

UNIVERSITEIT VAN PRETORIA / UNIVERSITY OF PRETORIA
DEPT SIVIELE INGENIEURSWESE / DEPT OF CIVIL ENGINEERING

MECHANICS SWK122 MEGANIKA SWK122
SEMESTER TEST 1 – SEMESTERTOETS 1

VAN en VOORLETTERS SURNAME and INITIALS	HANDTEKENING SIGNATURE	STUDENTENOMMER STUDENT NUMBER							
<i>Memorandum</i>		1	2	3	4	5	6	7	8
STUDIERIGTING [bv MEGANIES] STUDY DISCIPLINE [eg CIVIL]									

Volpunte / Full Marks: 60

Tyd / Time: 1½ ure / hours

Augustus 2009

1	2	3	Σ		
30	14	16	60		

INSTRUCTIONS READ:

- ⇒ Answer all questions in the provided spaces.
- ⇒ The invigilators will supply no additional or loose pages.
- ⇒ Rough work may be done on the final blank page but this page will not be marked.
- ⇒ Answers in pencil will not be marked.
- ⇒ Tippex or any other similar product may not be used.
- ⇒ No highlighter may be used.
- ⇒ Students may ask no questions for whatever reason during the exam or test. If you are of the opinion that you need additional information, make assumptions and state these assumptions.
- ⇒ The relevant units must substantiate all answers.
- ⇒ All aspects as described in the EXAMINATION REGULATIONS are applicable.
- ⇒ All calculations to reach an answer must be shown.
- ⇒ Circle the name of your lecturer on the table below.

INSTRUKSIES..... LEES:

- ⇒ Beantwoord alle vrae in die spasies voorsien.
- ⇒ Die toesighouers sal geen addisionele of los bladsye voorsien nie.
- ⇒ Rofwerk mag op die laaste blanko bladsy gedoen word en hierdie bladsy word nie gemerk nie.
- ⇒ Antwoorde in potlood word nie gemerk nie.
- ⇒ Tippex of enige soortgelyke produk mag nie gebruik word nie.
- ⇒ Geen glimpen ["highlighter"] mag gebruik word nie.
- ⇒ Studente mag nie tydens die eksamen vrae vra nie – om watter rede ookal. Indien u van mening is dat addisionele inligting benodig word, maak aannames en stel die aannames.
- ⇒ Alle antwoorde moet deur die nodige eenhede bevestig word.
- ⇒ Alle aspekte soos vervat in die EKSAMENREGULASIES is van toepassing.
- ⇒ Alle berekeninge om antwoorde te bepaal moet getoon word.
- ⇒ Omkring die naam van u dosent op onderstaande tabel.

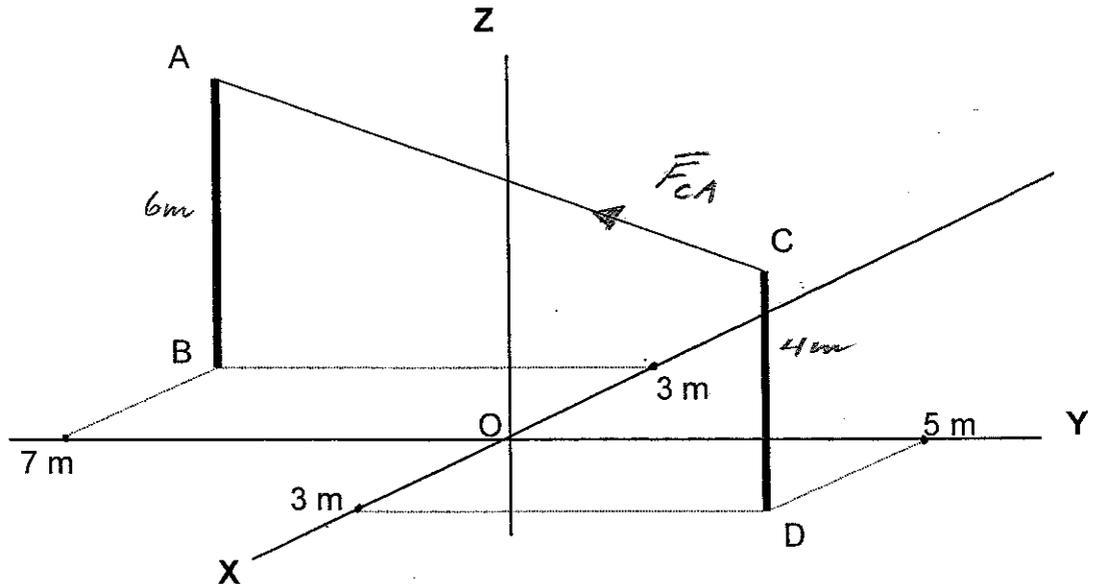
Dosente / Lecturers: Mr R Michael	Mr A de Klerk	Mnr F van Graan
Prof L Maree		
Eksterne Eksaminator / External Examiner: Prof BWJ van RENSBURG		

QUESTION 1 / VRAAG 1

[30]

Pole AB is 6 m high and pole CD is 4 m high. A cable spans between A and C and the force in cable AC is 4.2 kN.

Paal AB is 6 m hoog en paal CD is 4 m hoog. 'n Kabel span tussen A en C en die krag in kabel AC is 4.2 kN.



1[a] Determine the length of cable AC.
Bepaal die lengte van kabel AC.

[2]

$$\begin{aligned} \vec{AC} &= (C) - (A) = (3 \ 5 \ 4) - (-3 \ -7 \ 6) = (6 \ 12 \ -2) \text{ m} \\ AC &= |\vec{AC}| = \sqrt{(6)^2 + (12)^2 + (-2)^2} \\ &= \sqrt{184} = 13.565 \text{ m} \rightarrow \end{aligned}$$

1[b] Write the force that the cable exerts on the pole at C in Cartesian format in Newton (N). Define this force as F_{CA} .
Skryf die krag wat die kabel op die paal by C uitoefen in Cartesiese formaat in Newton (N). Definieer hierdie krag as F_{CA} .

[4]

$$\vec{CA} = (-6 \ -12 \ 2) \text{ m} \quad CA = |\vec{CA}| = \sqrt{184}$$

$$\vec{F}_{CA} = F_{CA} * \frac{\vec{CA}}{CA}$$

$$= \frac{4200 * (-6 \ -12 \ 2)}{\sqrt{184}}$$

$$= (-1858; -3716; 619) \text{ N} \rightarrow$$

1[c] Determine the coordinate direction angles of F_{CA} .

[3]

Bepaal die rigtingshoeke van F_{CA} .

$$\alpha = \cos^{-1} \frac{-1858}{4200} = 116.3^\circ$$

$$\beta = \cos^{-1} \frac{-3716}{4200} = 152.2^\circ$$

$$\gamma = \cos^{-1} \frac{619}{4200} = 81.5^\circ \rightarrow$$

1[d] Check your answer of Question 1[c].

[3]

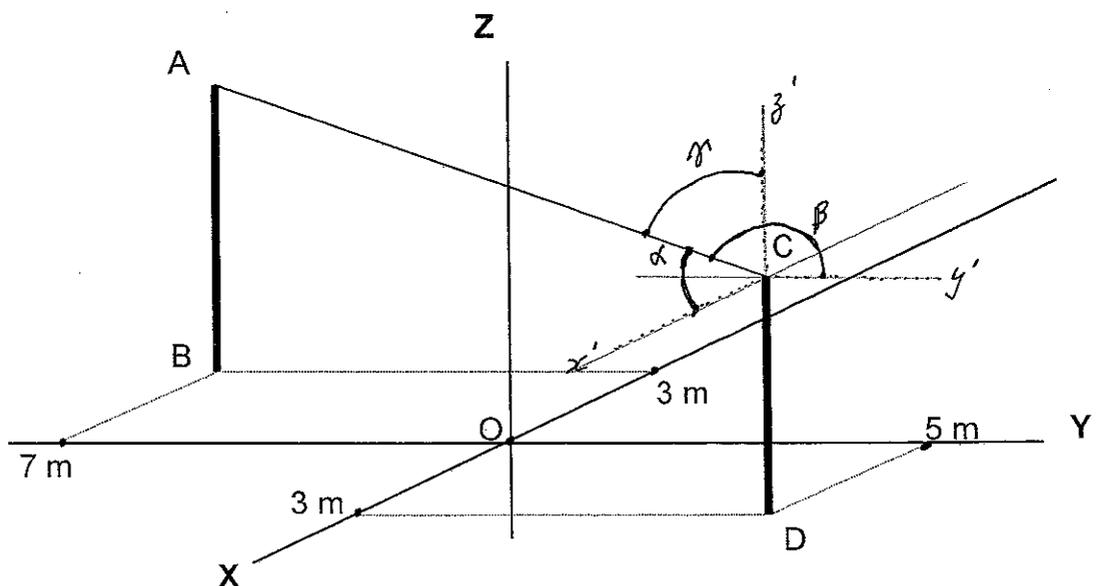
Toets u antwoord vir vraag 1[c].

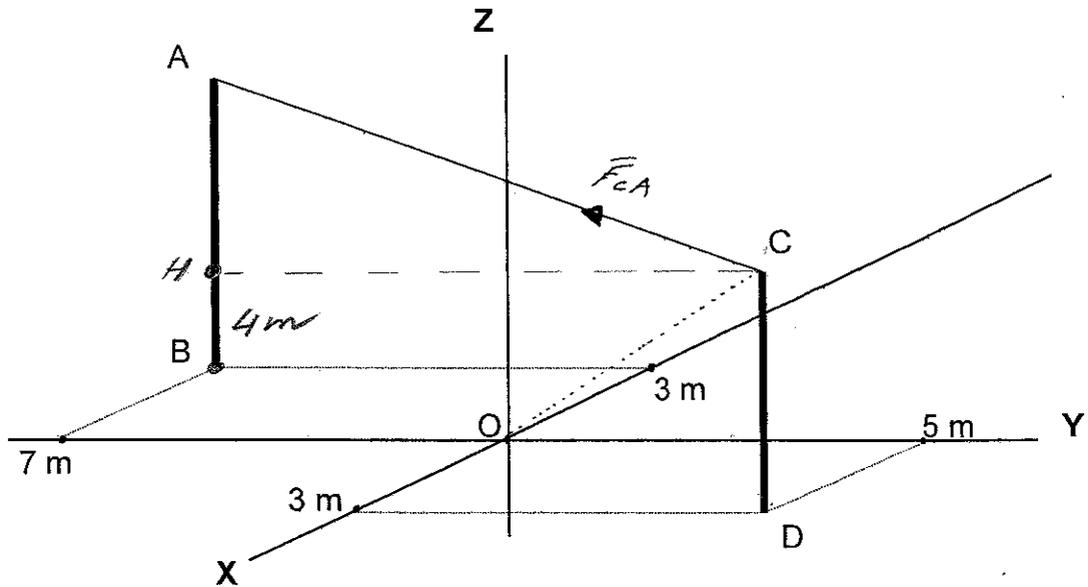
$$\begin{aligned} \cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma &= \cos^2(116.3^\circ) + \cos^2(152.2^\circ) + \cos^2(81.5^\circ) \\ &= 0.1963 + 0.7825 + 0.0218 = 1.000 \rightarrow \end{aligned}$$

1[e] Indicate the coordinate direction angles of F_{CA} on the figure below.

[3]

Dui die rigtingshoeke van F_{CA} aan op onderstaande figuur.





1[f] Determine magnitude of the component of F_{CA} in the direction of CO .
 Bepaal die grootte van die komponent van F_{CA} in die rigting van CO .

[6]

$$\odot F_{CA \parallel CO} = \frac{\vec{F}_{CA}}{CA} \cdot \vec{u}_{CO} \quad \vec{u}_{CO} = \frac{\vec{CO}}{CO} = \frac{(-3 \ -5 \ -4)}{\sqrt{50}}$$

$$\therefore F_{CA \parallel CO} = (-1858; -3716; 69) \cdot \frac{(-3 \ -5 \ -4)}{\sqrt{50}}$$

$$\therefore F_{CA \parallel CO} = (-1858; -3716; 69) \cdot \frac{(-3; -5; -4)}{\sqrt{50}}$$

$$= 3065.7 \text{ N} \rightarrow$$

OR: $\vec{CA} = (-6 \ -12 \ 2) \text{ m}$ $CA = \sqrt{184}$ (Question 1(a))

$$\vec{CO} = (0) - (C) = (0 \ 0 \ 0) - (3 \ 5 \ 4) = (-3 \ -5 \ -4) \quad CO = \sqrt{50}$$

$$\therefore \vec{CA} \cdot \vec{CO} = (-6 \ -12 \ 2) \cdot (-3 \ -5 \ -4) = 70$$

$$\cos \theta = \frac{\vec{CA} \cdot \vec{CO}}{(CA)(CO)} = \frac{70}{\sqrt{184} \sqrt{50}} \quad \therefore \theta = 43.13^\circ \rightarrow$$

$$\therefore F_{CA \parallel CO} = 4200 \cos 43.13^\circ = 3065.2 \text{ N} \rightarrow$$

1[g] Calculate the smallest angle between cable CA and the horizontal plane.
Bereken die kleinste hoek tussen kabel CA en die horisontale vlak.

[6]

$$\odot \overline{CA} = (-6 \ -12 \ 2) \text{ m} \quad CA = \sqrt{184}$$

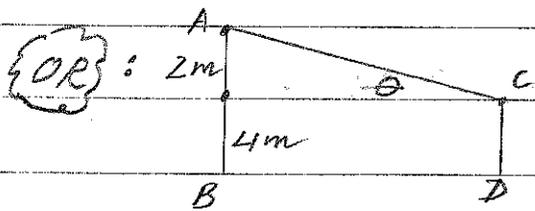
$$\odot \overline{CH} = (H) - (C) = (-3 \ -7 \ 4) - (3 \ 5 \ 4) = (-6; -12 \ 0)$$

$$CH = \sqrt{180}$$

$$\odot \overline{CA} \cdot \overline{CH} = (-6 \ -12 \ 2) \cdot (-6 \ -12 \ 0)$$

$$= 180$$

$$\therefore 180 = \sqrt{184} \times \sqrt{180} \times \cos \theta \quad \Rightarrow \theta = 8.5^\circ \rightarrow$$



$$\sin \theta = \frac{2}{AC} = \frac{2}{\sqrt{184}}$$

(AC = $\sqrt{184}$ m ; Quest 1(a))

$$\therefore \sin \theta = 0.147442$$

$$\therefore \theta = 8.5^\circ \rightarrow$$

1[h] Calculate the unit vector in the direction of OD.
Bereken die eenheidsvektor in die rigting van OD.

[3]

$$\underline{u}_{OD} = \left(\frac{3}{\sqrt{34}} ; \frac{5}{\sqrt{34}} ; 0 \right)$$

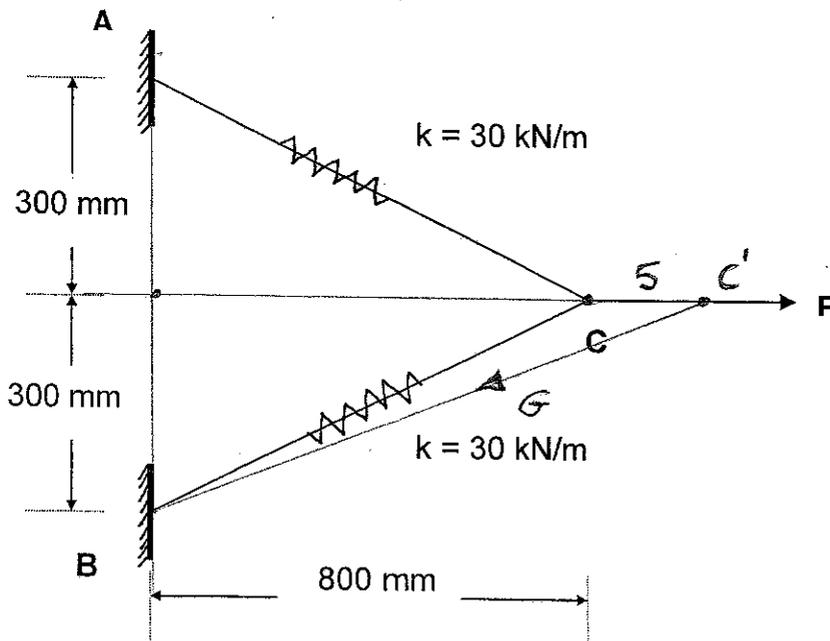
$$= (0.514 ; 0.858 ; 0) \rightarrow$$

QUESTION 2 / VRAAG 2

[14]

The two springs are unstretched when force $F = 0$.
 Point C moves 5 mm to the right on application of F .
 Calculate the value of F .

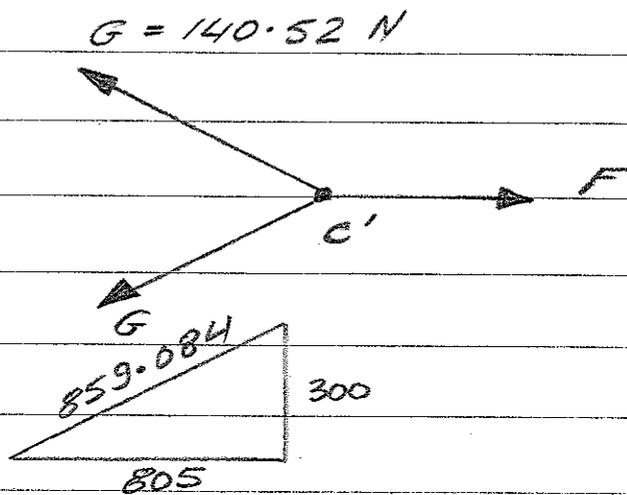
Die twee vere is onuitgerek as $F = 0$.
 Punt C beweeg 5 mm na regs met die aanwending van F .
 Bereken die waarde van F .



$$\odot \quad BC = \sqrt{300^2 + 800^2} = 854.4 \text{ mm}$$

$$BC' = \sqrt{300^2 + 805^2} = 859.084 \text{ mm}$$

$$\begin{aligned} G &= k \times \Delta L = (859.084 - 854.4) \times 30 \\ &= 4.684 \times 30 \\ &= 140.52 \text{ N} \rightarrow \end{aligned}$$



$$\sum F_{xc} \text{ at } C = 0 :$$

$$2 * \frac{140.52 * 805}{859.084} = F$$

$$F = 263.35 \text{ N.}$$



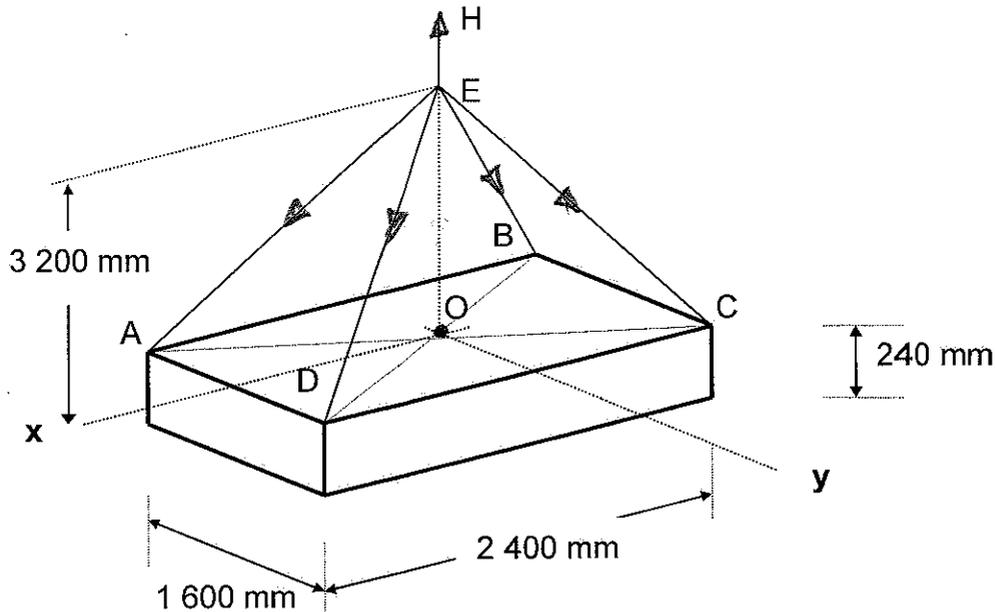
VALUE OF F / WAARDE VAN F = 263.35 N.....

QUESTION 3 / VRAAG 3

[16]

The figure shows a pre-cast concrete slab. The slab hangs horizontal and is supported by four cables. The centre of gravity of the slab is at point O. Point E is on the same vertical line as point O and also 3.2 m higher than O. The density of concrete is $2\,400\text{ kg/m}^3$.

Die figuur toon 'n voorafvervaardigde betonblad. Die blad hang horisontaal en word ondersteun deur vier kables. Die swaartepunt van die blad is by O. Punt E is op dieselfde vertikale lyn as punt O en ook 3.2 m hoër as punt O. Die digtheid van beton is $2\,400\text{ kg/m}^3$.



3[a] Calculate the volume of concrete necessary to cast the slab.
Bereken die volume beton nodig om die blad te giet.

[1]

$$\odot \text{ Vol} = 1.6 * 2.4 * 0.24$$

$$= 0.9216 \text{ m}^3 \rightarrow$$

3[b] Calculate the force in cable EH and state whether it is in tension or compression.
Bereken die krag in kabel EH en dui aan of dit 'n trekrag of drukrag is.

[3]

$$F_{EH} = 0.9216 * 2.4 * 9.8$$

$$= 21.676 \text{ kN} \rightarrow$$

3[c] Calculate the force in each of the four support cables.
Bereken die krag in elk van die vier ondersteuningskabels.

[12]

$$\odot \vec{F}_{EA} = F_{EA} * \vec{u}_{EA}$$

$$\begin{aligned}\vec{EA} &= (A) - (E) = (1.2; 0.8; 0) - (0; 0; 3.2) \\ &= (1.2 \quad 0.8 \quad -3.2) \text{ m} \quad \rightarrow\end{aligned}$$

$$EA = \sqrt{(1.2)^2 + (0.8)^2 + (-3.2)^2} = 3.51 \text{ m} \rightarrow$$

$$\therefore \vec{F}_{EA} = F_{EA} * \frac{(1.2 \quad 0.8 \quad -3.2)}{3.51} \rightarrow$$

$$\odot \text{ But: } \vec{F}_{EA} = \vec{F}_{ED} = \vec{F}_{EB} = \vec{F}_{EC}$$

$$\odot \sum F_z = 0 :$$

$$\therefore 4 F_{EA} * \frac{-3.2}{3.51} + F_{EH} = 0$$

$$\begin{aligned}\therefore F_{EA} &= \frac{21.676 * 3.51 * 1}{3.2 * 4} \\ &= 5.944 \text{ kN} \quad \rightarrow\end{aligned}$$

$$\therefore F_{EA} = F_{EB} = F_{EC} = F_{ED} = 5.944 \text{ kN} \rightarrow$$

SCRATCHPAD / ROFWERK

THIS PAGE WILL NOT BE MARKED / HIERDIE BLADSY WORD NIE NAGESIEN NIE