



# education

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Department:  
Education  
**REPUBLIC OF SOUTH AFRICA**

## **MECHANICAL TECHNOLOGY**

### **EXAMINATION GUIDELINES**

## **GRADE 12**

## **2009**

**This guideline consists of 10 pages.**

**Introduction:**

The purpose of these guidelines is to assist teachers and learners in their preparation for the National Senior Certificate (NSC) examination for Mechanical Technology.

These guidelines should be used in conjunction with the following documents

1. The National Curriculum Statement (NCS)
2. The content framework in the Learning Program Guidelines (LPG) dated January 2008
3. The Subject Assessment Guidelines (SAG) dated January 2008

**Content to be covered:**

The following table provides an elaboration of the content to be covered.

ASSESSMENT STANDARD	CONTENT	ELABORATION
ONE	Safety	Occupational Health and Safety Act and Regulations; Machine specific safety measures; Advanced tools and equipment specific safety measures.
TWO	Tools and equipment	Identify tools and equipment from drawings; Describe purpose, functions and principles of specialized tools and equipment; Label tools and equipment from given drawings.
THREE	Engineering Materials	Draw a table to classify materials according to their properties and uses; Reasons why certain products are made from enhanced materials taking into cognizance the environmental aspects.
FOUR	Terminology	Cutting methods on a milling machine i.e. up-cut, down-cut and gang milling; Identification of milling cutters for a milling machine; Three methods of indexing i.e. plain,

		<p>direct/rapid and differential indexing with calculations;</p> <p>Calculations on spindle speeds.</p>
<b>ASSESSMENT STANDARD</b>	<b>CONTENT</b>	<b>ELLABORATION</b>
<b>FIVE</b>	<b>Joining Methods</b>	<p>Identification of welding defects from drawings; causes, correction methods;</p> <p>Labeling of drawings on destructive and non-destructive weld tests;</p> <p>Description, analysis and application of weld tests;</p> <p>Labeling of diagrams/sketches and description of Metal Arc Gas Shielded (MAGS) or Metal Inert Gas Shielded (MIGS) welding.</p>
<b>SIX</b>	<b>Forces</b>	<p>Young's Modulus of Elasticity – Stress and Strain. Calculations and theory.</p>
<b>SEVEN</b>	<b>Maintenance</b>	<p>Properties of lubricating oil and cutting fluid;</p> <p>Reasons and procedure for replacing engine oil, transmission oil, differential oil;</p> <p>Replacement of bearings, belt and chain drives and clutches</p>
<b>EIGHT</b>	<b>Systems and Control</b>	<p>Calculations on speed ratios (gears, pulleys);</p> <p>Belt speed and lengths for open and crossed belt drives;</p> <p>Torque and power for friction clutches;</p> <p>Input and output movement, work done on levers;</p> <p>Velocity ratio; mechanical advantage;</p> <p>Pressure, volume and piston diameters for hydraulic and pneumatic systems</p> <p>Velocity ratio and mechanical advantage on wheels and axles.</p>

ASSESSMENT STANDARD	CONTENT	ELLABORATION
NINE	Turbines and pumps	Blowers: <ul style="list-style-type: none"> <li>• Super chargers</li> <li>• Turbo chargers</li> <li>• Roots blowers</li> <li>• Vane pumps</li> <li>• Centrifugal pumps</li> </ul>

**WEIGHTING OF THE ASSESSMENT STANDARDS (According to the SAG document):**

Question	Assessment Standards	Content covered	Marks	Time
1	1 – 9	Multiple-choice questions	20	15 minutes
2	6 and 8	Forces and Systems and Control	50	55 minutes
3	2	Tools and Equipment	20	15 minutes
4	3	Materials	20	15 minutes
5	1, 4 and 5	Safety, Terminology (Manufacturing Process) and Joining Methods	50	45 minutes
6	7 and 9	Maintenance and Turbines	40	35 minutes
<b>TOTAL</b>			<b>200</b>	<b>180 minutes</b>

**COGNITIVE LEVELS (According to Bloom's Taxonomy):**

COGNITIVE LEVEL	PERCENTAGE
Lower order questions	± 30%
Middle order questions	± 40%
Higher order questions	± 30%

## FORMULA SHEET FOR MECHANICAL TECHNOLOGY – GRADE 12

### 1. BELT DRIVES

$$1.1 \quad \text{Belt speed} = \frac{\pi D N}{60}$$

$$1.2 \quad \text{Belt speed} = \frac{\pi (D + t) \times N}{60} \quad (t = \text{belt thickness})$$

$$1.3 \quad \text{Belt mass} = \text{Area} \times \text{length} \times \text{density} \quad (A = \text{thickness} \times \text{width})$$

$$1.4 \quad \text{Speed ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$1.5 \quad N_1 D_1 = N_2 D_2$$

$$1.6 \quad \text{Open-belt length} = \frac{\pi (D + d)}{2} + \frac{(D - d)^2}{4c} + 2c$$

$$1.7 \quad \text{Crossed-belt length} = \frac{\pi (D + d)}{2} + \frac{(D + d)^2}{4c} + 2c$$

$$1.8 \quad \text{Power (P)} = \frac{2\pi N T}{60}$$

$$1.9 \quad \text{Ratio of tight side to slack side} = \frac{T_1}{T_2}$$

$$1.10 \quad \text{Power} = \frac{(T_1 - T_2) \pi D N}{60} \quad \text{where } T_1 = \text{force in the tight side}$$

$$1.11 \quad \text{Width} = \frac{T_1}{\text{permissible tensile force}}$$

**2. FRICTION CLUTCHES**

2.1  $Torque ( T ) = \mu W n R$   
 $\mu = \text{coefficient of friction}$   
 $W = \text{total force}$   
 $n = \text{number of friction surfaces}$   
 $R = \text{effective radius}$

2.2  $Power ( P ) = \frac{2\pi NT}{60}$

**3. STRESS AND STRAIN**

3.1  $Stress = \frac{Force}{Area} \quad \text{or} \quad ( \sigma = \frac{F}{A} )$

3.2  $Strain ( \epsilon ) = \frac{\text{change in length ( } \Delta L \text{ )}}{\text{original length ( } L \text{ )}}$

3.3  $Young's \text{ modulus ( } E \text{ )} = \frac{\text{stress}}{\text{strain}} \quad \text{or} \quad ( \frac{\sigma}{\epsilon} )$

3.4  $A_{shaft} = \frac{\pi d^2}{4}$

3.5  $A_{pipe} = \frac{\pi(D^2 - d^2)}{4}$

**4. HYDRAULICS**

4.1  $Pressure ( P ) = \frac{Force ( F )}{Area ( A )}$

4.2  $Volume = Cross\text{-sectional area} \times \text{stroke length ( } l \text{ or } s \text{ )}$

4.3  $Work \text{ done} = \text{force} \times \text{distance}$

**5. WHEEL AND AXLE**

$$5.1 \quad \text{Velocity ratio ( VR )} = \frac{\text{effort distance}}{\text{load distance}} = \frac{2D}{d_2 - d_1}$$

$$5.2 \quad \text{Mechanical advantage ( MA )} = \frac{\text{Load ( W )}}{\text{Effort ( F )}}$$

$$5.3 \quad \text{Mechanical efficiency ( } \eta_{\text{mech}} \text{ )} = \frac{\text{MA}}{\text{VR}} \times 100\%$$

**6. LEVERS**

$$6.1 \quad \text{Mechanical advantage ( MA )} = \frac{\text{Load ( W )}}{\text{Effort ( F )}}$$

$$6.2 \quad \text{Input movement ( IM )} = \text{Effort} \times \text{distance moved by effort}$$

$$6.3 \quad \text{Output movement ( OM )} = \text{Load} \times \text{distance moved by load}$$

$$6.4 \quad \text{Velocity ratio ( VR )} = \frac{\text{Input movement}}{\text{Output movement}}$$

**7. GEAR DRIVES**

$$7.1 \quad \text{Power ( } P \text{ )} = \frac{2\pi NT}{60}$$

$$7.2 \quad \text{Gear ratio} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$7.3 \quad \frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$7.4 \quad \text{Torque} = \text{force} \times \text{radius}$$

$$7.5 \quad \text{Torque transmitted} = \text{gear ratio} \times \text{input torque}$$

$$7.6 \quad \text{Module ( } m \text{ )} = \frac{\text{Pitch-circle diameter ( } PCD \text{ )}}{\text{Number of teeth ( } T \text{ )}}$$

$$7.7 \quad N_1 T_1 = N_2 T_2$$

$$7.8 \quad \text{Pitch-circle diameter ( } PCD \text{ )} = \frac{\text{circular pitch ( } CP \text{ )} \times \text{number of teeth ( } T \text{ )}}{\pi}$$

$$7.9 \quad \text{Outside diameter ( } OD \text{ )} = PCD + 2 \text{ module}$$

$$7.10 \quad \text{Addendum ( } a \text{ )} = \text{module ( } m \text{ )}$$

$$7.11 \quad \text{Dedendum ( } b \text{ )} = 1,157 m \quad \text{or} \quad \text{Dedendum ( } b \text{ )} = 1,25 m$$

$$7.12 \quad \text{Cutting depth ( } h \text{ )} = 2,157 m \quad \text{or} \quad \text{Cutting depth ( } h \text{ )} = 2,25 m$$

$$7.13 \quad \text{Clearance ( } c \text{ )} = 0,157 m \quad \text{or} \quad \text{Clearance ( } c \text{ )} = 0,25 m$$

$$7.14 \quad \text{Circular pitch ( } CP \text{ )} = m \times \pi$$



**8. SCREW THREADS**

$$8.1 \quad \text{Pitch diameter} = \text{Outside diameter} - \frac{1}{2}\text{pitch}$$

$$8.2 \quad \text{Pitch circumference} = \pi \times \text{pitch diameter}$$

$$8.3 \quad \text{Lead} = \text{pitch} \times \text{number of starts}$$

$$8.4 \quad \text{Helix angle: } \tan \phi = \frac{\text{Lead}}{\text{Pitch circumference}}$$

$$8.5 \quad \text{Leading tool angle} = 90^\circ - (\text{helix angle} + \text{clearance angle})$$

$$8.6 \quad \text{Following/Trailing angle} = 90^\circ + (\text{helix angle} - \text{clearance angle})$$

$$8.7 \quad \text{Number of turns} = \frac{\text{height}}{\text{lead}}$$

**9. CINCINNATI DIVIDING HEAD TABLE FOR THE MILLING MACHINE**

<b>Hole circles</b>											
Side 1	24	25	28	30	34	37	38	39	41	42	43
Side 2	46	47	49	51	53	54	57	58	59	62	66

<b>Standard change gears</b>										
24 x 2	28	32	40	44	48	56	64	72	86	100

$$9.1 \quad \text{Simple indexing} = \frac{40}{n} \quad (\text{where } n = \text{number of divisions})$$

$$9.2 \quad \text{Change gears: } \frac{Dr}{Dv} = (A - n) \times \frac{40}{A} \quad \text{or} \quad \frac{Dr}{Dv} = \frac{(A - n)}{A} \times \frac{40}{1}$$

or

$$\frac{Dr}{Dv} = (N - n) \times \frac{40}{N}$$

**10. CALCULATIONS OF FEED**

10.1  $Feed (f) = f_1 \times T \times N$

Where:  $f$  = feed in millimeters per minute

$f_1$  = feed per tooth in millimeters

$T$  = number of teeth on cutter

$N$  = number of revolutions of cutter per minute

10.2  $Cutting\ speed (V) = \pi \times D \times N$

Where:  $D$  = diameter of the cutter in meters

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