higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NONNATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

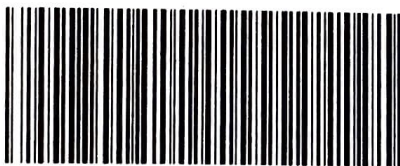# PLANT ENGINEERING: FACTORIES

(8190316)

31 May 2021 (X-paper)
09:00–12:00

CLOSED-BOOK EXAMINATION

Alpha-numerical or programmable calculators may not be used.

Nonprogrammable calculators may be used.

This question paper consists of 7 pages.

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307Q1J2131

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NONNATIONAL 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. Show all calculations.

6. Make reasonable assumptions where necessary and clearly state these, together with any formulae used.

7. Rule off across the page on completion of each question.

8. Candidates who were not accepted by the Commission will be disqualified.

9. Candidates will not be allowed into the examination venue more than half an hour after the start of the examination. No candidate may leave the examination venue before one hour has elapsed.

10. No cellphones may be taken into the examination venue.

11. Write neatly and legibly.

SECTION A (COMPULSORY)

QUESTION 1

1.1 A steam generator produces steam at a pressure of 800 kPa with a 0,98 dryness fraction at a rate of 6 t/h. Fuel having a calorific value of 30,3 MJ/kg is used at a rate of 680 kg/h. The feed water temperature is 48 °C.

STEAM PROPERTIES

P (kPa)	t_s (°C)	h_f (kJ/kg)	h_g (kJ/kg)	h_{fg} (kJ/kg)
800	170,4	721	2 047	2 768

Determine each of the following:

1.1.1 Efficiency

1.1.2 Equivalent evaporation from and at 100 °C (10)

1.2 An economic steam generator which is rated at 5 t/h delivers an average demand of 80% of its rated capacity. The number of dissolved solids in the feedwater is 125 mg/ℓ.

What should the rate of blow down in kg/h be in order to maintain a recommended level of dissolved solids in this steam generator between 2 000 and 3 000 mg/ℓ? (6)

1.3 What is the purpose of an internal water treatment programme supplying water to a steam generator? (4)

[20]

QUESTION 2

2.1 A single-phase 100 kVA transformer supplied with 2,2 kV has a turns ratio of 400:80. Primary and secondary resistances are 0,3 Ω and 0,01Ω respectively and the corresponding leakage reactances are 1,1 Ω and 0,035 Ω respectively.

Determine each of the following:

2.1.1 Equivalent impedance referred to the primary circuit (4)

2.1.2 Voltage regulation and secondary terminal voltage for full load having a power factor of each of the following:

		(a)	0,8 lagging		

		(b)	0,8 leading		

(2 × 3) (6)

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2.2 Prepare a checklist for maintaining a suburban electrical substation. (5)

2.3 List the checks to be carried out prior to using a phasing stick on an overhead power line. (5)

[20]

QUESTION 3: SANS/ISO 45001: 2018

Occupational health and safety management systems – Requirements with guidance for use (replaced OHSAS 18001 and 18002) is a health and safety management system.

3.1 An organisation shall establish processes for the implementation and control of planned temporary and permanent changes that impact on the occupational health and safety performance.

Name FIVE scenarios in which case you will implement manage of change. (5)

3.2 The organisation shall also establish, implement and maintain processes needed to prepare for and respond to potential emergency situations, as identified.

Name FIVE matters that shall be included in the emergency preparedness and response. (5)

3.3 A confined space may include, but not be limited to, underground vaults, tanks, storage bins, pits, vessels, sewers and silos. Before any employee enters a confined space, the employer shall ensure that an assessment of the hazards related to the confined space has been carried out.

Name TEN hazards associated with confined spaces (10)

[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO of the following five questions.

QUESTION 4

4.1 Name SIX electrical checks to be done on a medium voltage circuit breaker during maintenance. (6)

4.2 Name FOUR acceptable manners how fuses may be used when not installed in a distribution board. (4)

4.3   A feeder cable 317 m long develops a fault to earth on one phase. The fault is localised by the following resistance measurements obtained between one end of the faulty conductor and earth:

Distant end insulated = 7,01 ohms
Distant end solidly earthed = 1,85 ohms
Conductor resistance = 7,192 ohms/1 000 m

Calculate the distance of the fault from the test end.   (10)
       [20]

AND/OR

QUESTION 5

5.1   A tripod comprises three 75 mm bore pipes 5 m long and is used to raise a transformer having a mass of 5 t. The wall thickness of the pipes is 5 mm. The tripod is designed to be used in symmetrical arrangement with its legs at 60° with the horizontal.

Determine the safety factor of the system when it supports the full load of the transformer. It is assumed that the pipes are straight and pin-jointed. The modulus of elasticity for the steel pipes is 207 GPa.

Given: $P_{cr} = \dfrac{c\pi^2\,EI}{L^2}$ (Euler)

$P_{cr} = \dfrac{\sigma.A}{1 + \dfrac{I}{c.a} \cdot \left(\dfrac{L}{K}\right)^2}$ (Rankine)

       (16)

5.2   Briefly describe the construction, advantages and applications of the following types of steel ropes:

    5.2.1   Lang's lay

    5.2.2   Ordinary (regular) lay

       (2 × 2)   (4)

AND/OR

QUESTION 6

6.1   A 6600 V, 3-phase, star connected synchronous motor draws a full-load current of 80 A at a power factor of 0,8 leading. The armature resistance is 2,2 ohms with a synchronous resistance of 22 ohms per phase. If the stray losses of the machine are 3200 W, determine each of the following:

        6.1.1   EMF induced   (5)

        6.1.2   Output power   (5)

        6.1.3   Efficiency   (2)

6.2   A number of fires in factories and buildings start as a result of faults of electrical cables and cable joints.

Describe those items you as the responsible engineer must check to prevent such fires.   (8)
                                                                     [20]

AND/OR

QUESTION 7

7.1   A mono-rope conveyor has a total length of 400 m between the tensioning pulley and is used to transport material to the working place.

The bundles of material have a mass of 100 kg and are transported to the top of a 5 in 1 incline, 310 m from the loading station. The bundles are conveyed at 20 m intervals at a velocity of 0,8 m/s.

The rolling resistance coefficient is 0,15 and the coefficient of friction between the driving wheel and rope is 0,065. The driving rope passes two turns round the driving wheel.

Determine each of the following:

        7.1.1   Tight side tension of rope

        7.1.2   Minimum slack side tension in rope

        7.1.3   Minimum initial tension in rope

        7.1.4   Power to drive loaded rope

                                                                              (10)

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7.2 Select a suitable rope from below for the installation with a factor of safety of 6.

Nominal rope diameter (mm)	Estimated mass (kg/m)	Estimated breaking force (k/N)		Outer wire diameter (mm)
		1600 MPa	1800 MPa	
9,5	0,360	51,1	57,0	0,69
13	0,673	96,3	107,4	0,96
16	1,006	144,1	160,7	1,20
19	1,420	204,3	227,9	1,40
22	1,911	274,4	305,9	1,64
26	2,649	381,9	425,9	1,92

(5)

7.3 Sketch a tensioning arrangement for the system.

(5)

[20]

AND/OR

QUESTION 8

8.1 A centrifugal pump in an underground chamber of a high-security facility delivers 50 litres/s through a vertical column against a static head of 400 m and it needs 330 kW to drive it.

A leak of 25 litres/s develops exactly halfway up the delivery column. As a result, the quantity delivered at the top of the column drops to 29 litres/s.

Friction head loss in the delivery column is 0,005 Q^2m per 100 m, where Q is the flow in litres/s.

Calculate the power required to drive the pump under the new conditions if the efficiency remains constant.

(10)

8.2 A three-phase motor takes a constant input of 1,25 MVA at a power factor of 0,8 lagging. In order to reduce the kVA demand, it is proposed to install correction equipment to improve the power factor.

The annual cost per kVA demand is R1 100 and the capital cost of the correction equipment is R3 000 per kVAR with an interest and depreciation of 12% per year.

Calculate each of the following:

8.2.1 Most economical power factor

(4)

8.2.2 Annual saving when correction is made to the economic limit

(6)

[20]

TOTAL SECTION B: 40

GRAND TOTAL: 100