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:** **08 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. The examiner will only mark the first 2 questions you have answered.
- 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: Compulsory Questions

### Question 1

The attached load of a double drum rock winder operating in a 22° inclined shaft was increased to 7 tons. The vertical depth from the bank to the loading box is 300 m.

Calculate:

(a) The diameter and the braking strength of the simple triangular strand rope given the mass per metre run is 4 500 $d^2$ kg/m and the breaking strength 7,2 x 105$d^2$ kN where d = diameter of the rope in metres. (7)

(b). The daily hoisting capacity, given: (7)

| | |
|---|---|
| Maximum constant speed ..... | 5 m/s |
| Acceleration and deceleration rate ..... | 0,5 m/s2 |
| Loading and tipping time ..... | 35 s |
| Maintenance ..... | 1 hour/day |
| Pay load per skip ..... | 4 tons |

(c) The maximum emergency deceleration rate for an emergency stop in order to overrun the rope tension. (6)

Total: 20

## Question 2

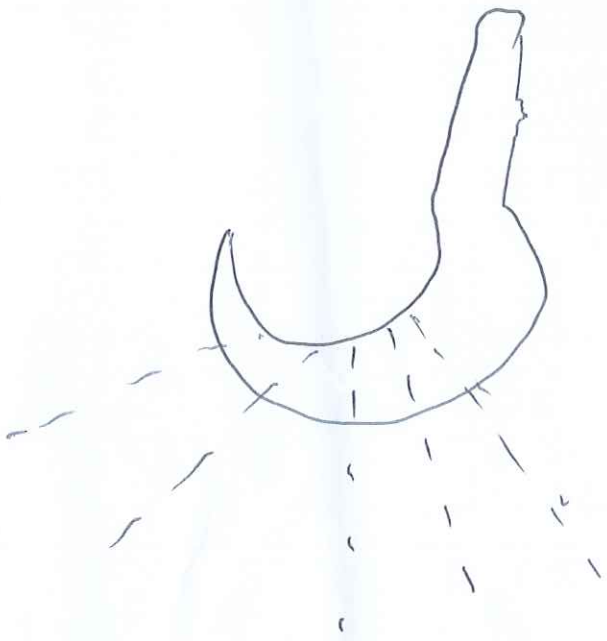
(a) You are an engineer at a mine. You have a major breakdown in the plant and two shafts, which feed into the plant, are on stop as a result of the breakdown. Amongst other tasks, a vertical lift, using 2 slings, has to be conducted, and the following is the information you have available at your disposal:

Sling height: 2,44 meters
Sling length: 3.66 meters
Weight of the lift: 6 tons
Vertical SWL of each sling: 3 tons at 90 degrees

(i) Using the information provided, determine if the slings are adequately rated to support the weight to be lifted. (14)

(ii) Why would a rigger prefer a 60 degrees sling angle to sling angles of less than 30 degrees, when doing vertical lifts? (6)

Total: 20



## Question 3

1. Discuss the advantages and disadvantages of earthing the neutral conductor of a three-phase system. (6)

2. Discuss the influence on the electrical distribution network if the neutral is earthed in more than one points. (3)

3. The underground haulage of a mine and some rooms and passages on surface are equipped with 60 W incandescent globes. One of the energy saving drives of the mine is to replace the incandescent globes with LED lights. The cost to change a globe is R15-00 for either and it includes travelling time from globe to globe.

Data:

| | |
|---|---|
| Quantity of incandescent lights | 1 580 |
| Power output of LEDs | 5 W |
| Power factor of LED | 0,503 |
| Price per energy unit | R 0.45/kWh |
| Price per apparent power unit | R 22.50/kVA |
| Lamp life of a LED | 10 000 hours |
| Lamp life incandescent | 1 000 hours |
| Price of an incandescent | R 2.45 |
| Price of a LED | R 24.00 |

Calculate the cost in replacing the incandescent globes with the LED's (7)
What will the impact be on the total electrical account? (1)
Propose some feasible ways to save energy on the mine. (3)

Total: 20

**[Section A: Total = 60 marks]**

## Section B: Answer only 2 Questions

### Question 4

A 4,27 m diameter autogenous mill has a circulating load of 300 t/h of solids of relative density 2,7 in the form of pulp at a relative density of 1,8. The pulp is discharged into a sump where it is diluted to a relative density of 1,25 and then pumped 20 m vertically and 15 m horizontally through a 350 mm diameter pipe to a cyclone.

Calculate the:

(a) critical speed of the mill in r/min (7)

(b) water addition in the sump in l/s (6)

(c) power of the pump motor to elevate the pulp to the cyclone (7)

Total: 20

S.G.

$l/s = 0.001\ m^3 \cdot s$

$\frac{kg}{s}\left[\frac{kg}{m^3}\right]^{-}$

$\frac{kg}{s} \times \frac{m^3}{kg}$

$P_m = 70,92\ kW$

$\eta = 90\%$

$f = 0.05$

$V = \frac{\pi D N}{60}$

3480 + 3420
680 + 3420

**Question 5**

You are an engineer on a high production shaft and your maximum demand is 150 MW when operating at a power factor of 0.8 lagging and your load factor currently is 40 %. Most of the machines used on the shaft are large machines i.e, pump motor is rated at 4 MW. Smallest rating is 2 MW. You need to improve on your electrical consumption. If you install power factor equipment and an improvement to .95 is realised. You also improve your load factor to 70%. The maximum demand charge is R20 per KVA the energy charge is 63 cents per unit consumed.

1). Define Power Factor? (2)

2). Define Load Factor? (2)

3). What will the savings be if you improve the power factor to .95 with an load factor of 40% per year. (4)

4). Define Demand and diversity factor? (4)

5). In doing power factor correction there are 3 methods or methodologies to implement. Name all three and the significance it has to the electrical power system. (8)

Total: 20

$\mu = 0.03$

$\rho_{steel} = 34$

**Question 6**

A chairlift installation must convey 450 persons per hour up a 30° incline shaft through a vertical height of 180 m by means of chairs suspended from chain driven carriers running on a rail circuit. Both landings are level and 22 m long. The velocity of the traction chain is 1,2 m/s and its mass is 7,30 kg/m and the mass of the safety rope is 1,5 kg/m. The mass of each carrier is 5 kg while that of a chair is 12kg.

a) Assume an appropriate friction factor and calculate the total pull in the chains at the driving sheave and the bottom sheave when the up-going chairs are loaded. [15]

b) Describe how the spin is taken out from the chairlift rope. [5]

Total: 20

$\Delta x = v_i t + \frac{1}{2} a t^2$ $v_f^2 = v_i^2 + a\Delta$

320 s $\Delta x = \frac{1}{2}(v_i + v_f)$

34.1407

17.66

4m spacer

**Question 7**

1. A three-phase, four wire 380 V underground electrical distribution system consists of a three-phase load of 100 kW at a power factor of 0,8 and three single-phase loads of 30, 40, and 59 kW respectively. Determine the current in each of the FOUR conducors. (10)

2. The delivery of a sludge pump must be varied by changing the slip-ring motor speed to 50% of the speed when the slip rings are short circuited with a 4% slip. Calculate the additional star connected resistance to be connected to the slip rings to achieve the decrease in speed. The three-phase 8-pole slip-ring motor is rated at 750 kW. The star-connected rotor winding has a resistance of 0,1 Ω/phase and a standstill leakage reactance of 0,5 Ω/phase. The frequency is 50 Hz. (10)

**[Total: Section B = 40]**

**[Total Section A and Section B = 100 marks]**