higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: FACTORIES

(8190316)

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CLOSED-BOOK EXAMINATION

Alpha-numerical or programmable calculators may not be used.
Nonprogrammable calculators may be used.

This question paper consists of 6 pages and an information sheet.

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SECTION A (COMPULSORY)

QUESTION 1

1.1 Name FIVE defects or conditions to check inside a fire-tube steam generator (coal fired) on the fire side when carrying out a periodic internal inspection and discuss corrective actions to be taken. (10)

1.2 A steam generator generates steam at an average rate of 50 000 kg/hour at a pressure of 3 000 kPa. The blow down is 10% of the steam generator's feedwater. The fuel consumption is 8 000 kg of coal per hour with a heating value 20 000 kJ/kg.

What fuel saving in kilogram of coal per year will result from the installation of a blowdown heat-recovery system which will reduce the blowdown water temperature to 39 °C?

STEAM PROPERTIES

P	t_s	v_g	h_f	h_{fg}	h_g	s_f	s_g
kPa	°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K
7	39	20,53	163	2 410	2 573	0,559	8,277
3 000	233,8	0,06663	1 008	1 794	2 802	2,646	6,184

(10)
[20]

QUESTION 2

A three phase, 6 600 V feeder supplies power exclusively to a pump station consisting of a number of pump and motor units. When all the original pump and motor units operate simultaneously the feeder carries a load of 1 000 kVA at a power factor of 0,8 lagging.

An additional 600 kVA synchronous motor is installed in the pump station to drive an extra pump. When run unloaded this motor absorbs 60 kW. The pump to be powered by the synchronous motor requires 270 kW to drive it. When delivering 270 kW the motor is 90% efficient.

2.1 Calculate, when all the original pumps are in operation and the synchronous motor is driving its pump, the

2.1.1 total line current in the feeder (10)

2.1.2 the power factor of the feeder at the pump station (1)

2.2 When all the original pumps are in operation and the synchronous motor is uncoupled from its pump and runs unloaded, determine the

2.2.1 total line current in the feeder (8)

2.2.2 power factor of the feeder at the pump station (1)
[20]

QUESTION 3

3.1 The SANS/ISO 45001:2018: Occupational Health and Safety Management System is a good document and the enforcement thereof is very important to enhance compliance to the Occupational Health and Safety Act.

What can be done to enforce compliance to the SANS/ISO 45001:2018: Occupational Health and Safety Management System? (4)

3.2 In the case of non-routine activities in SANS/ISO 45001:2018, workers have to be trained on the changes incorporated in the infrastructure, equipment, materials, physical conditions of the workplace and hazards arising from these changes. If the situation persists for a longer period, should these non-routine activities be considered as having become routine? Substantiate your answer. (3)

3.3 Based on SANS/ISO 45001:2018, give THREE examples of harassment. (3)

3.4 A gas monitor wat used to detect a leak during the normal operation of an electric generator that is cooled by hydrogen gas. The generator needs to be shut down to detect the origin of the leak and to repair it. Draw up a working procedure on how to make the generator safe for the repairs to be done. (10)
[20]

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions in SECTION B.

QUESTION 4

4.1 A truck is fitted with an A-frame of which the legs are hinged to the truck at their lower ends and joined together at their upper ends to form an apex to which one end of the cable from the winch is fixed. A load of 4 kN is suspended from the apex with an overhang of 800 mm. Each of the legs is 2,5 m long and their lower ends are 1,5 m apart. Calculate the force in the cable and in each leg. (12)

4.2 You need to investigate an incident where the goods hoist rope broken. Compile a list of FOUR possible causes why the rope failed and how one would investigate each cause. (8)
[20]

QUESTION 5

5.1 A single-phase transformer has 1 000 turns on the primary and 200 turns on the secondary winding. The no-load current is 3 A at a power factor 0,2 lagging. Calculate the primary current and power factor when the secondary current is 280 A at a power factor of 0,8 lagging. Assume the voltage drop in the windings to be negligible. (10)

5.2 Give TWO requirements for the installation of cables for circuits that operate at voltages exceeding 1 000 V. (2)

5.3 Name FIVE items that must be visually inspected on a transformer annually. (5)

5.4 What are the THREE main purposes for using oil inside transformers? (3)

[20]

QUESTION 6

6.1 A shrink fit is to be used to secure a steel boss of 100 mm outer diameter and 50 mm length on a hollow steel shaft of 50 mm outer diameter and 20 mm inner diameter. A phosphor bronze gear that must transmit 90 kW and has a 150 mm pitch circle diameter is to be bolted to the boss.

The tensile stress caused by the shrink fit must be limited to 85 MPa. The steel on steel coefficient of friction between shaft and boss is taken as 0,28. For both shaft and boss Poisson's ratio is 0,3 and Young's modulus 200 GPa.

Determine the

6.1.1 Smallest permissible inner diameter of the boss (14)

6.1.2 Lowest speed at which the shaft can rotate to transmit 90 kW (6)

[20]

QUESTION 7

7.1 Name FOUR factors that will change the characteristics of insulation oil inside a switchgear when in use. (4)

7.2 How is energy saved in the lift and escalator industry? (3)

7.3 A battery of 120 cells with an overcharge current, I, of 17 A, is mounted on a stand where the battery and stand occupy approximately 3 m^3 in a room with dimensions 4 m × 2 m × 3 m.

7.3.1 Calculate the concentration of gas in the room after 1 hour.

$V = N \times I \times 0{,}00045\ m^3$ (3)

7.3.2 If the concentration of hydrogen is below 0,8%, what should the change rate be? (3)

7.4 Name the FOUR most common types of batteries that used for uninterrupted power supplies. (4)

7.5 You have an electrical motor in a hazardous location with the following information on the motor data plate:

E Ex de IIB T4 Gb

Explain the meaning of the following letters or numbers used on the product:

7.5.1 E

7.5.2 Ex

7.5.3 de

7.5.4 II

7.5.5 B

7.5.6 T4

(½ × 6) (3)
[20]

QUESTION 8

8.1 A standby three-phase, 600 kVA alternator has a rated terminal voltage of 3 300 V (line). The stator winding is star-connected and has a resistance of 0,37 Ω/phase and a synchronous impedance of 4,3 Ω/phase. Calculate the voltage regulation for a load with a power factor of

8.1.1 unity (6)

8.1.2 0,8 lagging (4)

8.2 A straight conveyor belt at a gypsum factory is inclined at 15° to the horizontal and has a length of 76 m between loading and discharge point. The conveyor travels at 1,1 m/s. The angle of wrap round the tandem pulleys is 420° and the coefficient of friction is 0,3. If the slack side tension is maintained at 3 150 N by means of a counter-weight and there is a 5% loss due to friction in the idlers, calculate the maximum hourly rate in kg that could be transported by the belt. (10)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

INFORMATION SHEET

$P = \sqrt{3}\ VI \cos\theta$	$t = \frac{2A}{C_d\, a \sqrt{2g}} (H_1^{0,5} - H_2^{0,5})$
$Q = mC\Delta t$	$C = \frac{\sigma_c}{2} bn$
$P = (T_1 - T_2)\ v$	$T = \sigma_s A_s$
$pv = mRT$	$\frac{n}{d-n} = m \frac{\sigma_c}{\sigma_s}$
$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$	$\Delta P = \frac{32\,\mu L\, v}{D^2}$
$t_m = \frac{\Delta t_{in} - \Delta t_{out}}{\ln \frac{\Delta t_{in}}{\Delta t_{out}}}$	$z = \frac{\pi (D^4 - d^4)}{32.D}$
$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$	$I = \frac{\pi (D^4 - d^4)}{64}$
$x = \sqrt{\frac{P_i}{P_c}}$	$\frac{p_1}{w} + \frac{{v_1}^2}{2g} = \frac{p_2}{w} + \frac{{v_2}^2}{2g}$