higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1640**(E)**(N12)T

NON-NATIONAL CERTIFICATE
ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: FACTORIES

(8190316)

12 November 2018 (X-Paper)
09:00–12:00

CLOSED-BOOK EXAMINATION

REQUIREMENTS: Steam tables

Alpha-numerical or programmable calculators may NOT be used.

Only nonprogrammable calculators may be used.

PLANTENGF

This question paper consists of 6 pages and 1 formula sheet.

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. All work you do not want to be marked must be clearly crossed out.

INSTRUCTIONS AND INFORMATION

1. SECTION A is compulsory.
2. Answer any TWO questions in SECTION B.
3. Number the answers according to the numbering system used in this question paper.
4. Pencils may not be used.
5. Rule off on completion of each answer.
6. Calculations must be clearly shown to receive marks.
7. Candidates should make reasonable assumptions where necessary and these, together with any formulae used, must be clearly stated.
8. Candidates who were NOT accepted by the Commission will be disqualified.
9. NO candidates may enter the examination room later than half an hour after the start of the examination and NO candidate may leave the examination room before ONE hour has elapsed.
10. Cellphones are NOTallowed in the examination room.
11. Work neatly.

SECTION A (COMPULSORY)

QUESTION 1

1.1 Name FIVE defects or conditions on the water or steam side of a steam generator that should be checked during a periodic internal inspection. Also state the corrective action for each defect. (10)

1.2 A steam generating plant consists of an economiser, an evaporator, a superheater and an air preheater. The feed water temperature entering and leaving the economiser is 44 °C and 175 °C respectively. The air for combustion is heated in the air preheater from 15 °C to 150 °C. The steam pressure is 3 000 kPa. At the entrance to the superheater the dryness factor of the steam is 0,98 and at the superheater outlet the temperature of the steam is 250 °C. The heat value of coal is 31,8 MJ/kg. The air/fuel ratio is 20:1. The steam is generated at a rate of 9,5 kg/kg coal.

C_p for air = 1,005 kJ/kg K
C_p for flue gas = 1,045 kJ/kg K

Calculate the heat transfer per kg of fuel in each component of the plant. (10)
[20]

QUESTION 2

2.1 Two transformers, A and B, are both rated at 40 kVA. The core losses in A and B are 500 W and 250 W respectively, and the full-load copper losses are 500 W and 750 W respectively.

Tabulate the losses and efficiency at quarter, half and full load for a power factor of 0,8. Also find the load at which the efficiency is at maximum for each transformer. (13)

2.2 Name FOUR of the most common over-voltage protection devices used to protect a transmission system from severe over-voltages (such as lightning or fault conditions). (4)

2.3 Explain and discuss the levelised cost of electricity (LCOE). (3)
[20]

QUESTION 3

3.1 The competent person must establish an Occupational Health and Safety Management System (OHSMS).

3.1.1 State SIX items to consider for the planning stage of an OHSMS. (6)

3.1.2 One of the sections under the implementation and operation of the OHSMS is Resources, Roles, Responsibility and Accountability.

Name TWO other sections and briefly discuss each. (6)

3.2 You have a workshop on the premises for general maintenance of light delivery vehicles. One of the activities is to replace the exhaust system on these vehicles.

You must carry out a hazard identification risk assessment (HIRA) on the above activity.

Name FOUR hazards and rate each hazard according to the formula risk = severity × likelihood. (8)

[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions in SECTION B.

QUESTION 4

4.1 The main functions of a lubricant is to reduce friction and wear between moving parts and to save fuel or energy.

State FOUR additional functions of a lubricant and briefly describe each one. (8)

4.2 A leather belt connects a 1,2 m diameter pulley on a shaft running at 250 r/min with another pulley running at 500 r/min, the angle of lap on the latter being 175°. The maximum permissible load in the belt is 1,35 kN, and the coefficient of friction between the belt and the pulley surface is 0,25.

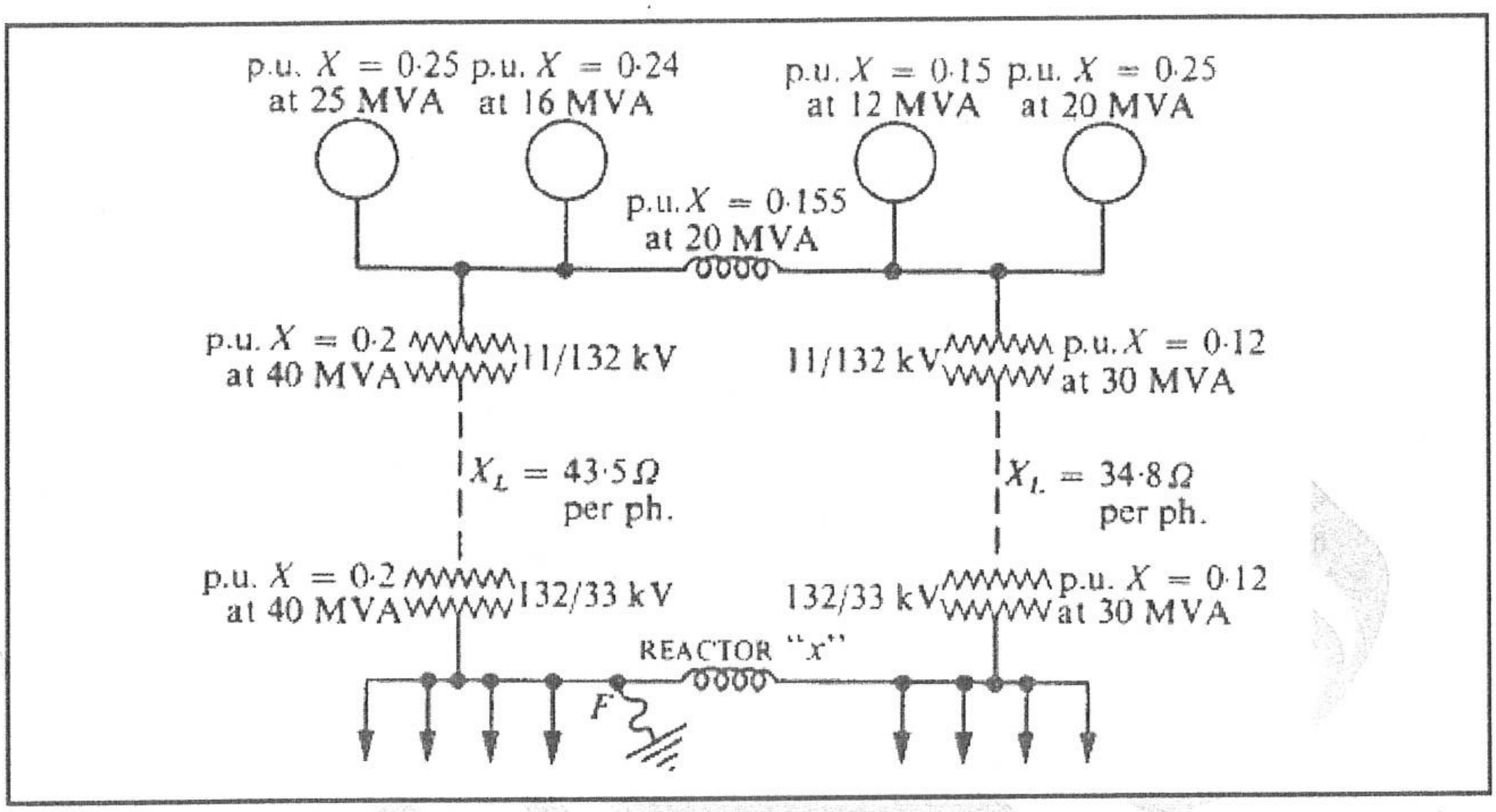
What is the maximum power the belt should transmit if the initial tension in the belt may have any value between 900 N and 1100 N? (12)

[20]

AND/OR

QUESTION 5

A three-phase 50 Hz system in which 33 kV busbars are supplied by four 11 kV alternators through two parallel overhead 132 kV transmission lines is represented by the diagram below.



DIAGRAM

Calculate the reactance per unit and the inductance per phase of reactor X so that the current in the three-phase symmetrical short circuit at F does not exceed 1 750 A. Use a 20 MVA base. (20)

[20]

AND/OR

QUESTION 6

6.1 A rectangular tank with a capacity of 12 m^3 has a discharge orifice close to the bottom of the tank. The diameter of the orifice is 0,025 m. The area of the tank is 4 m^2 and the value of C_d for the orifice is 0,62.

How long will it take to tap 6 000 ℓ into a tanker below the outlet, assuming the tank was full? (10)

6.2 A fan which ventilates a foundry runs at 500 r/min, and the air flow is measured at 150 m^3/s when the pressure developed across is 0,85 kPa the natural ventilation pressure in the foundry is 0,4 kPa. The foundry requires only 100 m^3/s air flow on Sundays and the fan is to be slowed down to meet the requirements. The efficiency remains 75%.

6.2.1 Determine the new speed required for Sundays.

6.2.2 Calculate the annual savings in electricity costs if the tariff is R 0,86/kWh.

(2 × 5) (10)
[20]

AND/OR

QUESTION 7

7.1 The results below were obtained on a 50 kVA transformer.
Open-circuit test:
- Primary voltage of 3 300 V
- Secondary voltage of 400 V
- Primary power of 430 W

Short-circuit test:
- Primary voltage of 124 V
- Primary current of 15,3 A
- Primary power of 525 W
- Secondary current, full-load value

Calculate each of the following:

7.1.1 Efficiency at full load and at half -load for power factor OF 0,7 (5)

7.1.2 Voltage regulations for power factor of 0,7:

(a) Lagging
(b) Leading (5)

7.1.3 Secondary terminal voltage corresponding to (a) and (b). (2)

7.2 A new plant is supplied by an 11 kV overhead power line. The voltage is reduced to 400 V in the substation.

Give EIGHT safety checks for the MV part of the installation on the test report that should be done before a certificate of compliance can be issued. (8)
[20]

AND/OR

QUESTION 8

8.1 You have implemented a predictive maintenance programme at the factory. One of the critical equipment is the distribution boards. Handheld test tools are used.

Name FIVE key indicators to look for and also state each type of instrument you will use to detect these indicators. (10)

8.2 Name THREE types of turbines and give the common use of each type. (6)

8.2 Name FOUR factors that can contribute to water hammering. (4)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

FORMULA SHEET

$P = \sqrt{3}\ V\ I\ \text{Cos}\ \theta$

$Q = mC\Delta t$

$P = (T_1 - T_2)\ v$

$P = mgL\text{Sin}\ \theta$

$P = \mu mgL$

$M = f\ z$

$hf = \dfrac{4fLv^2}{2gd}$

$h = k\dfrac{v^2}{2g}$

$pv = mRT$

$\dfrac{M}{I} = \dfrac{\sigma}{Y} + \dfrac{E}{R}$

$M = \dfrac{wL^2}{2}$

$M = WL$

$M = \sigma Z$

$\dfrac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$

$Z = \dfrac{I}{Y}$

$I_{xx} = \dfrac{\pi(D^4 - d^4)}{64}$

$h = \dfrac{4\text{Sin}\ \emptyset/2}{\emptyset + \text{Sin}\emptyset} \times R$

$T/h = CW^2\rho v$

$Q = \dfrac{UA(\emptyset_1 - \emptyset_2)}{\text{Ln}(\emptyset_1/\emptyset_2)}$

$W = \dfrac{n}{n-1} P_1V_1\{(P_2/P_1)\exp[(n-1)/n] - 1\}$

$V_{sphere} = \dfrac{\pi D^3}{6}$

$\Delta V_{sphere} = \dfrac{\pi PD^4}{8tE} \times (1 - v)$