



mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

MINE ENGINEER'S CERTIFICATE OF COMPETENCY EXAMINATION

MINES AND WORKS

PLANT ENGINEERING

DATE: 03 JUNE 2019

TOTAL MARKS: 100
TO PASS: 50

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

INSTRUCTIONS:

- This question paper consists of **EIGHT** 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.

SECTION A – Answer ALL questions in this Section [60]

Question 1

You are appointed as a 2.13.1 Engineer responsible for, amongst other things, surface infrastructure, winders, conveyor belts and pumping system. Your shaft is equipped with a Double drum winder for both men and material and a double drum BMR rock winder .

It is reported to you that a material car fell down the shaft.

1.1 What are the possible causes of objects falling down the shaft? (5)

1.2 What are the key things to do immediately after receiving the report? (5)

1.3 As a result of this incident, you need to do shaft exam. What procedure will you follow when conducting shaft exam and what are the key things to inspect? (10)
[20]

Question 2

You are an Engineer appointed in a huge process plant. The plant has a lot of transformers installed and you need to ensure that the transformers are operating optimally. The biggest transformer in the plant is a 10 MVA Dyn 11 transformer feeding your milling section. Your primary crusher is fed from two 3 MVA Dyn 1 transformers in parallel. You need to put a maintenance plan in place to ensure that the transformers are maintained correctly.

2.1 What is the routine test that you would consider to check if the transformers are still healthy? (5)

2.2 If you want to do condition monitoring on the transformers, what is the best test you would consider to establish their condition (2)

- 2.3 Give an explanation of how the above test is performed and how you would interpret the results (4)
- 2.4 Give a brief description of how to conduct a ratio test (3)
- 2.5 You have sent oil samples away to be analysed and the results came back and you see that the degree of polymerisation (DP) reading is below 200. What indication is this and what will be your plan of action. (2)
- 2.6 What is a Tan Delta test and give a brief description on how it is done (4)
- [20]

Question 3

You are an appointed Engineer at a deep level mine.

- 3.1 List distinct possible causes of total power outage on an underground mine? (7)
- 3.2 You are notified that there is a total power outage at the mine. What do you take into consideration and what actions do you take in order to evacuate employees? (8)
- 3.3 The number of employees underground is 500. Eskom notifies you that their supply will take a week to restore. Your only emergency generator fails. Evacuation is only possible through your shafts. What do you take into consideration and what actions do you take in addition to those previously mentioned in order to manage the emergency? (5)
- [20]

SECTION B – Choose only TWO questions in this section [40]

Question 4

4.1 Why is a plain induction motor unsuitable for wide speed control? (2)

4.2 An induction motor has to be installed in an emergency to operate at 50 % synchronous speed and with an output of 42 kW and mechanical losses of 1,4 kW. Estimate the copper loss in the rotor and the efficiency if the stator losses are 3,5 kW. (8)

A transformer is required to supply a load which varies as follows over a period of 24 hours:

100 kW for 5 hours

200 kW for 5 hours

300 kW for 12 hours

360 kW for 2 hours

Two transformers, each rated at 300 kVA, are available. Transformer A has an iron loss of 1,3 kW and a full-load copper loss of 3,7 kW. Transformer B has an iron loss of 2,5 kW and a full-load copper loss of 2,5 kW.

4.3 Calculate the annual cost of supplying the losses for each transformer if the cost of energy is 6,7 c/kWh. (4)

4.4 Which transformer will you select for the duty if transformer A costs R1 000 more than transformer B and the annual charges for interest and depreciation are 8 %? (2)

4.5 Calculate the full load and maximum efficiency of the transformer selected and also the load at which maximum efficiency occurs. Take the power factor to be unity. (4)

[20]

Question 5

You are an engineer at a mine, and the shaft conveyor belt falls within your area of responsibility. The belt snapped under tension whilst in operation, resulting in an injury. Effective tension of the belt before it snapped was 28500N.

The conveyor is inclined at an angle of 17 degrees to the horizontal and has an inclined length of 100m. It handles 400 tons of coal per hour. Its angle of wrap is 240 degrees, and its speed is 1,8 m/s. A force of 4000 tons is required to overcome friction. The coefficient of friction between the belt and pulley is 0,28.

- 5.1 What maintenance will be done on the conveyor belt under normal circumstances in relation to the above incident? (2)
- 5.2 Calculate T_1 , T_2 and effective tension, and confirm if the 28500N was the correct effective tension. (5)
- 5.3 Calculate the required power of the driving motor, allowing 90% efficiency for the gear (3)

You are required to install a cylindrical water vessel lying horizontal on two tapered I-beams.

The water vessel has the following values:

Mass of vessel	2 036 kg
Mass of water	4 411 kg
Mass of accessories	1 964 kg

I-beams have the following values:

Effective length of the tapered I-beam	1 500 mm
Section modulus of the tapered I-beam	$74.94 \times 10^{-6} \text{ m}^3$
Second moment of area of the tapered I-beam	$475.9 \times 10^{-8} \text{ m}^4$
Modulus of elasticity of the tapered I-beam	207 GPa

Determine:

- a) Maximum bending moment if two beams support the vessel. (5)
- b) Maximum bending stress (2)
- c) Maximum deflection (3)

[20]

Question 6

You are an appointed engineer on a shaft and it became evident that you need to upgrade the consumer substation with new switchgear, reconfigure the meter panels to ensure redundancy and to make sure that you can switch between meter panels with minimum downtime when a breakdown occurs from the ESKOM substation. Mining has seized and the shaft will only be used for pumping excess water in the region of 60MI a day.

Each pump station consist of two sets of 4 by 1.2 MW multistage pumps and motors each pumping at 150 l/s. Main consumer Sub feeds a main distribution sub in the shaft area.

The following equipment is situated in the Eskom substation.

3 by 10 MVA 132 / 6.6 kV Yd1 transformers

10 MVA 132 / 6.6 kV 32Yd1 transformer

All transformers have the same (Z) impedance at 4%

All NEC's will still be located at the Mine Consumer substation (Will not form part of the Eskom Reticulation)

The existing Consumer Substation is configured as follows

MP 1 = Surface reticulation and 2 by 3 MW man winders and 1 MW Service winder

MP2 = Pumping Feeders = 2 Pump Stations on different levels feeding set 1 on both

MP3 = Pumping Feeders = 2 Pump Stations on the same level but set 2

MP4 = 2 by 2 MW Ventilation Synchronous induction Main Fans and 3rd parties.

MP5 = Rock crushing plant consuming 6 MVA

The rock crushing plant has come to the end of its life and the one Eskom transformer will become a spare and will be used as a link to ensure redundancy. Only single bus switchgear will be installed due to capital constraints. By using the above information given what is required is a reconfiguration with 4 meter panels and meter panel that can be used as a redundant link to the others.

- 6.1 By means of a single line diagram show how you will configure the new consumer substation. (5)
- 6.2 What is meant by the term bus section and bus coupler? (2)
- 6.3 Where will the respective bus section and bus coupler be used? Indicate by means of a simple drawing. (4)
- 6.4 In your opinion what will determine how you will configure the layout of the substation (2)
- 6.5 Each transformer has a so called vector group. What is the meaning of the vector groups indicated in the information given (4)
- 6.6 Can you connect all the transformers in parallel? Give reasons for your answer. (3)
- [20]

Question 7

The main pump station of an underground mine is equipped with three multistage centrifugal pumps that deliver 63l/s each. There are two pumping columns in the 1050m deep vertical shaft. Each of the pumps can deliver directly to either of the two columns. The pumps are used to pump clear water from two underground dams to a surface dam.

- 7.1 Calculate the size of each delivery column in the vertical shaft. (2)
- 7.2 Calculate the required motor size for each pump. (5)
- 7.3 Calculate the steady state current of the pump during operation. (3)
- 7.4 A leak of 30 l/s develops exactly half way up the shaft column. As a result, the quantity delivered at the top of the column drops to 39 l/s. Calculate what the current of the pump motor will indicate under this new condition if the efficiency remain constant. (5)

7.5 If a positive displacement pump delivering 63 l/s was used instead of a multistage centrifugal pump, and a leak of 30 l/s develops exactly half way up the shaft column, what will the flowrate of water delivered at the top of the column be, and what will the current of the pump motor indicate under this new condition if the efficiency remain constant? (5)

[20]

Total: Section A [60] and Section B [40]

[100]

The End.