SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

FEBRUARY / *FEBRUARIE*
MARCH / *MAART*

2005

TECHNIKA (MECHANICAL)

TECHNIKA (MEGANIES)

HG 715-1/0

TECHNIKA MECHANICAL HG

715 1 0 HG

12 pages
12 bladsye

X05

GAUTENGSE DEPARTEMENT VAN ONDERWYS

SENIORSERTIFIKAAT-EKSAMEN

TECHNIKA (MEGANIES) HG

TYD: 3 uur

PUNTE: 300

BENODIGDHEDE:
- Sakrekenaar, tekeninstrumente en inligtingsbladsye

INSTRUKSIES:
- Beantwoord ALLE vrae.
- Sketse en diagramme moet groot, netjies en van byskrifte voorsien wees.
- Alle berekeninge moet getoon word.
- Antwoorde moet duidelik genommer wees in ooreenstemming met die nommers wat in die vraestel gebruik is.
- 'n Inligtingsblad (bladsye 9-12) is aan die einde van die vraestel aangeheg.

VRAAG 1

1.1 Beskryf die ultrasoniese toets wat op materiale uitgevoer word. (8)

1.2 Waarom word normalisering op materiaal toegepas? (3)

1.3 Omskryf **organiese chemie**. (2)

1.4 Gee die name van die volgende koolwaterstowwe in die alkaan-reeks:

1.4.1 C_3H_8 (2)

1.4.2 C_7H_{16} (2)

1.5 Noem VIER eienskappe van 'n ideale gas. (4)

1.6 Die volume van 'n sekere gas is 3,8 m^3 by 'n druk van 150 kPa en 'n temperatuur van 23°C. Bereken die finale temperatuur in °C van die gas indien die volume verminder word tot 1,8 m^3 teen 'n druk van 720 kPa. (5)

1.7 Definieer **Charles se wet**. (4)

GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (MECHANICAL) HG

TIME: 3 hours

MARKS: 300

REQUIREMENTS:
- Calculator, drawing instruments and information pages

INSTRUCTIONS:
- Answer ALL the questions.
- Sketches and diagrams must be large, neat and labelled.
- All calculations must be shown.
- Answers must be clearly numbered, according to the numbering used on the question paper.
- Information pages (pages 9-12) are provided at the end of the paper.

QUESTION 1

1.1 Describe the ultrasonic test used to test materials. (8)

1.2 Why is normalizing applied to materials? (3)

1.3 Define **organic chemistry**. (2)

1.4 Give the names of the following hydrocarbons in the alkane series:

1.4.1 C_3H_8 (2)

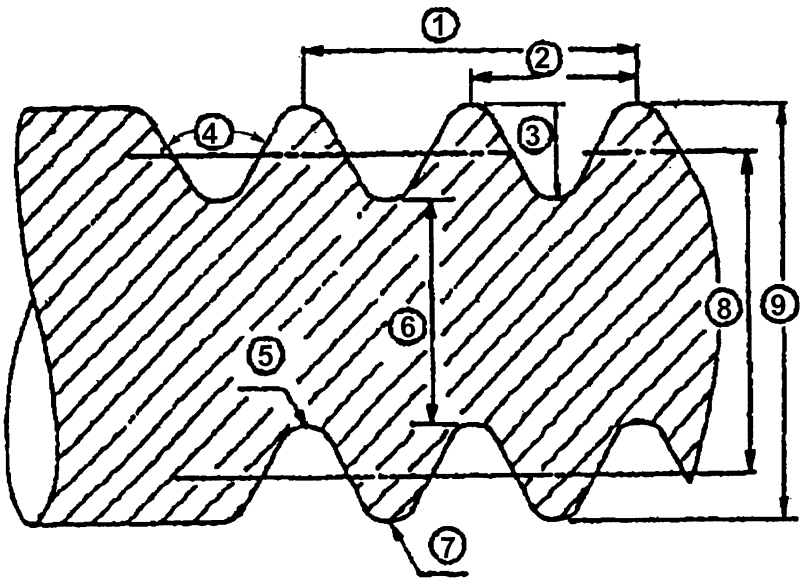
1.4.2 C_7H_{16} (2)

1.5 Name FOUR characteristics of an ideal gas. (4)

1.6 The volume of a certain gas is 3,8 m^3 at a pressure of 150 kPa and a temperature of 23°C. Calculate the final temperature in °C if the volume of the gas is reduced to 1,8 m^3 at a pressure of 720 kPa. (5)

1.7 Define **Charles' Law**. (4)

1.8 Benoem die verskillende terme in die skets hieronder wat by skroefdrade gebruik word.



(9)

1.9 Beskryf hoe die indeksmeeneem-plaat gebruik kan word om meervoudige skroefdraad te sny. (6)

1.10 Noem DRIE indeksering-metodes. (3)

1.11 Wat is die funksie van 'n verdeelkop? (2)
[50]

VRAAG 2

2.1 Gebruik die tabel van primêre passings in die inligtingsbladsye en verstrek die volgende:

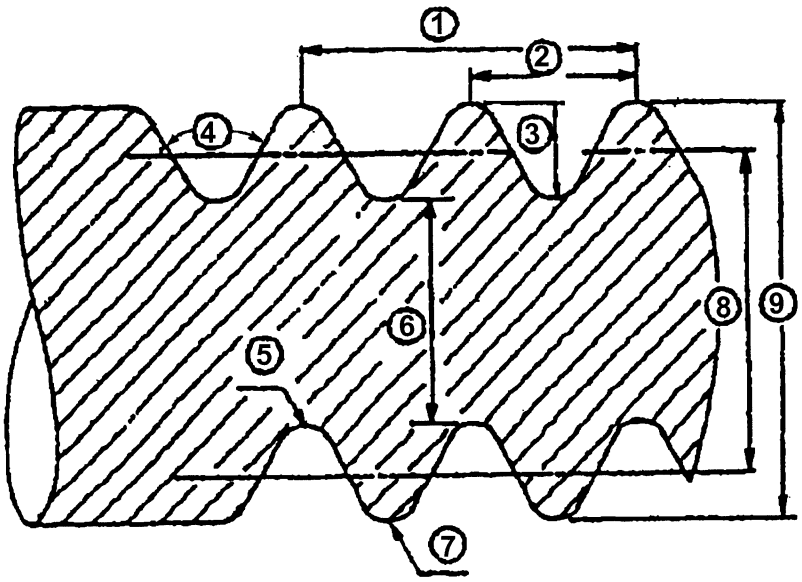
2.1.1 Die grense vir 'n **38H7-n6**-gat-as kombinasie (4)

2.1.2 Die soort passing (1)

2.2 Wat word met **toleransie** bedoel? (2)

2.3 Omskryf Young se elastisiteitsmodulus (E). (4)

1.8 Name the different terms in the sketch below used with screw threads.



(9)

1.9 Describe how the index driving plate could be used to cut a multiple-start thread. (6)

1.10 Name THREE indexing methods. (3)

1.11 What is the function of a dividing head? (2)
[50]

QUESTION 2

2.1 Use the table of primary fits in the information pages, and state the following:

2.1.1 The limits for a **38H7-n6** hole-shaft combination (4)

2.1.2 The type of fit (1)

2.2 What is meant by **tolerance**? (2)

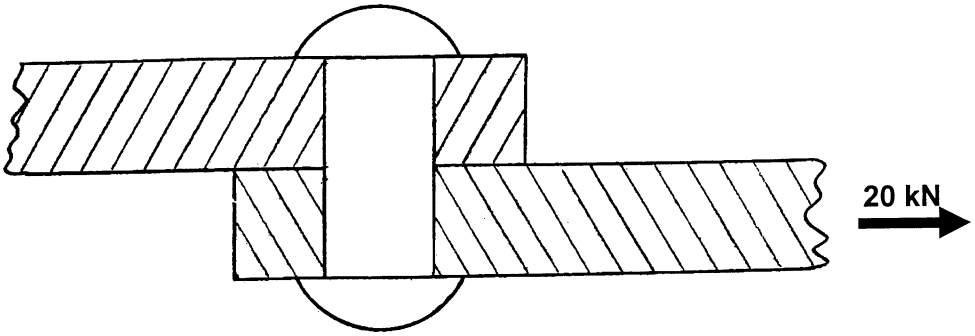
2.3 Describe Young's modulus of elasticity (E). (4)

2.4 Twee plat stroke staalplaat, 35 mm breed en 6 mm dik, word deur 'n enkelklinknael, 12 mm in diameter, gelas soos aangedui. 'n Belasting van 20 kN word op die plate toegepas. Bereken:

2.4.1 Die trekspanning in die soliede gedeelte van die plaat (4)

2.4.2 Die afskuifspanning in die klinknael (4)

2.4.3 Die trekspanning in die gedeelte van die plaat regoor die klinknaelgat (6)



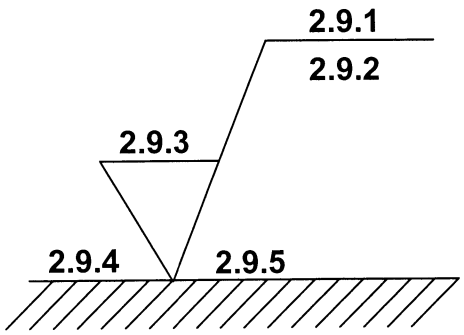
2.5 Omskryf **Ergonomie**. (4)

2.6 Wat is die funksie van 'n maatskaplike werkster? (2)

2.7 Noem die nadelige gevolge van die misbruik van alkohol en dwelms. (4)

2.8 Hoe sou jy 'n werknemer aanmoedig om gelukkig in sy of haar werk te wees? (4)

2.9 Die onderstaande figuur toon 'n oppervlakafwerking-simbool aan. Die simbool word gebruik om sekere inligting oor te dra. Noem die inligting wat by punte 2.9.1 – 2.9.5 verkry kan word.



(5)

2.10 Noem die faktore wat 'n invloed het op oppervlakafwerking. (4)

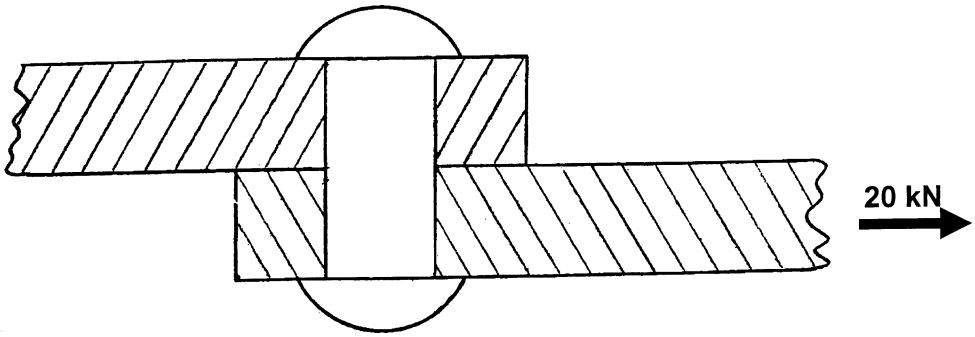
2.11 Waar kom oppervlakafwerking-simbole voor? (2)
[50]

2.4 Two pieces of flat iron, 35 mm wide by 6 mm thick, are riveted with a 12 mm diameter single rivet. A load of 20 kN is exerted on the flat iron.
Calculate:

2.4.1 The stress inside the solid piece of the flat iron (4)

2.4.2 The shear stress in the rivet (4)

2.4.3 The tensile stress in the flat iron on the centre line of the rivet (6)



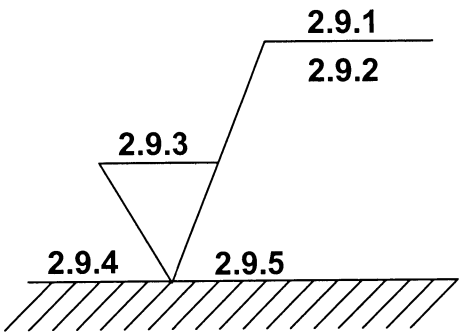
2.5 Describe **Ergonomics**. (4)

2.6 What is the function of a social worker? (2)

2.7 Name the detrimental effects of drugs and alcohol abuse. (4)

2.8 How would you motivate an employee to be happy in his or her work? (4)

2.9 The figure below shows a surface finishing symbol. The symbol is used to show certain information. Name the information shown from 2.9.1 – 2.9.5.



(5)

2.10 Name the factors that have an influence on surface finishing. (4)

2.11 Where do we find surface finishing symbols? (2)
[50]

VRAAG 3

3.1 Honderd drie en dertig (133) tande moet op 'n reguittand-rat gefrees word. Die verdeelkopverhouding is 40:1.

3.1.1 Bereken die indeksering wat nodig is. (Kies 130 indelings.) (2)

3.1.2 Bereken die wisselratte wat nodig is. (5)

3.1.3 Bepaal die draairigting van die indeksplaat. (2)

3.1.4 Maak 'n eenvoudige skets om die posisie en rangskikking van die wisselratte duidelik aan te toon. (4)

3.2 Beskryf die volgende strukture van staal:

3.2.1 Perliet (4)

3.2.2 Ferriet (4)

3.3 Beskryf en skets wat by die volgende haltepunte met die struktuur van staal gebeur:

3.3.1 AC_1 (5)

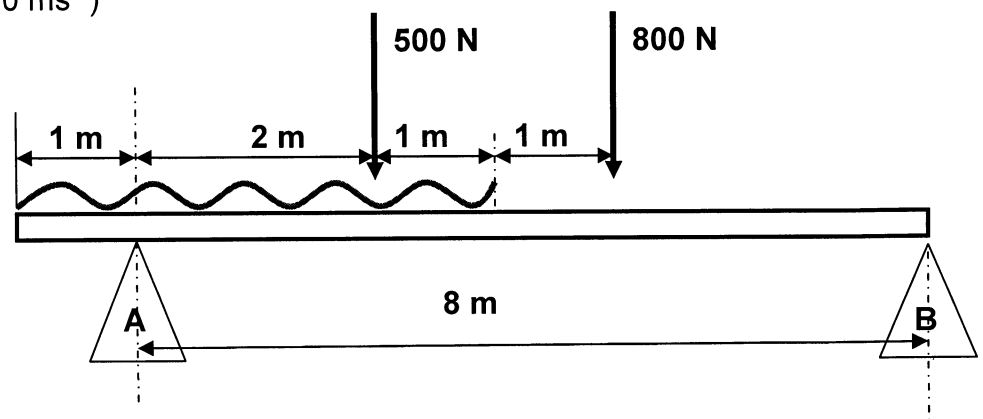
3.3.2 AC_2 (2)

3.4 Beskryf en skets die Rockwell-hardheidstoets. (8)

3.5 Gee die **Wet van Momente**. (4)

3.6 'n Gelykmatige balk is 8 m lank en het 'n massa van 120 kg. Dit rus in 'n horisontale posisie op twee stutte, een 1 m van die linkerpunt af en die ander by die regterpunt. Die balk dra puntbelastings van 500 N en 800 N op afstande 3 m en 5 m vanaf die linkerpunt. Dit dra ook 'n gelykmatig verspreide belasting van 80 N/m oor die linkerhelfte van die balk. Bereken die reaksies van die steunpunte en toets jou antwoorde.

($g = 10\ ms^{-1}$)



(10)
[50]

QUESTION 3

3.1 One hundred and thirty-three (133) teeth must be milled on a spur gear. The dividing head ratio is 40:1.

3.1.1 Calculate the indexing required. (Choose 130 divisions.) (2)

3.1.2 Calculate the change wheels required. (5)

3.1.3 Determine the direction of rotation of the index plate. (2)

3.1.4 Draw a simple sketch to indicate the position and arrangement of the change wheels. (4)

3.2 Describe the following structures of steel:

3.2.1 Perlite (4)

3.2.2 Ferrite (4)

3.3 Describe what happens at the following halting points of steel:

3.3.1 AC_1 (5)

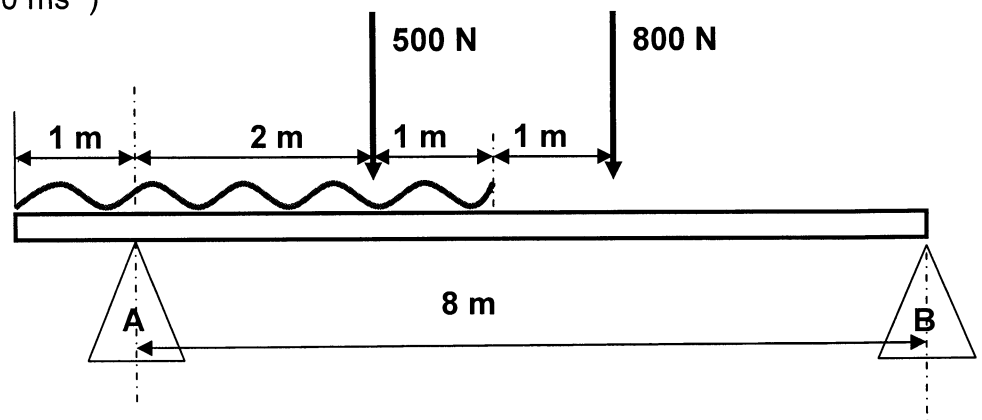
3.3.2 AC_2 (2)

3.4 Describe and sketch the Rockwell hardness test. (8)

3.5 State the **law of moments**. (4)

3.6 A uniform beam is 8 m long and has a mass of 120 kg. It is horizontal, and is at rest on two supports, one 1 m from the left-hand end and the other one at the right-hand end. It carries concentrated loads of 500 N and 800 N, 3 m and 5 m from the left-hand end respectively. It also carries a uniformly distributed load of 80 N/m over the left half of the beam. Calculate the reactions of the supports and test your answer.

($g = 10\ ms^{-1}$)

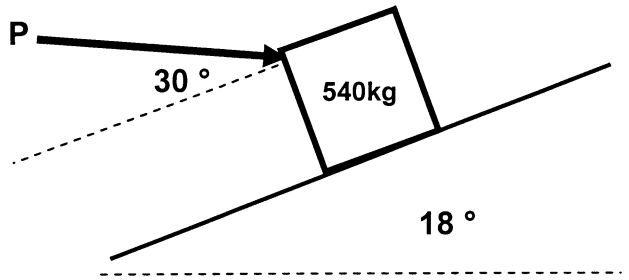


(10)
[50]

VRAAG 4

4.1 Noem VIER wrywingswette. (4)

4.2 'n Liggaam met 'n massa van 540 kg word op 'n skuinsvlak geplaas wat 'n hoek van 18° met die horisontaal vorm. Die wrywingskoëffisiënt is 0,48. Bereken die kleinste krag **P** nodig om die liggaam teen die helling op te beweeg.



(10)

4.3 Definieer 'n **radiaal**. (4)

4.4 Bewys dat 1 radiaal gelyk is aan 57,3°. (3)

4.5 Die massa van 'n vliegwiel is 62 kg en die traagheidstraal 220 mm. Die vliegwiel word vanaf 230 rpm tot 1 280 rpm in 12 sekondes versnel. Bereken:

4.5.1 Die hoeksnelheid in radiale per sekonde² (4)

4.5.2 Die versnellende draaimoment (4)

4.5.3 Die traagheidsmoment (4)

4.5.4 Die kinetiese energie wanneer die vliegwiel teen 1 280 rpm roteer (5)

4.6 Beskryf hoe ratreduksie met behulp van die episikliese ratstelsel verkry kan word. (4)

4.7 Teken 'n eenvoudige diagrammatiese voorstelling van 'n enkel-episikliese ratstelsel en toon die volgende komponente:

4.7.1 Sonrat (naafrat)

4.7.2 Planeetratte

4.7.3 Planeetratraam (draer)

4.7.4 Vellingrat (4)

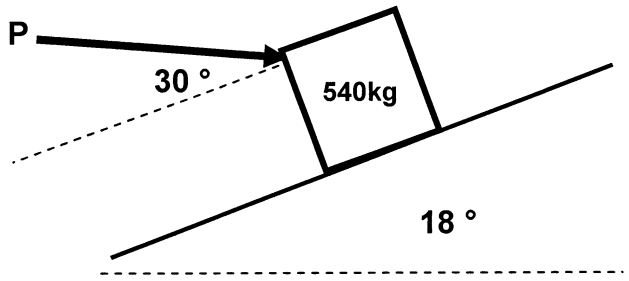
4.8 Bereken die wydte, dikte en lengte van 'n spy wat aan 'n Ø 52 mm-as gebruik moet word. Teken 'n netjiese skets van die spy met die afmetings daarop aangetoon. (4)

[50]

QUESTION 4

4.1 Name FOUR laws of friction. (4)

4.2 A body with a mass of 540 kg is placed on an inclined plane making an angle of 18° with the horizontal. The coefficient of friction is 0,48. Calculate the magnitude of the smallest force **P** that will push the object upwards against the incline.



(10)

4.3 Define a **radian**. (4)

4.4 Prove that 1 radian is equal to 57,3°. (3)

4.5 The mass of a flywheel is 62 kg and the radius of inertia is 220 mm. The flywheel is accelerated from 230 rpm to 1 280 rpm in 12 seconds. Calculate:

4.5.1 The angular acceleration in radians per second² (4)

4.5.2 The accelerating torque (4)

4.5.3 The moment of inertia (4)

4.5.4 The kinetic energy when the flywheel rotates at 1 280 rpm. (5)

4.6 Explain how gear reduction is obtained with an epicyclic gear train. (4)

4.7 Draw a simple sketch of an epicyclic gear train and indicate the following components:

4.7.1 Sun gear

4.7.2 Planet gear

4.7.3 Planetary carrier

4.7.4 Ring gear (4)

4.8 Calculate the width, thickness and length of a key to be used on a Ø 52 mm shaft. Draw a neat sketch of the key indicating the different dimensions on it. (4)

[50]

VRAAG 5

5.1 Teken 'n netjiese skets van 'n enkelplaat-spiraalveerkoppelaar-samestelling. Toon alle dele netjies op die skets aan en voeg die nodige byskrifte by. (18)

5.2 Noem DRIE tipes kruiskoppelings. (3)

5.3 Teken 'n tipiese drukvolume-diagram vir 'n vierslag-kompressie-ontsteking-enjin om die druk/volume-verwantskap gedurende een volledige kringloop aan te dui. Benoem alle komponente van die diagram. (8)

5.4 Die volgende gegewens het betrekking op 'n vierslag-enjin:

Gemiddelde effektiewe druk	928 kPa
Slaglengte	110 mm
Silinderdiameter	90 mm
Omwentelinge per minuut	3 500
Aangeduide drywing	113,64 kW

Bereken die

5.4.1 getal silinders van die enjin. (7)

5.4.2 arbeid gedurende een kragslag verrig. (3)

5.5 Definieer elk van die volgende:

5.5.1 Aangeduide drywing (4)

5.5.2 Remdrywing (4)

5.5.3 Termodinamika (3)
[50]

VRAAG 6

6.1 'n Massa van 6 kg word vertikaal opwaarts geprojekteer teen 'n snelheid van 8 m/s. Bereken die

6.1.1 maksimum hoogte wat dit sal bereik. (4)

6.1.2 kinetiese energie wanneer dit 2 meter bokant die grond is. (5)

6.1.3 snelheid wanneer dit 2 meter bokant die grond is. (4)

6.2 Noem VIER voordele van bandaandrywing bo rataandrywing. (4)

QUESTION 5

5.1 Draw a neat sketch of a single-plate spiral spring dry clutch assembly. Indicate all parts neatly on the sketch and add the necessary labels. (18)

5.2 Name THREE types of universal joints. (3)

5.3 Draw a typical pressure/volume diagram for a four-stroke compression ignition engine to illustrate the pressure/volume relationship for a complete cycle. Label all components of the diagram. (8)

5.4 The following is data on a four-stroke engine:

Mean effective pressure	928 kPa
Stroke length	110 mm
Cylinder diameter	90 mm
Revolutions per minute	3 500
Indicated Power	113,64 kW

Calculate the

5.4.1 number of cylinders of the engine. (7)

5.4.2 work done during one power stroke. (3)

5.5 Define the following:

5.5.1 Indicated Power (4)

5.5.2 Brake Power (4)

5.5.3 Thermodynamics (3)
[50]

QUESTION 6

6.1 A body with a mass of 6 kg is projected vertically upwards at a velocity of 8 m/s. Calculate the

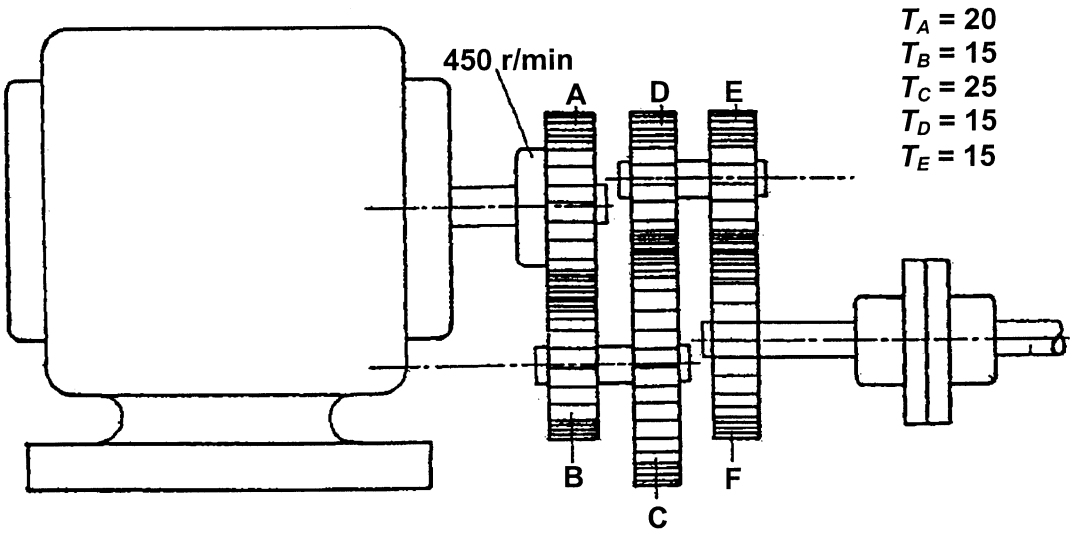
6.1.1 maximum height that it will reach. (4)

6.1.2 kinetic energy when it is 2 m above the ground. (5)

6.1.3 velocity when it is 2 m above the ground. (4)

6.2 Give FOUR advantages of a belt-drive over a gear-drive. (4)

6.3 Die onderstaande figuur toon 'n meganisme om krag oor te dra vanaf 'n elektriese motor wat teen 450 rpm draai na 'n masjienspil wat teen X rpm draai. Indien die tande op rat F gelyk is aan 22, bereken die rotasiefrekwensie van die masjienspil.



(6)

6.4 Die drywing wat oorgedra word deur 'n dryfband vanaf 'n dryfkatrol met 'n diameter van 300 mm wat teen 2 500 revolusies per minuut roteer, is 8 kW.

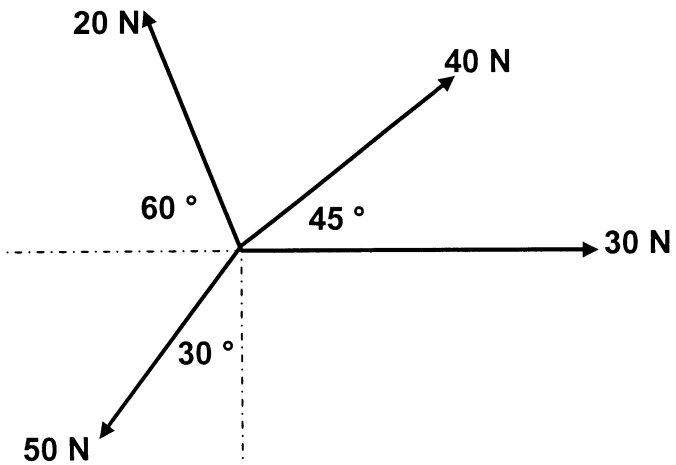
Die verhouding van die trekkrag van die stywe kant tot die slap kant is 2,5:1.

Bereken die

6.4.1 trekkrag in die stywe kant van die band. (8)

6.4.2 bandspoed in meter per sekonde. (3)

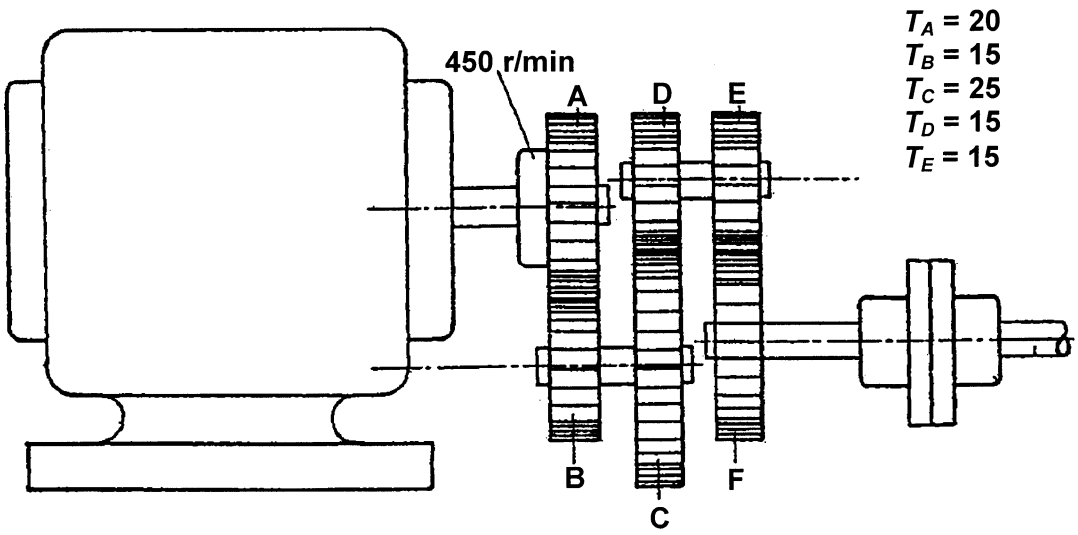
6.5 Die diagram toon VIER kragte wat op 'n punt inwerk.
Bereken die grootte en rigting van die ewewigskrag.



(16)
[50]

TOTAAL: 300

6.3 The figure below shows a mechanism to transfer force from an electric motor rotating at 450 rpm to a spindle rotating at X rpm. If the number of teeth on the gear F equals 22, calculate the rotational frequency of the machine spindle.



(6)

6.4 The power transmitted by a drive belt from a drive pulley with a diameter of 300 mm rotating at 2500 revolutions per minute, is 8 kW.

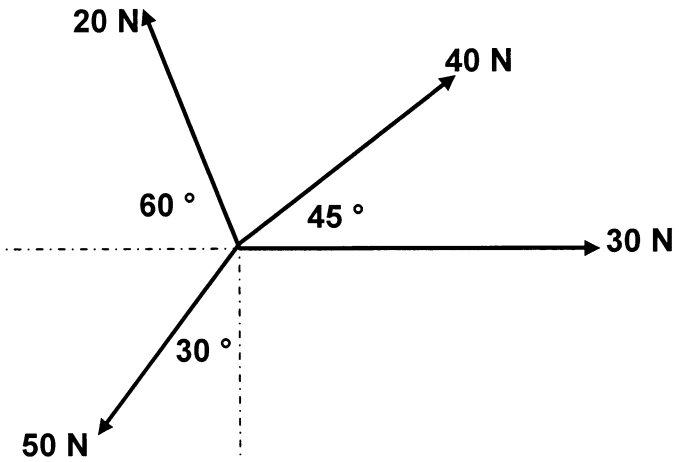
The ratio of the tractive force in the tight side to that in the slack side is 2,5:1.

Calculate the

6.4.1 tractive force in the tight side of the belt. (8)

6.4.2 belt speed in metres per second. (3)

6.5 The diagram below indicates FOUR forces acting on a point.
Calculate the magnitude and direction of the equilibrium force.



(16)
[50]

TOTAL: 300

INFORMATION PAGES / INLIGTINGSBLADSYE

1. **Tooth gears for milling machine / Tandratte vir freesmasjien**
   Standard and special wheels / Standaard- en spesiale wiele

   24 (two of these / twee van hierdie); 28; 32; 40; 44; 46; 47; 48; 52; 56; 58; 64; 68; 70; 72; 76; 84; 86 and/en 100 teeth / tande

2. **Index plate for milling machine / Indeksplaat vir freesmasjien**

   Standard Cincinnati index machine / Standaard-Cincinnati-indeksmasjien 24; 25; 28; 30; 34; 37; 38; 39; 41; 42; 43; 46; 47; 49; 51; 53; 54; 57; 58; 59; 62 and/en 66 holes/gate

3. **Take π = 3,14 / Neem π = 3,14**

4. **Take g = 10 m.s^{-2} / Neem g = 10 m.s^{-2}**

5. **Formulae / Formules**

   5.1 **Indexing / Indeksering:**

   5.1.1 **Simple indexing / Eenvoudige indeksering =** $\frac{40}{N}$

   [Dr = Drive gear / Dryfrat]
   [Dn / Gd = Driven gear / Gedrewe rat]

   5.1.2 **Differential indexing / Differensiaalindeksering =** $\frac{Dr}{Gdr} = \frac{(A-N)}{A} \times \frac{40}{1}$

   5.2 **Two-wire method of screw-thread measurement / Tweedraadmetode van skroefdraadmeting:**

   Calculation of included angle / Berekening van ingeslote hoek:

$$\sin\frac{\theta}{2} = \frac{R-r}{\frac{(M-m)}{2}+r-R}$$

   5.3 **Friction: Co-efficient of friction / Wrywing: Wrywingskoëffisiënt** $\mu = \frac{F\mu}{R}$

   5.4 **Stress / Spanning =** $\frac{F}{A}$

5.5 Cross-sectional area of solid cylinder / Dwarsdeursnee-area van soliede silinder = $\frac{\pi D^2}{4}$ or/of πr^2

5.6 Cross-sectional area of hollow cylinder / Dwarsdeursnee-area van hol silinder = $\frac{\pi(D^2 - d^2)}{4}$

5.7 $E = \frac{\text{Stress}}{\text{Strain}}$ /$E = \frac{\text{Spanning}}{\text{Vormverandering}}$

5.8 $\text{Strain} = \frac{\text{Change in length}}{\text{Original length}}$ /$\text{Vormverandering} = \frac{\text{Verandering in lengte}}{\text{Oorspronklike lengte}}$

5.9 $\text{Factor of Safety} = \frac{\text{Ultimate stress}}{\text{Working stress}}$ /$\text{Veiligheidsfaktor} = \frac{\text{Breekspanning}}{\text{Werkspanning}}$

5.10 Angular acceleration / Hoekversnelling = $\frac{\omega_2 - \omega_1}{t}$

5.11 Torque T / Draaimoment $T = mk^2\omega^2$

5.12 Moment of inertia / Traagheidsmoment $I = mk^2$

5.13 Angular velocity / Hoeksnelheid $\omega = \frac{2\pi N}{60}$

5.14 Kinetic energy of a flywheel / Kinetiese energie van 'n vliegwiel
$E_k = \frac{1}{2} mk^2\omega^2$

5.15 Belt drives / Bandaandrywings

5.15.1 Power P / Drywing $P - (T_1 - T_2)\ \pi Dn$

5.15.2 $D_{Dr} \times N_{Dr} = D_{DN} \times N_{DN}$ (Dr = Driver pulley)
(Dn = Driven pulley)

$D_{Dr} \times N_{Dr} = D_{Gdr} \times N_{Gdr}$ (Dr = Dryfkatrol)
(Gdr = Gedrewe katrol)

5.16 Gear drives / Rataandrywings

5.16.1 $N_A \times T_A = N_B \times T_B$

5.16.2 $\frac{\text{Revolutions of final driven gear}}{\text{Revolutions of first drive gear}} / \frac{\text{Omwentelinge van finale gedrewe rat}}{\text{Omwentelinge van eerste dryfrat}}$

=

$\frac{\text{Product of number of teeth on all drive gears}}{\text{Product of number of teeth on the driven gears}} / \frac{\text{Produk van getal tande op al die dryfratte}}{\text{Produk van getal tande op die gedrewe ratte}}$

5.16.3 Speed ratio = $\frac{\text{Product of number of teeth on all drive gears}}{\text{Product of number of teeth on all driven gears}}$

Spoedverhouding = $\frac{\text{Produk van getal tande van alle dryfratte}}{\text{Produk van getal tande van alle gedrewe ratte}}$

5.17 Power / Drywing

5.17.1 Indicated power IP = PLANn (N = Number of power strokes per second)
Aangeduide drywing AD = PLANn (N = Getal kragslae per sekonde)

5.17.2 Brake power BP / Remdrywing RD = $\frac{2\pi NT}{60}$

5.17.3 Torque T / Draaimoment T = Fr

5.17.4 Mechanical efficiency = $\frac{BP}{IP} x \frac{100}{1}$ /Meganiese rendement $\frac{RD}{AD} x \frac{100}{1}$

5.18 Motion equations / Bewegingsvergelykings

$v = u + at$	$v = at$	$v = u + gt$	$v = gt$
$s = ut + \frac{1}{2} at^2$	$s = \frac{1}{2} at^2$	$s = ut + \frac{1}{2}gt^2$	$s = \frac{1}{2}gt^2$
$v^2 = u^2 + 2as$	$v^2 = 2as$	$v^2 = u^2 + 2gs$	$v^2 = 2gs$

6. Table of primary fits (hole basis system) / *Tabel van primêre passings (gatbasisstelsel)*

Nominal sizes *Nominale groottes*		CLEARANCE FITS *VRY PASSINGS*												TRANSITION FITS *OORGANGPASSINGS*				INTERFERENCE FITS *SLUITPASSINGS*			
		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*		Tolerance *Toleransie*	
Over *Oor* mm	To *Tot* mm	H11	c11	H9	d10	H9	e9	H8	f7	H7	g6	H7	h6	H7	k6	H7	n6	H7	p6	H7	s6
		UNIT / *EENHEID* 0,001 mm																			
10	18	+ 110	- 95	+ 43	- 50	+ 43	- 32	+ 27	- 16	+ 18	- 6	+ 18	- 11	+18	+ 12	+18	+ 23	+ 18	+ 29	+ 18	+ 39
		0	- 205	0	- 120	0	- 75	0	- 34	0	- 17	0	0	0	+ 1	0	+ 12	0	+ 18	0	+ 28
18	30	+ 130	- 110	+ 52	- 65	+ 52	- 40	+ 33	- 20	+ 21	- 7	+ 21	- 13	+ 21	+ 15	+ 21	+ 28	+ 21	+ 35	+ 21	+ 48
		0	- 204	0	- 149	0	- 92	0	- 41	0	- 20	0	0	0	+ 2	0	+ 15	0	+ 22	0	+ 35
30	40	+ 160	- 120																		
		0	- 280	+ 62	- 80	+ 62	- 50	+ 39	- 25	+ 25	- 9	+ 25	- 16	+ 25	+ 18	+ 25	+ 33	+ 25	+ 42	+ 25	+ 59
40	50	+ 160	- 130	0	- 180	0	- 112	0	- 50	0	- 25	0	0	0	+ 2	0	+ 17	0	+ 26	0	+ 43
		0	- 290																		

Selection of Primary Fits (hole basis system)
Seleksie van Primêre Passings (gatbasisstelsel)

END / *EINDE*