

**GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION**

TECHNIKA (MECHANICAL) SG

**OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005**

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Pocket calculator
- Drawing instruments
- Information sheet (pages 9 to 12).

INSTRUCTIONS:

- ALL questions are COMPULSORY.
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**QUESTION 1A
MULTIPLE-CHOICE QUESTIONS**

Each of the following questions is supplied with various possible answers. Choose the correct answer or answers. Write down the question numbers below one another and **ONLY** the letter(s) of your choice next to them. The mark allocation at the right serves as an indication of the number of correct questions.

- 1.1 According to the law concerning factories, the worker's responsibility towards workshop safety is to _____ .
- A. perform all duties with the necessary precision
 - B. learn and apply safe working methods
 - C. obey all rules and regulations
 - D. do exactly what he/she is told to do (2)
- 1.2 Screw-threads are used to _____ .
- A. exert pressure
 - B. permanently fasten plates
 - C. make very minute adjustments
 - D. None of the above (2)

- 1.3 The purpose of intermediate gears is to _____ .
- A. increase the speed
 - B. decrease the speed
 - C. change direction of rotation
 - D. make up space between fixed gears
- (2)
- 1.4 Friction can be both advantageous or disadvantageous. Which of the following are examples of the advantageous use of friction in a workshop?
- A. Cutting tools
 - B. Belt drives
 - C. Gear drives
 - D. Brakes on machines
 - E. Clutches on machines
- (3)
- 1.5 The extension spindle is an important component of a dividing head. It is used for _____ .
- A. the set-up to cut hexagons
 - B. the mounting of change gears for helical milling
 - C. the extension of the spindle to accommodate more than one gear
 - D. angular indexing
- (1)
- 1.6 Single helical gear drives have advantages and disadvantages. Which of the following are advantages?
- A. Power transmission is distributed over at least two teeth.
 - B. It can cause end thrust.
 - C. The drive is fairly quiet.
 - D. It is frictionless.
- (2)
- 1.7 Which of the following should be taken into account when determining the speed of the table feed of a milling machine?
- A. Diameter of cutter
 - B. Dimensions of the work
 - C. Condition of the machine
 - D. The power of the machine
- (2)
- 1.8 Accidents in a workshop are caused by either personal or work-related factors. Which of the following are personal factors?
- A. No knowledge/skills
 - B. Broken-down machines
 - C. Wrong attitudes
 - D. Faulty electrical wiring
- (2)

- 1.9 The factors that influence the magnitude of the helix angle of a screw-thread are _____ .
- A. the lead of the thread
 - B. the primary clearance angle of the cutting tool
 - C. the root diameter of the screw-thread
 - D. the outside diameter of the workpiece
- (2)
- 1.10 The function of a milling machine tailstock is that _____ .
- A. it supports the workpiece whilst cutting gears
 - B. it clamps the workpiece whilst cutting gears
 - C. it supports the workpiece whilst cutting small tapers
 - D. None of the above
- (1)
- 1.11 Which of the following methods are used to test tapers on shafts?
- A. Between lathe centres
 - B. V-blocks and clamps
 - C. Squares and rulers
 - D. Height gauges and surface plates
- (2)
- 1.12 The aim of maintenance in a workshop is to _____ .
- A. cut the cost of replacement
 - B. prevent workers from working overtime
 - C. improve the quality/design of equipment
 - D. keep workers on their toes
- (2)
- 1.13 Unbalanced workpieces are detrimental to lathes. Which of the following are the effects of unbalanced workpieces?
- A. Damaged workpieces
 - B. Damaged lathe beds
 - C. Damaged spindle bearings
 - D. Distorted face plates
- (2)
- 1.14 The advantages of multi-start threads over single-start threads are that _____ .
- A. smaller pitches can be cut
 - B. movements are quicker
 - C. shallower threads and thus stronger thread spindles are acquired
 - D. larger diameter workpieces can be used
- (2)

- 1.15 Helical gears can transmit more power than spur gears. The reason for this is that _____ .
- A. the helix angle on helical gears is larger
 - B. helical gears can be cut on much larger diameter shafts
 - C. power transfer is distributed over two teeth
 - D. the drive is silent
- (1)
- 1.16 Compressive stress is applicable when _____ .
- A. two objects are pressed together
 - B. an object is being stretched
 - C. an object is held in a bench vice
 - D. two surfaces slide over each other
- (2)
- 1.17 Choose the disadvantageous uses of friction from the list below.
- A. Belt drives
 - B. Chain drives
 - C. Brakes on machines
 - D. Drill bits
- (2)
- 1.18 The advantages of climb milling are that _____.
- A. the work is forced against the vice or table
 - B. less energy is used
 - C. cutters stay sharp for a longer period
 - D. it helps to eliminate backlash
- (2)
- 1.19 The backlash on gears is the _____ .
- A. difference between the modules of the meshing gears
 - B. cause of chattering on gears
 - C. play between two meshing gears
 - D. cause of gears not meshing properly
- (1)
- 1.20 The frictional resistance between two sliding surfaces depends on three factors. Identify these factors.
- A. The types of materials of the two sliding surfaces
 - B. The magnitude of the frictional force between the surfaces
 - C. The degree of coarseness of the two surfaces
 - D. The magnitude of the contact surfaces
- (3)

- 1.21 Which one of the following metals is NOT part of the cubic space-lattice arrangement?
- A. Aluminium
 - B. Copper
 - C. Lead
 - D. Magnesium
 - E. Platinum
- (1)

- 1.22 What is the correct name of the hydrocarbon compound in the alkane series with the formula C_8H_{18} ?
- A. Heptane
 - B. Heksane
 - C. Octane
 - D. Propane
 - E. Butane
- (1)
[40]

QUESTION 2

- 2.1 Explain how AIDS can be spread from one person to another. (4)
- 2.2 Name TWO ways in which you can make your employees aware of the growing Aids crisis in our country. (2)
- 2.3 A load of 1,7 kN is lifted by the drum of a lifting device. The diameter of the drum is 0,2 m. Calculate the power if the drum rotates at 16 r/min. (4)
- 2.4 A mild steel tie-bar is 4,5 m long and is subjected to a tensile load of 600 kN. The stress in the bar is 570 MPa. Determine the diameter of the bar in mm. (10)
- 2.5 Define the following concepts:
- 2.5.1 Mass (2)
 - 2.5.2 Weight (2)
 - 2.5.3 Gravitational force (3)
 - 2.5.4 Hooke's Law (4)
 - 2.5.5 Young's Elasticity Modulus (4)
 - 2.5.6 Boyle's Law (3)
 - 2.5.7 Thermodynamics (2)
- [40]**

QUESTION 3

- 3.1 The fluid pressure in a cylinder is 6 MPa and the diameter of the cylinder is 0,54 m. Calculate the power exerted when the piston moves outwards. (7)
- 3.2 Define the following concepts:
- 3.2.1 Pressure (3)
- 3.2.2 Pascal's Law (4)
- 3.2.3 Hydraulics (4)
- 3.2.4 Viscosity of fluids (2)
- 3.3 Name FIVE properties of fluids. (5)
- 3.4 Why must a dam-wall be thicker at the bottom than at the top? (1)
- 3.5 Name SIX occupational diseases and name the cause of each. (12)
- 3.6 What is the main aim of the Factory Act? (2)
- [40]**

QUESTION 4

- 4.1 Why is differential indexing necessary? (2)
- 4.2 Calculate the indexing for each of the following cases:
- 4.2.1 A gear with 132 teeth (3)
- 4.2.2 Differential indexing for 51 divisions
- a) Calculate the indexing required. (Choose 50 divisions) (3)
- b) Calculate the change wheels required. (5)
- c) Determine the direction of rotation of the index plate. (1)
- d) Draw a simple sketch to clearly show the position and arrangement of the change gears. (3)
- 4.3 Give the name of the milling cutter suitable for milling a wide flat surface. (1)
- 4.4 Define the concept **ergonomics**. (4)
- 4.5 Name THREE basic crystal structures of steel. (3)
- 4.6 Name FIVE types of keys in common use. (5)
- 4.7 Calculate the width, length and thickness of an ordinary parallel key that is used to secure a component to a 30 mm diameter shaft. (6)
- 4.8 List FOUR characteristics of a good business leader. (4)
- [40]**

QUESTION 5

- 5.1 What is the difference between **velocity** and **speed**? (4)
- 5.2 Define **brake power**. (3)
- 5.3 An engine develops a torque of 200 Nm at 3 000 revolutions per minute. Calculate the brake power in kW. (5)
- 5.4 The following information concerns a four-stroke engine:
- Mean effective pressure – 850 KPa
 - Stroke 70 mm
 - Cylinder bore 80 mm
 - Crankshaft revolutions 3 600 per minute
 - Number of cylinders 4
- Calculate the indicated power of the engine in kW. (7)
- 5.5 Define **power**. (2)
- 5.6 Draw a simple sketch of a Prony brake. (8)
- 5.7 Draw a simple schematic diagram of a single epicyclic gear train. (8)
- 5.8 Describe how a direct-drive gear ratio can be obtained by means of a single epicyclic gear train. (3)

[40]

TOTAL: 200

END

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 p = 3,14 / Neem p = 3,14**
4. **Take g = 10 m.s² / Neem g = 10 m.s²**
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:

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

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

$$\text{silinder} = \frac{\rho D^2}{4} \text{ or/of } \pi r^2$$

5.6 Cross-sectional area of hollow cylinder / Dwarsdeursnee-area van hol

$$\text{silinder} = \frac{\rho(D^2 - d^2)}{4}$$

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

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

5.12 $\text{Moment of inertia} / \text{Traagheidsmoment } I = mk^2$

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

5.14 $\text{Kinetic energy of a flywheel} / \text{Kinetiese energie van ? vliegwiel}$

$$E_k = \frac{1}{2} mk^2 \omega^2$$

5.15 $\text{Belt drives} / \text{Bandaandrywings}$

5.15.1 $\text{Power } P / \text{Drywing } P = (T_1 - T_2) \pi Dn$

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 $\text{Gear drives} / \text{Rataandrywings}$

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

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

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

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

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

5.17 Power / Drywing

$$5.17.1 \text{ Indicated power } IP = PLANn \text{ (N = Number of power strokes per second)}$$

$$\text{Aangeduide drywing } AD = PLANn \text{ (N = Getal kragslae per sekonde)}$$

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

$$5.17.3 \text{ Torque } T / \text{Draaimoment } T = Fr$$

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

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 (gatbasisstelsel)*

Nominal sizes <i>Nominale groottes</i>		CLEARANCE FITS <i>VRY PASSINGS</i>												TRANSITION FITS <i>OORGANGPASSINGS</i>				INTERFERENCE FITS <i>SLUITPASSINGS</i>			
		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>		Tolerance <i>Toleransie</i>			
Over <i>Oor</i> mm	To <i>Tot</i> mm	H11	c11	H9	d10	H9	e9	H8	F7	H7	g6	H7	h6	H7	k6	H7	n6	H7	p6	H7	s6
UNIT / <i>EENHEID</i> 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