you make sure that the phasing between the two power plants are correct? Please explain the procedure you will follow? (4)

6.1.3 How would you explain the term High Fuel Oil (HFO)? (2)

6.1.4 How many Neutral Earthing Resistors (NER`s) can be connected to the system at any one time? Explain your answer. (2)

6.1.5 Explain how the 3 lamp synchronization system was used on the old power plant. (2)

6.1.6 On your generation station, which devices installed controls the frequency and the voltage of the generators to ensure correct power supply? Explain your answer. (4)

6.1.7 How would you rectify the phase rotation problem between the old and new plant (2)

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Question 7

7.1 As a standard practice, inclined conveyors are generally driven from a head pulley as opposed to a tail pulley. Explain why this is a generally accepted practice. (7)

7.2 You are an engineer in charge of a coal washing plant. Your discard belt delivers 1600 tons of discard into an overhead bunker in an 8 hour shift. It is assumed that the troughed belt runs at a speed of 165m per minute, and the discard has a density of 1500kg per m3. The belt installed for the application is spilling a lot of material, posing a significant risk of fire, and everyone believes it is too narrow, hence the spillage. Given the above information, determine the width of the belt required for this application. (9)

7.3 One of the safety devices in a conveyor belt is a slip interlock. Explain the function of this device and how you would test it at set frequencies to ensure that it is 100% functional. (4)

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TOTAL MARKS [100]