higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

N1640(E)(J4)H

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: FACTORIES

(8190316)

4 June 2018 (X-Paper)
09:00–12:00

REQUIREMENTS: Graph paper

CLOSED-BOOK EXAMINATION

Alpha-numerical or programmable calculators may NOT be used.

Only nonprogrammable calculators may be used.

PLANTENGF

0202020

This question paper consists of 7 pages and 1 information sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY
PLANT ENGINEERING: FACTORIES
TIME: 3 HOURS
MARKS: 100

NOTE: If you answer more than the required number of questions, only the required number will be marked. Clearly cross out ALL work you do NOT want to be marked.

INSTRUCTIONS AND INFORMATION

1. SECTION A is COMPULSORY
2. Answer any 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. NO marks will be given for calculations in which the steps cannot be clearly followed or for work in pencil.
6. Candidates are expected to make reasonable assumptions where necessary and these, together with formulae used, must be clearly stated.
7. Rule off on completion of each question.
8. Candidates are NOT allowed to use any notes, textbooks, references books or cell phones during the examination.
9. Candidates who were NOT accepted by the commission, will be disqualified.
10. NO candidates may enter the examination room more than half an hour after the start of the examination and NO candidate may leave the examination room before ONE hour has elapsed.
11. Cell phones are NOT allowed in the examination room.
12. Write neatly and legibly.

SECTION A (COMPULSORY)

QUESTION 1

1.1 A tank containing 400 kg of paraffin is to be heated from 10 °C to 40 °C in 20 minutes (1 200 seconds), using 400 kPa (gauge) steam. The paraffin has a specific heat capacity of 2 kJ/kg °C over that temperature range. h_{fg} at 400 kPa (gauge) is 2 108,1 kJ/kg. The tank is insulated and heat losses are negligible.

Determine the steam flow rate. (8)

1.2 Name the FOUR processes in a demineralisation plant for the steam generator to remove scale-forming impurities and explain each process. (8)

1.3 Give the ideal values of the feed water for a typical industrial package, fire-tube steam generator for each of the following:

1.3.1 pH

1.3.2 Total iron, mg/ℓ

1.3.3 Total copper, mg/ℓ

1.3.4 Total hardness expressed as $CaCO_3$, mg/ℓ

(4 × 1) (4)

[20]

QUESTION 2

2.1 A 100 kW, 460 V shunt generator is run on no load at its rated voltage and speed. The total current taken is 9,4 A, including a shunt current of 2,7 A. The resistance of the armature circuit (including compoles) at normal working temperature is 0,11 Ω.

Calculate the efficiency at the following:

2.1.1 Full load (6)

2.1.2 Half load (5)

2.2 Discuss TWO advantages and TWO disadvantages of air circuit breakers. (4)

2.3 Electrical cable drums should be clearly marked (stencilled or burned into the wooden drum flanges) for ease of identification.

Name FIVE items of information that should be included in this marking. (5)

[20]

QUESTION 3

3.1 A health and safety management system (OHSMS) prescribed by the chief inspector in Government Notice R859 of 2 September 2005 requires an occupational health and safety policy for a factory. The policy shall clearly state the overall health and safety objectives and a commitment to improve health and safety performance.

Name FIVE requirements of the policy. (5)

3.2 The Occupational Health and Safety Management Systems – Guidelines for the implementation of OHSAS 18001: 2007, is a guideline for the implementation of OHSAS 18001: 2007.

3.2.1 Name FIVE elements of the occupational health and safety system. (5)

3.2.2 Name the first TWO stages in the hierarchy to reduce the risk when determining controls, or considering changes to existing controls. (2)

3.3 A risk assessment must be done before the replacement of a pole-mounted transformer with the minimum interruption to customers.

Name FOUR hazards associated with this type of work and discuss precautionary measures for each of these hazards. (4 × 2) (8)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions in SECTION B.

QUESTION 4

4.1 The lower limit switches of an elevator failed and the car was stopped on the two buffer springs. The mass of the loaded elevator car is 1,135 t and its full speed is 1 m/s. The stiffness of the spring is 31 kN/m.

Calculate the maximum compression of the springs in this case and the maximum deceleration of the car. (10)

4.2 Name FIVE types of nondestructive testing to detect defects on a jib of a crane. (5)

4.3 An eroded valve in a 200 mm slurry pipeline needs to be replaced.

Name FIVE considerations when ordering a new valve. (5)
[20]

QUESTION 5

5.1 A single-phase motor operating from a 240 V, 50 Hz supply generates 10 kW with an efficiency of 84 per cent and a power factor of 0,7 lagging.

Calculate each of the following:

5.1.1 Input kilovolt-amperes (3)

5.1.2 Active and reactive components of the current (3)

5.1.3 Reactive kilovolt-amperes (or kilovars) (2)

5.1.4 Capacitance required in parallel to raise the power factor to 0,9 lagging (6)

5.2 Discuss the use of capacitor banks and induction motors to save electricity. (6)
[20]

QUESTION 6

6.1 The torque required to drive a ventilating fan is proportional to the square of its shaft speed, 76 kW being absorbed when the speed is 383 r/min. It is driven through a 2:1 speed reduction gear from a motor for which the output torque is zero at 750 r/min increasing uniformly as the speed decreases to 675 r/min when it generates 90 kW.

6.1.1 Sketch the torque-speed curves for the gear output and fan. (3)

6.1.2 Find the speed at which the fan will run at the corresponding power. (8)

6.1.3 Comment briefly on the running stability. (3)

6.2 A new stainless steel heat exchanger has developed severe cracks around the outlet.

Name THREE possible causes for these cracks and discuss each cause. (3 × 2) (6)
[20]

QUESTION 7

7.1 A 300 kVA transformer has a primary winding resistance of 0,4 Ω and a secondary winding resistance of 0,0015 Ω. The iron loss is 2 kW and the primary and secondary voltages are 4 kV and 200 V respectively.

Determine the efficiency of the transformer for each of the following if the power factor of the load is 0,78:

7.1.1 On full load (10)

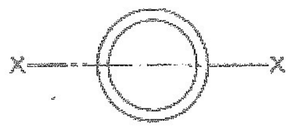
7.1.2 On half load (5)

7.2 Name SIX electrical checks to be done on a medium-voltage circuit breaker during maintenance. (5)
[20]

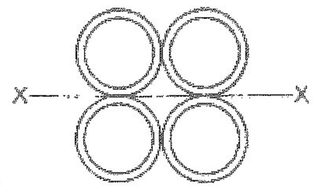
QUESTION 8

8.1 A steel tube with a 40 mm outside diameter and a 30 mm inside diameter is used as a simply supported beam on a span of 1 m. The maximum safe load it can carry at mid-span is 1 200 N.

To lift a bigger load than 1 200 N it is decided to arrange four of these tubes in parallel to one another and firmly fix them together to form a single beam. The centres of the tubes form a 40 mm side square with one pair of centres vertically over the other pair as shown below.



SINGLE TUBE



FOUR TUBES FIXED TOGETHER

Find the maximum central load which the beam can carry if the maximum stress is not to exceed that of the single tube above. (10)

8.2 Electrical protection of a power system deals with the clearing of an abnormal condition or fault from the system to prevent equipment damage and injury. There are a number of conditions in the power system that may be regarded as abnormal or faults.

List and briefly describe FIVE of these conditions that a protection system should clear. (5 × 2) (10)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

INFORMATION SHEET

$P = \sqrt{3}\, VI \cos\theta$	$t = \frac{2A}{C_d B \sqrt{2g}} (H_1^{0.5} - H_2^{0.5})$
$Q = mC\Delta t$	$C = \frac{\sigma_c}{2} bn$
$P = (T_1 - T_2)\, v$	$T = \sigma_s A_s$
$pv = mRT$	$\frac{n}{d-n} = m \frac{\sigma_c}{\sigma_s}$
$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$	$\Delta P = \frac{32 \mu L v}{D^2}$
$t_m = \frac{\Delta t_{in} - \Delta t_{out}}{\ln \frac{\Delta t_{in}}{\Delta t_{out}}}$	$Z = \frac{\pi (D^2 - d^2)}{32 D}$
$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$	$I = \frac{\pi (D^4 - d^4)}{64}$
$x = \sqrt{\frac{p_i}{p_c}}$	$\frac{p_1}{w} + \frac{v_1^2}{2g} = \frac{p_2}{w} + \frac{v_2^2}{2g}$