education

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 (LPGs) dated January 2008
3. The Subject Assessment Guidelines (SAGs) 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,

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

ASSESSMENT STANDARD	CONTENT	ELLABORATION
NINE	**Turbines and pumps**	Blowers: • Super chargers • Turbo chargers • Roots blowers • Vane pumps • Centrifugal pumps

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
		TOTAL	**200**	**180 minutes**

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 $$Belt\ speed = \frac{\pi DN}{60}$$

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

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

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

1.5 $$N_1 D_1 = N_2 D_2$$

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

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

1.8 $$Power\ (\ P\ ) = \frac{2\pi NT}{60}$$

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

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

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

2. FRICTION CLUTCHES

2.1 $Torque\ (T) = \mu WnR$

$\mu = coefficient\ of\ friction$

$W = total\ force$

$n = number\ of\ friction\ surfaces$

$R = effective\ radius$

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

3. STRESS AND STRAIN

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

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

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

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

4.3 $Work\ done = force \times distance$

5. WHEEL AND AXLE

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

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

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

6. LEVERS

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

6.2 $$Input\ movement\ (\ IM\ ) = Effort \times distance\ moved\ by\ effort$$

6.3 $$Output\ movement\ (\ OM\ ) = Load \times distance\ moved\ by\ load$$

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

7. GEAR DRIVES

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

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

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

7.4 $$Torque = force \times radius$$

7.5 $$Torque\ transmitted = gear\ ratio \times input\ torque$$

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

7.7 $$N_1T_1 = N_2T_2$$

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

7.9 $$Outside\ diameter\ (OD) = PCD + 2\ module$$

7.10 $$Addendum\ (a) = module\ (m)$$

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

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

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

7.14 $$Circular\ pitch\ (CP) = m \times \pi$$

8. SCREW THREADS

8.1 $Pitch\ diameter = Outside\ diamter - ½pitch$

8.2 $Pitch\ circumference = \pi \times pitch\ diameter$

8.3 $Lead = pitch \times number\ of\ starts$

8.4 $Helix\ angle:\ \tan Ø = \dfrac{Lead}{Pitch\ circumference}$

8.5 $Leading\ tool\ angle = 90° - (helix\ angle + clearance\ angle)$

8.6 $Following/Trailing\ angle = 90° + (helix\ angle - clearance\ angle)$

8.7 $Number\ of\ turns = \dfrac{height}{lead}$

9. CINCINNATI DIVIDING HEAD TABLE FOR THE MILLING MACHINE

Hole circles											
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

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

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

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

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*

****