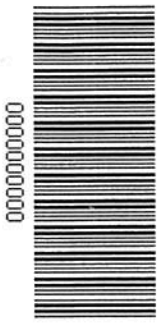

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T40**(E)**(J9)T
JUNE EXAMINATION

NATIONAL CERTIFICATE

PLANT ENGINEERING – MINES AND WORKS

(8190306)

9 June 2014 (X-Paper)
09:00–12:00

Programmable calculators may not be used.

CLOSED-BOOK EXAMINATION

This question paper consists of 9 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
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 of questions will be marked. All work you do not want to be marked must be clearly crossed out.

INSTRUCTIONS AND INFORMATION

1. Section A is COMPULSARY.
2. Answer only TWO questions in Section B.
3. Read ALL the questions carefully.
4. Number the answers according to the numbering system used in this question paper.
5. Rule off after completion of EACH question.
6. Candidates without acceptance by the Commission of Examiners will be disqualified.
7. No pencil answers will be marked.
8. Write neatly and legibly.

SECTION A (COMPULSORY)

QUESTION 1

You are a newly appointed engineer on one of the deepest shafts in the country. Your rock winder payload is 18 ton. The rock winder has already been damaged.

Information at hand that you could find is as follows:

Rope diameter = 55 mm

Mass of the rope = 8.5 kg/m

Distance from tip to loading box = 2 390 m

Last rope-test result = 2 246 kN

Detaching hook for safe working load used = 24 ton

Winder permitted speed = 15 m/s

Overrun distance = 15 m

You need to repair the damage and get the new conveyance installed to be able to carry on with the running of the shaft.

1.1 With the aid of a neatly drawn sketch and properly labelled, indicate all the safety devices in the headgear, their location and how they interconnect with each other. (5)

1.2 You need to replace the catch plate and indicate what size catch plate you will install for a 24-ton detaching hook. (2)

1.3 What is the first activity that you will supervise when arriving at the shaft to ensure safety and health? Give a brief description of what you will do. (3)

1.4 When selecting a new detaching hook and attachments, what information is required on the detaching hook and where will you find the information? (3)

1.5 You need to test if the repairs done are adequate and if the conveyance will function in the headgear. Give a brief description of the procedure you will follow to ensure the newly installed equipment will function properly, mentioning specific important dimensions. (7)

[20]

QUESTION 2

You are the newly 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 the minimum downtime when a breakdown occurs in the ESKOM substation. Mining has seized and the shaft will only be used to pump excess water in the region of 60Ml a day. Each pump station consists of two sets of 4 by 1.2 MW multistage pumps and motors each pumping at 150 l/s. The main consumer substation feeds a main distribution substation 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 neutral earthing compensators will still be located at the mine consumer substation and not form part of the Eskom reticulation.

The existing consumer substation is configured as follows

Meter Panel 1 = Surface reticulation and 2 by 3 MW man winders and 1 by 1 MW service winder

Meter Panel 2 = Pumping Feeders = 2 pump stations on different levels feeding a first set of pumps

Meter Panel 3 = Pumping Feeders = 2 Pump Stations on the same level feeding a second set of pumps

Meter Panel 4 = 2 by 2 MW ventilation synchronous induction main fans and other ancillary loads.

 Please turn over

Meter Panel 5 = 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 information given, what is required is a reconfiguration with 4 meter panels and a meter panel that can be used as a redundant link to the others.

2.1 By means of a single-line diagram show how you will configure the new consumer substation. (5)

2.2 What is meant by the terms busbar *section* and *busbar coupler*? (2)

2.3 Where will the respective busbar section and busbar coupler be used? Indicate by means of a simple drawing. (4)

2.4 In your opinion what will determine how you will configure the layout of the substation? (2)

2.5 Each transformer has a so-called vector group. What is the meaning of the vector groups indicated in the information given? (4)

2.6 Can you connect all the transformers in parallel? Give reasons for your answer. (3)

[20]

QUESTION 3

You are the appointed engineer in an underground section of the mine and fires seem to be happening frequently. You have just heard that another mining house has experienced fatal injuries due to fires and you want to do all that is practically possible to ensure your controls are adequate.

3.1 What are the three conditions that ignite and maintain a fire? (3)

3.2 What is a fourth condition that makes it difficult to extinguish fires and how is this formed? (2)

3.3 Name TWO installations in an underground environment that can cause catastrophic fires. (2)

3.4 Name THREE controls for each installation above to control fires and explosions (use a table for ease of presentation). (3 x 2) (6)

3.5 What causes fatal injuries to personnel during a fire underground? Explain your answer. (3)

3.6 What methods are used to detect fires and/or its prevalence underground? (2)

3.7 What are the prevailing, life-sustaining conditions in a refuge bay that you as the engineer must ensure? (2)
[20]

TOTAL SECTION A: 60

SECTION B (Choose TWO questions from this section.)

QUESTION 4

4.1 On the shaft one of the winders on surface is still an 2 300 HP Metvic AC winder. The winder is equipped with a common liquid controller that service both main motors

4.1.1 Make the power-circuit drawing of the stator reverser configuration. The drawing should include the DC isolation as well as the DC contactors. The DC supply is fed from its own generator set.

4.1.2 Explain the working principle of the stator reverser with reference to the drawing drawn above.

(2 x 5) (10)

4.2 What effects does lightning have underground in a coal mine? List the risks associated with such an occurrence. (5)

4.3 Describe FIVE protective measures to be taken in a coal mine to minimise the effects of stray electrical potentials. (5)
[20]

QUESTION 5

5.1 A scraper winch is equipped with an epicyclic gearbox of which the internal wheel can be held with the aid of a band brake. The planetary gears are mounted on a carrier which is connected to the rope drum. The internal wheel and planetary gears have 92 and 39 teeth respectively.

Calculate the required speed of the driving shaft if the maximum rope speed may not exceed 1 m/s. For the purpose of calculation, take the effective rope coil diameter to be 700 mm. (10)

 Please turn over

5.2 In an ammonia vapour-compression refrigerator, the pressure in the evaporator is 276 kPa and the ammonia at entry to the evaporator is 0,12 dry while at exit it is 0,91 dry. During compression the work done per kilogram for ammonia is 170 kJ.

5.2.1 Calculate the actual coefficient of performance.

5.2.2 If the rate of ammonia circulation is 5,6 kg/min, determine the volume entering the compressor.

5.2.3 The compressor is single acting, has a volumetric efficiency of 80% and runs at 120 r/min. Determine the bore and the stroke, given that these are equal. Properities of ammonia at 276 kPa are: latent heat 1 340 kJ/kg and the specific volume is 0,44 m^3/kg.

(10)
[20]

QUESTION 6

A 100 ton truck is to be used to convey 50 tons of rock from a quarry up a steady incline of 1 in 50. The truck is designed to apply emergency brakes to the front wheels within 10 seconds in case of the service brake failure. The engine develops 250 kW, the transmission efficiency is 85 % and the rolling resistance is 200 N/t. The wheel base of the truck is 7 m and the centre of gravity of the loaded truck is 3 m in front of the rear axle and 1,75 m above the road surface. The coefficient of friction between the road surface and the wheels is 0,25.

6.1 Calculate:

6.1.1 The maximum steady speed of the truck up the incline

6.1.2 The speed of the truck, 15 seconds after an engine failure and a loss of service brakes have occurred and if the truck travelled at full speed

6.1.3 The braking effort of the emergency brakes when the truck is running backwards (that is only if the front wheels are braked)

(3 x 3) (9)

6.2 Briefly comment on the degree of safety of the arrangement as set out. (11)
[20]

QUESTION 7

7.1 A machine is driven by a DC motor

7.1.1 Explain, with the aid of suitable diagrams, how thyristors may be used to control the speed and direction change of rotation of the machine. (8)

7.1.2 Explain how electrical braking is achieved with a thyristor-type control. (5)

7.2 The load cycle of a hoist is as follows:

An acceleration period of 15s during which power output is constant at 5 MW.

A constant speed period of 25s during which the power output falls uniformly from 3 MW to 2 MW.

A braking period of 10s during which the regenerated power falls uniformly from an initial value of 5 MW to zero.

An interval of 10s before the commencement of the next cycle.

Determine the rating of the motor required. (State any assumptions made) (7)

[20]

QUESTION 8

You are the engineer appointed in an underground section where vertical spindle pumps are used to dewater the mine. You have had numerous injuries while installation of these pumps happen, while other operations even experienced fatal injuries. Most of your pumps are 1.4 m long, weigh 120 kg and the centre of gravity is 1 m from the sump. The pumps have lifting lugs situated 100 mm above the pump's centre of gravity. With your understanding of pendulums answer the following questions that seek to address the high risks associated with pump installation.

8.1 If your eyebolt is 3 m above the sump of a vertical spindle pump, what will be the period of oscillation of the pump when it is mid-air and when it is about to be put in the sump? (6)

8.2 At what position is the highest risk of swing for the people installing the pump above? Explain your answer. (4)

8.3 If the pump swings from position A to C through B where A and C are the extremes position of the swing and B the equilibrium position, where in this swing is the gravitational force the highest? (3)

8.4 Someone deduced that the weight of the pump is the cause of the accidents. Do you agree with this assessment? Explain your answer. (3)

8.5 Given that some design changes can be done to the pump, what would you recommend in order to reduce the probability of accidents? (2)

8.6 If the above is possible what would your recommendations be to reduce the severity of these accidents? (2)
[40]

QUESTION 9

You are the engineer in the outside section of a uranium plant. Several pump stations pumps residue to the plant to recover residual gold and uranium. Pumps and motors used are 250 kW fed from a 525 volt supply. Some motors' starting method are direct on line and others have soft starters installed.

This particular pump station where you have problems pumping sufficient residue you need to increase the motors to 350 kW. One motor is 60 m away from the supply point and the cable run on the cable rack in air and its starting method is *direct on line*. The other motor is 150 m away from the supply point and the cable is buried in the ground and the starting method is by means of a soft starter.

Cable Size	**Z Ohm/Km**	**Sustained current rating**			**Volt Drop**
		Ground	Duct	Air	mV/A/m
70	0.4718	215	175	210	0.576
95	0.2460	257	210	253	0.427
120	0.2012	292	239	293	0.348
150	0.1698	328	269	336	0.294
185	0.1445	369	303	384	0.250
240	0.1220	422	348	447	0.211
300	0.1090	472	397	509	0.189

9.1 Taking the volt drop and impedance into consideration select the correct cable for the respective motors. (20)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100