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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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JUNE 2011

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF
COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

3 June (X-Paper)
09:00 – 12:00

CLOSED-BOOK EXAMINATION

Candidates may NOT use any notes, textbooks, references during this examination.

This question paper consists of 7 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF
COMPETENCY
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 COMPULSORY and must be answered by ALL the candidates.
 2. Answer any TWO questions in SECTION B.
 3. Read ALL the questions carefully.
 4. Rule off across the page on completion of each question.
 5. Show ALL the calculations.
 6. Examination results will be disqualified if the candidate had not been accepted by the Commission of Examiners prior to the examination.
 7. Candidates arriving 30 minutes late, will NOT be allowed to sit for the examination. No candidate writing the examination may leave the examination room before ONE hour after commencement has elapsed.
 8. Number the answers correctly according to the numbering system used in this question paper.
 9. Programmable calculators must NOT be used by any candidate.
 10. Write neatly and legibly.
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SECTION A (COMPULSORY)

QUESTION 1: WINDING PLANT

- 1.1 An engineer must explain to the owner of a winding plant that the connections between any winding rope and the conveyance shall be annealed when required by law.
- 1.1.1 Explain the purpose of annealing (2)
- 1.1.2 Explain what the process involves (2)
- 1.1.3 What type of material is exempted from this process (1)
- 1.2 Describe FIVE non-destructive tests to be performed on attachments exempted from heat treatment. (5)
- 1.3 A tower mounted multi-rope friction winder with a guide sheave assembly guiding the ropes are attached to the counterweight. There is no tail carriage.

The following are applicable:

Mass of empty skip	6 tons
Mass of loaded skip	12 tons
Mass of counter weight	9 tons
Total rope mass per side	5,55 tons
Total moment of inertia for guide sheave assembly	2,4 tons.m ²
Diameter guide sheaves	2 m
Friction load per skip	10 kN
Angle of wrap for ropes on the friction wheel	190°
Coefficient of grip for the rope	0,2

Calculate the maximum acceleration permissible for no slip to occur. (10)
[20]

QUESTION 2

- 2.1 You are appointed as an engineer on a mine. The main supply transformer broke down and there are only two smaller rated transformers available. A decision was made to connect them in parallel. State FIVE conditions to be met for their satisfactory performance in parallel. (5)
- 2.2 You as an engineer need to assess the load sharing between two transformers when a possible parallel connection has to be made. A load of 800 kW at a power factor of 0,8 lagging needs to be supplied. The rating of transformer A is 500 kVA with resistance 2,5% and reactance 6%. The rating of transformer B is 400 kVA with resistance 0,016 pu and reactance 0,07 pu.

Calculate the load sharing and power factor operation for both transformers. (10)

- 2.3 Due to high saturation levels of flux densities in power transformers, third and fifth harmonics are induced. State THREE effects of the harmonic currents. (3)
- 2.4 Can a delta-star transformer be paralleled with a delta delta transformer? Give a reason for the answer. (2)
- [20]**

QUESTION 3

- 3.1 The number of accidents due to derailments of a railway system, for which you as an engineer are responsible appear to be on the rampage. You found the major causes to be loose fishplate rail joints and excessive flange wear on the wheels.
- Give FIVE reasons for each of the above conditions in order of importance. (10)
- 3.2 A number of fires in mines and in buildings are started as a result of faults of electrical cables and cable joints. Describe those items to be checked by you, as the responsible engineer towards preventing such fires. (10)
- [20]**

TOTAL SECTION A: 60

SECTION B

QUESTION 4

- 4.1 An engineer is planning to do cross belting with a belt drive. Give the TWO general reasons why belting is crossed in belt driving practice. (2)
- 4.2 Explain why cavitations may create harmful effects with liquid in motion. (2)
- 4.3 Describe the process to prime a centrifugal pump when the pump is located above the water level, equipped with a by-pass connected to the delivery pipe and a foot valve connected to the suction side. The delivery pipe is filled with water and equipped with main delivery valve. (5)
- 4.4 Explain a technique to prevent water hammering on piston and plunger pumps. (2)
- 4.5 State THREE main problems that can be experienced with plunger pumps. (3)
- 4.6 An engineer experiences slip problems on a plunger pump. Give THREE possible reasons what can create slip. (3)
- 4.7 Lubricating devices are used to provide a regulated quantity of lubricant to machine parts. State THREE methods of lubrication. (3)
- [20]**

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QUESTION 5

- 5.1 A responsible engineer must prevent the possibility of explosions in a reciprocating air compressor plant. State FIVE areas to investigate as possible causes for explosions. (5)
- 5.2 State the major harmful constituents in the exhaust gases of a diesel engine and discuss the effect thereof on the human body. (3)
- 5.3 State the fault conditions under which oxygen can enter an acetylene cylinder in an oxy-acetylene system. (2)
- 5.4 Why do flashbacks occur with oxy-acetylene gas welding processes. (3)
- 5.5 Where must the TWO flashback arresters be situated? (2)
- 5.6 Why must humidity be kept low in underground workings? (1)
- 5.7 5.7.1 How can it be possible for diesel locomotives to run the engine rotation in the wrong direction? (1)
- 5.7.2 How can water be prevented from being drawn from the washer into the cylinders under these conditions? (1)
- 5.8 State ONE method to chemically treat mine water and neutralise acids and ONE method to collect solid particles which are too fine to settle. (2)
- [20]**

QUESTION 6

- 6.1 It is required to compress $20 \text{ m}^3/\text{s}$ of free air at 100 kPa and a temperature of 293 K to 700 kPa in a 10 stage rotary compressor. If the mechanical efficiency is 80% and $n = 1,4$ R of air is 0,287 kJ/kg.K and C_p of air is 1,005 kJ/kg.K
- Calculate the following:
- 6.1.1 The power required for the compressor (4)
- 6.1.2 If the temperature of the compressed air is not to exceed 323 K, determine the total rate of heat extracted. (4)
- 6.2 State the dangers when a pilot circuit is modified so that the pilot circuit is shortened by replacing the diode of the remote unit by a diode in the gate end box. (2)
- 6.3 State the dangers when a pilot circuit is modified by altering the value of the resistor across the start button. (2)

- 6.4 State FOUR features of a pilot circuit to specifically reduce the risk arising from the use of electricity in hazardous areas. (4)
- 6.5 6.5.1 Is a pilot wire system intrinsically safe when the setup is used in conjunction with a trailing cable to supply electricity to a underground machine? (1)
- 6.5.2 Explain the answer and give THREE reasons. (3)
- [20]

QUESTION 7

- 7.1 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 is 0,91 dry. During compression the work done per kilogram for ammonia is 170 kJ.
- 7.1.1 Calculate the actual coefficient of performance
- 7.1.2 If the rate of ammonia circulation is 5,6 kg/min, determine the volume of vapour entering the compressor per minute
- 7.1.3 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. Properties of ammonia at 276 kPa are: Latent heat is 1 340 kJ/kg and specific volume is 0,44 m³/kg. (10)
- 7.2 As an engineer you are to inspect a sheave wheel in service. What criteria will you use if there are no manufacturing records to be found and the operational history has not been recorded. (10)
- [20]

QUESTION 8

- 8.1 An intermediate conveyor belt operating underground in a coal mine and length of 1 200 m and belt width of 1 200 mm was damaged over its entire length and the belt is now only 1 000 mm wide. The same tonnage per hour needs to be transported without spillage from the receiving conveyor onto the discharge conveyor. What would you do to cater for this loss of width of belting to be able to transport the same tonnage of coal? (5)

- 8.2 An underground coal mine with an output of 100 000 tons per month decided to increase the tonnage to 120 000 tons per month. Due to budget constraints the engineer decided to speed up the conveyor drives by the cheapest possible means. The conveyor drives consists of electrical motor, gear boxes, drive pulleys and couplings. It is assumed that the motor power will still be sufficient after the speed up process.

Motor speed	1 400 r/min
Gearbox ratio	25:1
Conveyor speed	3 m/s
Required conveyor speed to be	3.6 m/s

What would you do to speed up the conveyor drives? (5)

- 8.3 Explain the causes of belt slip and what can be done to reduce the slip. (5)

- 8.4 Explain the operation of all the electrical and mechanical safety devices required on a conveyor used in a fiery mine including the type of conveyor belting. (5)

[20]

SECTION B: 40
TOTAL: 100

1406
253
3.6
56 = 3
36
3
3
3.6
672