


MECHANICS SWK122 MEGANIKA SWK122
SEMESTER TEST 2 – SEMESTERTOETS 2

VAN en VOORLETTERS	HANDTEKENING	STUDENTENOMMER																
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SURNAME and INITIALS	SIGNATURE	STUDENT NUMBER																

Volpunte / Full Marks: 60

Tyd / Time: 1½ ure / hours

October 2009

1	2	3	Σ		
24	26	10	60		

INSTRUCTIONS READ:

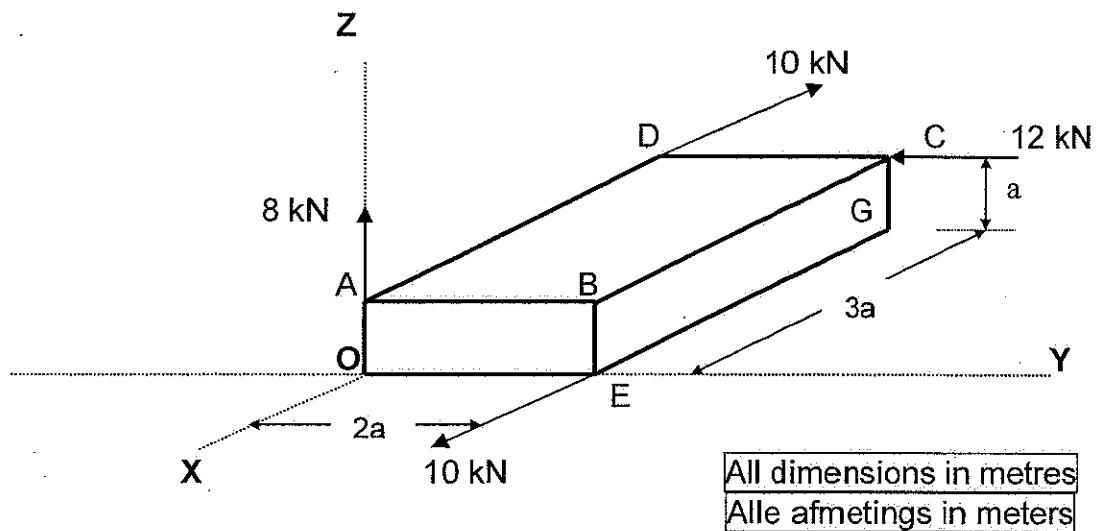
- ⇒ Answer all questions in the provided spaces.
- ⇒ The invigilators will supply no additional or loose pages.
- ⇒ Rough work may be done on the final blank page but this page will not be marked.
- ⇒ Answers in pencil will not be marked.
- ⇒ Tippex or any other similar product may not be used.
- ⇒ No 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.

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.

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

The figure shows a body with a number of forces acting in on it.
Die figuur toon 'n liggaam met 'n aantal kragte wat daarop inwerk.



1[a] Transform the given loading system to an equivalent system at the origin O. [10]
Transformeer die getoonde belastingstelsel na 'n ekwivalente stelsel in die oorsprong O.

$$\odot \vec{R}_O = 10 \ 12 \ 8 \text{ kN} \rightarrow$$

$$\odot \vec{M}_O = \vec{M}_1 + \vec{M}_2 = \vec{DE} \times (10 \ 0 \ 0) + \vec{OC} \times (0 \ -12 \ 0)$$

$$\vec{DE} = (E) - (D) = (10 \ 2a \ 0) - (-3a \ 0 \ a) = (3a \ 2a \ -a)$$

$$\vec{OC} = (C) - (O) = (-3a \ 2a \ a)$$

$\vec{M}_1 =$	$3a \ 2a \ -a$	$\vec{M}_2 =$	$-3a \ 2a \ a$
	$10 \ 0 \ 0$		$0 \ -12 \ 0$

$$= (0 \ -10a \ -20a)$$

$$= (12a \ 0 \ 36a)$$

$$\therefore \vec{M}_O = \vec{M}_1 + \vec{M}_2 = (0 \ -10a \ -20a) + (12a \ 0 \ 36a)$$

$$= (12a \ -10a \ 16a) \text{ kN}\cdot\text{m}$$

1[b] Show that the loading system reduces to a wrench.
Toon aan dat die belastingstelsel reduseer na 'n skroef.

[2]

$$\begin{aligned}\odot \bar{R}_0 \cdot \bar{M}_0 &= (0 \ -12 \ 8) \cdot (12a \ -10a \ 16a) \\ &= (0 + 120a + 128a) \\ &= 248a > 1 \Rightarrow \text{Wrench} \rightarrow\end{aligned}$$

1[c] Determine the force of the wrench in Cartesian format as well as the couple of the wrench in Cartesian format.

[12]

Bereken die skroefkrag in Cartesiese formaat asook die koppel van die skroef in Cartesiese formaat.

$$\odot \bar{F}_{\text{wrench}} = \bar{F}_W = \bar{R}_0 = (0 \ -12 \ 8) \text{ kN} \rightarrow$$

$$\odot \bar{u}_{\bar{F}_W} = \frac{\bar{F}_W}{F_W} = \frac{(0 \ -12 \ 8)}{\sqrt{208}} = (0 \ -0.832 \ 0.555)$$

$$\odot \bar{M}_0 \parallel \bar{F}_W = (\bar{M}_0 \cdot \bar{u}_{\bar{F}_W}) * \bar{u}_{\bar{F}_W}$$

$$\begin{aligned}&= (12a \ -10a \ 16a) \cdot \frac{(0 \ -12 \ 8)}{\sqrt{208}} * \frac{(0 \ -12 \ 8)}{\sqrt{208}} \\ &= (17.2a) * \frac{(0 \ -12 \ 8)}{\sqrt{208}} = (0 \ -14.3a \ 9.54a) \text{ kN.m} \rightarrow\end{aligned}$$

$$\odot \bar{M}_{\text{wrench}} = \bar{M}_\perp = \bar{M}_0 - \bar{M}_0 \parallel \bar{F}_W$$

$$\begin{aligned}&= (12a \ -10a \ 16a) - (0 \ -14.3a \ 9.54a) \\ &= (12a \ 4.3a \ 6.46a) \text{ kN.m} \rightarrow\end{aligned}$$

QUESTION 2 / VRAAG 2

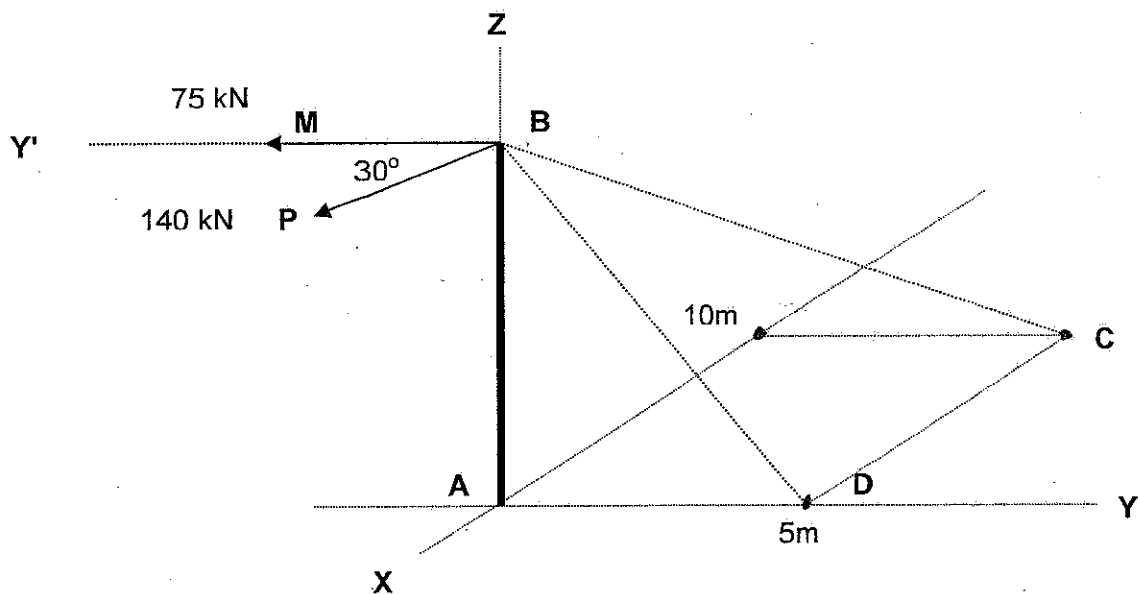
[26]

An electric pylon, AB, is 15 m high, weighs 1 420 kg and is supported by two steel cables BC and BD as well as a ball-and-socket joint at A.

The two electrical cables BM and BP lie in the horizontal plane and exert forces of 75 kN and 140 kN on the pole at B.

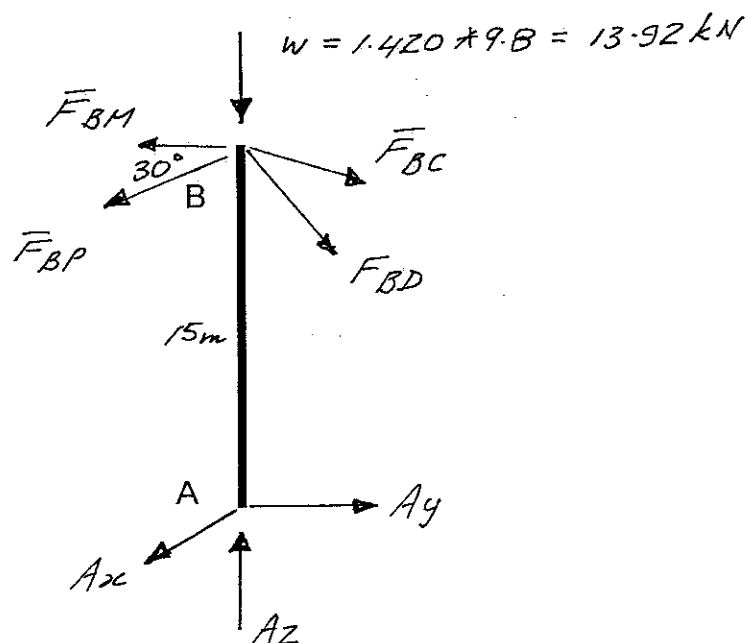
'n Elektriese mas, AB, is 15 m hoog, weeg 1 420 kg en word ondersteun deur twee staal kabels BC en BD asook 'n bal-en-potjie by A.

Die twee elektriese kabels BM en BP lê in die horisontale vlak en oefen kragte van 75 kN en 140 kN uit op die paal by B.



2[a] Draw the Free Body Diagram for pylon AB.
Teken die Vryliggaamskets vir die die mas AB.

[4]



2[b] Write the force in cable BC in Cartesian format.
Skryf die krag in kabel BC in Cartesiese formaat.

[2]

$$\odot \vec{F}_{BC} = F_{BC} * \vec{u}_{BC} = F_{BC} * \frac{\vec{BC}}{|\vec{BC}|}$$

$$\vec{BC} = (C) - (B) = (-10 \ 5 \ 0) - (0 \ 0 \ 15) = (-10 \ 5 \ -15) \text{ m}$$

$$BC = \sqrt{350}$$

$$\vec{F}_{BC} = \frac{F_{BC}}{\sqrt{350}} (-10 \ 5 \ -15)$$

$$= F_{BC} (-0.535 \ 0.267 \ -0.802) \text{ kN}$$

2[c] Determine the moment [in Cartesian format] of F_{BC} about A.
Bepaal die moment [in Cartesiese formaat] van F_{BC} om A.

[3]

$$\odot \vec{M}_1 = \vec{AB} \times \vec{F}_{BC} =$$

	0	0	15
F_{BC}	-0.535	0.267	-0.802

$$\therefore \vec{M}_1 = F_{BC} (-4 \ -8 \ 0) \text{ kN.m} \rightarrow$$

2[d] Determine the resultant of forces F_{BM} and F_{BP} in Cartesian format.
Bepaal die resultant van kragte F_{BM} en F_{BP} in Cartesiese formaat.

[2]

$$\odot \vec{R} = (0 \ -75 \ 0) + (140 \sin 30^\circ \ -140 \cos 30^\circ \ 0)$$

$$= (70 \ -196.24 \ 0) \text{ kN} \rightarrow$$

2[e] Determine the moment [in Cartesian format] of the resultant of forces F_{BM} and F_{BP} about A.

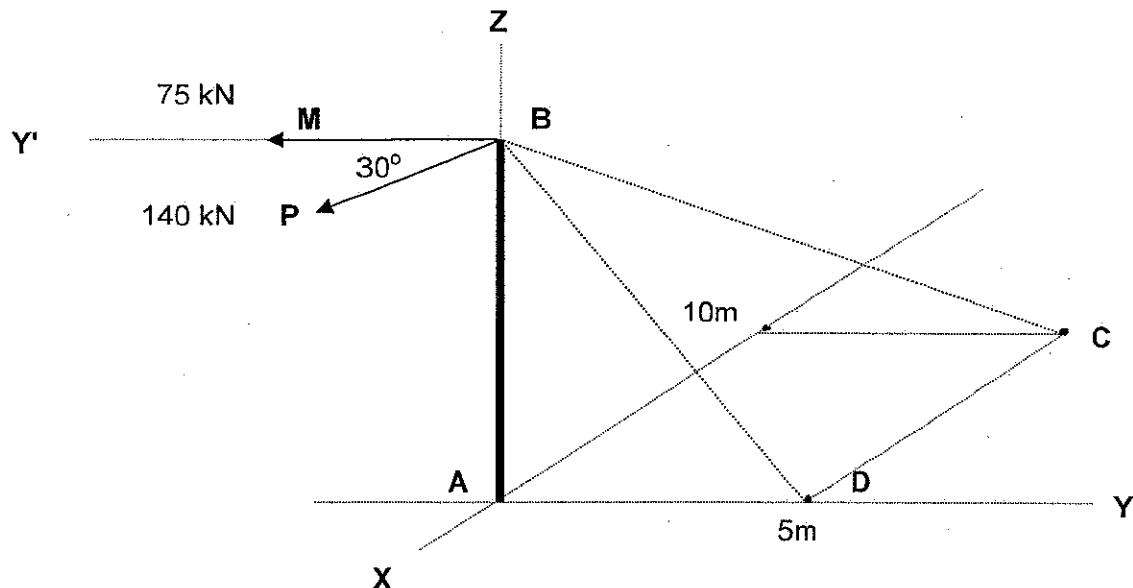
[3]

Bepaal die moment [in Cartesiese formaat] van die resultant van kragte F_{BM} en F_{BP} om A.

$$\odot \vec{M}_2 = \vec{AB} \times \vec{R} =$$

0	0	15
70	-196.24	0

$$\therefore \vec{M}_2 = (2944 \ 1050 \ 0) \text{ kN.m} \rightarrow$$



2[f] Determine the magnitude of the force in cable BC and in cable BD.

[6]

Bepaal die grootte van die krag in kabel BC en in kabel BD.

$$\odot \vec{F}_{BD} = F_{BD} \times \vec{u}_{BD} = F_{BD} \times \frac{\vec{BD}}{|\vec{BD}|} = \frac{F_{BD}}{\sqrt{250}} (0 \ 5 \ -15)$$

$$= F_{BD} (0 \ 0.316 \ -0.949) \rightarrow$$

$\vec{M}_B = \vec{AB} \times \vec{F}_{BD} =$	0	0	15
F_{BD}	0	0.316	-0.949

$$\therefore \vec{M}_B = F_{BD} (-4.74 \ 0 \ 0) \text{ kN.m} \rightarrow$$

$$\odot \text{ At A: } \sum M_{yy} = 0 : -8F_{BC} + 1050 = 0 \Rightarrow F_{BC} = 131 \text{ kN} \rightarrow$$

$$\odot \sum M_{xx} = 0 : -4F_{BC} + 2944 - 4.74F_{BD} = 0$$

$$\therefore -4(131) + 2944 - 4.74F_{BD} = 0$$

$$\therefore F_{BD} = 510 \text{ kN} \rightarrow$$

2[g] Determine all the reactions at A.
Bepaal al die reaksies by A.

[6]

$$\odot \sum F_x = 0:$$

$$A_x - 0.535 F_{BC} + 70 = 0$$

$$\therefore A_x = 0.535(131) - 70 = 0 \quad A_x = 0 \rightarrow$$

$$\odot \sum F_y = 0$$

$$A_y - 196.24 + 0.316 F_{BD} + 0.267 F_{BC} = 0$$

$$\therefore A_y - 196.24 + 0.316(510) + 0.267(131) = 0$$

$$\therefore A_y = 0 \rightarrow$$

$$\odot \sum F_z = 0$$

$$A_z - 13.92 - 0.802 F_{BC} - 0.949 F_{BD} = 0$$

$$\therefore A_z - 13.92 - 0.802(131) - 0.949(510) = 0$$

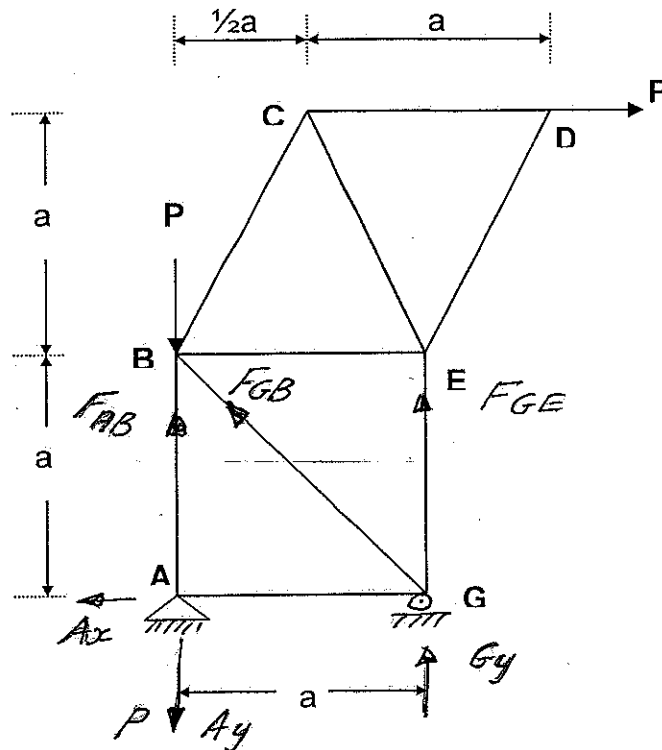
$$\therefore A_z = 603 \text{ kN} \rightarrow$$

QUESTION 3 / VRAAG 3

[10]

The skewed truss carries the given loads. All joints are pinned.

Die skewe kap dra die getoonde belastings. Alle knooppunte is geskarnier.



3[a] Determine all the reactions.
Bepaal al die reaksies.

[3]

$$\odot \sum M_A = 0: a \times G_y - 2Pa = 0 \quad \therefore G_y = 2P \rightarrow$$

$$\sum M_G = 0: a(A_y) + Pa - 2Pa = 0 \quad A_y = P \rightarrow$$

$$\sum F_x = 0 \quad \therefore A_x = P \rightarrow$$

$$\odot \text{Check: } \sum F_y = 0: G_y - A_y - P = 2P - P - P = 0 \rightarrow$$

3[b] Determine and note all zero force members [if any].
Bepaal en noteer alle nul-krag stange [indien enige].

[2]

$$\odot DE = 0$$

3[c] Determine the force in members AB, BG and EG and note these values as well [6]
as the sense [tension [T] or compression [C]] on the given table according to the example
in row 1 of the table.

NB: ONLY THE TABLE WILL BE MARKED.

Bepaal die krag in dele AB, BG en EG en skryf hierdie waardes asook die aard [trekkrag
[T] of drukkrag [C]] in op die gegewe tabel ooreenkomstig die voorbeeld in ry 1 van die
tabel.

LET WEL: SLEGS DIE TABEL WORD GEMERK

$$\odot \sum M_B = 0 :$$

$$F_{GE}(a) + 2P(a) - P(a) = 0$$

$$\therefore F_{GE} = -P = P \text{ (comp)} \rightarrow$$

$$\odot \sum M_G = 0 :$$

$$-F_{AB}(a) + P(a) = 0$$

$$\therefore F_{AB} = P \text{ (Tension)} \rightarrow$$

$$\odot \sum F_y = 0 :$$

$$F_{AB} - P + F_{GE} + 2P + F_{GB} \sin 45^\circ = 0$$

$$\therefore P - P - P + 2P + F_{GB} \sin 45^\circ = 0$$

$$\therefore F_{GB} = \frac{-P}{\sin 45^\circ} = -\sqrt{2}P = \sqrt{2}P \text{ (C)}$$

$$= 1.41 P \text{ (C)} \rightarrow$$

MEMBER / DEEL	FORCE / KRAG	SENSE / AARD [T ; C]
KL	40 kN	C
AB	P	T
BG	1.41 P	C
EG	P	C