higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N5

13 APRIL 2018

This marking guideline consists of 7 pages.

QUESTION 1

1.1 1.1.1 $$\sigma_{LOP} = \frac{F_{LOP}}{A_i} = \frac{72000}{3{,}1416 \times 10^{-4}} = 229{,}183MPa$$ ✓ ✓

1.1.2 $$E = \frac{\sigma_{LOP}}{E_{LOP}} = \sigma_{LOP} \times \left(\frac{L_i}{X_{LOP}}\right) = 229{,}183 \times 10^{6}.\left(\frac{0{,}085}{110 \times 10^{-6}}\right) = 177{,}096GPa$$ ✓ ✓

1.1.3 $$\sigma_Y = \frac{F_Y}{A_i} = \frac{90000}{3{,}1416 \times 10^{-4}} = 286{,}478MPa$$ ✓ ✓

1.1.4 $$\sigma_{Max} = \frac{F_{Max}}{A_i} = \frac{145000}{3{,}1416 \times 10^{-4}} = 461{,}548MPa$$ ✓ ✓

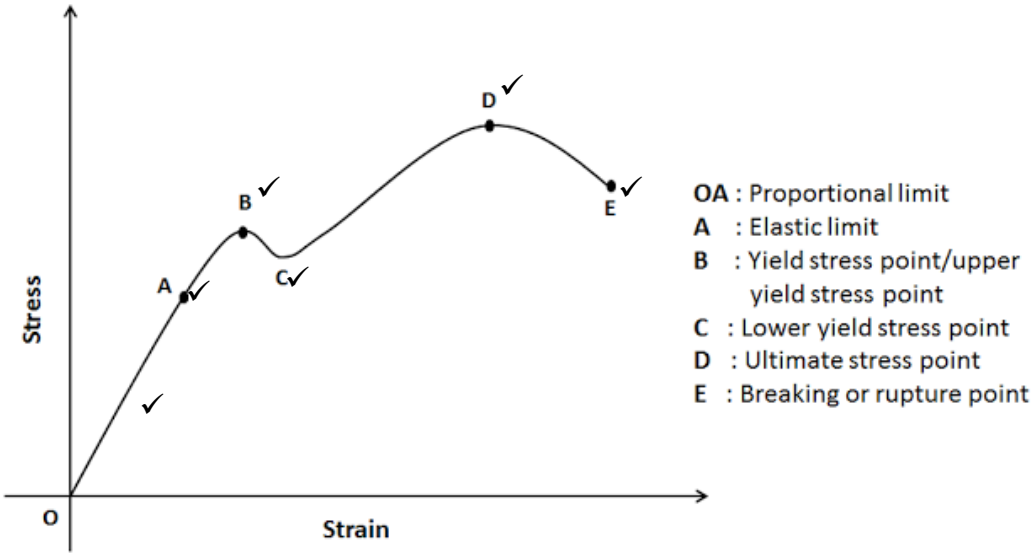
1.1.5 $$\sigma_F = \frac{F_F}{A_F} = \frac{80000}{5{,}8088 \times 10^{-5}} = 1377{,}221MPa$$ ✓ ✓

1.1.6 $$\%X = \frac{X_F}{L_i} = (\frac{21}{85}).100 = 24{,}71\%$$ ✓ ✓

1.1.7 $$\%\Delta A = \frac{A_i - A_F}{A_i} = (\frac{3{,}1416 \times 10^{-4} - 5.8088 \times 10^{-5}}{3{,}1416 \times 10^{-4}}).100 = 81{,}51\%$$ ✓ ✓

(7 × 2) (14)

1.2



[Image source: *http://www.mechanicalbooster.com/2016/09/stress-strain-curve-relationship-diagram-explanation.html*] (6)

[20]

QUESTION 2

2.1 2.1.1

$$F_{causing} = P_i.D_i.L$$
$$= 1{,}2\times10^6.(1{,}2).(2{,}5) \quad ✓$$
$$= 3\ 600\ kN \quad ✓$$

2.1.2

$$F_{resisting} = \sigma_T.2.t.L$$
$$= 72\times10^6.(2).(0{,}010).(2{,}5) \quad ✓$$
$$= 3\ 600\ kN \quad ✓$$

2.1.3

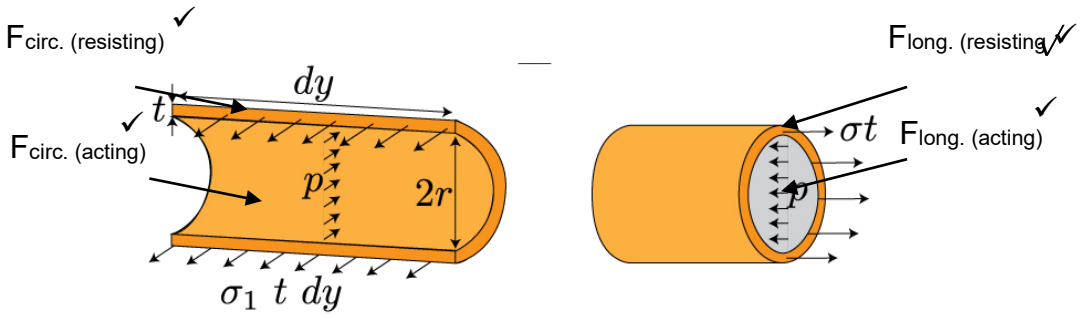
$$F_{causing} = P_i.\frac{\pi}{4}.D_i^{\,2}$$
$$= 1{,}2\times10^6.(\frac{\pi}{4}).(1{,}2^2) \quad ✓$$
$$= 1357{,}168\ kN \quad ✓$$

2.1.4

$$F_{resistnig} = \sigma_L.\pi.D_i.t$$
$$= 36\times10^6.(\pi).(1{,}2).(0{,}010) \quad ✓$$
$$= 1357{,}168\ kN \quad ✓$$

(4 × 2) (8)

2.2



[Image source: http://www.bu.edu/moss/mechanics-of-materials-combined-loading/] (4)

[12]

QUESTION 3

3.1

$$J_1 = \frac{\pi}{32}.D^4 = \frac{\pi}{32}.(0{,}048^4) = 5{,}2115\times10^{-7}\,m^4 \checkmark$$

$$\frac{T_1.L_1}{J_1.G_1} = \frac{T_2.L_2}{J_2.G_2} \checkmark$$

$$\frac{\frac{1}{3}T_2.L_1 \checkmark}{5{,}2115\times10^{-7}.(2{,}2.G_2)} = \frac{T_2.L_1}{J_2.G_2} \checkmark$$

$$\therefore J_2 = 3{,}4396\times10^{-6}\,m^4 \checkmark$$

$$J_2 = 3{,}4396\times10^{-6} = \frac{\pi}{32}.[D^4 - (0{,}048^4)] \checkmark$$

$$\therefore D = 79{,}697\ mm \checkmark \quad (7)$$

3.2

$$T_T = T_1 + T_2 \checkmark$$

$$= \frac{\pi}{16}.\tau_1.D^3 + \frac{\pi}{16}.\tau_2.[\frac{(D^4 - d^4)}{D}]$$

$$= \frac{\pi}{16}.(84\times10^6).(0{,}048^3) \checkmark + \frac{\pi}{16}.(46\times10^6).[\frac{(0{,}0797^4 - 0{,}048^4)}{0{,}0797}] \checkmark$$

$$= 1824{,}034 + 3970{,}474$$

$$= 5794{,}508\ N.m \checkmark \quad (4)$$

3.3

$$P = 2\pi.\frac{N}{60}.T$$

$$= 2\pi.\frac{388}{60}.(5794{,}5087) \checkmark$$

$$= 235{,}438\ kW \checkmark \quad (2)$$

[13]

QUESTION 4

4.1

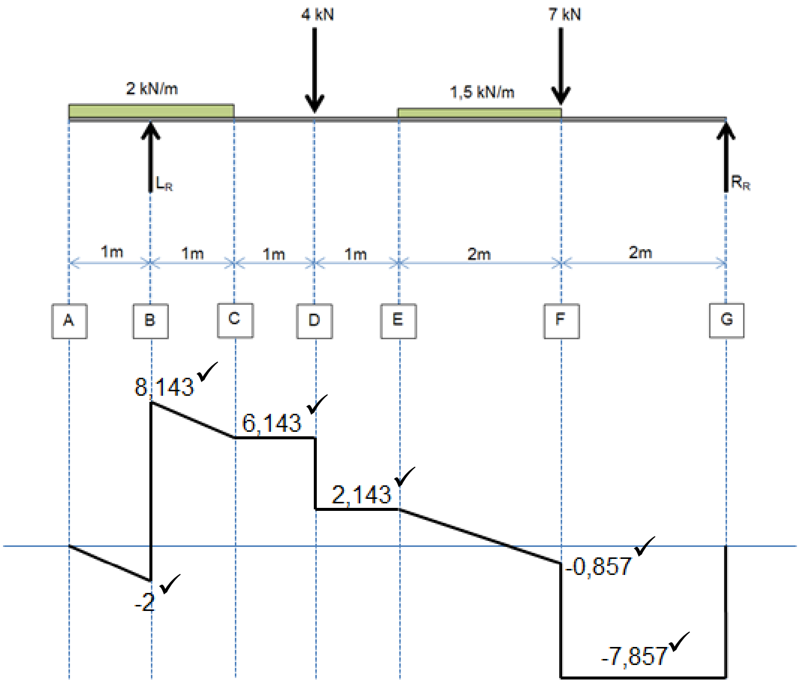
$$L_{Re\,action}.(7) = 2.(2).(7) + 4.(5) + 1{,}5.(2).(3) + 7.(2) \checkmark$$
$$\therefore L_{Re\,action} = 10{,}143kN \checkmark$$

$$R_{Re\,action}.(7) + 2.(1).(\frac{1}{2}) = 7.(5) + 3.(4) + 4.(2) + 2.(1).(\frac{1}{2}) \checkmark$$
$$\therefore R_{Re\,action} = 7{,}857kN \checkmark$$

$$PROOF: 2.(2) + 4 + 7 + 1{,}5.(2) = 10{,}143 + 7{,}857$$
$$18kN = 18kN \rightarrow OK \checkmark$$

(5)

4.2



(6)

4.3 $TP_1 = 1m$ From LHS √

$$TP_2 : \frac{X_1}{Y_1} = \frac{2 - X_1}{Y_2} \checkmark$$
$$\frac{X_1}{2{,}143} = \frac{2 - X_1}{0{,}857}$$ ....
$$0{,}857.X_1 = 2{,}143.(2 - X_1) \checkmark$$
$$\therefore X_1 = 1{,}429\ m \checkmark$$

$TP_2 = 2{,}5713\ m$ From RHS √

(4)

4.4

$$BM_A = 0$$

$$BM_B = -2.(1).(\frac{1}{2}) = -1\ kN.m$$ ✓

$$BM_C = -2.(2).(\frac{2}{2}) + 10{,}143.(1) = 6{,}143\ kN.m$$ ✓

$$BM_D = -2.(2).(\frac{2}{2} + 1) + 10{,}143.(2) = 12{,}286\ kN.m$$ ✓

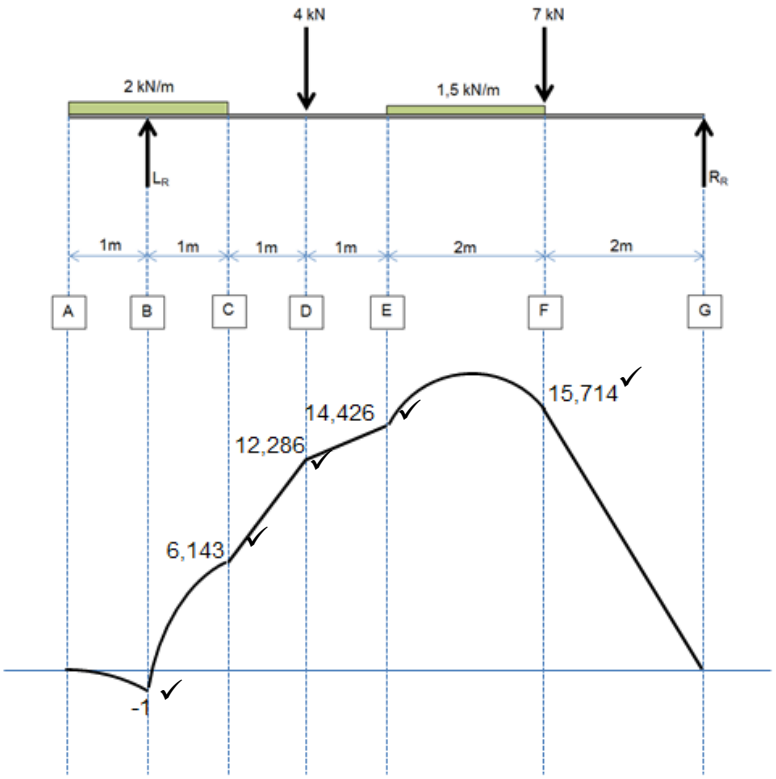
$$BM_E = 7{,}857.(4) - 7.(2) - 1{,}5.(2).(\frac{2}{2}) = 14{,}429 kN.m$$ ✓

$$BM_F = 7{,}857.(2) = 15{,}714\ kN.m$$ ✓

$$BM_G = 0$$

(5)

4.5



(5)

4.6

$$0 = -2.(x).(\frac{x}{2}) + 10{,}143.(x - 1)$$ ✓

$$-x^2 + 10{,}143.x - 10{,}143 = 0$$ ✓

$$x = \frac{-10{,}143 \pm \sqrt{(10{,}143^2) - 4.(-1).(-10{,}143)}}{2.(-1)}$$ ✓ ✓

$$= \frac{-10{,}143 \pm 7{,}8935}{-2}$$

$$= 1{,}12475 or\ 9{,}01825$$

$$= 1{,}125\ m$$ ✓

(5)
[30]

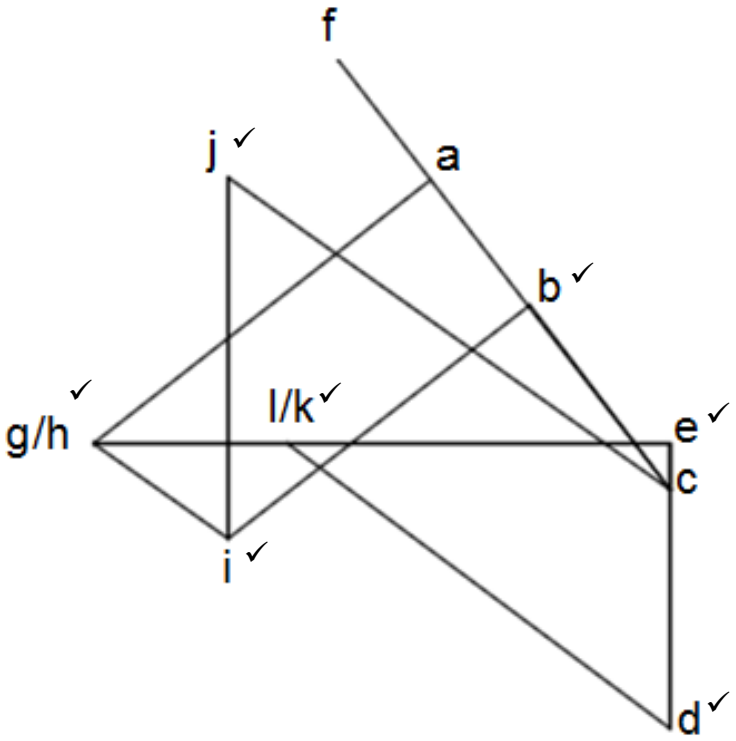
QUESTION 5

5.1 $20\sin 45 = 20\cos 45 = 14{,}142N$
$30\sin 45 = 30\cos 45 = 21{,}213N$

$DE_{vertical}.(8) = 30.(6) + 21{,}213.(4) + 14{,}142.(2)$
$\therefore DE = 36{,}642N$ ✓ (1)

5.2 $FH_{horizontal} = 14{,}142 + 14{,}142 + 21{,}213 = 49{,}497N$ ✓
$FH_{vertical} = 21{,}213 + 14{,}142 + 14{,}142 + 30 - 36{,}642 = 42{,}855$ ✓
$FH = \sqrt{49{,}497^2 + 42{,}855^2} = 65{,}471N$ ✓ (3)

5.3



Member	Force (N)	Nature
eg	75✓	Tie (T)✓
hi	21,5✓	Strut (S)✓
ij	47✓	T✓
kl	0✓	None✓
dl	62✓	S✓
jc	70✓	T✓
bi	49✓	S✓

(21)
[25]

TOTAL: 100