higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

POWER MACHINES N5

APRIL 2016

This marking guideline consists of 8 pages.

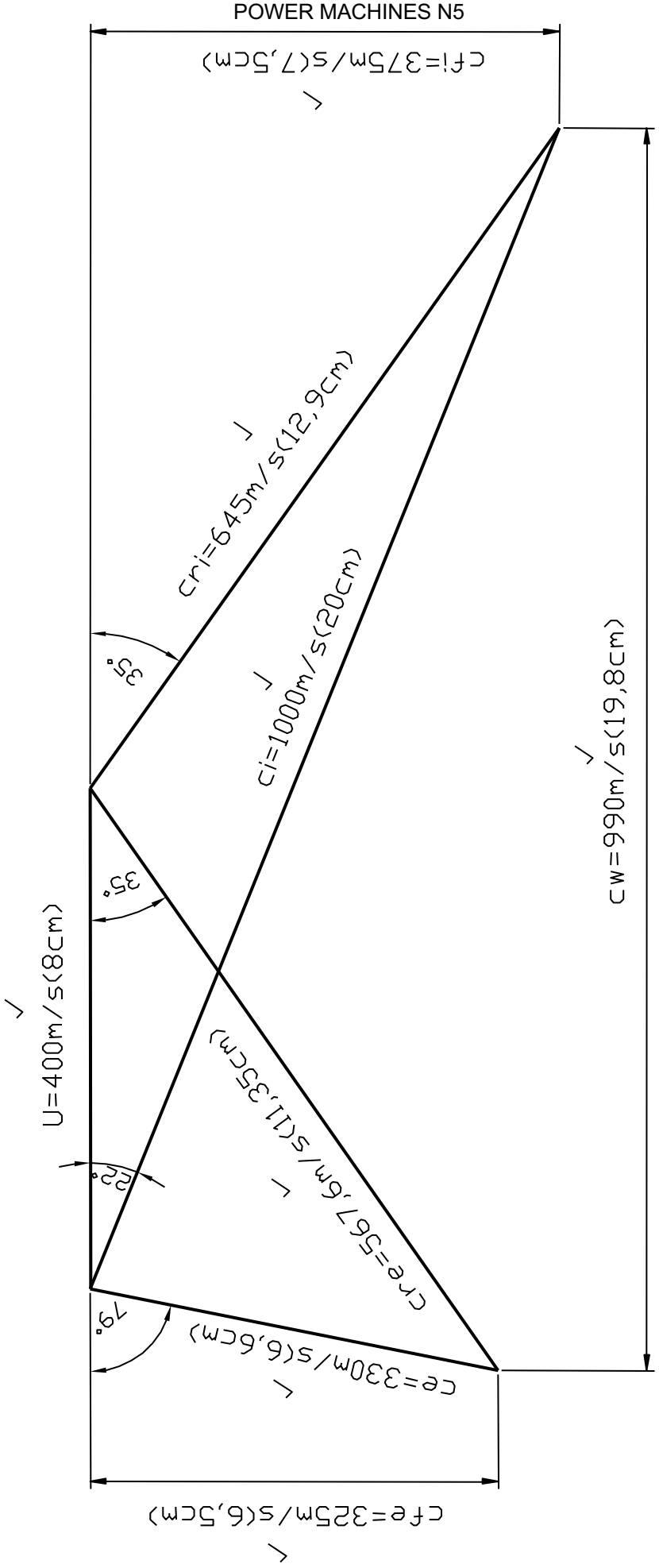
Copyright reserved

QUESTION 1

1.1
$$U = \frac{\pi DN}{60} \quad \checkmark \quad \checkmark$$
$$= \frac{\pi \times 1{,}96 \times 3898}{60}$$
$$= \underline{\underline{400\,m/s}} \quad \checkmark$$
(3)

1.2
$$U = 0{,}4 \times Ci$$
$$\therefore Ci = \frac{U}{0{,}4} \quad \checkmark$$
$$= \frac{400}{0{,}4} \quad \checkmark$$
$$= \underline{\underline{1000\,m/s}} \quad \checkmark$$
(3)

1.3 Diagram on next page.


cfi=375m/s(7,5cm)
cri=645m/s(12,9cm)
ci=1000m/s(20cm)
cw=990m/s(19,8cm)
35°
35°
U=400m/s(8cm)
22°
cre=567,6m/s(11,35cm)
79°
ce=330m/s(6,6cm)
cfe=325m/s(6,5cm)

(8)

1.4 1.4.1 Cri = 645 m/s ✓ (1)

1.4.2 Cre = 567,6 m/s ✓ (1)

1.4.3 Ce = 330 m/s ✓ (1)

1.4.4
$$Fc = m(cfi - cfe)$$
$$= \frac{100}{60}(375 - 325)$$
$$= \underline{\underline{83{,}333\,N}}$$
(3)
[20]

QUESTION 2

2.1 The efficiency of any boiler is defined by the ratio of heat transferred to feed water✓ in converting it to steam ✓divided by the heat supplied ✓ by the complete combustion of the fuel. ✓ (4)

2.2 2.2.1
$$EE = \frac{Total\ Heat\ Transferred}{2257}$$
$$\therefore Total\ Heat = 2257 \times EE \quad ✓$$
$$= 2257 \times 11{,}2 \quad ✓$$
$$= 25278{,}4\,kJ/kg \quad ✓$$

$$\eta = \frac{Total\ Heat}{Calorific\ Value} \times \frac{100}{1} \quad ✓$$
$$= \frac{25278{,}4}{30000} \times \frac{100}{1} \quad ✓$$
$$= \underline{\underline{84{,}26\%}} \quad ✓$$
(6)

2.2.2 $h_1 = 158\,kJ/kg$ ✓

$$Heat\ Gained = Heat\ Lost$$
$$M_s(h_2 - h_1) = Mf \times Cv \times \eta$$
$$h_2 = \frac{Mf \times Cv \times \eta}{M_s} + h_1 \quad ✓$$
$$= \frac{1775 \times 30000 \times 0{,}8426}{18000} + 158 \quad ✓$$
$$= 2650{,}692\,kJ/kg \quad ✓$$

$At\ \ 2500\,kPa\ the\ hg\ for\ dry\ steam\ is\ 2801\,kJ/kg.$ ✓

$\therefore\ The\ steam\ is\ wet, because\ h_g\ is\ greater\ than\ h_2.$✓ (6)

2.2.3 $h_{wet} = hf + xhfg$

$x = \frac{h_w - hf}{hfg}$ ✓

$= \frac{2650,692 - 962}{1839}$ ✓

$= 0,918$ ✓

$\therefore$ *The steam is* $91,8\%$ *dry.* ✓

(4)
[20]

QUESTION 3

3.1 $PV = MRT$

$R = \frac{PV}{MT} = \frac{V}{\rho T}$

$= \frac{115 \times 1}{1,75 \times 293}$ ✓ ✓

$= \underline{\underline{0,2243\,kJ/kg.K}}$ ✓

(3)

3.2 $Q = M \times Cp(T_2 - T_1)$

$Cp = \frac{Q}{M(T_2 - T_1)}$

$= \frac{80}{0,75(399 - 293)}$ ✓ ✓

$= \underline{\underline{1,0063\,kJ/kg.K}}$ ✓

(3)

3.3 $R = Cp - Cv$

$Cv = Cp - R$ ✓

$= 1,0063 - 0,2243$ ✓

$= \underline{\underline{0,782\,kJ/kg.K}}$ ✓

(3)

3.4 $\Delta U = M \times Cv(T_2 - T_1)$

$= 0,75 \times 0,782(399 - 293)$ ✓ ✓

$= \underline{\underline{62,169\,kJ}}$ ✓

(3)

3.5 $V_1 = \frac{M}{\rho}$

$= \frac{0,75}{1,75}$ ✓

$= \underline{\underline{0,42857\,m^3}}$ ✓

(2)

3.6

$$V_2 = \frac{MRT_2}{P_2}$$

$$= \frac{0,75 \times 0,224 \times 399}{115} \quad \checkmark \checkmark$$

$$= \underline{\underline{0,58289\,m^3}} \quad \checkmark$$

or

$$V_2 = \frac{V_1 T_2}{T_1}$$

$$= \frac{0,42857 \times 399}{293} \quad \checkmark \checkmark$$

$$= \underline{\underline{0,5836\,m^3}} \quad \checkmark$$

(3)

3.7

$$WD = P_2(V_2 - V_1) \quad \checkmark \checkmark$$

$$= 115(0,58289 - 0,42857)$$

$$= \underline{\underline{17,7468\,kJ}} \quad \checkmark$$

or

$$WD = mR(T_2 - T_1) \quad \checkmark \checkmark$$

$$= 0,75 \times 0,224(399 - 293)$$

$$= \underline{\underline{17,81\,kJ}} \quad \checkmark$$

(3)
[20]

QUESTION 4

4.1

$$Vs(V_1 - V_3) = \frac{\pi D^2}{4} \times L \quad \checkmark$$

$$= \frac{\pi \times 0,22^2}{4} \times 0,31 \quad \checkmark$$

$$= \underline{\underline{0,01178\,m^3}} \quad \checkmark$$

(3)

4.2

$$V_3 = 0{,}055(V_1 - V_3)$$
$$= 0{,}055 \times 0{,}01178 \quad \checkmark$$
$$= 0{,}00065\,m^3 \quad \checkmark$$

$$V_1 = Vs + Vc$$
$$= 0{,}01178 + 0{,}00065 \quad \checkmark$$
$$= 0{,}01243\,m^3 \quad \checkmark$$

$$V_4 = V_3\left(\frac{P_3}{P_4}\right)^{\frac{1}{n}}$$
$$= 0{,}00065\left(\frac{650}{98}\right)^{\frac{1}{1{,}35}} \quad \checkmark \quad \checkmark$$
$$= 0{,}00264\,m^3 \quad \checkmark$$

$$\therefore Ve = V_1 - V_4$$
$$= 0{,}01243 - 0{,}00264 \quad \checkmark$$
$$= \underline{\underline{0{,}00979\,m^3}} \quad \checkmark$$

(9)

4.3

$$\frac{P_f V_f}{T_f} = \frac{P_1(V_1 - V_4)}{T_1}$$
$$V_f = \frac{P_1(V_1 - V_4)T_f}{P_f T_1} \quad \checkmark$$
$$= \frac{98(0{,}01243 - 0{,}00264) \times 288}{101{,}325 \times 291} \quad \checkmark$$
$$= 0{,}00937\,m^3 \quad \checkmark$$

$$\therefore Free\ Air\ Delivered / \min = 0{,}00937 \times N$$
$$= 0{,}00937 \times 650 \quad \checkmark$$
$$= \underline{\underline{6{,}0905\,m^3 / \min}} \quad \checkmark$$

(5)

4.4

$$\eta_{vol} = \frac{V_1 - V_4}{V_1 - V_3} \times \frac{100}{1} \quad \checkmark$$
$$= \frac{0{,}00979}{0{,}01178} \times \frac{100}{1} \quad \checkmark$$
$$= \underline{\underline{83{,}1\%}} \quad \checkmark$$

(3)
[20]

QUESTION 5

5.1

$$F\mu = \mu \times Mg \quad \checkmark$$
$$= 0,33 \times 6 \times 9,81 \quad \checkmark$$
$$= 19,424\,N \quad \checkmark$$

$$h_1 = \sqrt{L^2 - r_1^2} \quad \checkmark$$
$$= \sqrt{0,33^2 - 0,13^2} \quad \checkmark$$
$$= 0,303\,m \quad \checkmark$$

$$\omega_1 = \sqrt{\frac{g(M+m) - F\mu}{m \times h_1}} \quad \checkmark$$
$$= \sqrt{\frac{9,81(6+1,8) - 19,424}{1,8 \times 0,303}} \quad \checkmark$$
$$= 10,231\,rad/s \quad \checkmark$$

$$\therefore N_1 = \frac{\omega_1 \times 60}{2\pi}$$
$$= \frac{10,231 \times 60}{2 \times \pi} \quad \checkmark$$
$$= \underline{\underline{97,7\,r/\min}} \quad \checkmark \quad \checkmark$$

(12)

5.2

$$h_2 = \sqrt{L^2 - r_2^2} \quad \checkmark$$
$$= \sqrt{0,33^2 - 0,21^2} \quad \checkmark$$
$$= 0,255\,m \quad \checkmark$$

$$\omega_2 = \sqrt{\frac{g(M+m) - F\mu}{m \times h_2}} \quad \checkmark$$
$$= \sqrt{\frac{9,81(6+1,8) - 19,424}{1,8 \times 0,255}} \quad \checkmark$$
$$= 11,153\,rad/s \quad \checkmark$$

$$\therefore N_2 = \frac{\omega_2 \times 60}{2\pi}$$
$$= \frac{11,153 \times 60}{2 \times \pi} \quad \checkmark$$
$$= 106,5\,r/\min \quad \checkmark$$

(8)
[20]

TOTAL: 100

Copyright reserved