GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (MECHANICAL) HG

OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005

TIME: 3 hours

MARKS: 300

REQUIREMENTS:

- Calculator, drawing instruments and information pamphlet.

INSTRUCTIONS:

- Answer **ALL** questions.

QUESTION 1

1.1 Define each of the following:

1.1.1 Velocity (3)

1.1.2 Power (2)

1.1.3 Kinetic energy (3)

1.2 Name FOUR advantages of belt drives over gear drives. (4)

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

1.4 Convert 36,2 rad/s to r/min. (2)

1.5 Use the table of primary selection of fits in the information pages and give the following:

1.5.1 The limits for a **12H9-d10** hole-shaft combination (4)

1.5.2 The type of fit (1)

1.6 The following data is provided for a four-cylinder four-stroke internal combustion engine:

Cylinder diameter	80 mm
Stroke	100 mm
Mean effective pressure on piston	860 kPa
Revolutions per minute	3 600 r/min
Effective brake-arm length	900 mm
Reading on scale	9 kg

Calculate the following:

1.6.1 The indicated power in kW (6)

1.6.2 The work done during ONE power stroke if the piston moves from the TDC to the BDC (3)

1.6.3 The brake power in kW (4)

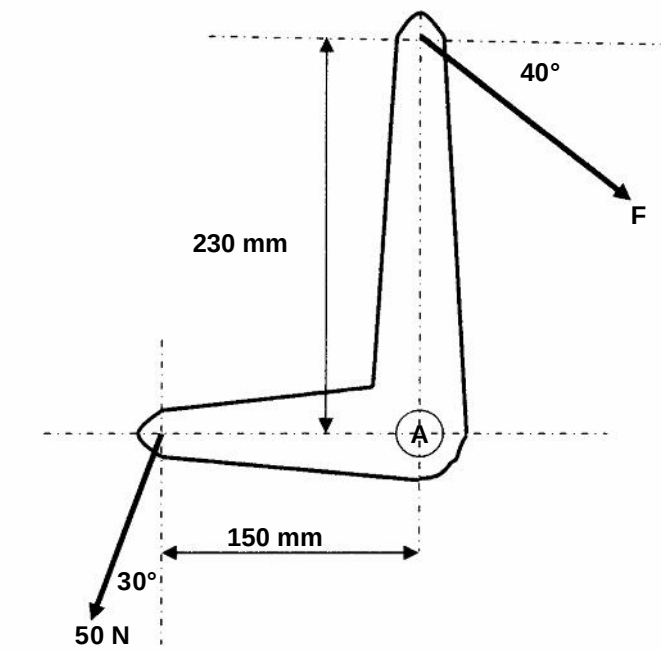
1.7 Name SIX occupational illnesses and state the cause of each. (12)

1.8 Define **thermodynamics**. (2)
[50]

QUESTION 2

2.1 Give the **law of moments**. (4)

2.2 Calculate the magnitude of the reaction at pivot point **A** of the lever that is in equilibrium.



(18)

2.3 Discuss the chemical combustion process of petrol. (6)

2.4 What is the purpose of a universal joint in a drive system? (2)

2.5 Draw the following symbols that are used in an electrical circuit:

2.5.1 Transistor (Name the components.) (3)

2.5.2 Rectifier diode (Show the direction of current flow.) (2)

2.6 State FOUR characteristics of a good operations leader. (4)

2.7 State FOUR facets which are important for successful work stream planning. (4)

2.8 What is **industrial housekeeping** and why is it very important? (5)

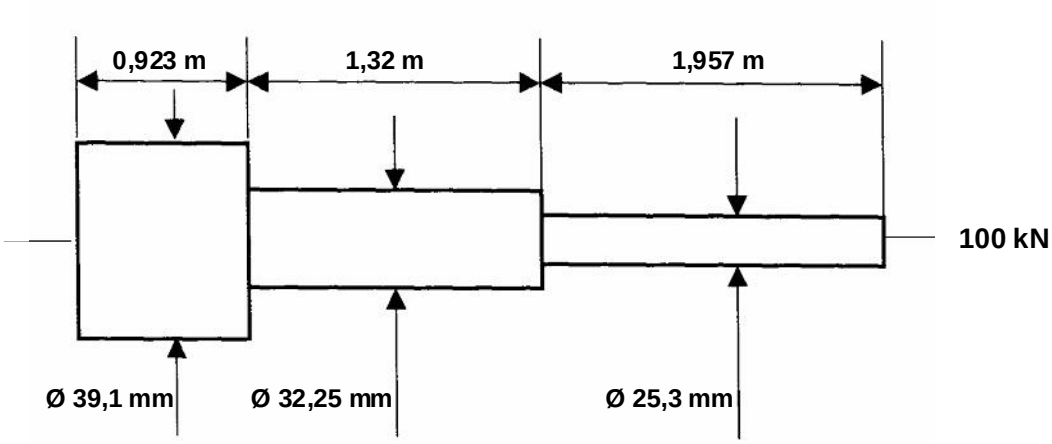
2.9 Name TWO types of keys that are used. (2)

[50]

QUESTION 3

3.1 Define **Hooke's Law**. (3)

3.2 A round bar is 4,2 m long and is subjected to a load of 100 kN. The bar is 39,1 mm in diameter for 0,923 m of its length and 32,25 mm for 1,32 m of the length. The diameter of the remaining length is 25,3 mm. Calculate the total extension if E = 190 GPa.



(20)

3.3 Define Young's modulus of elasticity (E). (4)

3.4 Describe the ultrasonic test used to test steel for defects. (8)

3.5 Name the factors causing structural change during welding. (5)

3.6 The included angle of an M50 V-screw thread with a pitch of 6 mm is 60°. Calculate the distance over the large and small measuring wires:

Given:

Maximum diameter of measuring wires 1,01 P
Minimum diameter of measuring wires 0,5 P (10)
[50]

QUESTION 4

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

4.2 The minutes-indicator of a church-tower clock is 1,2 m long and moves from the 12 to the 7.

Determine the

4.2.1 angular displacement (?) of the indicator (in radians). (4)

4.2.2 displacement(s) of the tip of the indicator. (4)

4.2.3 angular velocity (?) of the indicator. (4)

4.2.4 linear velocity (v) of the tip of the indicator. (3)

4.3 Describe how the index plate can be used to cut a multi-start screw thread. (8)

4.4 A rope with a length of 120 metres and a mass of 3,5 kg / metres is used to its full length to hoist a lift with a mass of 480 kg.

Calculate the

4.4.1 average tractive force in the rope. (6)

4.4.2 work done. (3)

4.4.3 power required if it takes three minutes to hoist the lift. (3)

4.5 Name THREE conditions before work can be done. (3)

4.6 A railway carriage with a mass of 48 tons is pulled up an incline of 1 in 200. The tractive resistance of the carriage is 530 N per ton of its mass. Determine the work done if the carriage is pulled up the incline over a distance of 80 metres. (8)
[50]

QUESTION 5

5.1 The diameter of a driver pulley is 0,4 m and the pulley rotates at 200 r/min. The tensions in the belt, which is driving another pulley with a diameter of 0,6 m, are 400 N and 200 N.

Calculate

5.1.1 the ratio of the tensions. (2)

5.1.2 the rotational frequency of the driven pulley. (4)

5.1.3 the power dissipated. (5)

5.1.4 the velocity ratio. (3)

5.2 One hundred and fifty-seven (157) teeth must be milled on a spur-gear. The dividing-head ratio is 40:1.

5.2.1 Calculate the indexing required. (Choose 160 divisions.) (2)

5.2.2 Calculate the change wheels required. (5)

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

5.2.4 Draw a simple sketch clearly showing the position and arrangement of the change wheels. (4)

5.3 Define the following concepts:

5.3.1 Potential energy (2)

5.3.2 Kinetic energy (2)

5.4 Draw neat sketches of THREE basic surface-finish symbols and state the meaning of each. (9)

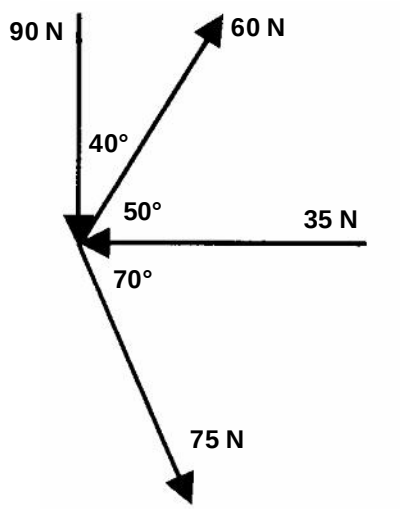
5.5 Draw a typical stress-strain graph if low-carbon steel (mild steel) is subjected to a destructive tensile test. Name all the components of the graph. (8)

5.6 What is the purpose of a key in a transmission system? (2)

[50]

QUESTION 6

6.1 The diagram below shows FOUR forces acting at a point. Calculate the magnitude and direction of the equilibrium force.



(18)

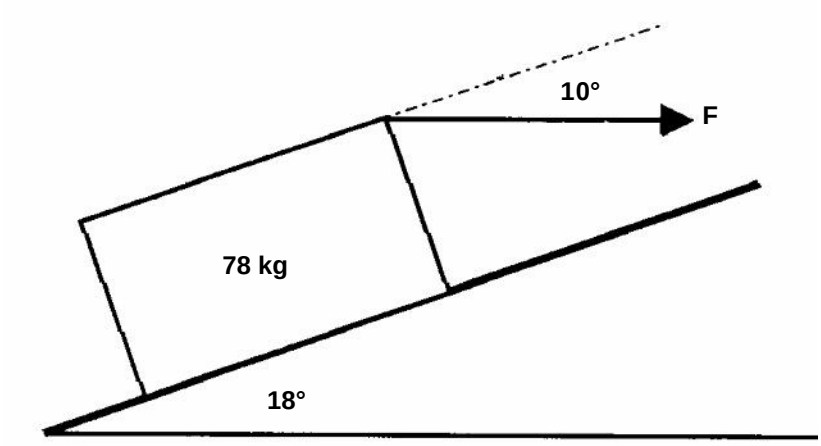
6.2 Define **Newton's law of inertia**. (3)

6.3 Define the following concepts:

6.3.1 The mean effective pressure on the piston of an internal-combustion engine (4)

6.3.2 Indicate power (4)

6.4 A body with a mass of 78 kg is placed on an inclined plane making an angle of 18° with the horizontal. The coefficient of friction is 0,38. Calculate the magnitude of the smallest force **F** required to pull the body **up** the incline.



(10)

6.5 State the carbon content percentage, properties and temperatures at which the grain structures of the following are formed:

6.5.1 Pearlite (3)

6.5.2 Ferrite (3)

6.5.3 Austenite (3)

6.6 Give the correct name for the $C_7 H_{16}$ hydrocarbon compound in the alkane series. (2)

[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 / Differensiaal-indeksering = $\frac{Dr}{Gdr} = \frac{(A - N)}{A} \times \frac{40}{1}$

   5.2 Two-wire method of screw-thread measurement / Tweedraad-metode van skroefdraad-meting:

   Calculation of included angle / Berekening van ingeslote hoek:

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

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

   5.4 Stress / Spanning = $\frac{f}{A}$

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

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

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

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

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

5.10 Angular acceleration / Hoekversnelling = $\frac{?_2 - ?_1}{t}$

5.11 Torque T / Draaimoment $T = mk^2?^2$

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

5.13 Angular velocity / Hoeksnelheid $? = \frac{2\pi n}{60}$

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

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 = $\frac{BP}{IP} \times \frac{100}{1}$ / **Meganiese rendement** $\frac{RD}{AD} \times \frac{100}{1}$

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 (gatbasis-stelsel)*

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 (gatbasis-stelsel)

END / *EINDE*