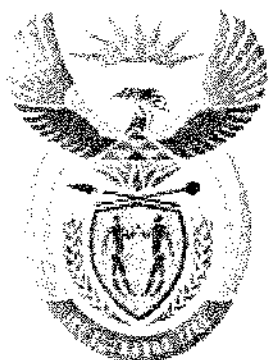


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# higher education & training

Department:  
Higher Education and Training  
REPUBLIC OF SOUTH AFRICA

T1310(E)(N26)N  
**NOVEMBER EXAMINATION**  
**NATIONAL CERTIFICATE**  
**POWER MACHINES N5**

(8190035)

**26 November 2014 (Y-Paper)**  
**13:00–16:00**

**REQUIREMENTS:** Steam Tables (BOE 173).  
Superheated Steam Tables (Appendix to BOE 173).

**Calculators may be used.**

**This question paper consists of 5 pages and a formula sheet of 3 pages.**

**DEPARTMENT OF HIGHER EDUCATION AND TRAINING**  
**REPUBLIC OF SOUTH AFRICA**  
NATIONAL CERTIFICATE  
POWER MACHINES N5  
TIME: 3 HOURS  
MARKS: 100

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**INSTRUCTIONS AND INFORMATION**

1. Answer ALL the questions.
  2. Read ALL the questions carefully.
  3. Number the answers according to the numbering system used in this question paper.
  4. Write neatly and legibly.
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**QUESTION 1**

- 1.1 State THREE advantages of a condenser. (6)
- 1.2 Every hour a surface condenser processes 6 500 kg exhaust steam, which has a dryness fraction of 0,83. Air leakage into the condenser is at a rate of 1,2 kg/1 000 kg of steam. The air pump suction pipe and the condensate have a temperature of 31 °C each. The barometer and vacuum gauge reading is 760 mm Hg and 662 mm Hg respectively. The temperature of the cooling water is increased by 21 °C after it passes through the condenser. The specific heat capacity of the water is 4 187 kJ/kg.K and R for air is 0,288 kJ.kg.K.
- Calculate the following:
- 1.2.1 The mass of cooling water required by the condenser every minute (8)
- 1.2.2 The capacity of the air pump in m<sup>3</sup>/min (6)
- [20]

**QUESTION 2**

- 2.1 A certain gas has a density of 1,28 kg/m<sup>3</sup> at 200 kPa and 267 °C. The law,  $PV^{1,29} = C$ , is used to expand 0,7 kg of this gas to 2,5 times its original volume, from 200 kPa and 267 °C.
- Calculate the following:
- 2.1.1 The characteristic gas constant (3)
- 2.1.2 The original and final volume of the gas (6)
- 2.1.3 The final pressure of the gas (3)
- 2.1.4 The final temperature of the gas (3)
- 2.1.5 The work done during the expansion (3)
- 2.2 State the function of a governor. (2)
- [20]

**QUESTION 3**

Gas leaves a single-stage impulse turbine at an angle of  $41^\circ$ . Friction over the blading causes a 10% loss in velocity. The relative velocity of the gas at the inlet to the blades is 350 m/s at an angle of  $30^\circ$ . The blade experiences a peripheral velocity of 175 m/s, when 50 kg of gas flows through the turbine every second.

- 3.1 Use a scale of 1 cm = 25 m/s and construct a velocity diagram in the ANSWER BOOK. Enter ALL the values (m/s) onto the diagram.

NB: NO marks will be awarded if the values (m/s) are NOT entered onto the diagram and if the diagram is NOT constructed to the given scale. (11)

HINT: Use the answer page in the landscape format to construct the diagram.

- 3.2 Determine the following from the diagram:

- 3.2.1 The nozzle angle (1)  
 3.2.2 The nozzle velocity (1)  
 3.2.3 The exit angle of the moving blades (1)  
 3.2.4 The axial thrust (3)  
 3.2.5 The power developed (3)  
**[20]**

**QUESTION 4**

- 4.1 18,04 kg of air is used for the complete combustion of a kilogram of fuel.

The fuel has the following composition:

Carbon = 87%

Hydrogen = 2,5%

Sulphur = 1%

The balance of the fuel is non-combustible.

Calculate the percentages of the products of combustion. (18)

- 4.2 Regulation C112 provides for the access and inspection openings of boilers.

Name TWO reasons for these openings. (2)

**[20]**

**QUESTION 5**

- 5.1 A single-stage, double-acting, compressor must deliver  $16 \text{ m}^3$  of air every minute. The compressor receives the air at  $101,3 \text{ kPa}$  and  $20^\circ\text{C}$  and delivers it at a pressure of  $900 \text{ kPa}$ . The effective volume is  $0,94$  of the swept volume, and the speed of the compressor is  $375 \text{ r/min}$ . The index of compression is  $1,3$  and the mechanical efficiency is  $79\%$ .

Calculate the following:

- 5.1.1 The volumetric efficiency (3)
- 5.1.2 The swept volume (4)
- 5.1.3 The temperature of the delivered air (3)
- 5.1.4 The power required to drive the compressor (6)
- 5.2 Regulation C97.7 refers.

State the hydraulic test pressure for the following boilers:

- 5.2.1 Boilers which do NOT exceed the working gauge pressure of  $500 \text{ kPa}$ .
- 5.2.2 Boilers which exceed the working gauge pressure of  $500 \text{ kPa}$ . (2 x 2) (4)
- [20]

**TOTAL: 100**

## FORMULA SHEET

1.  $Q = W + \Delta U$
2.  $\Delta U = mC_v \Delta T$
3.  $Q = mC_v \Delta T$
4.  $Q = mC_p \Delta T$
5.  $Q = P_1 V_1 \ln \frac{V_2}{V_1}$
6.  $\Delta S = m \left( C_v \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1} \right)$
7.  $W = P_1 \Delta V$
8.  $W = P_1 V_1 \ln \frac{V_2}{V_1}$
9.  $W = \frac{P_1 V_1 - P_2 V_2}{n-1}$
10.  $W = \frac{P_1 V_1 - P_2 V_2}{\gamma-1}$
11.  $R = C_p - C_v$
12.  $\gamma = \frac{C_p}{C_v}$
13.  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
14.  $PV = mRT$
15.  $P_1 V_1 = P_2 V_2$
16.  $P_1 V_1^n = P_2 V_2^n$
17.  $\frac{T_2}{T_1} = \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}} = \left( \frac{V_1}{V_2} \right)^{n-1}$
18.  $\frac{T_2}{T_1} = \left( \frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} = \left( \frac{V_1}{V_2} \right)^{\gamma-1}$
19.  $h = h_f + x h_{fg}$
20.  $h = h_g + C_p \Delta T$
21.  $h = h_f + h_{fg} = h_g$
22.  $V_{\text{sup}} = \frac{n-1}{n} \left( \frac{h_{\text{sup}} - 1941}{P} \right)$
23.  $x = \frac{V_{\text{sup}}}{V_g}$
24.  $x = \frac{M}{M+m}$
25.  $U = H - PV$
26.  $gZ_1 + U_1 + P_1 V_1 + \frac{1}{2} C_1^2 + Q =$   
 $gZ_2 + U_2 + P_2 V_2 + \frac{1}{2} C_2^2 + W$
27.  $\eta = \frac{\dot{m}_s (h_2 - h_1)}{\dot{m}_f CV}$
28.  $EE = \frac{\dot{m}_s (h_2 - h_1)}{\dot{m}_f 2257}$
29.  $p = (B_m \pm M_m) \frac{101,325}{760}$
30.  $m = \frac{100}{23} \left[ C \frac{8}{3} + 8H_2 + S - O_2 \right]$
31.  $C_x H_y + \left( x + \frac{y}{4} \right) O_2 = xCO_2 + \frac{y}{2} H_2O$

$$32. \quad H.C.V. = (CV_c.C) + CV_{H_2} \left( H_2 - \frac{O_2}{8} \right) + (CV_s.S)$$

$$33. \quad L.C.V. = H.C.V. - h_{fg}(9H_2)$$

$$34. \quad H.C.V. = \frac{(m_w + w_e)C_p \Delta T}{m_f}$$

$$35. \quad W = P_1 V_c \left( \frac{n}{n-1} \right) \left[ \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right] = mRT_1 \left( \frac{n}{n-1} \right) \left[ \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

$$36. \quad \eta_c = \frac{V_e}{V_s} \cdot 100 = 1 - \frac{V_c}{V_s} \left[ \left( \frac{P_2}{P_1} \right)^{\frac{1}{n}} - 1 \right] = 1 + \alpha - \alpha \left( r_p \right)^{\frac{1}{n}}$$

$$37. \quad \eta_a = \frac{V_a}{V_s} \cdot 100$$

$$38. \quad F_c = m(C_{fe} - C_{ff})$$

$$39. \quad P = mU[C_{wi} - (-C_{we})]$$

$$40. \quad \eta = \frac{2U[C_{wi} - (-C_{we})]}{C_{ai}^2} \cdot 100$$

$$41. \quad KE = \frac{1}{2}mv^2$$

$$42. \quad U = \pi DN$$

$$43. \quad mV = AC$$

$$44. \quad (m + M)g = m\omega^2 h$$

$$45. \quad V_s = \frac{\pi}{4} D^2 L$$

$$46. \quad \theta_1 = t_c - twi$$

$$47. \quad \theta_2 = t_c - two$$

$$43. \quad \log. \text{ temp. diff. } = \frac{\theta_1 - \theta_2}{\ln \frac{\theta_1}{\theta_2}}$$

$$48. \quad P_{iso} = P_1 V_1 \ln \left( \frac{P_2}{P_1} \right)$$

$$49. \quad P_{act} = \frac{n}{n-1} P_1 V_1 \left[ \left( \frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

$$50. \quad \eta_{iso} = \frac{P_{iso}}{P_{act}} \cdot 100$$

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