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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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AUGUST 2010

NATIONAL CERTIFICATE

POWER MACHINES N5

(8190035)

21 July (X-Paper)
09:00 – 12:00

REQUIREMENTS: Steam tables (BOE 173)
Superheated steam tables (Appendix to BOE 173)

Calculators may be used.

Candidates will require drawing instruments, pens and a ruler.

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

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

INSTRUCTIONS AND INFORMATION

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

QUESTION 1

1.1 State FOUR particulars which must be stamped on the shell of every new boiler, as required by law. (4)

1.2 What is meant by the *specific heat capacity* of an object? (2)

1.3 Name TWO types of steam condensers. (2)

1.4 What is meant by the term *adiabatic compression*? (2)
[10]

QUESTION 2

0,225 kg air, at a pressure of 830 kPa and temperature of 536 °C expands adiabatically in a cylinder to a temperature of 148 °C. The specific heat capacity at constant pressure is 1,005 kJ/kg.K and the characteristic gas constant for air is 0,287 kJ/kg.K.

Calculate the following:

2.1 The specific heat capacity at constant volume (3)

2.2 The value of the index of expansion (3)

2.3 The initial volume (3)

2.4 The final pressure (3)

2.5 The final volume (3)
[15]

QUESTION 3

A boiler is to produce 170 kg of steam per minute, at a pressure of 4 MPa and a temperature of 300 °C. The feed water temperature is 43,8 °C, the thermal efficiency of the boiler is 73% and the heat value of the coal is 33,8 MJ/kg.

Calculate the following with the aid of steam tables:

3.1 The mass of coal consumed per hour (9)

3.2 The equivalent evaporation from and at 100 °C (6)
[15]

QUESTION 4

A boiler contains dry saturated steam at a pressure of 1 035 kPa.

Calculate the following, by interpolating, with the aid of steam tables:

4.1 The saturation temperature (5)

4.2 The sensible heat (5)

4.3 The latent heat (5)
[15]

QUESTION 5

A fuel consists of 3% N_2; 1% H_2O; 3% H_2; 86% C; 1% S; 2,5% O_2 and the remainder ash, according to mass. 22% excess air is supplied to ensure complete combustion.

Calculate the following using the formula method:

5.1 The theoretical mass of oxygen required for the complete combustion of 1 kg of fuel (5)

5.2 The theoretical mass of air required for the complete combustion of 1 kg of fuel (3)

5.3 The theoretical air fuel ratio (2)

5.4 The actual mass of air supplied for the complete combustion of 1 kg of fuel (3)

5.5 The actual air fuel ratio (2)
[15]

QUESTION 6

A double-acting, single-stage compressor delivers 12,6 m^3 of air per minute at a pressure of 725 kPa. The mechanical efficiency of the compressor is 78% and the inlet pressure and temperature are 101,3 kPa and 16 °C respectively. The clearance volume is 4,5% of the swept volume and the index of compression is 1,3. The compressor runs at a speed of 330 r/min.

Calculate the following:

6.1 The volumetric efficiency (4)

6.2 The swept volume (3)

6.3 The delivery temperature (3)

6.4 The power required to drive the compressor (5)
[15]

QUESTION 7

The nozzles of a single-stage impulse turbine are positioned at an angle of 22° with the plane of rotation. The gas leaves the nozzles at a velocity of 680 m/s. The diameter of the turbine wheel is 1,25 m and the inlet and outlet angles of the blades are both 36°. The gas enters the blades without shock and flows frictionless over the blades at a rate of 2 500 kg per hour.

7.1 Use scale 1 cm = 50 m/s and construct a velocity diagram in the ANSWER BOOK (landscape) and enter ALL the m/s values onto the diagram. (5)

7.2 Use the diagram and determine the following:

7.2.1 The axial thrust developed by the turbine (2)

7.2.2 The power developed by the turbine (2)

7.2.3 The diagram efficiency (2)

7.2.4 The outlet angle of the gas (1)

7.2.5 The speed of the turbine in r/min (3)
[15]

TOTAL: 100

45. $\theta_1 = t_c - twi$

46. $\theta_2 = t_c - two$

47. $Log.temp.diff. = \dfrac{\theta_1 - \theta_2}{\ell n \dfrac{\theta_1}{\theta_2}}$

48. $P_{iso} = P_1 V_1 \ell n \left(\dfrac{P_2}{P_1} \right)$

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

50. $\eta_{iso} = \dfrac{P_{iso}}{P_{act}} \bullet 100$