higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

N1640**(E)**(N14)H
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

PLANT ENGINEERING: FACTORIES

(8190316)

14 November 2016 (X-Paper)
09:00–12:00

CLOSED-BOOK EXAMINATION

Only nonprogrammable calculators may be used.

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
PLANT ENGINEERING: FACTORIES
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. 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. ALL calculations must be shown.
6. NO marks will be given for calculations in which the steps cannot be clearly followed or for work completed in pencil.
7. Candidates are expected to make reasonable assumptions where necessary and these, together with any formulae used, must be clearly stated.
8. Rule off on completion of each question before starting the answer to a new question.
9. Candidates who were NOT accepted by the Commission will be disqualified.
10. NO candidate may leave the examination room before one hour has elapsed.
11. Cellphones are NOT allowed in the examination room.
12. Write neatly and legibly.

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SECTION A (COMPULSORY)

QUESTION 1

1.1 Give THREE reasons for water treatment in a steam generator. (3)

1.2 Name ONE advantage and ONE disadvantage of using steam for soot blowers in a steam generator. (2)

1.3 A solution must be heated from 20 °C to 80 °C at a rate of 2,1 t/h in a tubular contraflow heat exchanger. Hot air enters the exchanger at 350 °C at a rate of 2,36 t/h. The specific heat capacity of the hot air is 1,05 kJ/kg.K. The heat transfer coefficient of gas to metal is 34 W/m^2K and of metal to water 6,2 kW/m^2. The temperature drop through the metal is neglected. The specific heat capacity and density of the solution is 3,8 kJ/kg.K and 1,21 t/m^3 respectively.

Calculate the following:

1.3.1 Number of 25 mm inner diameter tubes required if the solution velocity is limited to 17 mm/s (8)

1.3.2 Length of the tubes (7)
[20]

QUESTION 2

2.1 The primary and secondary windings of a 500 kVA transformer have resistances of 0,42 Ω and 0,0011 Ω respectively. The primary and secondary voltages are 6 600 V and 400 V respectively and the iron loss is 2,9 kW.

Assume the power factor of the load to be 0,8 and calculate the efficiency on:

2.1.1 Full load (7)

2.1.2 Half load (3)

2.2 Name FIVE stages, from manufacturing until use, where the integrity of a power transformer needs to be verified. (5)

2.3 Give THREE main reasons why oil is used in power transformers. (3)

2.4 Name TWO cooling methods for power transformers. (2)
[20]

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QUESTION 3

3.1 The *Occupational health and safety management systems (OHSAS 18002: 2011) – Guidelines for the implementation of OHSAS 18001*, is a guideline for the implementation of OHSAS 18001. The procedures for hazard identification and risk assessment shall take into account routine and nonroutine activities.

3.1.1 Name FOUR other aspects that must also be taken into account when establishing the procedures. (4)

3.1.2 State FOUR considerations, in the correct order, to be followed after elimination to reduce risks when determining controls or considering changes to existing controls. (4)

3.2 You intend to purify the oil of a power transformer.

Write a procedure which must include the following:

3.2.1 Documents to be checked

3.2.2 Equipment needed

3.2.3 Precautionary measures

3.2.4 Actual activities

3.2.5 Final checks

(12)
[20]

TOTAL SECTION A: 60

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SECTION B

Answer any TWO of the following questions.

QUESTION 4

4.1 A factory takes 900 kVA at a lagging power factor of 0,6. A synchronous motor is to be installed to raise the power factor to 0,9 lagging when the motor is taking 300 kW.

Calculate the corresponding kilovolt-amperes (kVA) taken by the synchronous motor and the power factor at which the motor will be operating. (10)

4.2 Where a generating set is intended to operate in parallel with a main supply, or where two or more generating sets may operate in parallel, circulating harmonic currents shall be limited so that the thermal rating of the conductors is not exceeded.

Name FIVE methods to reduce the circulating harmonic currents. (5)

4.3 Name FIVE requirements for the positioning of distribution boards in an electrical installation. (5)

[20]

QUESTION 5

A surface condenser handles 5 400 kg/h steam of dryness factor 0,8, vacuum gauge 660 mm Hg and barometer 740 mm Hg. Air leakage in is 0,9 kg/1 000 kg with steam handled. Temperature of condensate and at air suction pipe is 39 °C each. Cooling water enters at 18 °C and leaves at 41 °C.

Calculate the following:

5.1 Cooling water in kg/min (6)

5.2 Capacity of air pump in m^3/min if volumetric efficiency is 85% (7)

5.3 Capacity of air pump in m^3/min if air is cooled to 22 °C before being pumped from condenser: efficiency is 85% (3)

5.4 Percentage saving in pump volume due to cooling air from 39 °C to 22 °C (1)

5.5 The mass of steam extracted with the air at 22 °C in kg/min (3)

[20]

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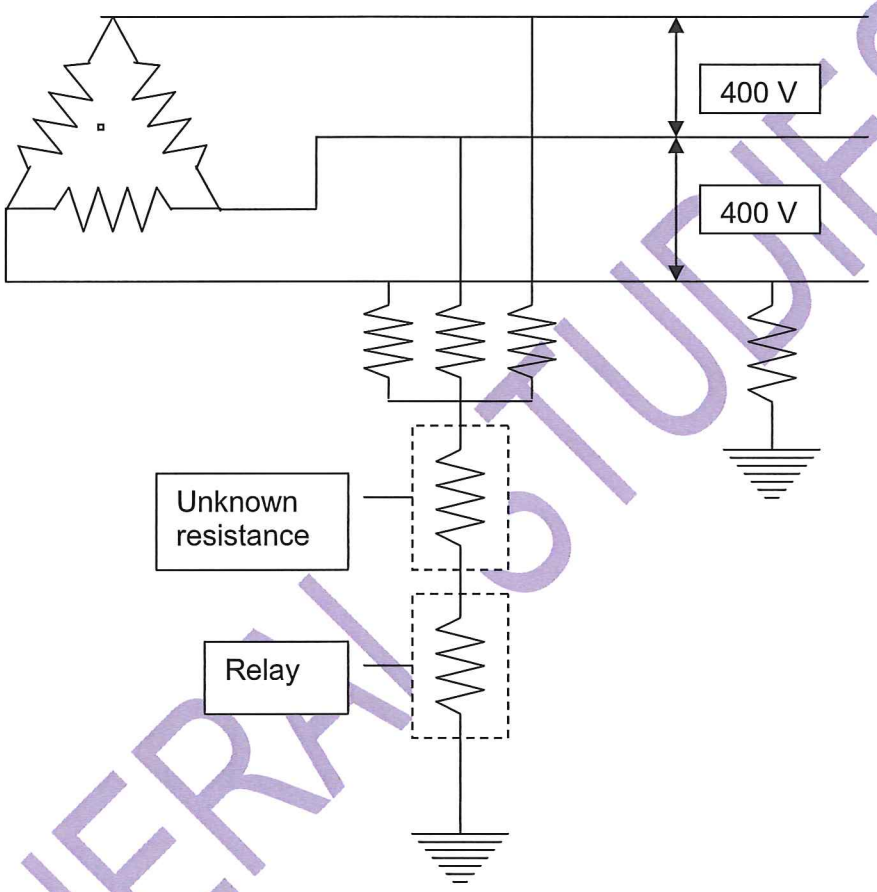
QUESTION 6

6.1 A transformer, the line voltage of which is 400 volts, is provided with earth fault protection. The impedance of resistance between each phase and earth is 3 kΩ, while the minimum reliable pick-up current of the relay is 25 mA for a zero impedance earth fault.



Calculate the resistance, in series with the relay, which will permit double the minimum pick-up current to flow through the relay. (12)

6.2 Name FIVE measures that may be taken to provide protection for the person operating electrical switchgear in case of internal arcing. (5)

6.3 A parabolic concentrating solar power plant equipped with a heat storage system is used to generate electricity.

Name any THREE of the transitional phases involved. (3)
[20]

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QUESTION 7

7.1 A steel chimney for the steam generator that is to be subjected to a horizontal wind pressure equal to 960 Pa on one side, needs to be replaced. A steel pipe with an outside diameter of 1,5 m and inside diameter of 1,46 m is available for this purpose. The density of the steel is 7 830 kg/m^3 and g = 9,81 m/s^2.

Determine the maximum permissible height of the chimney if the maximum stress in the steel at the base is 16 MPa. (10)

7.2 The pipes used for transporting fluidised coal from the crushing plant to the boiler need to be lined with ceramic.

Name FIVE advantages and FIVE limitations of using ceramic. (10)
[20]

QUESTION 8

8.1 A 300 kW, 400 V (line-to-line), 50 Hz, Y-connected, six-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 refering to the stator are X_1 = 0,06, X_2 = 0,6, X_φ = 2,5, R_1 = 0,0073 and R_2 = 0,0064.

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

8.1.1 Determine the motor RMS short-circuit current. (8)

8.1.2 Give the reason why the electric transients in the induction machines are often neglected. (2)

8.2 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)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

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INFORMATION SHEET

$P = \sqrt{3}\, VI \cos\theta$	$t = \frac{2A}{C_d a \sqrt{2g}} (H_1^{0,5} - H_2^{0,5})$
$Q = mC\Delta t$	$C = \frac{\sigma_c}{2} bn$
$P = (T_1 - T_2)\, v$	$T = \sigma_s A_s$
$pv = mRT$	$\frac{n}{d-n} = m \frac{\sigma_c}{\sigma_s}$
$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$	$\Delta P = \frac{32 \mu L v}{D^2}$
$t_m = \frac{\Delta t_{in} - \Delta t_{out}}{\ln \frac{\Delta t_{in}}{\Delta t_{out}}}$	$z = \frac{\pi (D^4 - d^4)}{32.D}$
$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$	$I = \frac{\pi (D^4 - d^4)}{64}$

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