GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION

FITTING AND TURNING SG

OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Pocket calculator and drawing instruments

INSTRUCTIONS:

- Answer ALL the questions.
- Unless otherwise indicated, all dimensions are in millimetres.
- For ALL applicable questions, the dividing head ratio is 40:1 and the milling machine lead screw pitch is 6 mm.
- An information sheet appears on pages 8 to 10 of this question paper.
- Use ONLY the formulae indicated on the information sheet. Derivatives of these formulae may however also be used.

QUESTION 1

Answer Question 1.1 to 1.8 on the **answer sheet** on the **inside cover** of the **answer book**. For each question, indicate the correct answer(s) by making a cross (**X**) over the appropriate letter(s) on the answer sheet. The mark allocation on the right-hand side is an indication of the number of correct answers for each question. There may be more than one correct answer.

1.1 The working depth of a gear refers to _____.

A. the depth at which the gears mesh properly
B. the addendum
C. the dedendum
D. two times the addendum (2)

1.2 The involute shape of gear teeth is the most commonly used shape of gear teeth. This shape is preferred for the following reasons:

A. It is cheaper than other shapes.
B. They are stronger at the root.
C. It does not easily wear off.
D. They are easy to machine. (2)

1.3 The function of a milling machine tailstock is to support the workpiece _____.

A. and clamp it during machining
B. while tapers are being machined
C. when cutting splines
D. when cutting helical gears (2)

1.4 The arbor on a milling machine is employed when _____.

A. large flat surfaces must be machined
B. we use side and face cutters
C. the machine cross travel is too small
D. the machine has limited power (2)

1.5 Absolute programming is when _____.

A. all dimensions are the same
B. we take all dimensions from one point
C. we refer to a common reference point
D. all dimensions are different (2)

1.6 A dividing head on a milling machine is used _____.

A. to determine the angle between two plates on a workpiece
B. when gear racks are machined
C. to set up toolmakers' buttons
D. to divide the circumference of a workpiece into a number of equal divisions (2)

1.7 Accidents in a workshop occur as a result of personal or work-related factors. Which of the following are personal factors?

A. Very little or no knowledge/skills
B. Bad electrical connections
C. Bad attitudes
D. Holes in workshop floors (2)

1.8 One button in a set of toolmakers' buttons is always longer than the others. The reason is that _____.

A. the shorter buttons are sometimes too short for accurate spacing
B. it is always machined more accurately than shorter ones
C. it helps when the holes are closely spaced
D. None of the above. (1)

Answer Questions 1.9 to 1.13 in your **answer book**. Write only TRUE or FALSE next to the appropriate question number.

1.9 The sector arms on a dividing head are used only for rapid indexing.

1.10 Single helical gears cause end thrust on machine bearings.

1.11 Friction is a definite disadvantage when we consider machine bearings.

1.12 When a fluid in a container is placed under pressure, its volume will decrease.

1.13 Undercutting at the start of a screw thread is done to increase the strength of the screw thread. 5x2=(10)

[25]

QUESTION 2

2.1 Briefly discuss the aspects **accessibility** and **visibility** with regard to measures for a good workshop layout. (8)

2.2 Mention FIVE **aims** of preventative maintenance. (5)

2.3 Draw the dividing head and lead screw gear arrangement when a gear rack must be machined on a milling machine. (6)

2.4 A helical gear with a real module of 5,32 mm and a helix angle of 20° must be cut on a milling machine. The pitch circle diameter of the gear is 212,8 mm. Calculate the following, indicating all calculations:

2.4.1 Normal module of the gear

2.4.2 Number of teeth of the gear

2.4.3 Number of teeth marked on the cutter

2.4.4 Cutting depth of the gear

2.4.5 Outside diameter of the gear (14)

2.5 Calculate the chordal width of a spur gear with 60 teeth and a module of 5 mm. (2)

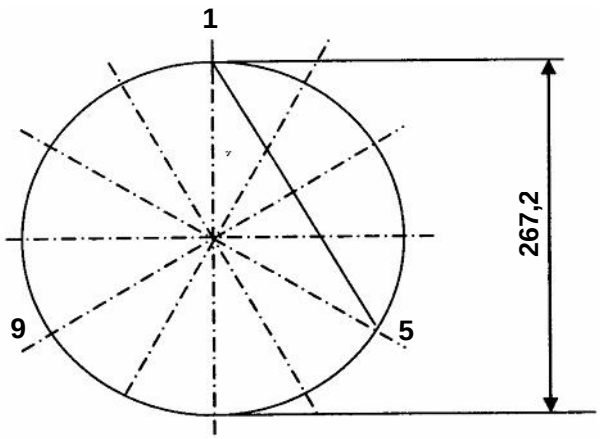
[35]

QUESTION 3

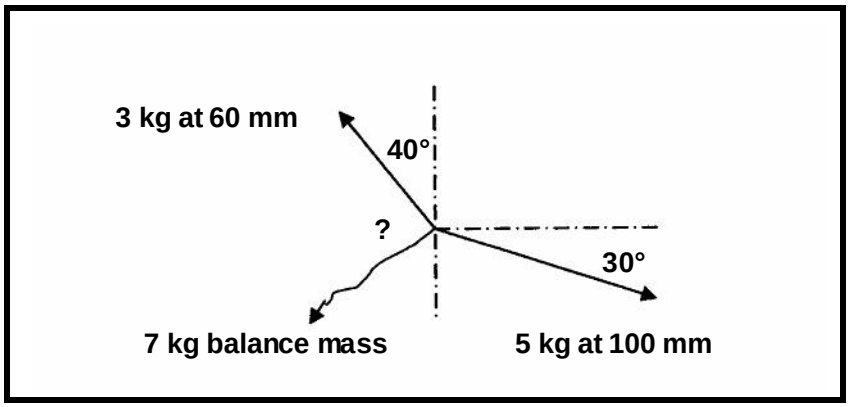
3.1 Twelve holes must be drilled on a PCD of 267,2 mm on a centre lathe. Toolmakers' buttons with a diameter of 15 mm are used for the set up. Calculate the following:

3.1.1 Centre distance between holes **1** and **5**.

3.1.2 Distance between buttons **1** and **9**. (10)



3.2 The simple line diagram below shows two arms of a cranked lever, completely out of balance. Draw up a mass/distance table and determine graphically the distance from the hub at which a 7 kg mass must be fitted in order to balance the lever. Determine the angle between the balance mass and the 3 kg arm. Use a scale of 1 cm = 40 kg.mm. (11)



3.3 Draw neat sketches to illustrate each of the following:

3.3.1 Static balancing using two unequal mass pieces (4)

3.3.2 Incremental programming with reference to numerically controlled lathes (5)

3.4 State FIVE methods that may be used to test the accuracy of external tapers. (5)
[35]

QUESTION 4

4.1 A two-start external square thread must be cut on a centre lathe. The lead of the thread is 30 mm and the outside diameter is 75 mm. The clearance angle is 4°. Calculate the following details of the screw thread and show all your calculations:

4.1.1 Helix angle
4.1.2 Leading angle
4.1.3 Following angle (11)

4.2 Explain in detail how the screw thread described in Question 4.1 should be cut using the "change gear" method. (10)

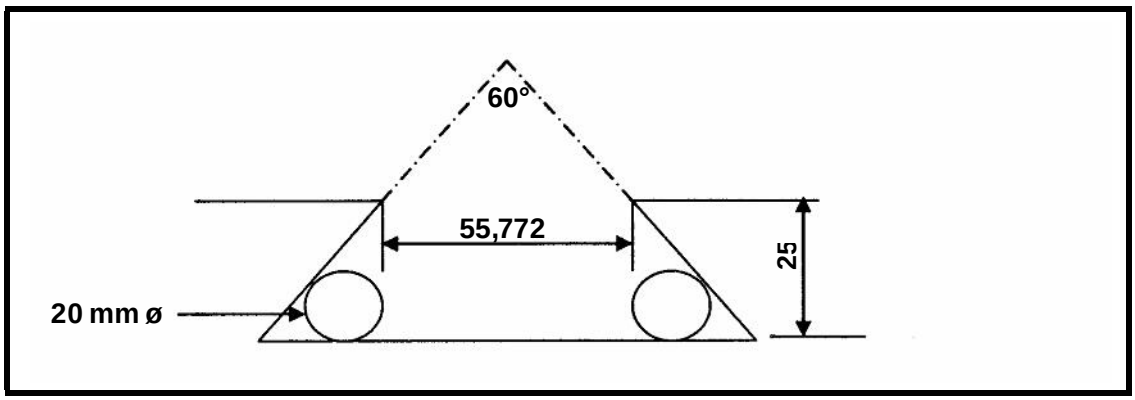
4.3 Give a brief description of "up-cut" milling under the following headings:

4.3.1 A sketch to show what up-cut milling is
4.3.2 THREE advantages of up-cut milling
4.3.3 TWO disadvantages of up-cut milling (8)

4.4 Mention SIX reasons why milling cutters fail. (6)
[35]

QUESTION 5

5.1 The dovetail in the sketch below is being tested for accuracy using two precision rollers. The dimension in the neck of the dovetail is 55,772 mm and the rollers have a diameter of 20 mm. The included angle of the dovetail is 60°, as indicated. Calculate the distance between the two rollers and show all calculations. (16)



5.2 The liquid pressure in a 360 mm diameter cylinder is 4 MPa. Calculate the force exerted when the piston moves outward and show your calculations. (7)

5.3 Calculate the diameter of a strut used to support a load of 25 000 kg. The stress in the strut is 200 MPa. Show all calculations. (8)

5.4 Name the FOUR laws of **sliding friction**. (4)
[35]

QUESTION 6

6.1 When a force of 100 N is exerted on the plunger of a hydraulic press, the plunger will move 90 mm downward. Calculate the following and show your calculations:

6.1.1 Distance the ram will move upward if the area of the plunger is 0,2 m^2 and the area of the ram is 1,8 m^2

6.1.2 Force that will be exerted by the ram (8)

6.2 You are required to sharpen the teeth of a 180 mm diameter side and face milling cutter on a tool and cutter grinder. The teeth have a primary clearance angle of 7° and a 200 mm diameter cup grinding wheel is used for the job.

6.2.1 Draw a sketch of the set-up to illustrate the position of the tooth rest of the tool and cutter grinder. (6)

6.2.2 Calculate the off-set of the tooth rest and show your calculations. (3)

6.3 A gear blank must be divided into 103 divisions using a milling machine dividing head with a ratio of 40:1. Choose 100 divisions (for the differential indexing) and calculate the following:

6.3.1 Required indexing
6.3.2 Change gears needed
6.3.3 Direction of rotation of the index crank (10)

6.4 State FIVE examples in practice when friction is applied as an advantage. (5)

6.5 Draw a neat, cross-sectional sketch of a toolmaker's button in position on a plate. (3)
[35]

TOTAL: 200

INFORMATION SHEET

1. Gears for milling machine

Standard and special gear wheels.

24 (two of); 28; 32; 40; 44; 46; 47; 48; 52; 56; 58; 64; 68; 70; 72; 76; 84; 86 and 100 teeth.

2. Index plate for milling machine

24; 25; 28; 30; 34; 37; 38; 39; 41; 42; 43; 46; 47; 49; 51; 53; 54; 57; 58; 59; 62 and 66 holes.

3. Formulae

3.1 Stress = $\frac{F}{A}$

3.2 Cross-sectional area of solid cylinder = $\frac{\pi}{4} D^2$

3.3 Cross-sectional area of hollow cylinder = $\frac{\pi(D^2 - d^2)}{4}$

3.4 Fluid pressure in a hydraulic press: $\frac{F1}{A1} = \frac{F2}{A2}$

Volume of fluid displaced by plunger = volume displaced by piston
volume = area x L

3.5 Spur gears:

3.5.1 PCD	=	Tm
3.5.2 add	=	m
3.5.3 ded	=	$1{,}157_m$
3.5.4 Clearance	=	$0{,}157_m$
3.5.5 OD	=	PCD + 2 add
3.5.6 T	=	$\frac{PCD}{m}$

3.5.7 Chordal addendum = $m + \left[\frac{mT}{2}(1 - \cos\frac{90^0}{T})\right]$

3.5.8 Chordal width = $mT \sin\frac{90^0}{T}$

3.5.9 Circular pitch = πm

3.6 Helical gears

3.6.1 PCD = TMw

3.6.2 add = m_n

3.6.3 ded = 1,157 m_n

3.6.4 clearance = 0,157 m_n

3.6.5 OD = PCD + 2 add

3.6.6 T = $\frac{PCD}{m_c}$

3.6.7 m_n = $m_c \cos\theta$

3.6.8 Number of teeth marked on the milling cutter;

Number = $\frac{T}{(\cos\theta)^3}$

3.6.9 Chordal addendum = $m_n + \left[\frac{m_n T}{2}(1-\cos\frac{90^0}{T})\right]$

3.6.10 Chordal thickness = $m_n T \sin\frac{90^0}{T}$

3.6.11 Lead of helix : $l = \pi \times PCD \times \cot\theta$

or

$l = \frac{\pi x PCD}{\tan\theta}$

3.6.12 Helix angle : $\tan\theta = \frac{\pi x PCD}{l}$

3.6.13 Circular pitch = πm_n

3.6.14 Lead of milling machine = Dividing head ratio x pitch of leadscrew

3.6.15 Change gears required $\frac{Dr}{G} = \frac{L}{l}$

3.7 Indexing:

3.7.1 Simple indexing = $\frac{40}{N}$

3.7.2 Angular indexing = $\frac{\theta}{9^0}$

3.7.3 Differental indexing = $\frac{Dr}{G} = \frac{(A-N)}{A} \times \frac{40}{1}$

3.7.4 Rack:

$$\text{Indexing} = \frac{\textit{Dividing head ratio}}{\textit{Pitch of lead screw}} \times \frac{\textit{Pitch of rack}}{\textit{Gear ratio}}$$

3.8 Grinding of milling cutter teeth:

3.8.1 Regular disc grinding wheel: Offset = R sin θ.
3.8.2 Cup grinding wheel: Offset = r sin θ.

3.9 Graphical solution of static balancing:

Out-of-balance effect = Mass x distance of mass from centre of face plate.

3.10 Tool angles for cutting square threads:

3.10.1 Helix angle: $\tan \eta = \frac{Lead}{\pi D_m}$

3.10.2 Leading tool angle = 90^0 – (Helix angle + Clearance angle)

3.10.3 Following tool angle = 90^0 + (Helix angle – Clearance angle)

END