UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA

DEPARTEMENT SIVIELE INGENIEURSWESE
DEPARTMENT OF CIVIL ENGINEERING

MECHANICS SWK122 – SEMESTER TEST 1
MEGANIKA SWK122 – SEMESTERTOETS 1

14 Augustus 2008 / *14 August 2008*

⇨ **PLEASE CIRCLE THE NAME OF YOUR LECTURER**
⇨ **TREK ASSEBLIEF 'N RING OM DIE NAAM VAN U DOSENT**

Dosente / Lecturers: Prof H Gräbe Prof L Maree Prof C Roth Dr E Chaparanganda Mr J Pretorius Mnr F van Graan
Eksterne Eksaminator / External Examiner: Prof BWJ VAN RENSBURG

Volpunte / *Full Marks* : **60**
Tyd / *Time* : **1½ uur / *hour***

Memorandum

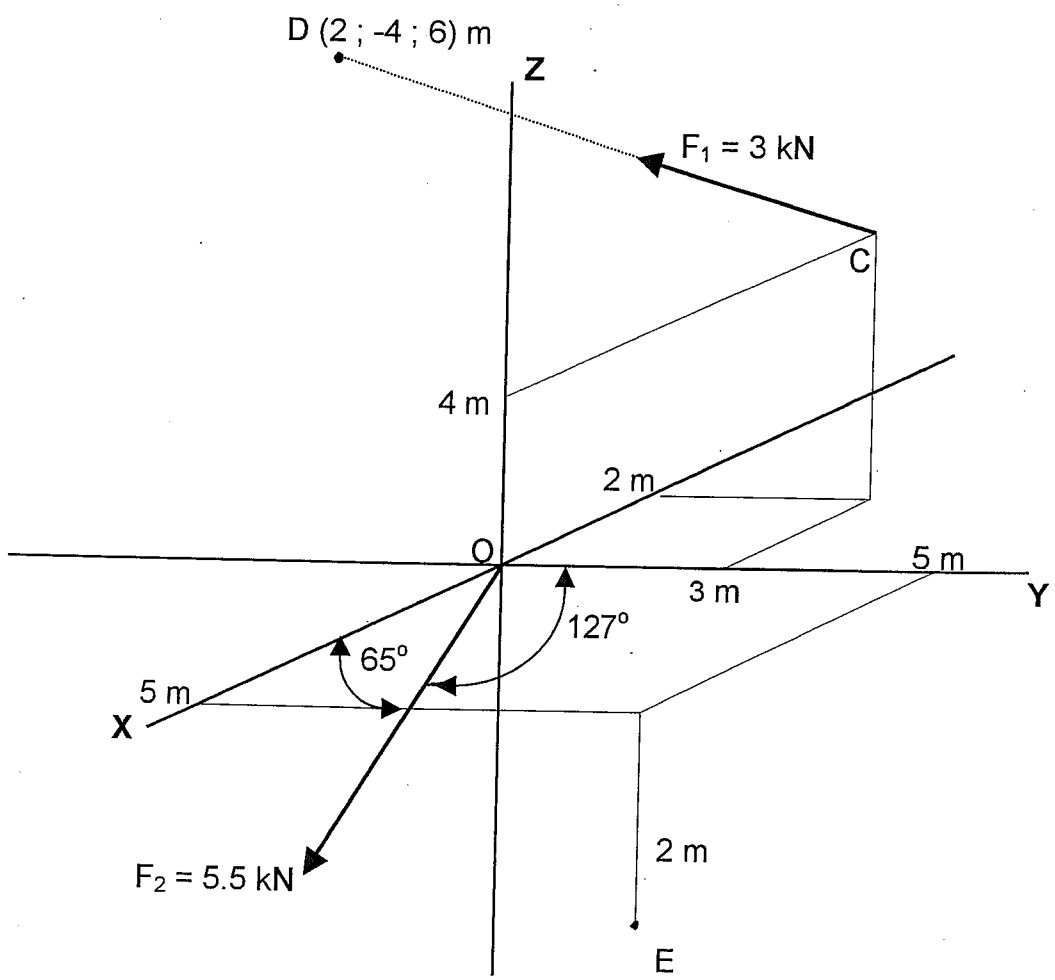
Voorletters en **Van** ***Initials** and **Surname***
Studentenommer ***Student number***
Studierigting [bv Meganies] ***Study discipline** [eg Mining]*
Handtekening ***Signature***

Vraag Question	Punt Mark	
1	30	
2	12	
3	18	
Σ	**60**	

NB ▸ **All answers must be substantiated by the relevant units.**
LW **Alle antwoorde moet deur die nodige eenhede bevestig word.**

▸ **All aspects as described in the EXAMINATION REGULATIONS are applicable.**
Alle aspekte soos vervat in die EKSAMENREGULASIES is van toepassing.

QUESTION 1 / VRAAG 1 **[30]**



[a] Determine position vector **DC**. **[2]**

Bepaal posisievektor DC.

$\overline{DC} = (C) - (D) = (-2\ 3\ 4) - (2\ -4\ 6)$

$= (-4\ \ 7\ \ -2)\ m$ →

[b] Write force F_1 in Cartesian format in Newton (N). **[4]**

Skryf krag F_1 in Cartesiese format in Newton (N).

$\overline{F_1} = F_1 * \overline{u}_{F_1} = F_1 * \frac{\overline{CD}}{CD}$

$= 3000 * \frac{1}{\sqrt{69}} * (4\ -7\ 2)$

$= (1445\ \ -2528\ \ 722)\ N$

[c] Determine the unit vector in the direction of F_2. **[4]**

Bepaal die eenheidsvektor in die rigting van F_2.

⊙ $\overline{u}_{F_2} = (\cos 65^\circ \quad \cos 127^\circ \quad \cos \gamma)$

$\cos \gamma = (1 - \cos^2 65^\circ - \cos^2 127^\circ)^{1/2} = 0.6777$

$\therefore \overline{u}_{F_2} = (0.4226; -0.6018; 0.6777) \rightarrow$

[d] Write force F_2 in Cartesian format in N. **[2]**

Skryf krag F_2 in Cartesiese format in N.

⊙ $\overline{F}_2 = 5500(0.4226; -0.6018; 0.6777)$

$= (2324; -3310; 3727)\ N \rightarrow$

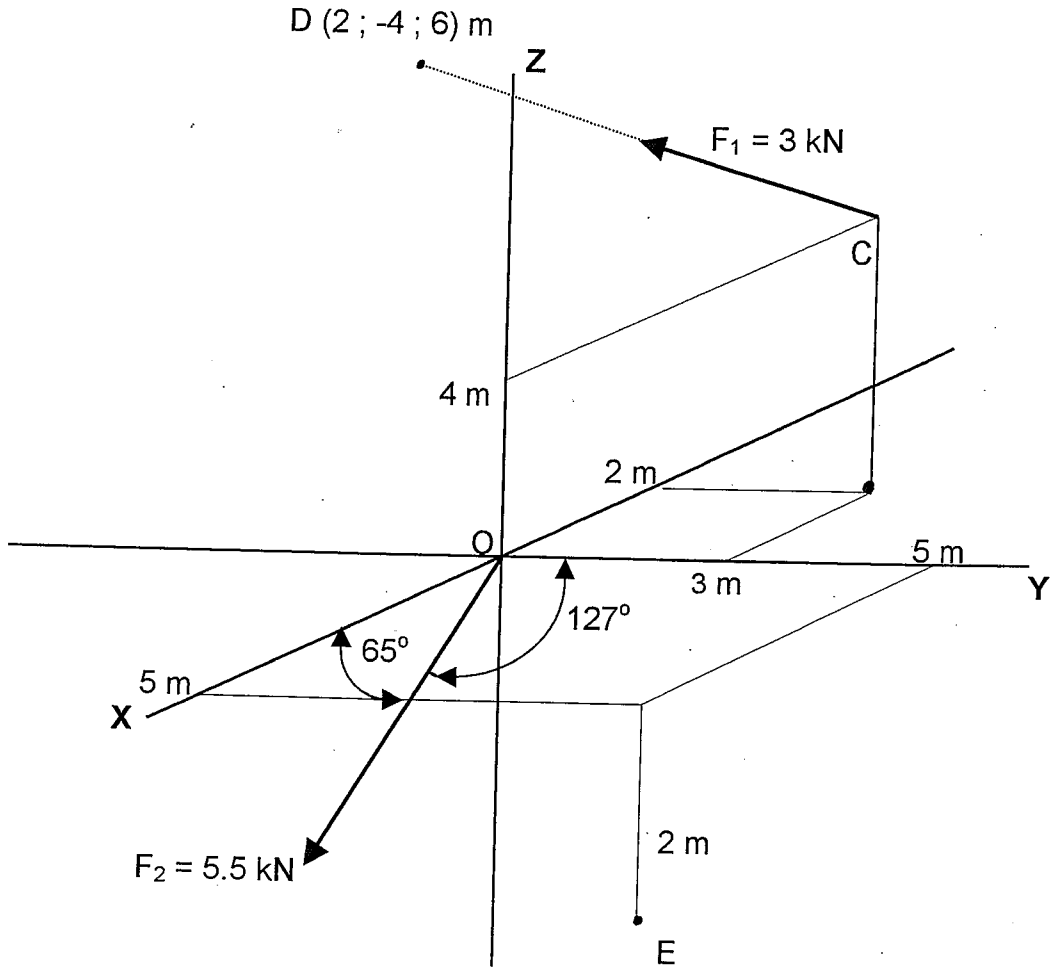
[e] Determine the moment [in Cartesian format] of F_1 about E. **[3]**

Bepaal die moment [in Cartesiese formaat] van F_1 om E.

⊙ $\overline{M}_{E_{F_1}} = \overline{EC} \times \overline{F_1} = [(-2; 3; 4) - (5; 5; -2)] \times \overline{F_1}$

$$= \begin{vmatrix} -7 & -2 & 6 \\ 1445 & -2528 & 722 \end{vmatrix}$$

$= (13724 \quad 13724 \quad 20586)\ N.m \rightarrow$



[f] Determine the moment [in Cartesian format] of $\mathbf{F_2}$ about E. **[3]**

Bepaal die moment [in Cartesiese formaat] van $\mathbf{F_2}$ om E.

$\odot \bar{M}_{E_{F_2}} = \overline{EO} \times \bar{F}_2 = (-5\ -5\ 2) \times \bar{F}_2$

$$= \begin{vmatrix} -5 & -5 & 2 \\ 2324 & -3310 & 3727 \end{vmatrix}$$

$= (-12015 \quad 23283 \quad 28170)$ N.m →

[g] Determine the resultant moment [in Cartesian format] about E. **[3]**

Bepaal die resultantmoment [in Cartesiese formaat] om E.

$\odot \bar{R}_{M_E} = (e) + (f)$

$= (13724;\ 13724;\ 20586) + (-12015;\ 23283;\ 28170)$

$= (1709;\ 37007;\ 48756)$ N.m →

[h] Determine the magnitude of the component of the resultant moment about EO. **[5]**

Bepaal die grootte van die komponent van die resultantmoment om EO.

$$\odot \quad \bar{u}_{EO} = \frac{\overline{EO}}{EO} = \frac{1}{\sqrt{54}}(-5 \quad -5 \quad 2)$$

$$= (-0.68 \quad -0.68 \quad 0.272)$$

$$\odot \quad M_{R_{//EO}} = \bar{M}_R \cdot \bar{u}_{EO}$$

$$= (1709;\ 37007;\ 48756) \cdot (-0.68;\ -0.68;\ 0.272)$$

$$= -13065 \ N.m$$

[i] Write this component of the resultant moment about EO in Cartesian format. **[4]**

Skryf hierdie komponent van die resultantmoment om EO in Cartesiese formaat.

$$\bar{M}_{R_{//EO}} = M_{R_{//EO}} * \bar{u}_{EO}$$

$$= (-13065) * (-0.68;\ -0.68;\ 0.272)$$

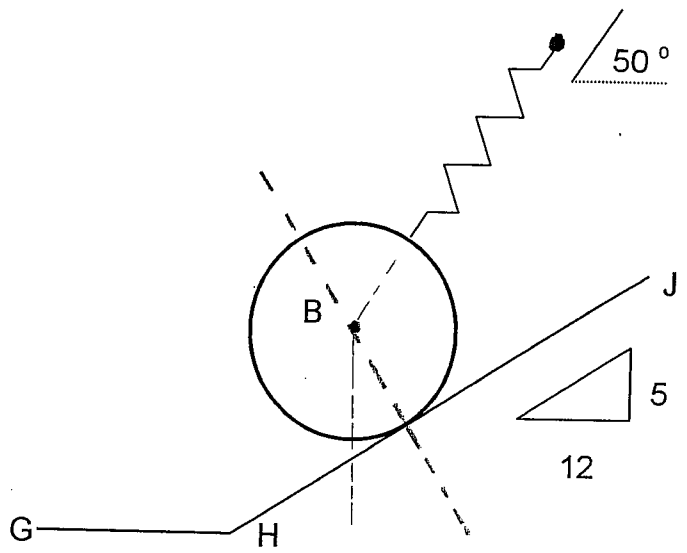
$$= (8884;\ 8884;\ -3554)\ N.m \longrightarrow$$

QUESTION 2/ VRAAG 2

[12]

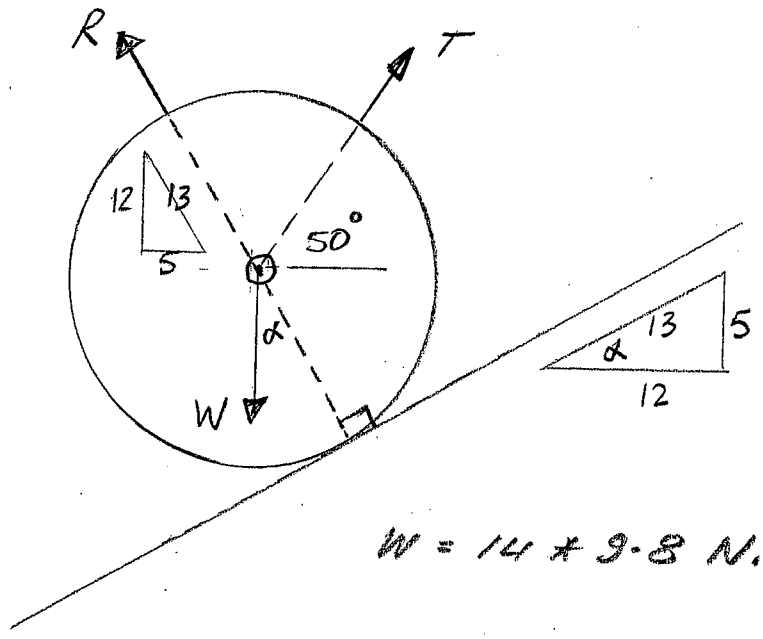
The figure shows a steel cylinder (**B**) with a radius of 124 mm and a mass of 14 kg. The cylinder rests on a smooth surface and is supported by a spring (k = 1 200 N / m).

Die figuur toon 'n staal silinder (B) met 'n straal van 124 mm en 'n massa van 14 kg. Die silinder rus op 'n gladde oppervlakte en word ondersteun deur 'n veer (k = 1 200 N/m).



[a] Draw the Free Body Diagram for the cylinder. **[2]**

Teken die Vryliggaamskets vir die silinder.



[b] Calculate the extension of the spring. **[10]**

Bepaal die uitrekking van die veer.

⊙ At O :

$\sum F_x = 0 \Rightarrow T\cos 50° - \frac{R}{13} * 5 = 0$

$T = 0.6R \quad -(1)$

$\sum F_y = 0 \Rightarrow \frac{R}{13}(12) + T\sin 50° - W = 0 \quad -(2)$

(1) in (2): $\frac{12}{13}R + (0.6R)\sin 50° - 14(9.8) = 0$

$1.383R = 137.2 \qquad R = 99.2\ N \rightarrow \quad -(3)$

(3) in (1): $T = 99.2 * 0.6$

$\therefore T = 59.5\ N \rightarrow \quad -(4)$

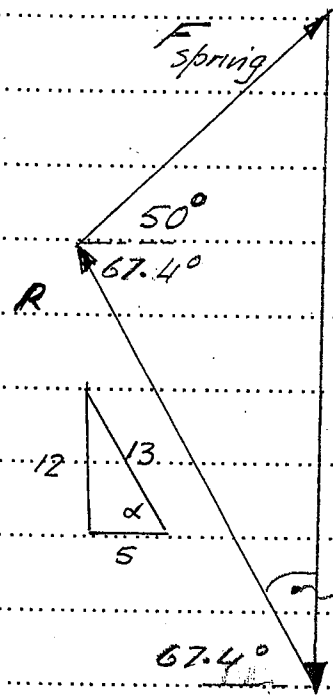
⊙ $F = ks$

$\therefore 59.5 = 1.2 * s$

$s = 49.6\ mm \rightarrow$

[b] Calculate the extension of the spring. **[10]**

Bepaal die uitrekking van die veer.



$\alpha = \tan^{-1}\left(\frac{12}{5}\right)$

$= 67.4°$

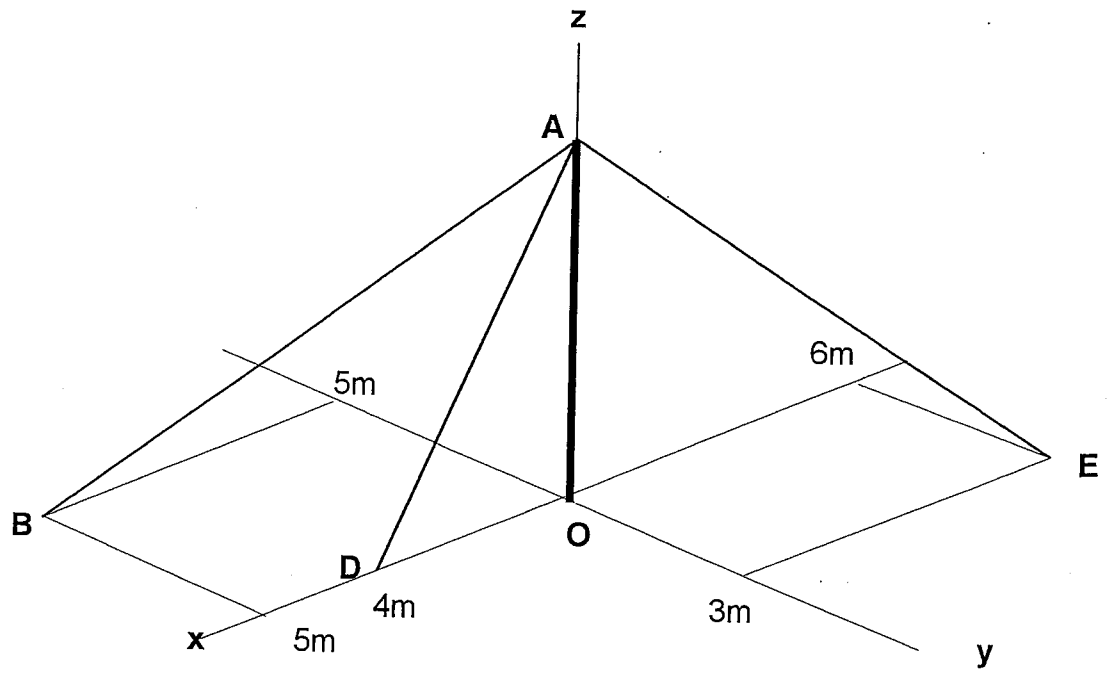
$\circlearrowright \quad F_{spring} = \frac{W * \sin 22.6°}{\sin 117.4°} = 59.38\ N \rightarrow$

$\circlearrowright \quad F = k * s$

$\therefore \quad 59.38 = 1.2 * s$

$s = 49.49\ mm \rightarrow$

QUESTION 3 / VRAAG 3 **[18]**



The antenna (AO) is 8 m high and is held in position by three cables (AB, AD and AE). The force at A in the direction AO is 12 kN.

Die antenna (AO) is 8 m hoog en word in posisie gehou deur drie kabels (AB, AD en AE).
Die krag by A in die rigting AO is 12 kN.

Determine the force in cable AB in N.

Bepaal die krag in kabel AB in N.

$\bar{F}_{AB} = F_{AB} * \bar{u}_{AB}$

$\overline{AB} = (B) - (A) = (5\ -5\ 0) - (0\ 0\ 8) = (5\ -5\ -8)\ m$

$AB = \sqrt{114} = 10.68\ m$

$\therefore \bar{F}_{AB} = F_{AB} * \sqrt{114}\ (5\ -5\ -8)$

$= F_{AB}(0.468\ -0.468\ -0.749)$ —(1)

⊙ $\bar{F}_{AD} = F_{AD} * \bar{u}_{AD}$

$= F_{AD} * \sqrt{80}\,(4\ \ 0\ \ -8)$

$= F_{AD}(0.447;\ 0;\ -0.894)$ — (2)

⊙ $\bar{F}_{AE} = F_{AE} * \bar{u}_{AE}$

$= F_{AE} * \sqrt{109}\,(-6\ \ 3\ \ -8)$

$= F_{AE}(-0.575;\ 0.287;\ -0.766)$ — (3)

⊙ $\sum F_y = 0$: $-0.468 F_{AB} + 0.287 F_{AE} = 0$

$\therefore F_{AE} = 1.631 F_{AB}$ → — (4)

⊙ $\sum F_x = 0$: $0.468 F_{AB} + 0.447 F_{AD} - 0.575 F_{AE} = 0$ — (5)

(4) in (5):

$0.468 F_{AB} + 0.447 F_{AD} - 0.575(1.631) F_{AB} = 0$

$\therefore F_{AD} = 1.051 F_{AB}$ → (6)

⊙ $\sum F_z = 0$: $-0.749 F_{AB} - 0.894 F_{AD} - 0.766 F_{AE} = -12000$ — (7)

(4); (6) in (7):

$\therefore +0.749 F_{AB} + 0.894(1.051 F_{AB}) + 0.766(1.631 F_{AB}) = 12000$

$F_{AB} = \dfrac{12000}{2.9379}$

$= 4085\ N$ →