higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: FACTORIES

(8190316)

8 November 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 9 pages and 1 information sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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. Cross out all work that you do not want to be marked.

INSTRUCTIONS AND INFORMATION

1. Answer all the questions in SECTION A.
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. No marks will be given for calculations in which the steps cannot be clearly followed or for work completed in pencil.
7. Make reasonable assumptions where necessary and clearly state these, together with any formulae used.
8. Rule off across the page on completion of each question.
9. No notes, textbooks, references books or cellphones are allowed in the examination venue.
10. Candidates who were not accepted by the Commission will be disqualified.
11. No candidate may enter the examination room more than 15 minutes after the start of the examination and no candidate may leave the examination room before ONE hour has elapsed.
12. Write neatly and legibly.

SECTION A (COMPULSORY)

QUESTION 1

1.1 1.1 A hospital autoclave requires steam at 1,4 MPa and a dryness fraction of 0,98. A throttling calorimeter with a separator was installed to ensure compliance with this requirement.

Determine if the quality of the supply steam complies with this requirement if the following readings were obtained during the test:

Inlet pressure	1,4 MPa
Outlet pressure	100 kPa
Temperature at inlet	195 °C
Temperature at outlet	121 °C
Discharge from separator temperature	0,227 kg/min at saturation
Discharge rate after throttling	2,18 kg/min

From superheat tables at 100 kPa and 121 °C, enthalpy = 2716 kJ/kg.

From steam tables:

P (kPa)	t_s (°C)	h_{fg} (kJ/kg)	h_g (kJ/kg)
1400	195,0	1958	2788

(7)

1.2 The fusible plug of a three-pass steam generator extinguished the coal fire during a night shift.

Give THREE possible causes for the incident and describe how you would determine the composition of the material to refill the fusible plug for the said steam generator. (5)

1.3 Briefly describe TWO types of steam generators for the rapid raising of steam.

Give details of:

1.3.1 Their application in the industry

1.3.2 Quality of the steam generated

1.3.3 Fuel

1.3.4 Efficiency

(4 × 2) (8)

[20]

QUESTION 2

2.1 A D.C. series motor runs at 600 rev/min when taking 110 A from a 240 V supply. The resistance of the armature circuit is 0,12 Ω, while that of the series winding is 0,03 Ω. Calculate the speed when the current has fallen to 50 A, assuming the useful flux per pole for 110 A to be 0,024 Wb, and that for 50 A to be 0.0155 Wb. (8)

2.2 Name FOUR types of applications for a D.C. series motor and TWO reasons why it is more suitable than other type of motors. (4)

2.3 Name FIVE explosion techniques used in the explosive gas atmosphere. (5)

2.4 Name THREE measures that may be taken to provide protection to persons operating electrical switchgears in case of an internal arc. (3)

[20]

QUESTION 3

3.1 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.

Select the correct answer on the standard:

3.1.1 What is the advantage of implementing SANS/ISO 45001 within an organisation?

A Drives continual improvement
B Enhances customer and stakeholder confidence
C Assists with regulatory compliance
D All of the above

3.1.2 What does PDCA stand for?

A Plan, Do, Check, Act
B Plan, Do, Confirm, Amend
C Prepare, Do, Check, Act
D Prepare, Do, Confirm, Action

3.1.3 What sized organisations can implement SANS/ISO 45001?

A All organisations, regardless of size
B Organisations with 10 or more employees
C Organisations with 50 or more employees
D Organisations with 100 or more employees

3.1.4 In line with SANS/ISO 45001, who must establish, implement, and maintain an occupational health and safety policy?

A Employees
B The internal auditor
C Top management
D Stakeholders

3.1.5 In line with SANS/ISO 45001, when should top management review an organisation's management system to ensure its continuing suitability, adequacy, and effectiveness?

A Weekly
B Monthly
C Annually
D At planned intervals

3.1.6 When an incident or nonconformity occurs, an organisation must:

A React in a timely manner
B Review existing assessments of OH&S and other risks
C Determine and implement any action needed, including corrective action
D All of the above

3.1.7 How does SANS/ISO 45001 define a 'hazard'?

A A source with the potential to cause injury and ill health
B An item that has caused injury to an individual
C A physical object that is a known risk
D None of the above

3.1.8 What is the purpose of documented information?

A To support the achievement of strategic/OH&S objectives
B To enable the successful management of a system
C To demonstrate conformity (where applicable)
D All the above

3.1.9 Within SANS/ISO 45001, what does 'may' indicate?

A A requirement
B A permission
C A recommendation
D A possibility

3.1.10 Of what must workers be made aware?

A The OH&S policy and objectives
B Their contribution to the effectiveness of the OH&S management system
C The implications and potential consequences of not conforming to the OH&S management system
D All the above

(10 × 1) (10)

3.2 A daily safety inspection checklist needs to be drawn up for the operator of a centrifugal power press that is fitted with operating controls and which requires the simultaneous engagement of both hands, before starting with the shift.

List 10 items that you should include in this check list. (10)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions in SECTION B.

QUESTION 4

4.1 You must make a selection between two single phase transformers. Each of the two transformers, A and B, has an output of 40 kVA. The core losses in A and B are 500 and 250 W, respectively. The full-load copper losses are 500 and 750 W, respectively.

Tabulate the following at half, three quarter, and full load for a power factor of 0,8:

4.1.1 Losses (5)

4.1.2 Efficiencies (5)

4.2 For each transformer, find the load at which the efficiency is a maximum. (4)

4.3 Which transformer will you select if the average load on the transformer will be 75%? (1)
[20]

AND/OR

QUESTION 5

5.1 A good hoist raises a 320 kg load over 36 m by means of a rope with a mass of 1 kg/m. The drum of the hoist has a mass of 100 kg, a radius of gyration of 350 mm, and an effective diameter of 900 mm. The maximum speed of the hoist is 6 m/s and the load is accelerated at a constant of 1,8 m/s^2.

Determine the power demand of the motor immediately prior to the end of the acceleration period. (10)

5.2 Name 10 safety rules that must be observed when servicing a goods hoist. (10)
[20]

AND/OR

QUESTION 6

6.1 A dragline is powered by a direct current, 40 kW, 550 V, 750 rpm series motor. This motor draws 76 A at its rated load. Its armature resistance is 0,35 Ω, and the resistance of the series-field is 0,15 Ω.

The speed of the skip of the dragline, when the motor is running at its rated load, is 0,5 m/s.

A new skip of changed volume and shape is fitted to the dragline. The speed of the skip is found to be reduced to 0,36 m/s, and the motor current drawn increases to 114 A.

Determine for the motor, with the new skip fitted to the dragline, the percentage:

6.1.1 Change in torque produced. (11)

6.1.2 Power overload. (3)

6.2 Name SIX factors that must be considered when selecting an electrical cable. (6)
[20]

AND/OR

QUESTION 7

7.1 A 50 mm diameter pipe was used to measure the viscosity of crude oil having a relative density of 0,93. During the test, a pressure difference of 17,25 kN/m^2 was noted over a 6 m length of pipe. The measured rate of flow was 524 kg in 180 seconds.

Determine the dynamic and kinetic viscosity. (10)

7.2 Name FOUR basic stages that are performed at crude oil refineries until the final product emerges. (4)

7.3 You have a conveyor belt that supplies gypsum to a silo.

Name TWO safety devices that must be installed to protect persons who are working near the conveyor belt from getting caught in the moving parts. (2)

7.4 SANS 484-1 and SANS 484-2 present two methods to join the conventional splicing of textile-reinforced multi-ply rubber-covered conveyor belting, namely the hot-splicing method and the cold-splicing method.

Give a description of both methods. (4)
[20]

AND/OR

QUESTION 8

8.1 Describe the major cause of explosions in screw type (Lysholm) air compressors. Detail control measures to prevent such explosions. (4)

8.2 An uncooled Lysholm compressor aspirates air at a pressure of 103,4 kPa and a temperature of 15 °C and delivers at a pressure of 207 kPa.

Determine the isentropic work done per m^3 free air as well as the final temperature of the air.

Take $\gamma = 1,4$

$$W = \frac{\gamma}{\gamma-1} \cdot p_1 V_1 \cdot \left[r_p^{\left(\frac{\gamma-1}{\gamma}\right)} - 1 \right]$$ (6)

8.3 A 300 kW, 400 V (line-to-line) 50 Hz, star-connected 6-pole squirrel-cage induction motor has a full-load efficiency of 93% and a power factor of 90%. The motor constants in ohms per phase referred to the stator are:

$X_1 = 0,06$, $X_2 = 0,6$, $X_\varphi = 2,5$, $R_1 = 0,0073$, and $R_2 = 0,0064$

While the motor is operating in the steady state under rated conditions, a 3-phase short-circuit occurs on its supply line near the motor terminals.

8.3.1 Determine the motor rms short-circuit current. (8)

8.3.2 State the reason why the electric transients in the induction machines are often neglected. (2)

TOTAL SECTION B: 40
GRAND TOTAL: 100

PLANT ENGINEERING: FACTORIES

INFORMATION SHEET

$P = \sqrt{3}\, VI \cos\theta$	$t = \frac{2A}{C_d a \sqrt{2g}} (H_1^{0.5} - H_2^{0.5})$
Per unit voltage regulation = $\frac{I_2 (R_e \cos\theta_2 + X_e \sin\theta_2)}{V_1}$	$P_{cr} = \frac{c\pi^2 EI}{L^2}$ (Euler)
$Q = \frac{K \times 2 \times \pi \times L \times (t_1 - t_2)}{\ln \frac{r_2}{r_1}}$	$P_{cr} = \frac{\sigma A}{1 + I/ca\,(L/K)^2}$ (Rankine)
$Q = mC\Delta t$	$C = \frac{\sigma_c}{2} bn$
$P = (T_1 - T_2)\, v$	$T = \sigma_s A_s$
$pv = mRT$	$\frac{n}{d-n} = m \frac{\sigma_c}{\sigma_e}$
$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$	$\Delta P = \frac{32\, \mu L v}{D^2}$
$t_m = \frac{\Delta t_{in} - \Delta t_{out}}{\ln \frac{\Delta t_{in}}{\Delta t_{out}}}$	$z = \frac{\pi (D^4 - d^4)}{32.D}$
$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$	$I = \frac{\pi (D^4 - d^4)}{64}$
$x = \sqrt{\frac{P_i}{P_c}}$	